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ABSTRACT

This eight-volume student text is designed for use by Air Force personnel enrolled in a self-study extension course for pest management specialists. Covered in the individual volumes are civil engineering; pest management (entomology, pest management planning and coordination, and safety and protective equipment); pest management chemicals and equipment (pesticides in the environment, pesticide characteristics and classification, and pesticide dispersal equipment); disease vectors (mosquitoes, flies, fleas, lice, ticks, and mites); vertebrate pests (rodents, birds, and others); economic pests (pests of stored products, structural pests, and ornamental and turf pests); household, venomous, and vegetative pests; and general contingency responsibilities (first aid techniques, field hygiene and sanitation, work party security, convoy techniques, expedient field water treatment, and vehicle operation). Each volume in the set contains a series of lessons, exercises at the end of each lesson, a bibliography, and answers to the exercises. Volume review exercises and a change supplement for the package are also included. (MN)

ED272712

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

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Extension Course Institute
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CE 044211

ECI COURSE MATERIALS SHIPPING LIST

COURSE NUMBER	COURSE TITLE	EFFECTIVE DATE
56650	PEST MANAGEMENT SPECIALIST (AFSC 56650)	19 May 86

INSTRUCTIONS The following materials are needed to complete this course. Check this list immediately upon receiving your course package, and if any materials are missing or incorrect (numbers don't match), notify ECI immediately. Use the ECI Form 17 for this purpose, and be sure to include your identification number, address, course and volume number, and VRE form designation (if a VRE is involved). Send all correspondence separately from your answer sheet.[1]

ITEM	TYPE	DESIGNATION OR TITLE	INVENTORY CONTROL NUMBER	VRE ANSWER SHEET IDENTIFICATION
3	VOL	VOL 1, Introduction to Civil Engineering	56650 01 8404	
4	VRE	VOLUME REVIEW EXERCISE (VOL 1)	56650 01 27	56650 01 27
5	VOL	VOL 2, Introduction to Pest Management	56650 02 8408	
6	VRE	VOLUME REVIEW EXERCISE (VOL 2)	56650 02 22	56650 02 22
7	VOL	VOL 3, Pest Management Chemicals and Equipment	56650 03 8409	
8	VRE	VOLUME REVIEW EXERCISE (VOL 3)	56650 03 22	56650 03 22
9	VOL	VOL 4, Disease Vectors	56650 04 8408	
10	VRE	VOLUME REVIEW EXERCISE (VOL 4)	56650 04 22	56650 04 22
11	VOL	VOL 5, Economic Pests	56650 05 8410	
12	VRE	VOLUME REVIEW EXERCISE (VOL 5)	56650 05 22	56650 05 22
13	VOL	VOL 6, Vertebrate Pests	56650 06 8[illegible]	
14	VRE	VOLUME REVIEW EXERCISE (VOL 6)	56650 06 22	56650 06 22
15	VOL	VOL 7, Household, Venomous, and Vegatative Pests	56650 07 8411	
16	VRE	VOLUME REVIEW EXERCISE (VOL 7)	56650 07 23	56650 07 23
17	VOL	VOL 8, General Contingency Responsibilities	56650 08 8105	
18	VRE	VOLUME REVIEW EXERCISE (VOL 8)	56650 08 21	56650 08 21
19	SUPP	CHANGE SUPPLEMENT (VOLs 1 through 7)	56650 00 S01 8510	
		NOTES: DIRECT ANY QUESTIONS OR COMMENTS RELATING TO ACCURACY OR CURRENCY OF TEXTUAL MATERIALS TO AUTOVON 736-2072.		

[1] SEE REVERSE SIDE FOR ADDITIONAL INSTRUCTIONS.

ECI FORM 25 JUN 84 PREVIOUS EDITION WILL BE USED.

LIST OF CHANGES

COURSE NUMBER	
56650	CAREER FIELDS, POLICIES, PROCEDURES AND EQUIPMENT CHANGE. ALSO, ERRORS OCCASIONALLY GET INTO PRINT. THE FOLLOWING ITEMS UPDATE AND CORRECT YOUR COURSE MATERIALS. PLEASE MAKE THE INDICATED CHANGES.
EFFECTIVE DATE OF SHIPPING LIST	
19 May 86	

NOTE: PLEASE MAKE THE CORRECTIONS INDICATED BELOW. THESE CORRECTIONS MAY OMIT SOME ERRORS, SUCH AS TYPOS, THAT DO NOT AFFECT THE MEANING OF THE MATERIAL.

1. CHANGE FOR THE TEXT: VOLUME 1

Page 42, Exercises (028)-2: Change "figure 3-4" to "figures 3-3 and 3-4."

2. CHANGE FOR THE TEXT: VOLUME 2

Page 119, [illegible] 207-1: Change "Mallophaga; chewing lice" to "siphonaptera."

3. CHANGES FOR THE TEXT: VOLUME 3

a. Page 33, Exercises 429-1.d: Change "75" to "175."

b. Page 42, col 1, line 22: Change "wihin" to "within."

c. Page 55, Exercises (440)-4: Change "an aerosol bomb" to "a pressurized cylinder."

d. Page 69, answer 435-1.(5): Change "f, j." to "j, g."

4. CHANGE FOR THE TEXT: VOLUME 6

Page 21, Exercises (A09)-2: Change "traps for . . . mice?" to "snap traps for controlling white-footed mice near buildings?"

5. CHANGES FOR THE TEXT: VOLUME 8

a. Page 11, Exercises (E07)-1.d: Delete.

b. Page 104, answer E07-1.(5)e: Delete.

6. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 1

The following questions are no longer scored and need not be answered 1, 16 and 27.

7. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 2

Question 100 is no longer scored and need not be answered.

8. CHANGES FOR THE VOLUME REVIEW EXERCISE: VOLUME 3

a. Page 5, question 35: In the stem of the question, change "dinitto" to "dinitro."

b. Question 64 is no longer scored and need not be answered.

9. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 4

Question 79 is no longer scored and need not be answered.

LIST OF CHANGES

COURSE NUMBER	
56650	CAREER FIELDS, POLICIES, PROCEDURES AND EQUIPMENT CHANGE. ALSO, ERRORS OCCASIONALLY GET INTO PRINT. THE FOLLOWING ITEMS UPDATE AND CORRECT YOUR COURSE MATERIALS. PLEASE MAKE THE INDICATED CHANGES.
EFFECTIVE DATE OF SHIPPING LIST: 19 May 86	

10. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 5

Question 29 is no longer scored and need not be answered.

11. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 6

The following questions are no longer scored and need not be answered: 3 and 24.

56650 00 S01 8510

CHANGE SUPPLEMENT

CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volumes 1, 2, 3, 4, 5, 6, and 7

IMPORTANT: Make the corrections indicated in this supplement before beginning study of Volumes 1, 2, 3, 4, 5, 6, and 7. This supplement contains both "pen-and-ink" changes and replacement pages. Tear out the replacement pages and insert them in your volumes. In order to reduce your posting time, we have omitted from the pen-and-ink section some errors that do not affect the meaning of the material.

Extension Course Institute
Air University

CHANGES FOR THE TEXT: VOLUME 1

Pen-and-Ink Changes:

Page/Col	*Subject*	*Line(s)*	*Correction*
15L		23	Change "or" to "of."
30L		6	Change "epoxy" to "herbicide."
42L		1 fr bot	Change "2" to "3."
46L	001 - 1		Change answer to read "you should have placed CE beside items 2, 3, 5, 6, 7, 8, and 9."

Page Changes:

Remove Pages	*Insert Pages*
1–2	1–2
17–18	17–18
21–22	21–22
43–44	43–44
47–48	47–48

Specialty Requirements and Organizational Assignments

MAINTAINING Air Force property is a very important job. Just as your home will deteriorate if you don't keep it properly maintained and repaired, so will Air Force buildings and structures.

The Air Force owns a vast amount of real estate. Consider the size of your base in comparison to several of the largest industries in your area; then think of how many bases the Air Force operates. It's hard to comprehend, isn't it? But you can see that Air Force holdings, in keeping with its mission, are tremendous.

Equally tremendous is the cost of operating, maintaining, and replacing Air Force property. Yet, Government funds, like your personal funds, are limited; and the costs of materials and equipment go up every year. As a result, it's vital that you use Air Force resources wisely and carefully. Don't waste time or materials, learn your job well so you can operate more efficiently, and cooperate with other workers where you're assigned. When we all work together towards common goals, we make Air Force money work harder for America's defense and its taxpayers.

In this chapter, we'll discuss the base civil engineering organizational structure, its mission, and your duties and responsibilities as a pest manager.

1-1. Base Civil Engineering Organizational Structure

The base civil engineering organization is commanded by the base civil engineer (BCE). This person is responsible for all the work performed by civil engineering (CE). The job includes getting maximum efficiency for each dollar spent while attaining planned objectives. This means that human resources, material resources, and financial resources must be used as effectively as possible to meet the organization's goals.

Civil engineering is a large, complex organization with many jobs going on at the same time. The BCE uses many managers to h[illegible] do th[illegible]. One of these m[illegible]age[illegible] the sanitati[illegible]intendent. This person is in charge of the 56 car[illegible]ield of which you are a part. Your job as a pest manag[illegible] specialist is extremely important as the health of base personnel depends to a large extent on how well you do your job. Buildings can be eaten, infested, and become unusable if you aren't there to control pests such as termites, rats, fleas, roaches, and stored-products pests.

Before getting an indepth look at your job tasks, let's look at the mission of a civil engineering organization.

001. Identify activities relative to the mission of a civil engineering organization.

Base Civil Engineering Mission. The mission of Civil Engineering is to provide the necessary assets and skilled personnel to prepare and sustain global installations as stationary platforms for projecting aerospace power in peace and war.

The dual mission of war readiness and asset sustenance is accomplished with an integrated military and civilian work force capable of rapid transition between missions.

Civil Engineering supports the mission and each installation by working to accomplish the following vital tasks:

(1) Insure readiness.
(2) Provide real property.
(3) Sustain real property.
(4) Provide utility services.
(5) Establish the physical environment.
(6) Provide fire protection.
(7) Provide nonreal property.
(8) Provide technical and management services.

There are many duties involved in accomplishing the CE mission. Just a few of them are to:

a. Manage Air Force real property.
b. Provide utilities.
c. Maintain and repair structures and equipment.
d. Provide custodial, sanitation, and pest management services.
e. Provide fire protection and rescue services.
f. Recover from damage to facilities from any cause including decontamination due to chemical, biological, or radiological incidents or attacks.
g. Manage the Prime Base Engineer Emergency Forces (Prime BEEF) Program as required.
h. Accomplish disaster preparedness actions and provide assistance in disasters according to the AF 355 series of directives.
i. Report through the Air Force Operational Reporting Sys[illegible]m (AF[illegible]-1[illegible]) [illegible]stallation [illegible]amage, assistance, and [illegible] re[illegible] to recover air bases.
[illegible]ovide environmental protection.
[illegible]onserve natural resources.
l. Construct and alter structures.

Even though CE must provide utilities to all base facilities and then keep these utilities in good repair, CE doesn't operate everything on the base. For example, CE doesn't operate clubs, dining halls, aircraft, missiles, etc.

Exercises (001):

Look at the following activities and place CE to the left of each item that directly applies to the CE mission.

____ 1. Fueling aircraft.

____ 2. Managing Air Force real property.
____ 3. Managing the Prime BEEF Program.
____ 4. Operating the NCO Club.
____ 5. Accomplishing disaster preparedness actions.
____ 6. Building structures.
____ 7. Repairing roofs on aircraft hangars.
____ 8. Providing custodial services.
____ 9. Providing environmental protection.
____ 10. Operating dining halls

002. Indicate to what command block various CE units belong.

Civil Engineering Organizational Chart. Figure 1-1 shows the structure of CE. Study the chart in order to learn the levels of command throughout the organization. At the very top of the chain of command is the base civil engineer. He or she is ultimately responsible for anything that goes wrong in CE.

As President Truman said, "The buck stops here." Passing the buck in CE will eventually stop at the BCE. You well know that an Air Force person should go through the chain of command. If you skip a link in the chain, things start to go wrong. As another saying goes, a chain is no stronger than its weakest link. The lines on the chart in figure 1-1 represent the chain in the CE structure. The blocks represent an office, shop, or unit in which a manager or supervisor is in control. Spot the pest management block on the chart. Notice that it is the same level as pavements, protective coating, and heat systems blocks. The chain of command line for pest management and environmental support goes through the sanitation block. As you will see later in the career field chart, the sanitation superintendent is in control of all the units below him. The protective coating and plumbing blocks are under the command of structures as is masonry and metalworking.

As you follow the command line upwards, you see that the next command in the chain is Operations. The chief of operations is the boss [illegible] sanitation superintendent. From Operations the command line goes up the chain to the civil engineer. [illegible] can see from figure 1-1, the BCE holds the chief of operations responsible for all the CE shops. Work control is not in a direct command line to the shops. It works in a staff function to help the operations chief. From this example, you should be able to trace the command line through the various units. See if you can.

Exercises (002):

1. Refer to figure 1-1 and answer the following questions for each of the CE units listed. What is the command block immediately above the listed unit?

CE Units	*Command Block Above Unit*
(1) Heat systems.	____________
(2) Custodial services.	____________
(3) Planning.	____________
(4) Mechanical	____________
(5) Equipment operations.	____________
(6) Fire protection.	____________
(7) Real estate cost accounting.	____________
(8) Squadron section (Sq Sec).	____________
(9) Masonry.	____________
(10) Structural	____________

003. Identify functions and responsibilities of CE units.

The base civil engineer needs a number of CE units to help perform his or her mission and responsibilities. The job entails even more than that of a mayor or city manager in a large city. Although the mayor is responsible for providing the city with fire prevention equipment, police protection, garbage and refuse collection and disposal, and furnishing utility services, the BCE must do all these things plus:

a. Maintain real property facilities in a condition for normal use.

b. Conserve natural resources and control environmental pollution.

c. Furnish insect and rodent control services.

d. Construct and alter facilities to support mission changes.

e. Provide management and professional engineering services to insure effective and economical operation of all activities.

These activities are broad in scope. Let's look at the CE units which help the BCE perform this mission and also break down these broad areas into narrower areas of activities.

Functions and Responsibilities of CE Units. As we look into these individual sections, refer to figure 1-1 to help you understand their mutual relationship.

Squadron and administration. This unit handles the administrative and personnel work of CE. The administrative section receives, distributes, and dispatches all communications for CE; prepares reports and correspondence; maintains correspondence files; maintains the CE library; conducts special programs, such as fund drives and awards, and maintains the records.

The squadron section takes personnel actions delegated by the squadron commander. Some of these duties include counseling, maintaining duty rosters, conducting general military training and commander's call, and enforcing discipline.

Industrial engineering (IE). This unit provides consulting services aimed at increasing productivity and improving use of Ce resources. It does this not only for the BCE but for all levels of management and labor as well, acting as a problem solver. Subject areas for IE studies include bench stock, the BCE taxi system, inservice work plans (IWP), supply expenditures and discipline, service calls, and vehicles.

There are other areas of IE responsibility that apply more directly to your job as a pest manager. If your organization has an automated management system, IE implements it;

BCE REAL PROPERTY MAINTENANCE REQUEST (This form is subject to the Privacy Act of 1974—see reverse)	Use to identify routine maintenance or repair requirements that are not an emergency or urgent in nature. Prepare and forward original and one copy to BCE for each facility on which work is requested. Keep the last copy for your file.		
TO: Base Civil Engineering	FROM: (Name, Grade, and Organization) TSGT ADAMS 761 CES	RETURN TO: (Office Symbol) DEHD	ORGANIZATION CODE
1. FACILITY NO. OR MFH STREET ADDRESS 2483		2. PHONE NUMBER(S) 6234 / 6235	

3. DESCRIPTION OF WORK REQUIREMENTS (A thorough description of maintenance requirement(s) will minimize the need for CE personnel to visit the job site to determine what work is requested and what tools, equipment, and materials are needed, thereby completing the work on the first attempt. Answer these questions: What? Where? How many? Type/size? Color? Rate? Urgency? Time restrictions?)

1. Replace panic hardware on exterior door on northeast side of building.

2. Replace door knob on interior door of room 4.

FOR CE USE ONLY

9. DATE RECEIVED

10. ACTION

4. DATE OF REQUEST	SIGNATURE OF REQUESTOR	
18 April 85	Jack Adams	
5. REVIEW/ACTION BY CUSTOMER SERVICE	DATE	SIGNATURE
6. REVIEW/ACTION BY CHIEF PRODUCTION CONTROL	DATE	SIGNATURE
7. ASSIGNED FOR ACTION	A. FUNCTION/INDIVIDUAL	B. ACTION REQUIRED
8. CUSTOMER NOTIFIED	DATE	SIGNATURE

AF FORM APR 83 1135 PREVIOUS EDITION WILL BE USED. FILE COPY

Figure 2–2. Sample of AF Form 1135.

this type of work are repairing a screen door on MFH, replacing cracked floor tiles in a building, and repairing a leaky cold water faucet in a latrine.

Service calls. The service call method of requesting work is used for emergency and urgent job orders. Examples of emergencies are:

a. Loss of steam in a steam-heated building.
b. Water flooding the floor in a kitchen.
c. Water pressure failure in military family housing.
d. Electrical power failure in a facility.
e. Clogged plumbing in a latrine.
f. Leak in a natural gas line.
g. A window knocked out in subzero weather.

When situations similar to the above occur, the service call is used to correct them. Under the service call concept, BCE uses two ways to meet emergency needs: the do-it-now (DIN) service call and the shop referred service call.

Do-it-now (DIN) service calls. If you must call the service call specialist (SCS) in CE regarding an emergency situation, such as a stuck latrine valve, the service call specialist will notify a DIN plumber by two-way radio and dispatch him or her to your location. The DIN plumber, like other shop workers, has a DIN vehicle stocked with parts, tools, and equipment needed to perform service call work.

The goal of service call management is to get the job done right the first time and every time. You should expect the DIN plumber to unstick the latrine valve and perform maintenance on it so that it will not stick again. CE expects DIN workers to complete the job on the first trip to the job site. To do this, the SCS must get all the information necessary to clearly describe the job to the worker. The SCS must be courteous but must find out if a danger exists; what the problem consists of; when, where, and how it happened; make, type, size, or color; urgency of need; and any time restrictions. Although there is not a time established for DIN calls, it is essential that the DIN capability be kept as mobile as possible.

Shop referred service calls. A service call can be referred to a shop only with coordination through the PCC. A service call would be referred to a shop for completion if it meets at least one of the following conditions:

a. If the work appears to be beyond the DIN capability.
b. If the DIN craftsman is unable to complete the work.
c. If the work would require more than a reasonable time to be completed by the DIN craftsman. (Not limited to one hour but should not be tied up for several hours.)

For any service call referred to the shop, the service call specialist prepares an AF Form 1879, BCE Job Order Record (fig. 2-3).

Exercises (010):

For each of the following written requests for work, indicate whether it should be submitted on AF Form 332 or AF Form 1135. Write the correct form number in the appropriate blank.

_____ 1. Request BCE to repair floor tile in MFH quarters.

FACILITY NO.	ACTIVITY OR STREET ADDRESS				DATE		TIME	JOB ORDER NO.
NAME AND GRADE OF REQUESTOR					PHONE NO./ALTERNATE		COLLECTION WORK ORDER NO.	
SERVICE REQUIRED					ZONE NO.	TYPE OF SERVICE: EMERGENCY / URGENT / ROUTINE	SMART / MFH / MC	
					WORK ID CODE		ESTIMATED TOTAL TIME	
REQUIRED COMPLETION DATE			ESTIMATED COMPLETION DATE		CREW SIZE		ACTUAL TOTAL TIME	
AREA/FACILITY WHERE JOB IS LOCATED					REMARKS *(Tools, equip, materials, special craftsman multi-shop notes, etc.)*			
DANGEROUS CONDITIONS EXISTING *(if any)*								
RESTRICTIONS *(time, entry, security)*								
MAKE OF EQUIPMENT		TYPE/SIZE OF ITEM		COLOR OF ITEM				
ASSIGNED TO	DATE	TIME	COMPLETED BY	DATE	TIME	INITIALS	LUC 12	LUC
REFERRED TO	DATE	TIME	COMPLETED BY	DATE	TIME	INITIALS	LUC 12	LUC
DEFERRED TO	DATE	TIME	DISPOSITION		AUTHORIZED			

AF FORM 1879 PREVIOUS EDITION IS OBSOLETE. BCE JOB ORDER RECORD

Figure 2-3. AF Form 1879.

BCE MULTI-CRAFT JOB ORDER			JOB ORDER NO.
COST CENTER	COLLECTION WORK ORDER NO.	FACILITY NO.	DATE PREPARED
NAME OF INSPECTOR	USING AGENCY	INDIVIDUAL TO CONTACT *(Name and Phone No.)*	

WORK DESCRIPTION	LOCATION	MATERIALS		WORK ID CODE	M/HR EST.	CRAFT	INCOM-PLETE WORK
		ITEM	QNTY				

AF FORM FEB 84 1219 PREVIOUS EDITION OF MAY 78 WILL BE USED.

Figure 2–5. AF Form 1219.

QUALITY CONTROL EVALUATION		JOB ORDER/WORK ORDER NUMBER	
This questionnaire is designed to improve Civil Engineering service to you. Answer all questions and place in base distribution.			
TO: BASE COMMANDER / BASE CIVIL ENGINEER / In Turn	FROM *(Base Address, include Bldg/Qtrs. No.)*	DATE SERVICE COMPLETED	
SERVICE REQUESTED			
DUTY SECTION OF WORKER	WORKER'S SIGNATURE		
QUESTIONNAIRE *(Explain all no answers)*		YES	NO
1. BASE CIVIL ENGINEER PERSONNEL WERE COURTEOUS.			
2. BASE CIVIL ENGINEER RESPONSE WAS TIMELY.			
3. RECEIVED ADEQUATE NOTIFICATION AS TO WHEN THE WORKER WOULD ARRIVE. *(If applicable)*			
4. WORKER UTILIZED TIME EFFICIENTLY.			
5. JOB WAS COMPLETED.			
6. IF NOT, WERE YOU GIVEN AN ESTIMATED COMPLETION DATE FOR THE JOB?			
7. WORK WAS PERFORMED SATISFACTORILY.			
8. JOB SITE WAS CLEANED UP AFTER COMPLETION.			
REMARKS			
CUSTOMER'S SIGNATURE		DATE	

AF FORM NOV 78 1255 PREVIOUS EDITION WILL BE USED. ☆U.S. Government Printing Office: 1981—340-879/812

Figure 2-6. AF Form 1255.

012. Given necessary information, make appropriate entries on AF Form 1255, Quality Control Evaluation.

Monitoring Customer Satisfaction. What is the first thing you should do when you arrive at a new job site? Pump up your sprayer? Survey the area? Actually, you should give your customer an AF Form 1255, Quality Control Evaluation (fig. 2-6).

The purpose of this form is simple. It's to motivate you to give timely and quality service to BCE customers. It's also a management tool used to improve customer relations and your productivity. This form says to your customers that you care about your work and so does the BCE. By giving your customer this form at the beginning of the job, he or she knows on what to evaluate you as you do the work.

There are some entries you should make on this form before you hand it over, none of them having to do with the worker's good looks and charm. Specifically, you should include:

a. Job or work order number.
b. Description of the service requested.
c. Facility number.
d. Your name.
e. Your duty section.

After your customer completes the form send it to the base commander and then the BCE. Each month, IE gives the BCE statistics for all CE shops regarding notable evaluations (both good and bad). Operations superintendents and supervisors also get the results through the chief of operations.

Exercises (012):

1. Use figure 2-6 to complete this exercise. Use the following information to complete the parts of AF Form 1255 you are responsible for as a worker.
   Job order number: 5826.
   Customer name: SSgt Hipsley.
   Building number: 1927.
   Work requested: control rodents in basement.
   Action taken: placed glue traps in basement.

AIR FORCE (AF) FORMS

	Number	Date	Unit of Rqn	Title	Const Pkg	Func Code	Prescribing Directive
	606	Feb 74	LA	ADPE Tape Identification	SH/18	2310	AFR 300-6
	607	Jan 80	TG	Weapons Systems Pouch Tag	TG	4710	AFR 182-2
	608	Jun 71	ST	Nickname Assignment/Change/Cancellation Request	ST	5020	AFR 205-1
I	610	Nov 78	CD	Change of Address—Correspondents/Publishers	CD	4710	AFR 182-1
	611	Nov 77	CS	Average Training Cost Per Graduate	CS	2140	AFR 173-7
	612	Nov 77	CS	Variable Training Cost Per Graduate	CS	2140	AFR 173-7
	613	Nov 77	CS	SAP Training Cost Per Student	CS	2140	AFR 173-7
	614	Oct 71	CD	Charge Out Record	CD	4730	AFM 12-20
	614a	May 71	CD	Charge Out Record (8" x 5-1/4")	CD	4730	AFM 12-20
	615	Aug 80	CS	Unit Watercraft Operations and Cost Summary Report	CS	4300	AFR 75-58
	616	Aug 81	CS	Request and Authority to Cite Funds	CS	1800	AFR 177-101
	617	Aug 80	CS	Unit Watercraft Maintenance Summary Report	CS	4300	AFR 75-58
B	618	Mar 79	ST	Medical Board Report	ST	5480	AFR 168-4
I	620	• Jan 82	CS	Colonel Resume	CS	1110	AFR 36-23
	621	Dec 54	CS	Report of Annual Financial Plan (LRA)	CS	2110	AFM 172-1V2
I	623	May 76	FL	On-The-Job Training Record	FL	5610	AFM 50-23
	623a	Mar 79	CS	On-The-Job Training Record—Continuation Sheet	CS	5610	AFM 50-23
I	624	Dec 79	CD	Base/Unit Locator and PSC Directory	CD	4700	AFR 11-24
	625	Apr 77	CS	Analysis of Unobligated Balances (Used by AFLC and AFSC only) (LRA)	CS	2110	AFM 172-1
	626	Oct 80	CS	Hand Receipt for Lending Closet Items	CS	1200	AFR 211-24
	627	Jan 72	ST	Application for Registration or Certification of Official Mail	CF/650	4730	AFR 182-2
	628	Dec 81	ST	Diet Instruction Evaluation Checklist and Authorization	ST	5483	AFR 168-4
	629	• Nov 1	CD	Small Arms Hand Receipt	SH/5	5050	AFR 125-37
	630b	Dec 62	CS	Material Procurement Program Control Plan (LRA)	CS	4100	AFR 401-1
	631	Nov 68	ST	Report of Separation from United States Air Force Academy (S&I HQ USAF/MPPA, Wash DC 20330)	ST	5622	AFR 53-3
	633	Aug 80	CS	Managerial Potential Assessment (MPA)	CS	0960	AFR 40-110V1
•	634	Feb 82	CS	USAF Fraud, Waste, and Abuse Data Collection	CS	4900	AFR 123-2
•I	635	May 82	CS	USAF Fraud, Waste, and Abuse Disclosure	CS	4900	AFR 123-2
	636	Dec 71	CS	B3500 Systems Change Release (LRA)	CS	2360	AFM 171-110V7
	637	Jul 80	CS	BCE Job Order Log	CS	3900	AFR 85-1
	638	Mar 68	CS	Refrigeration Unit Standard Temperature Chart	CS	3600	AFR 145-1
	639	Nov 64	CS	Averate Unit Operating Cost Worksheet (For use only by Industrially Funded Laundry & Dry Cleaning Operations & MAJCOMs having jurisdiction.)	CS	1700 4000	AFR 170-16
	640	May 60	CS	Base Civil Engineer Schedule of Costs	CS	1700	AFM 170-27
	641-4	May 63	ST	Position Survey	ST	0940	AFR 40-511
	642	Sep 81	ST	Air Force Achievement Medal and Air Force Commendation Medal Justification	ST	0710	AFR 900-48
	643	• Nov 81	CD	• Audio Visual Equipment Control and Use Record	CD	2510	• AFR 95-2V3
B	644	Sep 80	CS	Record of Dental Attendance	CS	5450	AFR 162-1
	646	Jul 79	CS	• US Air Force Pest Management Program Review (LRA)	CS	3930	AFR 91-21
B	647	Dec 69	CD	Donation of Body Parts for Transplantation Purposes	CD	5400	AFR 160-12
	648	Aug 70	CS	Certificate of Cost Incurred (LRA)	CS	1700	AFM 170-27
	649	Jul 75	CS	Verification of Long Distance Telephone Calls	CS	4510	AFM 100-22
	650	Jan 75	CS	Health Benefits Control Register (By Enrollment Code)(LRA)	CS	1813	AFR 177-104
I	651	Aug 78	CS	Hazardous Air Traffic Report (HATR)	CS	4900	AFR 127-3
	652	Oct 80	ST	Request for Loan of Master Personnel Record (S&I. HQ AFMPC/MPCDOP, Randolph AFB TX 78150)	ST	1150	AFR 31-4
I	653	Jul 76	CD	Flight Currency Record (Aero Club)(PA)	CD	1240	AFR 215-12
I	654	Jun 76	CD	PIF/Safety/Annual Currency Record (Aero Club)(PA)	CD	1240	AFR 215-12
I	655	Oct 79	ST	Clothing Request and Receipt—Female	ST	4240	AFM 67-1V1
I	656	Oct 79	ST	Clothing Request and Receipt—Male	ST	4240	AFM 67-1V1
· I	656	Oct 79	CS	Clothing Request and Receipt—Male (S&U, AFROTC, Maxwell)	CF	4240	AFM 67-1
I	657	Mar 78	CS	Personal Clothing Record —Female Airmen (Air Force Reserve and Air National Guard)	CS	4230	AFM 67-1V1
I	658	Mar 78	CS	Personal Clothing Record—Male Airmen (Air Force Reserve and Air National Guard	CS	4230	AFM 67-1V1
S	659	Dec 70	CS	Personal Clothing Claim	CS	4230	AFM 67-1
	659PA	Sep 75	CS	Personal Clothing Claim (LRA)	CS	4230	AFM 67-1
	660	Jun 67	CD	Daily Labor Time Card	BX 2000	1700	AFM 170-27
	662	Jul 81	CS	Food Service Production Log	CS	3600	AFR 146-7
	663	Nov 76	CS	Record of Daily Sales	CS	4230	AFM 67-1V1
	666	Jan 74	CS	Certification of Charge Sales Accepted by the Finance Officer	CS	4230	AFM 67-1V1
	667	Dec 64	CS	Inventory Report	CS	4220	AFM 67-1

BEG-554

Figure 3-3. Sample page from AFR 0-9.

(PRESS HARD WHEN USING BALL POINT PEN)

SHORT TITLE AND DATE	UNIT OF RQN	CLASS	SYMBOL	REQUISITION	REQUIREMENT
AF Form 646	CS				

TO:	FROM:	FOR FORMS USE ONLY	
PDO 1234A Bldg 117	900 IV Bldg 1927, Stop 43	MONTHLY USAGE 25	ON HAND 5

REMARKS	
	EMERGENCY / ONE TIME
	PE RESPONSE
	FOLLOW UP/TRACER
	MISSED SHORT ID
	REQUIREMENT:
	OTHER *(Specify)*
	DATE PREPARED 17 Apr 85
	SIGNATURE AND TITLE

AF FORM DEC 83 764a PREVIOUS EDITION WILL BE USED. RQN AND RQMT REQUEST

Figure 3–4. Sample, AF Form 764a.

possible intelligence value to the enemies of our country; but many US citizens do just that, merely by talking too much. So, never discuss your duties, the place where you work, or the equipment you operate.

029. Specify basic facts about the operational security (OPSEC) program and its relationship to other security programs.

Definition and Purpose of OPSEC. OPSEC is a program that surveys and identifies items of information and physical security that are of intelligence value to an enemy. Items of information include unclassified small bits of information that lend themselves to revealing information concerning the what and how of actions to take place. Breaks in regular routines and new routines are examples. The types of information that should be protected are subjects such as:

- Objective of the mission.
- Location of operations.
- Date and time of the actions.
- Types and number of forces involved.
- Amounts and types of weapon systems and equipment used.
- Limitations of resources.
- Method of employment of troops and equipment.

The purpose of OPSEC is to prevent the disclosure of all information, including bits of information, that contain intelligence value, which can be used by the enemy to reduce the effectiveness of an operation. We must protect knowledge of our plans concerning a mission so that our side will have the advantage of surprise.

Relationship of OPSEC to Other Security Programs. Operations security, communication security, information security, and physical security are closely related to each other. Each of these four programs supports the others. However, OPSEC has broader applications in that it seeks to protect bits of unclassified information as well as that which is classified. It makes little sense to protect an operation by classifying some parts of it or to expand COMSEC resources protecting information about it when unclassified conversations, stereotyped procedures, and other readily available data could provide an enemy with the intelligence needed to predict an operation. An effective OPSEC program will eliminate or control many of the sources of intelligence.

Exercises (029):

1. What does OPSEC do?

2. List three types of information that should be protected under the OPSEC concept.

3. What is the main difference between OPSEC and other security programs?

QUALITY CONTROL EVALUATION

JOB ORDER/WORK ORDER NUMBER: 5826

This questionnaire is designed to improve Civil Engineering service to you. Answer all questions and place in base distribution

TO: BASE COMMANDER, BASE CIVIL ENGINEER, In Turn

FROM: *(Base Address, include Bldg/Qtrs No.)*

DATE SERVICE COMPLETED

SERVICE REQUESTED: Control rodents in basement, building 1927

DUTY SECTION OF WORKER: (Your duty section)

WORKER'S SIGNATURE: (Your name)

QUESTIONNAIRE *(Explain all no answers)*	YES	NO
1. BASE CIVIL ENGINEER PERSONNEL WERE COURTEOUS.		
2. BASE CIVIL ENGINEER RESPONSE WAS TIMELY.		
3. RECEIVED ADEQUATE NOTIFICATION AS TO WHEN THE WORKER WOULD ARRIVE. *(If applicable)*		
4. WORKER UTILIZED TIME EFFICIENTLY.		
5. JOB WAS COMPLETED		
6. IF NOT, WERE YOU GIVEN AN ESTIMATED COMPLETION DATE FOR THE JOB?		
7. WORK WAS PERFORMED SATISFACTORILY.		
8. JOB SITE WAS CLEANED UP AFTER COMPLETION.		

REMARKS

CUSTOMER'S SIGNATURE

DATE

AF FORM NOV 78 1255 PREVIOUS EDITION WILL BE USED. *U.S. Government Printing Office: 1981—340-070/812

Figure A-1. Objective 012. exercise 1.

013 - 1 (1) 4
(2) 1
(3) 5
(4) 2
(5) 3.

013 - 2 Your completed AF Form 561. Part 1 only. should look like this.

BASE CIVIL ENGINEER WEEKLY WORK SCHEDULE (PART I) | WEEK ENDING | COST CENTER | APPROVED

LINE NO.	DESCRIPTION A	LABOR UTIL. CODE (LUC) B	MAN/HRS. C	MON SCHED	MON ACT	TUES SCHED	TUES ACT	WED SCHED	WED ACT	THU SCHED	THU ACT	FRI SCHED	FRI ACT	SAT SCHED	SAT ACT	SUN SCHED	SUN ACT
1	ASSIGNED		280	56		56		56		56		56					
2	BORROWED		40	8		8		8		8		8					
3	OVERTIME	38															
4	TOTAL AVAILABLE (total of items 1,2, and 3)		320	64		64		64		64		64					
5	SUPERVISION	31	20	4		4		4		4		4					
6	TRAINING	32															
7	LEAVE	33	24	8		8		8									
8	ALL OTHER	34															
9	LOANED LABOR	39															
10	TOTAL INDIRECT (total of items 5 through 9)		344	12		12		12		4		4					
11	AVAILABLE FOR WORK (Item 4 minus item 10)		276	52		52		52		60		60					

Figure A-2. Objective 013. exercise 6.

014 – 1 To provide a uniform reporting system and to identify direct labor cost against work orders.
014 – 2 ATA and ETA.
014 – 3 AF Form 1734.
014 – 4. Handprinted on AF Form 1734 below the first group of names.

015 – 1 BCE.
015 – 2. The director of base medical services.
015 – 3 The major command.
015 – 4. They must be currently licensed and certified personnel.
015 – 5. Certified Air Force personnel.
015 – 6. Environment.

016 – 1. (1) f.
(2) e
(3) c.
(4) c.
(5) a.
(6) c.
(7) d.
(8) d.
(9) c.
(10) b.
(11) f.
(12) d.

017 – 1 For temporary custody of an item.
017 – 2 24 hours.

018 – 1 To make a visual check to see if property listed on paper is actually there.
018 – 2 Obeying a set of rules necessary to conserve and protect Air Force equipment and supplies.
018 – 3 (1) AF equipment must be operational.
(2) Adequate supplies in good condition must be on hand.
(3) Use equipment and supplies only for their intended purposes.
(4) Safeguard equipment and supplies.
(5) Keep accurate records.
018 – 4 a. 4.
b 3
c. 1
d 1 and 2

019 – 1 X
019 – 2 It's the table of allowances.
019 – 3 X
019 – 4 X
019 – 5 X
019 – 6 X
019 – 7 X.
019 – 8 TAs do this

020 – 1 The back of the form and AFR 67–23.
020 – 2. Any two of the following apply: to increase or decrease equipment authorization, to order new equipment items, or to turn in or replace old equipment.
020 – 3 Nomenclature, unit of issue, and the number ordered.
020 – 4 It's used by the planning section to order materials needed to complete work orders.

021 – 1. Materiel control.
021 – 2 The NSN.
021 – 3 The item was made in Turkey.
021 – 4 Tool kit, general mechanic's, 5180–00–177–7033.

022 – 1. AFR 19–1.
022 – 2. National Environmental Policy Act.
022 – 3. HQ USAF, each major command, and each base.
022 – 4. Air Force policy is to comply with the nature and spirit of national policy and support and assist Federal, State, and local agencies in preventive pollution control.

023 – 1. False. Buy returnable bottles.
023 – 2. False. Don't buy unnecessary electrical devices.
023 – 3. True.
023 – 4. True.
023 – 5. True.
023 – 6. True.
023 – 7. True.
023 – 8. False. Dark walls absorb light.
023 – 9. False. A small engine uses less fuel.
023 – 10. True.

CHAPTER 3

024 – 1. b.
024 – 2. d.
024 – 3. c.
024 – 4. a.
024 – 5. a.

025 – 1. It states policies, responsibilities, and procedures for pest management at AF installations.
025 – 2. A telephone maintenance truck.
025 – 3. All personnel engaged in mixing and applying pesticides.
025 – 4. When ground pest management measures fail, are not practical, or not possible.
025 – 5. AFR 91–22.

026 – 1. Mobile Airfield Marking Team.
026 – 2. Military Entomology Operational Handbook.
026 – 3. Maintenance and Repair of Roofs.
026 – 4. AFM 91–19.
026 – 5. AFR 91–30.
026 – 6. AFR 91–38.

027 – 1. a. Average Training Cost Per Graduate.
b. BCE Job Order Log.
c. Small Arms Hand Receipt.
d. AF Form 614.
e. AF Form 640.
f. AF Form 657.
027 – 2. May 1976.
027 – 3. AFR 123–2.

028 – 1. Short title and date of the form needed, unit of requisition, how many you normally use each month, how many are on hand, and how many you want to requisition.
028 – 2. a. July 79 is written in the same block as AF Form 646.
b. Place the number 4 under REQUISITION.

029 – 1. It is used to survey and identify items of information and physical security that are of intelligence value to the enemy.
029 – 2. Any three of the following apply: mission objectives, location of operations, date and time of the actions, and types and numbers of forces involved.
029 – 3. OPSEC has broader applications in that it seeks to protect bits of unclassified information as well as that which is classified.

030 – 1. All spaces should be marked with an X.

CHANGES FOR THE TEXT: VOLUME 2

Pen-and-Ink Changes:

Page-Col	*Subject*	*Line(s)*	*Correction*
3L		13 fr bot	Change "order" to "orders."
5R	Fig. 1-1		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
		2	Change "024" to "204."
7L		25	Change "distrubed" to "disturbed."
		7 fr bot	Change "many" to "Many."
7R	Fig. 1-3		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
8L		13	Change "Inset" to "Insect."
		16	Add "*" after "*Insect body*." At bottom of column add footnote "* Adapted from *Scientific Guide to Pest Control Operations*, 3rd ed., by Lee C. Truman, Ph.D. et al. 1976, c. Harvest Publishing Company, pp. 15–19. Reprinted by permission of the publisher."
9L		15 fr bot	Change "that" to "which."
10L	Fig. 1-6		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
12R		22 fr bot	Change "MALLOPHAGE" to "MALLOPHAGA."
13	Fig. 1-13		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
14	Fig. 1-14		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
14L		4	Change "flis" to "flies."
15	Fig. 1-15		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
16L		26	Change "*sheath, wing*" to "*sheath-wing*."
18L	206 - 1.b		Change "glattened" to "flattened."
22L		12	Change "The" to "According to the *Scientific Guide to Pest Control Operations*, the."
24L	209 - 1		Change *Column B* entries to read as follows: "a. Trachea. b. Ganglion. c. Spiracles. d. Proventriculus. e. Malpighian tubules. f. Ostia."
	209 - 1 (3)		Change "nerv" to "nerve."
27R		6 fr bot	Change "communicable disease center" to "Communicable Disease Center."
36R		12	After "are" change ", , , , and" to "1, 2, 3, 4 and 5."
39R		29	Change "card,board" to "cardboard."

Page-Col	Subject	Line(s)	Correction
44R		29	Before ''Pheromones'' add ''*.'' At bottom of column add footnote ''* Passage on pheromones adapted from *Pest Control Magazine*, February 1982, ''Pheromones,'' by David K. Mueller. Reprinted by permission of the publisher.''
46R		11	Change ''*summary*'' to ''*management*.''
		16	Change ''1532(en1'' to ''1532-1.''
48R	221 - 1.c		Change ''Tpopography'' to ''Topography.''
51L		22 fr bot	Delete ''Bl.''
		27 fr bot	Change ''aerosols'' to ''they.''
		28 fr bot	After ''insects'' add a comma.
51R		20 fr bot	Change ''has'' to ''have.''
52L		6	Delete ''susceptible.''
53R		20	Change ''systematic'' to ''systemic.''
64L		16	After ''$30.'' add sentence ''Labor costs were $227.00.''
64R		22–23	Delete ''in conducting surveys.''
71	Fig. 2-29	Col 39	Change ''N'' to ''S.''
73L		5	Change ''w'' to ''2.''
80R		2 fr bot	Delete ''(see fig. 3-1).''
86L		22	Change ''Matach'' to ''Match.''
87R		23	Change ''a'' to ''if.''
		7 fr bot	Change ''fo'' to ''of.''
88R		26	Change ''of'' to ''or.''
94R		13	Before ''Surplus'' add ''*.'' At bottom of column add footnote ''* Adapted from *Scientific Guide to Pest Control Operations*, 3rd ed., by Lee C. Truman, Ph.D., et al. 1976, c. Harvest Publishing Company, p. 72. Reprinted by permission of the publisher.''
98L		15 fr bot	Change ''provides'' to ''provided.''
102R	251 - 1 (3)		Change ''unevaported'' to ''unevaporated.''
106L		19	Change ''herbicide'' to ''herbicides.''
121L	228 - 5	3	After ''Installation'' change ''Bryan'' to ''Bayou.''
	229 - 5	1	Change ''AVDJO'' to ''AVDJ0.''
		11	Change ''SNOP20'' to ''SNOP20.''
		13	Delete ''on.''
		26	Change ''1'' to ''0'' and ''0'' to ''4.''

Page Changes:

Remove Pages	*Insert Pages*
57–60	57–60

When requesting initial certification for an individual, the body of the letter should contain the following information:

a. Category of certification requested.

b. Name of an individual, rank/grade, and social security number.

c. Training accomplishments and length of time performed in the career field.

This letter should be signed by the base civil engineer, and copies of recent training certificates related to pest management received by the individual should be forwarded as attachments with the letter.

Recertification of individuals who presently hold a certificate of competency is required every 3 years if performing in either of the capacities outlined.

Requests for recertification are prepared and processed in the same manners as for certification, with only the contents of the letter body changed to provide the following information:

(1) Category of certification requested.

(2) Name of individual (last—first name—middle initial).

(3) Rank.

(4) Social security number.

(5) Present certification number and expiration date.

(6) Recent career field training accomplishments.

Upon receipt of certification or recertification request, the major command pest management professional will approve or disapprove the request. If the request is approved on its own merits, a certificate of competency will be forwarded to the individual; however, if the certifying official needs further justification, instructions identifying additional actions to be taken will be forwarded.

When certification is approved, the person being certified will receive DD Form 1826 and DD Form 1826–1, a "pocket copy" of the diploma. The individual must keep this small card with him or her at all times when pest management operations are being conducted.

A roster listing each certified individual, certification number, and expiration date must be maintained within civil engineering to act as a reminder and to identify certified individuals to other concerned individuals.

Exercises (226):

1. What individuals must possess DD Form 1826, Certificate of Competency?

2. How often must individuals who disperse pesticides be recertified?

3. What is the purpose of DD Form 1826?

4. When an individual is thought to be properly prepared for certification, what is the first action to be taken?

5. List the information that must be provided to request initial certification.

227. Cite the purpose, use, and disposition of DD Form 1532–1, Pest Management Maintenance Record, and make necessary entries on the form based on a given situation.

DD Form 1532–1, Pest Management Maintenance Record. Air Force Regulation 91–21 requires you to maintain this form (fig. 2-25A and 2-25B) for each facility and area you treat to control pests. The main purpose of this card is to help you maintain a complete record of all pest problems and the procedures used to deal with those problems, whether you use chemical or other control techniques. In effect, it gives you a pest management history of the area or facility. This, in turn, helps you make adjustments to your control program as needed. Additionally, the form lets you identify people who previously worked at the location and saves you the trouble of producing local forms or logbooks, which serve the same purpose. Workers should take the cards with them and make necessary entries after control measures are conducted.

Filling out the card is very simple, but there is one "glitch." When you indicate the amount of pesticide, it must be recorded in *dry ounces* of active ingredient rounded off to the nearest whole number (for a large area, you can list it in dry pounds). Refer to table 2-1 to see how to convert pesticide amounts to dry ounces.

When you've completed both sides of this form, start a new one by transcribing the information from the top four blocks of the old form to the new one. You can plan on the old cards being around for a long time on most buildings since you must keep them until 2 years after the treated building is destroyed.

Exercises (227):

1. What is the main purpose of DD Form 1532–1?

2. When should entries be made on the form?

3. When can completed cards be destroyed?

BUILDING/AREA 1624					SIZE 1.4 MSF	TYPE OF CONSTRUCTION WO	USE DESIGNATION Admin. area and Dormitory				
Date	Units Serviced	Work Origin	Unit of Measure	Target Pest	Control Operation	If Pesticide Is Used				Labor Time	Applicator Initials
						Name	EPA Reg	% Conc	Amount		
19 Mar 84	All except Admin. area	SW	1.2 MSF	Cockroaches	Residual Spray	Diazinon EC	100-463	.5%	6 oz	3 hrs	7PC

DD FORM 1532-1
82 JAN

PEST MANAGEMENT MAINTENANCE RECORD

MEASUREMENT UNITS

MSF = 1,000 square feet
MCF = 1,000 cubic feet
LFT = Linear feet
AC = Acres

ORIGIN OF WORK

SW = Scheduled work
WR = Work request
SC = Service or trouble call
R = Routine inspection

TYPE OF CONSTRUCTION

CO = Concrete
WO = Wood
BL = Block
OT = Other
BV = Brick veneer
ST = Steel, sheet metal

Figure 2–25A. DD Form 1532–1 (Front).

Date	Units Serviced	Work Origin	Unit of Measure	Target Pest	Control Operation	If Pesticide Is Used				Labor Time	Applicator Initials
						Name	EPA Reg	% Conc	Amount		

REMARKS	
19 Mar 84. Admin area not treated due to unreadiness and poor sanitation	JPC

(Attach additional card to continue record)

Figure 2-25B. DD Form 1532-1 (Back).

TABLE 2-1
CONVERTING LIQUID PESTICIDE AMOUNTS TO DRY OUNCES

Situation:	You're working with a pesticidal concentrate containing 4 pounds active ingredient (AI) per gallon. You dilute it to field strength by adding 2.5 ounces of concentrate to one gallon of water.
Other Necessary Facts:	There are 128 fluid ounces in a gallon of water. There are 16 dry ounces in a pound.
Working the Problem:	Since the concentrate has 4 pounds AI per gallon:
Step 1	16 dry ounces x 4 lbs 1 gal = 64 dry ounces *per 128 fluid ounces. * "per" always means "divide", therefore:
Step 2	64 dry ounces divided by 128 fluid ounces= .5 dry ounces per fluid ounce. Since you added 2.5 fluid ounces of concentrate to the water:
Step 3	2.5 fluid ounces x .5 dry ounces per fluid ounce = 1.25 dry ounces.
Step 4	Round off to the nearest whole ounce 1.0 dry ounces entered on DD Form 1532-1.

CP.073

4. Refer to figure 2-25A and make further entries on the form using the following information:

   On 22 March 84, you receive a call from MSgt Michael M. Kelley in the administration section in Building 1624. Since you treated all the other rooms, his area was invaded with cockroaches and he wants them controlled. You returned to the building the next day and, as you surveyed the section, you noticed a coffee pot area that was poorly maintained and workers routinely kept candy and other foodstuffs in their desks. After you explained the need for higher sanitation standards, you used two gallons (3 dry ounces) of Diazinon EC. Your total labor time was 1 hour. (Check your entries with those in the answer section.)

228. State the purpose, use, and disposition of DD Form 1070 and determine necessary entries on the form based on a given situation.

DD Form 1070, Termite and Wood Decay Inspection. A DD Form 1070 must be maintained for each facility that is constructed completely or partially of wood on all Federal installations. This includes virtually all facilities, regardless of preventive measures used in the construction.

Purpose. Each facility that is constructed completely or partly of wood must be inspected for signs indicating the presence of structural pests and conditions within and around the facility that would be conducive to structural pests. These inspections must be accomplished no less often than annually for each facility and should be inspected at least semiannually. This form serves as a record of these inspections and provides information pertaining to building conditions and actions taken.

Completion procedures. The DD Form 1070 is shown in figure 2-26 with entries provided to illustrate its use. This form is not difficult to fill out, but you must insure that the entries made on the form indicate true conditions found during the inspection of the facility. You must also insure that recommendations are annotated correctly, and when recommendations or other actions have been accomplished, the form must be annotated to reflect these actions.

Looking at figure 2-26, you will notice that the top portion is used to identify the number, type, and location of the facility; the date of the inspection; and the inspector's name. If you happen to be the inspector, you are responsible for the information entered or not entered on this form; therefore, the true conditions found inside, outside, and beneath a facility must be accurately and completely recorded.

Part I is used to indicate conditions within and around the facility that are conducive to structural pests' infestations. As an example, Xs have been placed in this part to identify the conditions found during an inspection conducted on a facility, and an additional comment has been entered in the block identified as "other."

Part II is used to identify the location where structural pests are actually found during the time of the inspection. If you will observe, no Xs have been placed in any of the blocks in this part, which indicates there were no structural pests present at the time the inspection was conducted.

Parts III and IV are used to identify the type of termite and fungi, respectively, found during the inspection. Since there were no termites or fungi observed, no entries were made in any of the blocks in either of these parts.

CHANGES FOR THE TEXT: VOLUME 3

Pen-and-Ink Changes:

Page-Col	*Subject*	*Line(s)*	*Correction*
6L		26 fr bot	After "However," add "if."
9R		26 fr bot	Change "earthy" to "earthly."
10L		12 fr bot	Change "insect" to "insects."
10R		14	After "applications" add "are."
		15	Delete the first "of" and change "are" to "per."
		21	After "Vapona" add "(R)."
		34	After "Cygon" add "(R)."
		43	After "Dibrom" add "(R)."
11L		4	After "Dipterex" add "(R)."
		14	After "Abate" add "(R)."
		19 fr bot	After "Dursban" add "(R)."
		9 fr bot	Change "culex" to "*Culex*."
		7 fr bot	Change "Aedes vexans" to "*Aedes vexans*."
		2 fr bot	Change "aedes" to "*Aedes*."
11R		12	After "Safrotin" add "(R)."
12L		27	After "Sevin" add "(R)."
		29 fr bot	Change "dogs," to "dogs and."
		17 fr bot	After "Baygon" add "(R)."
		2 fr bot	After "Ficam" add "(R)."
13L		23	After "Kepone" add "(R)."
14L		3	Change "vikane" to "Vikane (R)."
		26	Change "cleaning a freight car of" to "clearing a freight car or."
14R		4	After "lesson." add "*." At bottom of column add footnote "* Information on Pyrethrum, Resmethrin, and Silica aerogel adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
		19 fr bot	After "Altosid" and "Precor" add "(R)."
		17 fr bot	Change "culex" to "*Culex*."
		8 fr bot	Change "Amdro" to "Amdro (R)" and "amdro" to "Amdro."
		2 fr bot	Change "amdro" to "Amdro."
15L		17–18	Change "Psorophora, Aedes, Anopheles, Culex, Culiseta" to "*Psorophora, Aedes, Anopheles, Culex, Culiseta*" and "lepidoptera" to "*Lepidoptera*."
		21	After "Teknar" add "(R)."
		22	After "Bactimos" add "(R)."
	411 - 1 (1)		Change "culex" to "*Culex*."
15R		15 fr bot	After "Warfacide" add "(R)."

Page-Col	*Subject*	*Line(s)*	*Correction*
15R		14 fr bot	After "bait." add "*." At bottom of column add footnote "* Information on Warfarin adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
16L		18	After "RoZol" add "(R)."
		25	After "gloves." add "*." At bottom of column add footnote "* Chlorophacinone information adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
16R		12 fr bot	After "Talon" add "(R)."
		11 fr bot	Change "control, Maki" to "Contrac (R), Maki (R)."
18L		3	Delete "pithin."
		14	After "Starlicide" add "(R)."
19R		2 fr bot	Change "duron" to "diuron."
20L		27	Change "condition" to "conditions."
21R		7 fr bot	Change "garlic wild, prostate" to "wild garlic, prostrate."
22R		24 fr bot	After "Roundup" add "(R)."
		17 fr bot	After "Hyvar X" and "XL" add "(R)."
23L		4	After "Treflan" add "(R)."
23R		7 fr bot	After "Benlate" and "Tersan 1991" add "(R)."
24L		8	After "Ansi" and "Tersan SP" add "(R)."
		15	After "Manzeb" and "Tersan LSA" add "(R)."
		19	After "Arbotect S" add "(R)."
		28	After "Bayleton" add "(R)."
		35	After "Tersan 75" add "(R)."
25R		5	Change "Dessicants" to "Desiccants."
		16	Change "dessication" to "desiccation."
26L		13	After "B-1956" add "(R)."
26R		26 fr bot	Change "icides" to "Pesticides."
27L		12	After "are" add "not."
28L		29	Change "you're" to "unless you're."
34L		5 fr bot	After "crack" add "and."
34R		4 fr bot	Insert comma after "gas" and delete the parenthesis marks.
42L		6 fr bot	After "pump" and "bulb" add "(R)."
44L		5	After "Glue boards" add "*." At bottom of column add footnote "* Glue board information adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
47L		2 fr bot	Change "sprayer, stand" to "liquid formulation, withstand."
48L		13 fr bot	After "Accessories" add "*." At bottom of column add footnote "* Lesson adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
48	Fig. 3-29		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."

Page-Col	*Subject*	*Line(s)*	*Correction*
56L	441 - 4		Change exercise to read "How should you hold the plunger duster to produce heavy dust patterns?"
57R		26	After "*sprayer*" add "*." At bottom of column add footnote "* High-pressure pesticide information adapted from *The Silver Skunk* (Owner's Manual, Model PRO-5-138). Reprinted by permission of the publisher."
58L		13	Change "*Rotor hammer*" to "*Roto Hammer* (R)."
58R	442 - 1 (6)	2	Change "rpm" to "gpm."
61L		5	Change "perform" to "performing."
70L	441 - 4		Change answer to read "So that the delivery tube is beneath the dust."

Page Changes:

Remove Pages	*Insert Pages*
iii–iv	*iii–iv*
	66a

Preface

THIS THIRD VOLUME of CDC 56650, *Pest Management Specialist,* contains information on pesticides in the environment; pesticide classification, characteristics, and diluting; and pest management equipment.

In Chapter 1, Pesticides in the Environment, you'll learn about the impact pesticides have on our environment, how you can work to reduce this impact, and pest resistance and tolerance to pesticides.

Chapter 2, Pesticide Classification, Characteristics, and Diluting, discusses a wide variety of pesticides. The list includes insecticides, rodenticides, herbicides, and fungicides for plant diseases.

In Chapter 3, Pesticide Dispersal Equipment, we'll discuss types and uses of equipment, its operation, and maintenance and calibration.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in the publication is for information purposes only and does not imply indorsement by the Air Force.

This volume is rated at 33 hours (11 points).

Material in this volume is technically accurate, adequate, and current as of April 1984.

Acknowledgement

PREPARATION of this volume was aided through the cooperation and courtesy of Harcourt Brack Jovanovich Publications, publishers of the *Scientific Guide To Pest Control Operations*, 3rd edition. Information from this publication helped in developing the text regarding several types of pest management chemicals and equipment.

In accordance with the copyright agreement, distribution of this volume is limited to DOD personnel.

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Books

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The Silver Skunk, Owners Manual, Model PRO–5–138. Sharon Hill, Pennsylvania: Power Spray Technology, Inc. 1978.

Department of Air Force Publications

AFESC TR–80–01, *Handbook on Bird Management and Control*, Air Force Engineering and Services Center, Tyndall Air Force Base, Florida.

AFR 91–19, *Herbicide Manual for Noncropland Weeds*.

CHANGES FOR THE TEXT: VOLUME 4

Pen-and-Ink Changes:

Page-Col	*Subject*	*Line(s)*	*Correction*
iv		5	Change "differently" to "different."
1R		23	Change "disease" to "diseases."
		25	Change "vertebrates" to "vertebrate."
3R		4	Change "CD" to "CE."
		2 fr bot	Change "as" to "such as."
5R		23 fr bot	After "out" add "of water."
		19 fr bot	Change "*edes*" to "*Aedes*."
6L		1 fr bot	After "in" add "a."
9L		7 fr bot	Change "1-6" to "1-5."
		3 fr bot	After "called" and "the."
9R		4 fr bot	After "of" add "the."
14L		21 fr bot	Change "coast" to "Coast."
14R		3	After "in" add "the."
16R		27	Change "*pipien*" to "*pipiens*."
18L		12	Enclose "gallinipper" in quotation marks.
		24	Change "*cilita*" to "*ciliata*."
		15 fr bot	Change "gulf coast" to "Gulf Coast."
		12 fr bot	Change "Eastern" to "eastern."
19L		1 fr bot	Change "*tarsails*" to "*tarsalis*."
19R		2 fr bot	Change "*nigromaculitis*" to "*nigromaculatis*."
21L		1	Change "*Annopheles*" to "*Anopheles*."
		10	Change "carb" to "crab."
21R		11	Change "of" to "or."
24L		22	Change "Aedes albopictus" to "*Aedes albopictus*."
30	Fig. 2-3		Add "(Reproduced courtesy of *Pest Control Technology*, Cleveland, Ohio)."
32R	613 - 9		Delete.
33L		23 fr bot	Change "Muscina" to "*Muscina*."
		11 fr bot	Change "like foods," to "foods like."
		8 fr bot	Change "Muscina" to "*Muscina*."
		7 fr bot	Change "Ophyra" to "*Ophyra*."
34L		12	Change "Calliphoridea" to "Calliphoridae."
34R		22 fr bot	Change "files" to "flies."
36R		9	Change "*Alternata*" to "*alternata*."

Page-Col	Subject	Line(s)	Correction
37L		8	Change "anaphylastic" to "anaphylactic."
37R		5 fr bot	Change "Chrysops discalis" to "*Chrysops discalis.*"
38R	617 - 1 (10)		Delete.
40R		9 fr bot	After "water" add a comma.
43L		6	Change "electrocured" to "electrocuted."
43R		6	After "Sprays" add "*." At bottom of column add footnote "* Lesson adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
47R		26	Change "coast" to "Coast."
		29	Change "south" to "South."
		40	Change "central" to "Central."
		45	After "having" add "an."
		47	Change "temperature" to "temperate."
49L		1	Change "and as" to "as it is."
50L		21	Change "area" to "areas."
52		Bottom margin	Add footnote "Table adapted from *Pest Control Technology*, July 1982. Reprinted by permission of the publisher."
57L		14 fr bot	Change "*corrective*" to."*Corrective.*"
57R		30	Delete "5."
58R		9 fr bot	After "vectors" add "of."
		3 fr bot	After "years." add sentences "Their bodies have a roughened, warty appearance, with tiny protuberances called "mammillae." The hypostome has well-developed teeth."
65R		1	Change "O. hermsi" to "*O. hermsi.*"
	635 - 1 (1)		Delete the parentheses after "wait" and "host."
		9 fr bot	Insert ____ (6) aligned under ____ (5) and delete "1'108u' 1."
		4 fr bot	Change "(6)" to "(7)."
66L		2	Change "(7)" to "(8)."
		8	Change "(8)" to "(9)."
		13	Change "(9)" to "(10)."
66R		16	After "Controls" add "*." At bottom of column add footnote "* Control information adapted from *Pest Control*, March 1982. Reprinted by permission of the publisher."
		23	Change "carbary—" to "carbaryl, and." After "dust" add a comma.

Page-Col	*Subject*	*Line(s)*	*Correction*
68L		21 fr bot	Change "rickettsailpox" to "rickettsialpox."
68R		16 fr bot	Change "*DDermatophagoides*" to "*Dermatophagoides*."
69L		1 fr bot	Change "nymphae" to "nymphs."
69R		10 fr bot	Change "venter" to "center."
	Fig. 4-7	legend	Change "Mite" to "Tick."
70R		6 fr bot	Change "numphochrysalis" to "nymphochrysalis."
71L		6	Change "gulf coast" to "Gulf Coast."
71R		9	Change "sparrow" to "sparrows."
	Fig. 4-12		Change "CHELICERA" to "CHELICERAE."
72R		14	Change "specie" to "species."
		4 fr bot	Change "form" to "from."
76L	603 - 6		Change "T" to "F."
76R	606 - 2		Add "and *Culex pipiens*."
	607 - 1		Change "*ciliatea*" to "*ciliata*."
77L	617 - 1		Delete "(10) g."
78R	638 - 2		Change "Acrina" to "Acarina."
	641 - 1		Change "Environmental" to "Cultural."
	641 - 6		Change "mosquito" to "chiggers."

Page Changes:

Remove Pages	*Insert Pages*
55–56	55–56
73–74	73–74

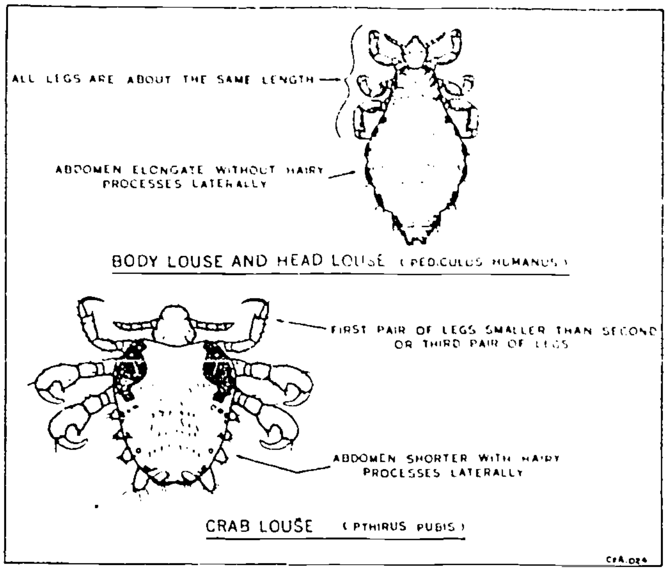

Figure 4–1. Species of lice.

629. Identify given statements pertaining to louse characteristics as applying to the head louse, body louse, or both.

Head and Body Lice. The body louse (*Pediculus humanus human.* -) and head louse (*Pediculus humanus capitis*) are very similar to each other physiologically, but they differ morphologically in size, proportion, and color. They also differ biologically in habits, one form living on the head and neck and the other on the body.

Adult identification. The adult body louse is ? to 4 millimeters long, greyish white in color, and is generally 10 to 20 percent larger than the head louse. The head louse is 1 to 2 millimeters long and is greyish white with dark margins.

Habitat. Adults and nymphs of head lice are found in the hair and on the scalp; they tend to be most prevalent on the back of the neck and behind the ears. They aren's known to infest eyebrows or eyelashes.

Although as many as 1,000 body lice have been removed from the undergarments of one person, it is more typical to find less than 10 lice per person. Most of the lice are on the inner surface of the clothing, next to the skin. Females tend to congregate along seams for egg laying. Some adults may migrate away from the skin to the outer garments and to other people. Head and body lice can move fairly rapidly and will pass from host to host, or from host to bedding, by simple contact.

It is difficult to find human lice and crab lice away from humans. Beds occupied every night by unsanitary individuals have a greater chance of being infested. If unoccupied for several nights, they tend to be free of lice. Head and body lice may be acquired by personal contact and by putting on infested garments. Head lice may be acquired by contact with upholstered chairs and by using infested brushes and combs. Hairs with eggs attached may be blown about. Lice tend to leave a feverish patient and seek other hosts.

Habits. These lice depend upon human blood as a means of life. They suck blood for long periods of time, but they don't ordinarily become engorged. Some individual lice feed too avidly, causing rupture of their digestive system, and succumb because of their greed. During feeding, dark red feces may be deposited on the skin.

When ready to feed, the louse anchors its mouth to the skin, stabs an opening through the skin, pours saliva into the wound, and pumps blood from the injury into the digestive system by means of the pharyneal pump.

The body louse remains attached to clothing fibers and bends over to feed while the head louse simply remains attached to body hairs.

Entomologists may disagree with one another on a number of issues but one in which there is no disagreement is that lice, including pubic lice, do not jump or fly

The question of whether head lice can jump or fly may have arisen because static electricity generated by combing the hair can cause them to be suddenly repelled from the comb. It is essential to dispel the notion that lice can jump or fly in order to focus attention on the fact that lice are transmitted principally through contacts with an infested person or to a lesser extent with fomites (infested objects).

The possibility exists that lice could be blown about by wind, but this is remote. There are also rare instances where lice from humans were found on insects, but insects as a means of transferring lice from person to person cannot be realistically regarded as any more than a very infrequent possibility.

(Lice habits information adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher.)

Egg laying. Mating occurs frequently and at any time in the adult's life, from the first 10 hours to old age. Eggs are laid 24 to 48 hours later, depending upon temperature conditions. Eggs are cemented on head hairs by head lice or on the underclothing by body lice. If the human is relatively nude, as in some tropical a' as, lice

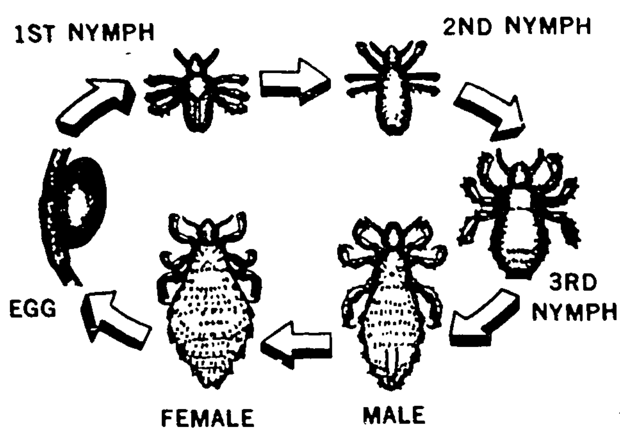

Figure 4–2. Life cycle of a head louse.

may infest beads and necklaces. Body lice may deposit 9 or 10 eggs per day and a total of 270 to 300 eggs in a lifetime. Head lice are less prolific, depositing about 4 eggs per day for a total of about 88 days in a lifetime. The hatching of eggs is greatly reduced or completely prevented by exposure to temperatures about 100° F. or lower than 75° F.

Nymph development. After emerging from the egg, the louse nymph molts three times before becoming a sexually mature adult. Therefore, there are three nymphal instars, differing from each other by the increased length of the abdomen as development progresses. The nymphal stages require 8 to 9 days for lice remaining in contact with the human body, but may take 2 to 4 weeks when the clothing is removed at night. If the clothes aren't worn for several days, all lice will usually succumb. The total life cycle of head and body lice may be completed in about 18 days.

Exercises (629):

1. Match columns A and B. Column B items are used more than once.

	Column A	*Column B*
____	(1) The adult louse is about 2 to 4 millimeters long and greyish white.	a. Head lice.
____	(2) The adult louse is 1 to 2 millimeters long and is greyish white with dark margins.	b. Body lice.
____	(3) Are not known to infect eyebrows or eyelashes.	c. Both.
____	(4) Can move fairly rapidly from host to host by simple contact.	
____	(5) May be acquired by putting on infected garments.	
____	(6) Female lays eggs along clothing seams.	
____	(7) Tend to leave feverish patients and seek other hosts.	
____	(8) May deposit 9 or 10 eggs per day.	
____	(9) May deposit 4 eggs per day.	
____	(10) The nymphal stage requires 8 or 9 days when remaining in contact with the human body.	

630. Cite information regarding the basic characteristics of crab lice.

Characteristics of Crab Lice. Crab lice (*Pthirus pubis*) are small (0.8 to 1.0 mm), greyish-white insects with a short abdomen bearing hairy lateral tufts and large second and third pairs of legs that give them a crablike appearance (fig. 4-1).

These insects are most commonly found on hairs in the pubic areas, but they may be found on hairy areas of the chest and armpits. Infestations of the eyebrows and eyelashes are frequently reported. Crab lice on the eyebrows feed in a very localized area and cause hemorrhages in the skin which result in a bluish pigment directly above the eyebrows.

The life cycle of the crab louse is similar to that of the head and body lice. The eggs are glued to hairs but are smaller than the body louse eggs.

There are three nymphal stages. In a few specimen that were carefully studied, it took 13 to 17 days for them to become adults. Adult life lasts less than a month. All stages are more sedentary than those of head or body lice. They tend to settle down at one spot, grasping hairs with the legs of both sides of the body, inserting the mouthparts, and taking blood intermittently for many hours at a time. The legs are adapted for grasping large hairs, and, in the position adopted, the adult prefers hairs widely spaced (compared with the dense hairs of the head). This may partly explain the distribution of the crab louse, which is found most commonly on the hair in the pubic and anal areas. This insect survives only a short time away from the host.

Crab lice are spread chiefly by sexual contact, but they may be acquired by other means, such as infested toilet seats and beds (rare), and by close personal contact. Many authorities believe that there has been a resurgence in the number of cases of crab louse infestations related to the present worldwide climate of cultural permissiveness.

Exercises (630):

1. On what body parts are crab lice most commonly found?

2. Where are crab louse eggs found?

3. How are crab lice chiefly spread?

631. Specify details related to controls for lice.

Controlling Lice. (Adapted from *Pest Control*, February 1982. Reprinted by permission of the publisher.) The first thing you need to understand about controlling head, body, or crab lice is that, as a pest manager, there's generally not much you can or should do. Medical personnel are responsible for taking any direct personal action to control lice. If your shop gets contacted, *c*. Placing the live host animals in cages that have wire or hardware cloth bottoms so that any mites that drop off after engorging will fall into a pan of water put under the cage. (This procedure is often used to collect chiggers from snakes, turtles, or small rodents.)

d. Placing a dead host animal in a glass jar containing water and a detergent. The jar is shaken thoroughly to separate ectoparasites from the animal. The liquid is then poured into a funnel containing filter paper. Any mites will be strained out on the paper.

Exercises (640):

1. Mite survey methods vary with the habits of the species ________ ________ .
2. Black glass plates or cardboard rectangles are used to survey ________ ________ areas.
3. Berlese funnels are frequently used to collect ________ and ________ mites.

641. Given selected techniques, determine the type of control being used, the mite to be controlled, and complete given statements regarding chemical controls for mites.

Mite Control. Mites can be controlled through environmental methods, including sanitation, mechanical, and construction and maintenance controls, as well as by chemical methods. The method used depends on the mites to be controlled and the circumstances.

Cultural methods. Rat and house mouse mites can be controlled by:

a. Trapping or poisoning rats and mice to eliminate the the source of the blood meal essential for nourishment and reproduction of mites.

b. Starving out rodents by storing garbage and food in ratproof containers, rooms, or buildings.

c. Keeping rodents out of buildings by rodent stoppage.

Bird mites can be controlled by:

a. Modifying buildings so the birds cannot enter or nest. (Give special attention to louvers, gables, eaves and attics—even though the work calls for screening, carpentry, or masonry.)

b. Trapping or poisoning birds to eliminate the source of blood meals for the mites.

Clover mites can be controlled by:

a. Removing vegetation near houses and pruning shrubs so that they are at least a yard from buildings.

b. Maintaining a strip of bare ground 2 to 3 feet wide around buildings.

Chigger control depends on modifying the environment to permit sunlight and air to circulate freely, thus drying the usual damp habitat of the chigger. These modifications consist of:

a. Keeping lawns and gardens closely cut and edged, and keeping flower beds free of weeds.

b. Eliminating tall weeds and shrubs, particularly blackberry and raspberry bushes, which furnish food and shelter for the bird and rodent hosts of chiggers.

c. Using (in scrub typhus areas) mechanical equipment, such as bulldozers and flamethrowers—thus reducing human contact with the mites—to clear campsites, and using rodent control to eliminate chigger hosts.

Grain and flour mites can usually be controlled by:

a. Rotating food materials to remove the oldest items first (to prevent buildup of infestations).

b. Ventilating to prevent the accumulation of moisture (mites thrive on foods that have a moisture content of 20 percent or more).

c. Eliminating foci or infestations (by vacuum cleaning entire warehouses, with attention to horizontal surfaces such as beams and window ledges).

Chemical methods. Sprays or dusts are used for residual treatment indoors and are frequently used as spot treatments in trouble areas—around windows and doors, at the tops of foundations, around plates and at the ends of joists, on baseboards, and at the edges of floors. Dusts are usually applied at higher concentrations than are sprays. They are placed in voids, in louvers near bird nests, in rodent runways, where the mites will, and children will not, normally come into contact with the insecticide.

Residual treatment outdoors has been used for the control of clover mites and chiggers especially, but less commonly on the outside of buildings for control of bird and rat mites.

Fumigation control of flour and grain mites is difficult and should be carried out only by a certified pest control operator. All fumigants are very poisonous and should be used only by qualified operators and only according to the directions on the fumigant container's label.

Sulfur has long been used as a chigger repellent. Although the results are variable, it has often given control when dusted into socks, underwear, and outer clothing. Children at summer camps often prefer sulfur to some of the new repellents that have a disagreeable odor.

Many mosquito repellents, such as Indalone, ethyl hexanediol, and dimethyl phthalate will, when applied to the skin, also repel chiggers for 2 to 4 hours. One of the best of the newer repellents is diethyltoluamide.

Most of the good mosquito repellents are also effective when used to treat clothing. The most durable treatment recommended at this time is benzyl benzoate, which will withstand two or three washings. Resmethrin, which contains 30 percent benzyl benzoate, withstands one or two washings.

Persons who have been in an area infested with chiggers can kill most or all mites that have attached themselves by using a thick lather in a hot bath or shower as soon as possible after exposure. After the bath, an alcohol rubdown will help, particularly on the welts. For temporary relief from itching, compounds such as calomine lotion are available at most drug stores.

Much progress has been made in the treatment of mite infestations on humans and animals. Sulfur ointment, long used in the treatment of scabies, is no longer recommended because it can cause a dermatitis as severe as that caused by the mites. Best results are obtained by taking a hot, soapy bath first, drying the skin thoroughly, and then applying one of the three following remedies to all the body below the neck.

(1) Kwell cream, or a lotion containing 1 percent gamma isomer of benzene hexachloride or lindane:

(2) Eurax, a salve incorporating 10 percent N-ethyl-O-crotontoluide in vanishing cream.

(3) Twelve percent benzyl benzolate.

The next day take a bath and change to clean clothing, night clothes, and bedding. Itching may persist for several days and is not a sign of superinfection. It is important that this be understood; overtreatment is common. In perhaps 5 percent of the cases a second course of treatment is necessary after an interval of 1 to 2 weeks.

In treating scabies, thoroughness is essential. Launder every piece of clothing and bedding that may have come into contact with the infested person. If one member of a family or group of persons has scabies, all close contacts should get treatment.

Exercises (641):

Given some techniques for controlling mites, state whether the type of control is cultural or chemical, and name the mite(s) that it would control.

1. Starving out rodents by sto[illegible] garbage and food in ratproof containers, rooms, or buildings.

2. Using diethyltoluamide.

3. Maintaining a strip of bare ground 2 to 3 feet wide around buildings.

4. Rotating food materials to remove the oldest items first.

5. Keeping lawns and gardens closely cut and edged and keeping flower beds free of weeds.

6. Treating clothing with benzyl benzoate.

7. Trapping or poisoning birds to eliminate the source of blood meals for the mites.

Complete the following statements:

8. Persons who have been in an area infested with chiggers can kill most of the mites that have attached themselves by using a ________ ________ in a ________ ________ or ________ as soon as possible after exposure.

9. Fumigation control of ________ and ________ mites is different and should be carried out only by a ________ pest control operator.

10. For controlling mites indoors and outdoors, you should apply sprays and/or dusts around ________ and ________, at the tops of ________, around plates at the end of ________, on ________, at the edges of ________.

CHANGES FOR THE TEXT: VOLUME 5

Pen-and-Ink Changes:

Page-Col	*Subject*	*Line(s)*	*Correction*
1R		14	Change "*Mauritanicus*" to "*mauritanicus*."
3L	Fig. 1-2		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
3R		20	Change "it becomes" to "they become."
5L		6	Before "The" add "*." At bottom of column add footnote "* Adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher.
7L		27	Change "straited" to "striated."
10L		1	After "Measures" add "*." At bottom of column add footnote "* Lesson adapted from *Scientific Guide to Pest Control Operations*, 3rd ed., and *Pest Control*, February 1982. Reprinted by permission of the publishers."
16	Table 1-3. Block 12	4	Change "INITAITED" to "INITIATED."
17L		7	After "Fabric Pests" add "*." At bottom of column add footnote "* Lessons 809–812 adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
19L	Fig. 1-9		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
21L	Fig. 1-10		Add "(Reproduced courtesy of Harvest Publishing Company, Cleveland, Ohio)."
25L		14	After "Termites" add "*." At bottom of column add footnote "* Lessons 813–821 adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
28	Fig. 2-2		Add "(Reprinted courtesy of *Pest Control Technology*, (April, 1982), Cleveland, Ohio)."
29L		14	After "Formosan termite." add "*." At bottom of column add footnote "* Information on Formosan termites adapted from *Pest Control Technology*, April, 1982. Reprinted by permission of the publisher."
33	Fig. 2-3		Add "(Reprinted courtesy of Harvest Publishing Company, Cleveland, Ohio)."
34–39	Figs. 2-4, 2-5, 2-6, 2-7, 2-8, and 2-10		Add "(*Ibid.*)" after each figure.
40R		7	Change "2-8" to 2-2."
52R		3 fr bot	Delete "a single, toothed hooker."
59R		19 fr bot	Delete the two commas.
60R		21	Delete "There may be."
62R		10 fr bot	Change "Testacelliadae" to "Testacellidae."
		8 fr bot	Capitalize "*testacella*."

Page-Col	*Subject*	*Line(s)*	*Correction*
65R		10 fr bot	After "Diseases" add "*." At bottom of column add footnote "* Information in lessons 846–848 adapted from *Turf Manager's Handbook*. Reprinted with permission of Harcourt Brace Jovanovich Publications, copyright 1979."
71L		15 fr bot	Change "ar" to "are."
73L		9 fr bot	Change "Tebuthiuron" to "Thiabendazole."
76L		1	Change "Severel" to "Several."
78R	808 - 10		In the last column, change "10" to "9."
	808 - 13		In the last column, change "9" to "10."
80R	832 - 4		Change "Arborvital" to "Arborvitae."

CHANGES FOR THE TEXT: VOLUME 6

Pen-and-Ink Changes:

Page-Col	*Subject*	*Line(s)*	*Correction*
1L		5–6	Delete "This chapter covers . . . bats and birds."
2L		10	Change "here" to "where."
7L	Fig. 1-3		Add "(Reprinted courtesy of Harvest Publishing Company, Cleveland, Ohio)."
10L		7 fr bot	Change "technique" "techniques."
		6 fr bot	After "Rodents" add "*." At bottom of column add footnote "* Lessons A05 and A06 adapted from information in *Scientific Guide to Pest Control Operations*, 3rd ed., *Pest Control* (August, 1981) and *Pest Control Technology* (September, 1982). Reprinted by permission of the publishers."
12	Fig. 1-7		Add "(Reprinted courtesy of Harvest Publishing Company, Cleveland, Ohio)."
16L		17	Change "poisions" to "poisons."
16R		11 fr bot	Delete "rats."
17L		4 fr bot	Change "maforttributes" to "major attributes."
19R		23	Change "Cactis" to "Cacti."
21R		7 fr bot	Change "western" to "Western."
22L		9 fr bot	Change "species" to "genus."
23L		9	After "Gophers" add "*." At bottom of column add footnote "* Lesson adapted from *Pest Control*, September, 1981. Reprinted by permission of the publisher."
		14 fr bot	Change "Thermerica" to "America."
23R		25 fr bot	Change "till" to "still."
		21 fr bot	Change "mount" to "mound."
		11 fr bot	Change "little" to "some."
25R			Add exercise "7. What poison and bait combinations work best for controlling pocket gophers?"
27L		21 fr bot	Change "nap" to "nape."
27R		1	After the second comma, add "or."
32R		23	Change "any where" to "anywhere."
35L		4 fr bot	Before "Match" insert "A17."
35R		1	Change "and rock doves" to "(rock doves)."
36L	A17	*Col B*, item f	Change "Sartling" "Starling."
37R		10	After "reactions" add "problems."
40R		5	Change "to" to "help."
41L		4 fr bot	Change "seat" to "seal."
45L		28	Change "n" to "in."
		11 fr bot	Change "areas" to "acres."
45R		14 fr bot	Change "airburst" to "airbursts."
46L		29 fr bot	After the second "and" add "kill."

Page-Col	Subject	Line(s)	Correction
46R		31 & 47	Change "australian" to "Australian."
		33	After "small" add "area."
47L		25	Change "Releast" to "Release."
		9 fr bot	Change "trappig" to "trapping."
48R		9 fr bot	After "unused" add "bait."
49R		2 fr bot	Change "for" to "as a."
50R		6	Change "reple" to "repel."
		17	Change "42–5" to "42–S."
51L		1 fr bot	Change "*mexican*" to "*Mexican.*"
51R		3	Change "lb" to "lbs."
		24	Change "*mexican*" to "*Mexican.*"
		35	Change "they are insects" to "of their insectivorous diet."
53L		1	After "noise" add "of."
	15		Change "large" to "big."
54L		2 fr bot	Change "*mexican*" to "*Mexican.*"
55L		11	Change "*mexican*" to "*Mexican.*"
56R		6	Change "can" to "are."
		7	Change "are" to "can."
57L		10 fr bot	After "Characteristics" add "*." At bottom of column add footnote "* Lessons A27 and A28 are adapted from *Scientific Guide to Pest Control Operations*, 3rd ed., and *Pest Control Technology*. December, 1982. Reprinted by permission of the publishers."
58L		12 fr bot	Change "A pound or two" to "Also, a pound or two of."
		9–10 fr bot	Change "; this" to "will."
58R		9	Change "orjust" to "or just."
		5 fr bot	Change "afater" to "after."
		2 fr bot	Change "get" to "set."
59L		7	After "roots" add "while."
65R	A15 - 7		Change ", starlings, pigeons, etc." to "and starlings."
66R	A28 - 3	3	Delete "no."
	A28 - 7	2	Change "tube" to "tub."

CHANGES FOR THE TEXT: VOLUME 7

Pen-and-Ink Changes:

Page-Col	*Subject*	*Line(s)*	*Correction*
3L	Fig. 1-2		Add "(Reprinted courtesy of Harvest Publishing Company, Cleveland, Ohio)."
3R		13	After "Characteristics" add "*." At bottom of column add footnote "* Lessons C02–C06 adapted from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
4	Fig. 1-3		Add "(Reprinted courtesy of Harvest Publishing Company, Cleveland, Ohio)."
7L		6 fr bot	Change "attach to" to "feed on."
14R	C05	Col B, item c	Change "Pharoah" to "Pharaoh."
12R		13	Change the second "the" to "this."
		19 fr bot	Change "Pharoah" to "Pharaoh" in both places.
16L		25	After "entrenched" add "*." At bottom of column add footnote "* Information on pharaoh ant control adapted from *Pest Control Technology*, August, 1982. Reprinted by permission of the publisher."
16R		2 fr bot	Change "Pharoah" to "Pharaoh."
19R		4	Change "temperature" to "temperate."
21R	Fig. 1-8		Add "(Reprinted courtesy of Harvest Publishing Company, Cleveland, Ohio)."
30L		6	After "venom" add "that."
		4 fr bot	Change "Latrodectus mactans" to "*Latrodectus mactans*."
32L		6 fr bot	After "Spiders" add "*." At bottom of column add footnote "* Adapted in part from *Scientific Guide to Pest Control Operations*, 3rd ed. Reprinted by permission of the publisher."
33R		14	Change "Androctonus" to "*Androctonus*."
34R		21 fr bot	After "best" add "physical."
37L		11 fr bot	Delete "greyish."
41L		8	Change "tree" to "(tree."
54R		13	Change "bladdewort" to "bladderwort."
61R	C52 - 4, 11		Change "acquatic" to "aquatic."
64L	C19 - 1 (2)		Change "e." to "b, e."

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CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 1

Introduction to Civil Engineering

Extension Course Institute

Air University

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Preface

THIS VOLUME of CDC 56650, *Pest Management Specialist,* provides you with general knowledge about the base civil engineer organizational structure, career progression, specialty duties and responsibilities; managing activities and resources; publications, forms, and security; and ground safety.

Successful completion of this course will help you perform your duties as a pest management specialist. The exercises are designed to help you master the contents of the course. That, along with practical experience on the job, earns you success, prestige, and promotions.

In latter volumes of this CDC, you'll study many aspects of pest management, including principles of integrated pest management (IPM), chemicals and equipment, safety and identification, and survey and control of pests of health and economic importance. Study each lesson carefully in order to solve specific management situations in succeeding lessons.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in this publication is for information purposes only and does not imply indorsement by the Air Force.

Call the author at AUTOVON (736–6559) between 0700 and 1600 CST, Monday through Friday, to get an immediate response to *subject matter* questions which come up while you're studying this course. Or you may write the author at 3770 TCHTG/TTGIC. Sending subject matter questions to ECI only slows the response time. You should also tell the author about subject matter and technical errors (except minor printing errors) that you find in the text, the volume review exercises, or the course examination. This will help the author keep up with changes that must be made when the course is revised.

Consult your education officer, training officer, or NCO if you have questions on course enrollment or administration, Your Key to a Successful Course, and irregularities (possible scoring errors, printing errors, etc.) on the volume review exercises and course examination. Send questions these people can't answer to ECI, Gunter AFS AL 36118, on ECI Form 17, Student Request for Assistance. *NOTE: Do not use the Suggestion Program to submit corrections for printing or typographical errors.*

This volume is valued ast 12 hours (4 points).

Material in this volume is technically accurate, adequate, and current as of November 1983.

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Contents

NOTE: This course teaches through numbered lesson segments, each containing a behavioral objective, text, and exercises. The objective sets your learning goal. The test gives you the information you need to reach that goal, and the exercises let you check your achievement. When you complete each segment, see whether your answers match those in the back of the volume. If your response to an exercise is incorrect, review the objective and its text.

Specialty Requirements and Organizational Assignments

MAINTAINING Air Force property is a very important job. Just as your home will deteriorate if you don't keep it properly maintained and repaired, so will Air Force buildings and structures.

The Air Force owns a vast amount of real estate. Consider the size of your base in comparison to several of the largest industries in your area; then think of how many bases the Air Force operates. It's hard to comprehend, isn't it? But you can see that Air Force holdings, in keeping with its mission, are tremendous.

Equally tremendous is the cost of operating, maintaining, and replacing Air Force property. Yet, Government funds, like your personal funds, are limited; and the costs of materials and equipment go up every year. As a result, it's vital that you use Air Force resources wisely and carefully. Don't waste time or materials, learn your job well so you can operate more efficiently, and cooperate with other workers where you're assigned. When we all work together towards common goals, we make Air Force money work harder for America's defense and its taxpayers.

In this chapter, we'll discuss the base civil engineering organizational structure, its mission, and your duties and responsibilities as a pest manager.

1-1. Base Civil Engineering Organizational Structure

The base civil engineering organization is commanded by the base civil engineer (BCE). This person is responsible for all the work performed by civil engineering (CE). The job includes getting maximum efficiency for each dollar spent while attaining planned objectives. This means that human resources, material resources, and financial resources must be used as effectively as possible to meet the organization's goals.

Civil engineering is a large, complex organization with many jobs going on at the same time. The BCE uses many managers to help do these jobs. One of these managers is the sanitation superintendent. This person is in charge of the 56 career field of which you are a part. Your job as a pest management specialist is extremely important as the health of base personnel depends to a large extent on how well you do your job. Buildings can be eaten, infested, and become unusable if you aren't there to control pests such as termites, rats, fleas, roaches, and stored-products pests.

Before getting an indepth look at your job tasks, let's look at the mission of a civil engineering organization.

001. Identify activities relative to the mission of a civil engineering organization.

Base Civil Engineering Mission. The primary mission of civil engineering activities is to acquire, construct, maintain, and operate real estate property facilities and to provide related management, engineering, and other support work and services. Examples of the mission include:

- Acquiring land for construction
- Constructing forms for concrete.
- Modifying and repairing buildings.
- Operating and maintaining heating plants.
- Providing water and electricity to base facilities.
- Controlling plant and animal pests.

Although CE provides utilities to base facilities and performs maintenance on them, it doesn't operate most facilities on the base. These functions belong to other Air Force units. For example, CE does not operate aircraft, missiles, clubs, or dining halls.

Exercises (001):

1. Place a checkmark to the left of each activity that directly relates to the mission of the BCE. Leave the other activities blank.

_____ (1) Fuel aircraft.
_____ (2) Acquire land.
_____ (3) Paint aircraft hangar.
_____ (4) Maintain missiles.
_____ (5) Poison soil for termites.
_____ (6) Provide natural gas.
_____ (7) Engineer air conditioning for facility.

______ (8) Operate dining hall.
______ (9) Manage Air Force real estate property.
______ (10) Repair roof on aircraft hangar.
______ (11) Operate NCO club.
______ (12) Apply toxic pesticides.

002. Indicate to what command block various CE units belong.

Civil Engineering Organizational Chart. Figure 1-1 shows the structure of CE. Study the chart in order to learn the levels of command throughout the organization. At the very top of the chain of command is the base civil engineer. He or she is ultimately responsible for anything that goes wrong in CE.

As President Truman said, "The buck stops here." Passing the buck in CE will eventually stop at the BCE. You well know that an Air Force person should go through the chain of command. If you skip a link in the chain, things start to go wrong. As another saying goes, a chain is no stronger than its weakest link. The lines on the chart in figure 1-1 represent the chain in the CE structure. The blocks represent an office, shop, or unit in which a manager or supervisor is in control. Spot the pest management block on the chart. Notice that it is at the same level as pavements, protective coating, and heat systems blocks. The chain of command line for pest management and environmental support goes through the sanitation block. As you will see later in the career field chart, the sanitation superintendent is in control of all the units below him. The protective coating and plumbing blocks are under the command of structures as is masonry and metalworking.

As you follow the command line upwards, you see that the next command in the chain is operations. The chief of operations is the boss of the sanitation superintendent. From operations the command line goes up the chain to the civil engineer. As you can see from figure 1-1, the BCE holds the chief of operations responsible for all the CE shops. Work control is not in a direct command line to the shops. It works in a staff function to help the operations chief. From this example, you should be able to trace the command line through the various units. See if you can.

Exercises (002):

1. Refer to figure 1-1 and answer the following questions for each of the CE units listed. What is the command block immediately above the listed unit?

CE Units	*Command Block Above Unit*
(1) Heat systems	
(2) Custodial services	
(3) Planning	
(4) Mechanical	
(5) Equipment operations	
(6) Fire protection	
(7) Real estate cost accounting	
(8) Squadron section [illegible]	
(9) Masonry	
(10) Structural	

003. Identify functions and responsibilities of CE units.

The base civil engineer needs a number of CE units to help perform his or her mission and responsibilities. The job entails even more than that of a mayor or city manager in a large city. Although the mayor is responsible for providing the city with fire prevention equipment, police protection, garbage and refuse collection and disposal, and furnishing utility services, the BCE must do all these things plus:

a. Maintain real property facilities in a condition for normal use.

b. Conserve natural resources and control environmental pollution.

c. Furnish insect and rodent control services.

d. Construct and alter facilities to support mission changes.

e. Provide management and professional engineering services to insure effective and economical operation of all activities.

These activities are broad in scope. Let's look at the CE units which help the BCE perform this mission and also break down these broad areas into narrower areas of activities.

Functions and Responsibilities of CE Units. As we look into these individual sections, refer to figure 1-1 to help you understand their mutual relationships.

Squadron and administration. This unit handles the administrative and personnel work of CE. The administrative section receives, distributes, and dispatches all communications for CE; prepares reports and correspondence, maintains correspondence files; maintains the CE library; conducts special programs, such as fund drives and awards, and maintains the records.

The squadron section takes personnel actions delegated by the squadron commander. Some of these duties include counseling, maintaining duty rosters, conducting general military training and commander's call, and enforcing discipline.

Industrial engineering (IE). This unit provides consulting services aimed at increasing productivity and improving use of CE resources. It does this not only for the BCE but for all levels of management and labor as well, acting as a problem solver. Subject areas for IE studies include bench stock, the BCE taxi system, inservice work plans (IWP), supply expenditures and discipline, service calls, and vehicles.

There are other areas of IE responsibility that apply more directly to your job as a pest manager. If your organization has an automated management system, IE implements it;

Base Civil Engineer Organization Chart

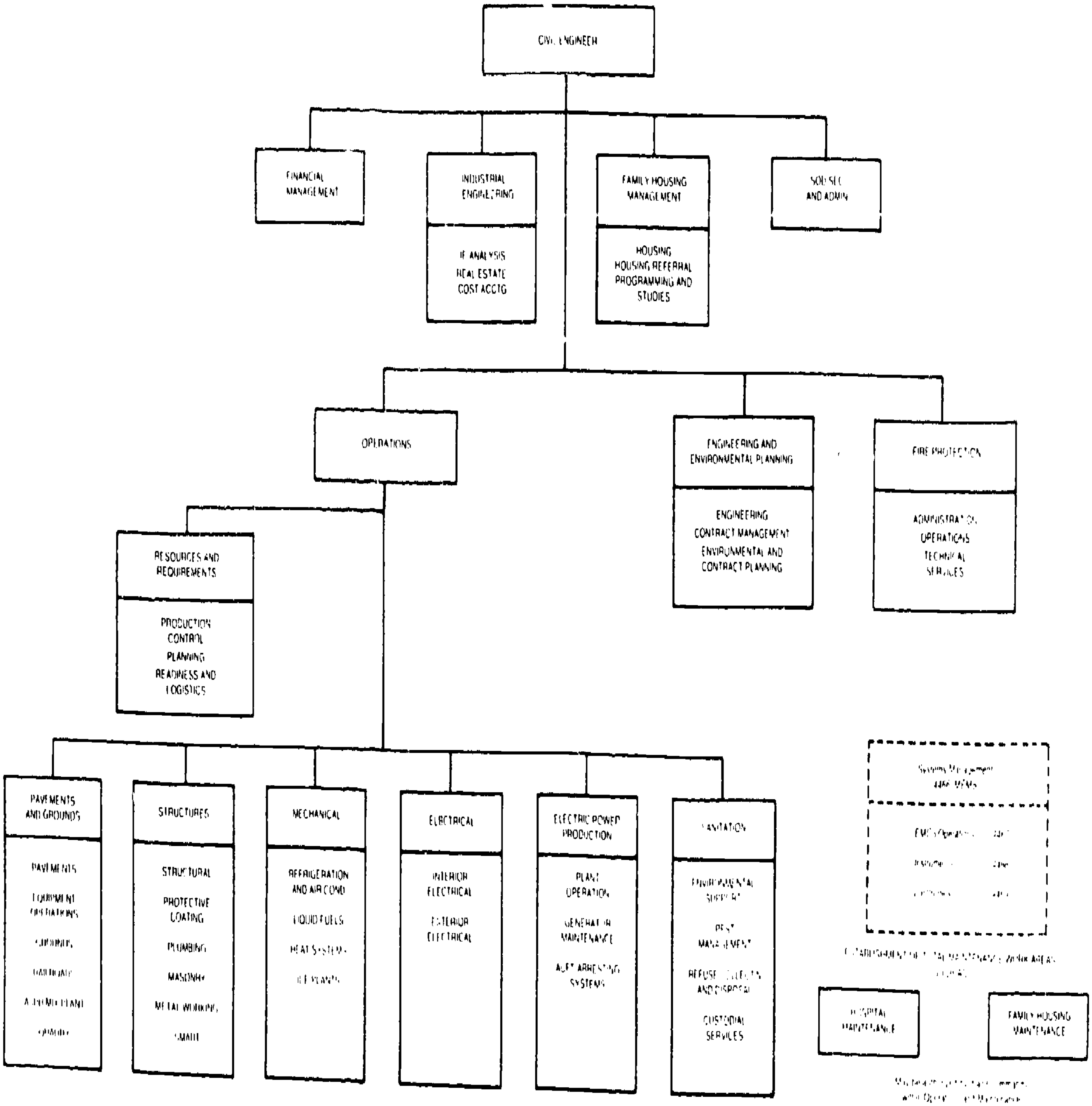

Figure 1-1. Base Civil Engineering Organization Chart.

CA-46

monitors and interprets the results of reports, such as quarterly pest management reports; and uses the information to advise the BCE. It also carries out the BCE quality control program and reports to the BCE on customer evaluations of your work and the work of other sections under the chief of operations.

Operations. This unit directs, coordinates, and controls all work approved and authorized to be done by the CE work force. This section also serves as consultant during the design of new or alteration of old facilities.

The resources and requirements section serves as a staff activity to operations. This section assigns priorities and schedules work to appropriate shops. It also operates the service call system and controls vehicles assigned to CE.

The main work areas under operations are pavements and grounds, structures, mechanical, electrical, electric power production, and sanitation. Each of these areas may contain several shops; for instance, the structures area has structural, protective coating, plumbing, masonry, and metalworking shops. Sometimes there are variations in the number of shops when there is no need for a particular activity.

Fire protection. This unit takes care of fire prevention activities on base. It performs fire control services, inspects and tests fire protection and fire alarm systems, and services ground-type portable fire extinguishers.

Financial management. This section is responsible for financial plans, budgets, and annual and long-range work plans. It also approves work requests and buys materials for the approved work.

Engineering and environmental planning. The architectural and professional engineering services for CE are handled through this section. Problems that are beyond the capability of operations and maintenance people are referred to the professional engineers of this unit. This unit also reviews and develops technical provisions of contracts for real property facilities.

As additional duties, this section takes care of the architectural and engineering aspects of the base master plan by preparing architectural and engineering drawings and maps; and it manages the environmental impact analysis process. In addition, personnel of this section monitor all real property facilities and systems to develop improvements and to update systems or equipment. They also make technical inspections of all maintenance, repair, construction, and service work done by contract to assure quality work and contract compliance.

Family housing management. This unit manages activities in these functional areas.

a. Use of military family housing including inquiries, interviews, assignments, terminations, and related administrative work.

b. Planning, programming, and budgeting for maintenance, repair, alteration, and new construction applicable to military family housing (MFH).

c. Change of occupancy inspection.

d. Housing referral service.

Exercises (003):

1. Match each BCE unit in column B with the function in column A. Some column B items may be used more than once.

Column A	*Column B*
_____ (1) Dispatches letters to base organizations	a. Squadron and administration
_____ (2) Checks the quality of linals[illegible]	b. Industrial engineering
_____ (3) Operates service calls	c. Operations
_____ (4) Fills chug (chuck) holes in asphalt streets	d. Fire protection
_____ (5) Fills empty extinguishers	e. Financial management
_____ (6) Approves work requests	f. Engineering and environmental planning
_____ (7) Inspects military family housing	g. Family housing management
_____ (8) Inspects inhouse work	
_____ (9) Inspects construction work performed by contract.	
_____ (10) Removes wall from section of headquarters building	

004. State what the letters in BEEF stand for; and from statements of BEEF objectives, identify five that apply to the Prime BEEF program.

Project Prime BEEF. "When the whistle blows, are we ready to go?" This was the question asked by the Director of CE Operations, HQ USAF, in December 1963. The answer was "No" until the base engineer emergency force (BEEF) came into existence. Now under project Prime BEEF the answer is "Yes." Project Prime BEEF creates within Air Force civil engineering the ability to respond to emergencies. The emergencies may result from acts of aggression or disasters.

The role of civil engineering has changed considerably since World War II. Civil engineering now has a direct combat support role. If you are selected to be a member of Prime BEEF contingency force–2 (CF–2) team, you must train to become more involved in limited war operations. You, as a pest management specialist, must know how to treat temporary field facilities, such as mess halls, showers, and latrines. You must be able to control various types of pests in a hurry. And, in addition, you must have the knowledge and ability to protect the facilities from enemy acts.

Prime BEEF contingency forces are made up of selected airmen and officers at both CONUS and oversea bases. In the event of an enemy attack, a natural disaster, or an emergency workload, a BEEF team can be sent to help the work force at the affected location. There are a number of Prime BEEF contingency force teams. Now, however, you should learn the five main objectives of the Prime BEEF program.

Objectives of Prime BEEF. According to AFR 93-3, *Air Force Civil Engineering Prime Base Engineer*

Emergency Force (BEEF) Program, the five primary objectives of the Prime BEEF program are to:

(1) Align the CE military force to give direct combat support to help carry out the Air Force mission.

(2) Develop and maintain a highly skilled, mobile military response for contingency operations worldwide.

(3) Develop and maintain a highly skilled, inplace military engineer force for direct combat support of CONUS and theater forces directly tasked in operations plans.

(4) Provide supplementary training to make sure that military personnel are capable of performing direct combat tasks.

(5) Develop and maintain Air National Guard (ANG) and United States Air Force Reserve (USAFR) civil engineering forces to complement active duty forces for direct combat support.

Exercises (004):

1. What do the letters BEEF stand for in the Prime BEEF program?

2. Identify the five short statements of objectives that apply to the Prime BEEF program by placing a checkmark in the appropriate spaces.

   ____(1) Direct combat support to the Air Force mission.
   ____(2) Unskilled personnel tabbed for training in an emergency.
   ____(3) Mobile military response for worldwide contingency operations.
   ____(4) Balanced military-civilian mix.
   ____(5) Direct combat support of CONUS forces tasked in operations plans.
   ____(6) Supplementary training for performance of combat tasks.
   ____(7) Trained military personnel for permanent overseas duty.
   ____(8) Use of ANG and USAFR forces to complement active duty forces.

1-2. Career Progression

In your career field (56) there are only two ladders: the pest management ladder and the environmental support ladder. In your career work, however, you work very closely with CE people in the 55 career field. This section of the text covers the career field charts of both the 55 and 56 career fields. You will also get a brief summary of the tasks in each specialty in each career field.

005. Given airman 55 and 56 career field charts, trace airmen progression; and list the grade spread for various AFSCs.

Progression in the Career Field. How would you like to be the superintendent of sanitation before you have 20 years in the Air Force? You might say "I would have to be extremely lucky." Or, as most airmen who don't make E-8 or E-9 by the time they have been in 20 years, you might say "I didn't know the right people." The fact is, you can progress to a high rank if you are willing to follow four simple rules. These rules work. They rarely fail. Ask an E-8 or E-9. He or she will verify that statement. The four rules for success in any field are (1) work hard, (2) study effectively, (3) cooperate with other workers, and (4) listen to and respond positively to the desires of your leader.

The chart in figure 1-2 is the Airman Sanitation Career Field Chart. Figure 1-3 is the Airman Structural/Pavements Career Field Chart. These charts are graphic representations of the 56 and 55 career fields. Refer to the appropriate chart during the discussion.

To trace progress in the career field, start at the bottom of the chart and work upward. For example, at the bottom of both charts is a basic airman, AFSC 99000. The first step up the ladder is helper. In the 56 career field, he or she is a pest management helper, AFSC 56610. In the 55 career field, the AFSC varies with the ladder. A construction equipment helper is 55111, a carpentry helper 55210, plumbing helper 55215, etc. The grade of the step is on the left side of the chart. A basic airman is E-1, helper E-2, and apprentice—your position now—E-3. Notice on the chart that an airman helper may upgrade to the apprentice level by graduating from a basic course. Another method of upgrading is by completing the 3-level CDC along with on-the-job training.

To progress to the specialist level, the position you are working toward now, you complete the 5-level CDC along with on-the-job performance training. In your case you will become a pest management specialist, AFSC 56650. Your grade for this position can range from E-3 through E-5. With this amount of information, you should have no trouble tracing airmen progression through any career ladder.

Exercises (005):

Trace the progression of an airman through various career ladders using figures 1-2 and 1-3. You may trace them mentally or with a pencil. After you have done this, answer the following questions.

1. What is the first step up the ladder from basic airman in the masonry ladder?

2. What course is desirable when progressing from pest management helper to apprentice pest management specialist?

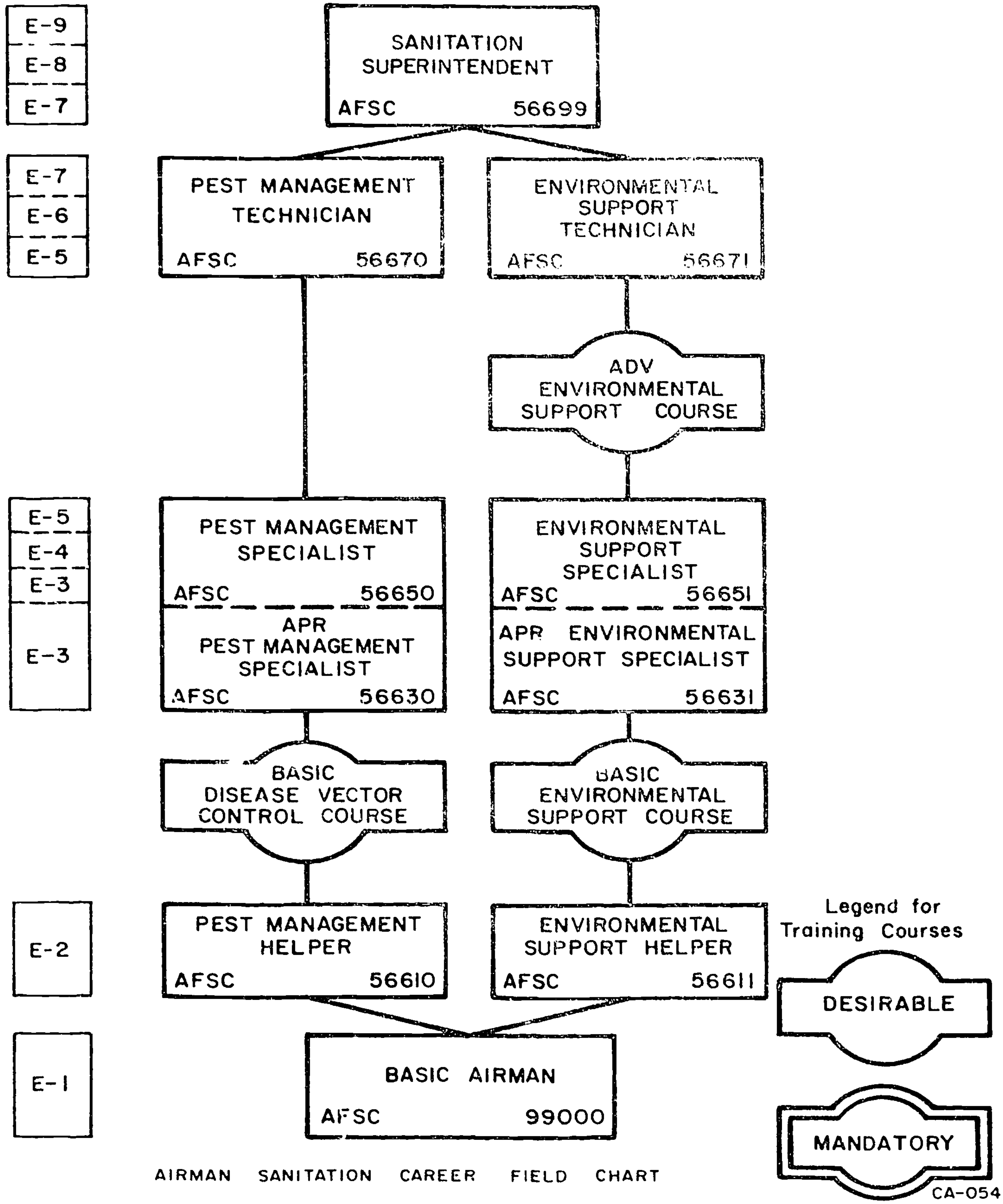

Figure 1-2. Airman Sanitation Career Field Chart.

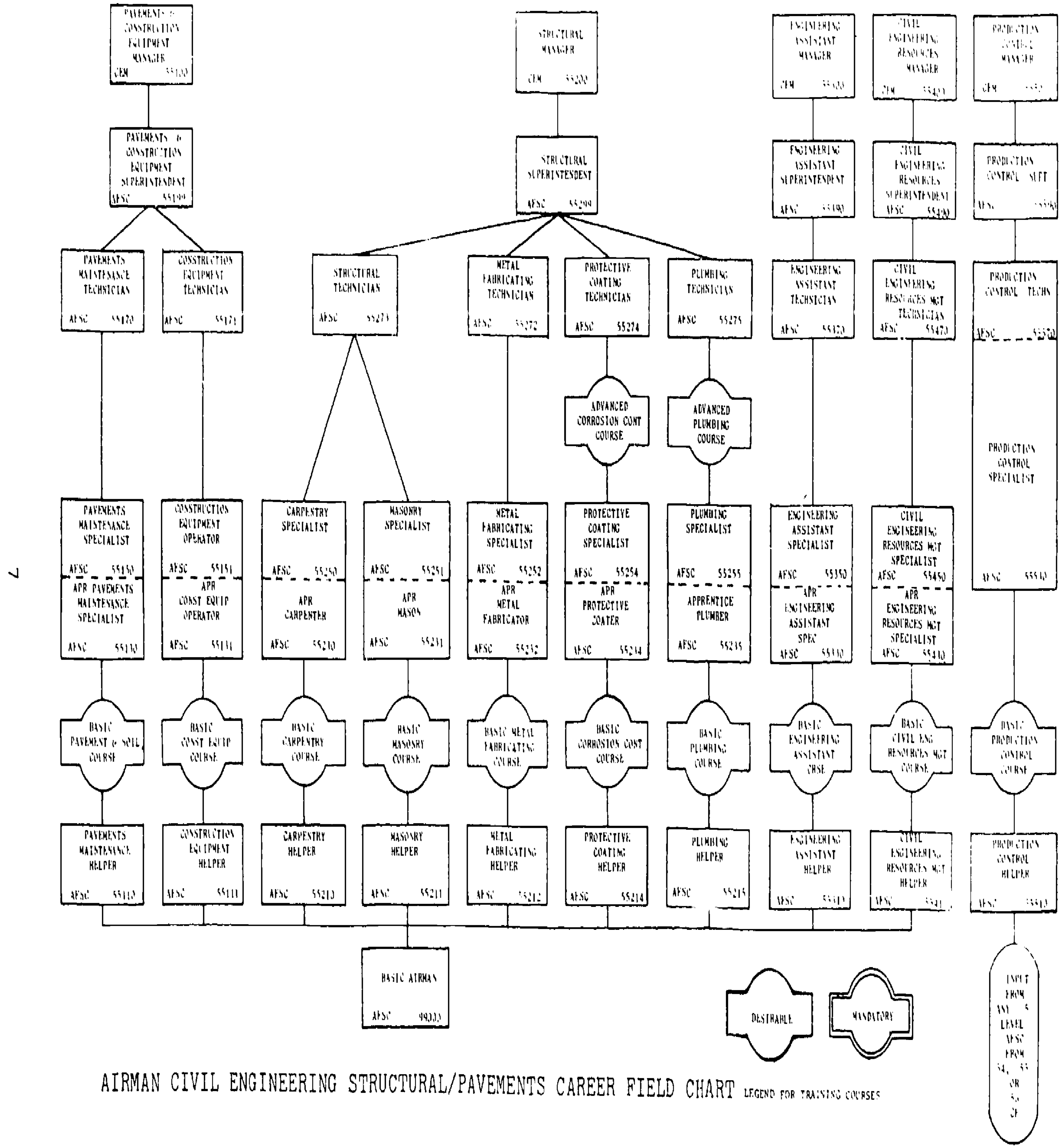

Figure 1-3. Airman Civil Engineering Structural/Pavements Career Field Chart.

3. What is the grade for an apprentice pest management specialist?

4. What is the AFSC and grade spread for the following positions?

   a. Plumbing specialist.

   b. Pavements maintenance technician.

   c. Sanitation superintendent.

5. What is the title and highest grade that can be attained by progressing up the carpentry ladder?

6. Name the five specialists that can progress up the top of the ladder in the 552XX AFSCs.

7. What is the title of the 553XX ladder?

006. Identify tasks of the 55 and 56 career fields with their specific specialty.

Mission of the 55 Career Field. The Airman Structural/Pavements Career Field has a mission of constructing and maintaining base buildings and pavements. It also includes maintaining railroads and soil bases, performing erosion control, and operating heavy equipment. Using figure 1-3 as a guide and working from left to right, here is a summary of the duties of each career ladder at the 5-level AFSC.

Pavement maintenance specialist (AFSC 55150). This specialist constructs, maintains, and repairs airfield pavements, streets, walks, parking areas, and associated drainage. The specialist also inspects, maintains, and repairs railroad beds and tracks. The specialist operates concrete and asphalt batch plants and rock crushing installations. The position calls for sampling and testing soils, gravels, and concrete.

Construction equipment operator (AFSC 55151). The equipment operators holding this position operate and maintain equipment such as dozers, front-end loaders, sweepers, graders, cranes, etc. They use this equipment to level, grade, and fill surfaces. They lift and move objects such as sand and gravel. The specialty calls for excavating ditches, stabilizing and compacting soil, and removing snow and ice from surface areas.

Carpentry specialist (AFSC 55250). A summary of this job includes laying out work and preparing materials for use; constructing, modifying, and repairing buildings; assembling and erecting prefabricated or portable structures; fabricating and repairing interior facilities; constructing packing and shipping containers; maintaining woodworking tools; installing and repairing building hardware; and supervising carpentry personnel.

Masonry specialist (AFSC 55251). Notice in figure 1-3 that as the carpentry specialist and the masonry specialist climb the career ladder, they both become structural technicians at the 7 level. The masonry specialist advises the carpentry specialist in placement and building of forms. They construct concrete footings, foundations, and floor slabs and lay brick, building blocks, stone, and tile. In addition, they plaster the interior and exterior of buildings.

Metal fabricating specialist (AFSC 55252). This specialist fabricates, repairs, installs, and maintains sheet metal articles, parts, and assemblies, such as heating and ventilating ducts, metal roofing, gutters, and downspouts, shower stalls, sink tops, steamtables, and metal buildings.

Protective coating specialist (AFSC 55254). This specialist applies coatings such as paint to structural surfaces. Prior to applying the coating, he or she must prepare the surface by eliminating or neutralizing surface films. The specialist makes surface repairs or patches cracks or holes in wood, metal, masonry, or concrete surfaces with fillers or sealants. Also, he or she applies airfield pavement and traffic markings.

Plumbing specialist (AFSC 55255). Personnel holding this position read and interpret blueprints of plumbing installations. They select types of materials used for plumbing systems. They install and maintain hot and cold water systems and sewage systems and plumbing fixtures, such as heating devices, sinks, toilets, showers, water heaters, radiators, sterilizers, and laundry machinery.

Engineering assistant specialist (AFSC 55350). These individuals perform construction materials tests; prepare engineering drawings; perform plane surveying; assist professional engineers on project design; and perform other general engineering tasks.

Real estate and cost accounting specialist (AFSC 55450). Personnel who work in this position maintain records and accounts for real estate cost-management analysis activities; prepare summaries of statistical, cost accounting, and management data reflecting actual versus planned performance of base civil engineer activities; compare accomplishments with objectives; and ascertain variations from work plans.

Production control technician (AFSC 55570). In this area of CE, there is no 5 skill level. The 55530 is either semiskilled or an apprentice. Note from figure 1-3 that input to this career ladder is any 5-level AFSC from the 54, 55, or 56 career fields. The technician for this AFSC identifies, plans, monitors, and supervises work requirements for maintenance, repair, and minor construction work performed by civil engineering work forces and/or contract and supervises programs and work control activities.

Mission of the 56 Career Field. The Airman Sanitation Career Field includes operating and maintaining water processing and waste processing plants, systems, and equipment. It also includes planning, directing, and conducting pest management operations. There are only two specialties in this career field: pest management and environmental support. A brief description of these specialties follows. In the next section, your specialty description is covered in detail.

Pest management specialist (AFSC 56650). This specialist plans and develops pest management programs, conducts corrective and preventive pest management operations, operates and calibrates pesticide dispersal equipment, ensures proper use of safety equipment, maintains tools and equipment, and supervises pest management personnel.

Environmental support specialist (AFSC 56651). This worker operates, maintains, and repairs potable water treatment and distribution systems; field water treatment equipment, and waste processing plants. The specialist analyzes raw and treated water and applies chemicals as required. He or she monitors sewage and other waste product disposal to avoid polluting the environment.

As you work with people in the 55 and 56 career areas, assume a cooperative attitude. This of course applies to all people with whom you work. It will help CE to get the jobs done faster and better, which is a major objective of base civil engineering.

Exercises (006):

1. Match the career field specialties in column B with the appropriate tasks in column A. Items in column B may be used more than once.

Column A	*Column B*
______(1) Plans work for minor construction.	a. Pavements maintenance.
______(2) Surveys a location to construct a building.	b. Equipment operator.
______(3) Levels the construction site.	c. Carpentry.
______(4) Constructs the concrete floor slab.	d. Masonry.
______(5) Erects the frame of the building.	e. Protective coating.
______(6) Bricks building exterior.	f. Plumbing.
______(7) Places hot and cold pipes inside building.	g. Engineering assistant.
______(8) Installs gypsum boards for inside walls.	h. Resources managment.
______(9) Paints interior walls and ceilings.	i. Production control.
______(10) Keeps records of cost of building.	j. Pest management.
______(11) Constructs parking area and walks for building.	k. Environmental support.
______(12) Operates water plant.	
______(13) Poisons rats.	
______(14) Monitors disposal of trash.	
______(15) Sprays mosquitoes.	

1-3. Specialty Duties and Responsibilities

If your job wasn't important to the Air Force, it wouldn't exist. Without your work, buildings would deteriorate, morale would suffer, and even airfield safety might be compromised. Also, consider the results if there were no control of pests, such as termites, mosquitoes, and birds, and you'll realize just how important you are.

Of course, there are several other vital aspects of your job. In this lesson, we'll dig deeper than in the previous one to fully identify your duties and responsibilities as a pest management specialist or technician.

007. Identify responsibilities of a pest management specialist or technician.

Duties and Responsibilities. AFR 39-1, *Airman Classification Regulation*, is the official document that shows your duties and responsibilities as a pest management specialist. A summary of those duties includes performing procedures for implementing, conducting, and evaluating pest management programs to achieve safe, effective, and economical control and prevention of plant and animal pests. Read the material in figure 1-4 to get a more detailed explanation of your duties and responsibilities.

Pest Management Specialist, AFSC 56630/50. Notice that the document in figure 1-4 covers both AFSC 56630 and 56650. As you learned earlier, the 56630 is an apprentice pest manager; the 56650 is the pest management specialist. Both use the same job description, but the apprentice is semiskilled in the listed duties. As you work on the job with experienced people and as you study this CDC, you will become more knowledgeable and skilled in your job. In a short time you will move up the ladder to become a full-fledged pest management specialist.

You should read your duties and responsibilities a number of times so that you know exactly what your job entails. Later, in this CDC, you will study the specifics of your job—the actual pests, tasks, and procedures for applying control measures and toxic pesticides.

AFSC 56650
Semiskilled AFSC 56630
Helper AFSC 56610

AIRMAN AIR FORCE SPECIALTY

PEST MANAGEMENT SPECIALIST

1. SPECIALTY SUMMARY

Performs procedures for implementing, conducting, and evaluating pest management programs to achieve safe, effective, and economical control and prevention of plant and animal pests. *Related DOD Occupational Subgroup:* 720

2. DUTIES AND RESPONSIBILITIES

a. *Plans and develops pest management programs.* Conducts pest management surveys and researches historical data to determine type and extent of pest management actions required to effectively and economically control or prevent infestations by pestiferous arthropods, vertebrate pests, venomous reptiles, molluscs, fungi, and vegetation. Collects specimens to establish, identify, and determine population density. Researches biological publications to determine breeding and development processes, habitats, appearance cycles, and other important characteristics. Coordinates with medical activities to control health hazards to humans and domestic animals when known or suspected vectors of disease are detected. Uses biological laboratory equipment to prepare and maintain comprehensive laboratory displays of preserved specimens for training purposes and for assisting in the identification of field collected specimens. Coordinates and cooperates with other agencies in assessing environmental and/or operational impact of proposed pest management programs.

b. *Conducts pest management operations.* Analyzes pest management problems and, to the extent practicable, applies integrated control principles consisting of such techniques as drainage or improved management of impounded water, sanitation, vegetation management, mechanical control, and other manipulative practices to minimize the use of pesticides. Selects approved pesticides with the highest target specificity to minimize the effects on nontarget organisms. Cooperates with medical and other agencies in preventing transportation of quarantinable and economic pests. Develops a knowledge of pesticide properties and characteristics and carefully follows labeling instructions to ensure safety to humans and domestic animals and to prevent damage to property and the environment. Maintains accurate records of pesticide usage.

c. *Conducts preventive programs.* Identifies conditions which tend to create an environment conducive to the establishment and propagation of pest infestations and initiates corrective action. Performs preventive measures such as soil poisoning, application of residual pesticides, and pre-emergence herbicides. Detects incipient pest populations and initiates control actions. Checks for changes in pest activity during preventive cycle to prevent population buildups. Selects chemical treatments to provide maximum residual benefits consistent with environmental protection considerations. Maintains records of applied preventive actions.

d. *Operates and calibrates pesticide dispersal equipment.* Operates pesticide dispersal equipment such as thermal and mechanical aerosol generators, turbine mist-dust blowers, hydraulic sprayers, ultra-low-volume generators, and hand-powered dispersal equipment and calibrates to obtain predetermined discharge rates, droplet sizes, and discharge patterns.

e. *Provides for personal protection of pest management personnel.* Ensures the proper use of approved personal protective equipment such as respirators, chemical resistant gloves and aprons, gas masks and breathing devices, coveralls, and protective footwear and headgear. Provides properly functioning and calibrated gas detection equipment for use in fumigation operations. Ensures that pesticide mixing areas are equipped with approved emergency showers and eye washes.

f. *Applies pesticides.* Selects and applies pesticides to areas, ornamental vegetation, pest vegetation, aquatic areas, domestic animals, and other applications as necessary, including indoor and outdoor space applications of aerosols and dusts, and gas tight applications of fumigants. Formulates, applies, and disposes of pesticides in strict compliance with instructions on Environmental Protection Agency (EPA) registered labels. Maintains security and control of hazardous materials.

g. *Maintains tools and equipment.* Maintains all associated tools and equipment, evaluates authorized equipment for performance and ease of maintenance, and recommends modifications or changes. Initiates procurement action for required equipment.

h. *Supervises pest management personnel.* Supervises pest management personnel. Serves as leader of crews engaged in applying pest management techniques. Instructs operating personnel on safety precautions for pest management operations. Supervises personnel when mixing, transporting, storing, and disposing of toxic substances. Instructs personnel in operating, maintaining, and storing equipment and tools.

3. SPECIALTY QUALIFICATIONS

a. *Knowledge.* Knowledge of biological principles relating to plant and animal classifications, life cycles, habitat, identification, disease transmission, and economic importance; principles employed in surveying for, identifying, and controlling populations of plant and animal pests; classification characteristics, and hazards of pesticides, including formulation and application techniques and labeling interpretation; pesticide handling, storage, and disposal procedures; integrated control techniques; safety precautions and first-aid techniques; selection, use, and maintenance of equipment and tools; and Air Force, (EPA), and United States Department of Agriculture (USDA) regulations is mandatory. Possession of mandatory knowledge will be determined according to AFR 35-1.

b. *Education.* Completion of high school with courses in biology, chemistry, and mathematics is desirable.

c. *Experience.* Experience in pest management functions such as application of pesticides and operation and maintenance of pesticide dispersal equipment is mandatory.

d. *Training.* Completion of Pest Management course is desirable.

e. *Other.*

(1) Physical qualification for military drivers according to AFR 160-43 is mandatory for entry in this AFSC.

(2) No record of entomophobia, claustrophobia, or hypersensitivity to pesticidal chemicals or arthropod venoms is mandatory for entry into this AFSC.

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Figure 1-4. Pest management specialist duties and responsibilities.

Pest Management Technician AFSC 56670. Since you will probably work for a technician supervisor and you will work toward being one, you should have some idea of the duties of that job. Refer to figure 1-5, and read it carefully before you complete the following exercise. Since the 7-level technician has progressed through the 5-level position, naturally he or she is able to perform those tasks in addition to those performed at the 7 level.

Exercises (007):

1. Using figures 1-4 and 1-5, mark those duties pertaining to the pest management specialist with a 5, and those pertaining to the technician with a 7. Some duties may apply to both skill levels.

_____ (1) Develops procedures and evaluates effectiveness.
_____ (2) Conducts pest management surveys.
_____ (3) Researches historical data.
_____ (4) Ensures and enforces personal protection of personnel.
_____ (5) Selects and applies pesticides.
_____ (6) Analyzes pest management problems.
_____ (7) Maintains records of pesticide use.
_____ (8) Applies integrated control procedures.
_____ (9) Determines efficiency of pest management procedures.
_____ (10) Maintains records of applied preventive actions.
_____ (11) Identifies conditions conducive to pest infestations.
_____ (12) Maintains records to account for costs.
_____ (13) Prepares schedules and makes work assignments.
_____ (14) Solves complex pest management problems.
_____ (15) Ensures proper use of personal protection equipment.
_____ (16) Maintains security and control of hazardous materials.
_____ (17) Conducts OJT.
_____ (18) Maintains tools and equipment.

1-4. Field Evaluation of Formal School Graduates

Certainly, for you to perform your job properly, you have to be effectively trained. Likewise, for us to give you accurate training, we need feedback from people in the field. In this lesson, we'll discuss the graduate evaluation program, its purpose, and how it's conducted.

008. State the purpose of the graduate evaluation program and the reasons for completing AF Form 1284, *Training Quality Report (TQR).*

Evaluation of Graduates. For ATC to determine the effectiveness of formal schools and Career Development Courses (CDC), it makes an evaluation of recent graduates to find out how well former students are doing on the job. This information is then used to make adjustments in training, and possibly in the specialty training standard (STS). These evaluations are used to determine the:

a. Ability of recent graduates to perform their assigned tasks to the level of proficiency indicated in the STS.

b. Extent to which the acquired skills are used.

c. Extent to which knowledge attained is retained.

d. Need to revise the STS, formal courses, or CDCs in order to improve training effectiveness and responsiveness to the requirements of the using commands.

e. Need for further evaluation of training problem areas by this evaluation of graduates.

We get this information from field evaluation visits, direct correspondence questionaires, and job performance evaluation reports.

In field evaluations, personnel from training activities visit the using agencies to evaluate graduates who have been assigned within 6 months. Evaluation data come from discussions with the graduate, immediate supervisors, or others who know about the graduate's performance. Using an STS as a reference, the graduate is evaluated on the frequency of use and ability to perform the tasks for which trained.

Direct correspondence questionnaires are sent to recent graduates and their supervisor. These questionnaires pertain to the graduate's qualification in terms of the skill and proficiency levels reflected in the approved STS.

Job performance evaluations are made by the immediate supervisor. The supervisor fills out an AF Form 1284 (fig. 1-6) when:

a. A student does not meet the proficiency level specified for a task or knowledge listed in an approved STS. To be objective, the supervisor considers the elapsed time between graduation and operational performance as well as the difference between training equipment and operational equipment.

b. The graduate is not required to perform tasks listed in the STS while working in the assigned AFS.

c. The STS code levels or tasks exceed the requirements of the graduate's AFSC.

There are instructions on the back of the form regarding its completion.

The CDC is evaluated by means of a short questionaire (11 questions) contained in the VRE for the last volume of the course. Information from these questions is then used along with other data to revise the course as needed.

Exercises (008):

1. What is the purpose of the graduate evaluation program?

AIRMAN AIR FORCE SPECIALTY

*PEST MANAGEMENT TECHNICIAN

1. SPECIALTY SUMMARY

Performs and supervises procedures for implementing, conducting, and evaluating pest management programs to achieve safe, effective, and economical control and prevention of plant and animal pests. *Related DOD Occupational Subgroup*:720.

2. DUTIES AND RESPONSIBILITIES

a. *Provides advice on the solution of problems associated with pest management.* Advises subordinates, superiors, and other concerned personnel in planning and managing pest management programs. Solves complex pest management problems and accomplishes tasks beyond the technical capabilities of Pest Management Specialists. Makes appropriate recommendations to other agencies when problems require action beyond the scope of pest management capabilities. Develops procedures for problems not covered by precedent and evaluates effectiveness.

b. *Performs technical pest management functions.* Plans, develops, supervises, and evaluates pest management programs; supervises pest management operations, preventive programs, and operation and calibration of pesticide dispersal equipment. Ensures and enforces personal protection of pest management personnel. Selects and applies pesticides and maintains tools and equipment.

c. *Manages pest management activities.* Inspects buildings, materials, supplies, equipment, shops, and grounds. Determines efficiency of pest management procedures for prevention and control of arthropods, vertebrate pests, vegetation, and fungi. Supervises and inspects technical pest management operations to ensure compliance with pertinent regulations. Ensures that all applications of toxic substances comply with instructions printed on Environmental Protection Agency (EPA) registered labels. Ensures safe storage, handling, and transportation of toxic substances. Ensures timely maintenance and secure storage of tools and equipment. Ensures the environment is not threatened by pesticide misuse. Performs continuous surveillance of facilities and operations to ensure early detection of safety hazards. Monitors pest management operations closely to ensure maximum cost effectiveness. Maintains records to account for costs, to compile historical data, and to ensure effectiveness of the overall pest management program. Reviews results of operational data in an effort to improve the pest management program.

d. *Supervises pest management personnel.* Observes workers during performance of duties to ensure compliance with applicable regulations and prescribed procedures. Ensures that workers comply with EPA registered labeling instructions when formulating, applying, and disposing of toxic substances. Takes immediate action to correct unsafe practices, improperly functioning equipment, and other deviations from prescribed procedures. Prepares schedules, makes work assignments and follows up to ensure compliance with work schedules and assignments. Maintains records on assigned personnel and performs required periodic performance evaluations. Orients new personnel, conducts on-the-job training, and ensures adherence to all applicable personnel directives.

3. SPECIALTY QUALIFICATIONS

a. *Knowledge.* Knowledge of biological principles relating to plant and animal classification, life cycles, habitat, identification, disease transmission, and economic importance; principles employed in surveying for, identifying, and controlling populations of plant and animal pests; classification, characteristics, and hazards of pesticides, including formulation, application and disposal techniques and labeling interpretations; pesticide handling, storage, and disposal procedures; integrated control techniques; environmental protection techniques; safety precautions and first-aid techniques; selection, use, and maintenance of equipment and tools; and pertinent regulations is mandatory. Possession of mandatory knowledge will be determined according to AFR 35-1.

b. *Experience.* Qualification as a Pest Management Specialist is mandatory. In addition, experience in performing or supervising functions such as testing, controlling, and preventing insects and other arthropods, vertebrate pests, vegetation and fungi; or inspecting, troubleshooting, and operating spraying, dusting, and fumigating equipment is mandatory.

c. *Training:*

(1) Completion of an advanced pest management course is desirable.

(2) Completion of prescribed 7-level management course is mandatory.

d. *Other.* No history of entomophobia, claustrophobia or hypersensitivity to pesticidal chemicals or arthropod venoms is mandatory for award and retention of this AFSC.

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Figure 1-5. Pest management technician duties and responsibilities.

TRAINING QUALITY REPORT (TQR)

1961 CG/CCQT APO San Francisco	TO: HQ ATC/TTSE RANDOLPH AFB TX 78148		TO: HQ AFCC/MPXT	
Doe, John L.	508-54-3793	SSgt	1961 Comm Gp/FFCZ	Clark AB, RP
3ABR27230	Air Traffic Control Operator	June 8X	272X0	Air Traffic Control Oper/Tech — Dec 198X

JOB AREA	ITEM NO	PROFICIENCY CODE	REMARKS
General Control	8f	2b	SSgt Doe was unfamiliar with flight plan and control information; required extensive OJT to meet the "2b" standard.
IFR Operations	9b	2b	Not familiar with clearance limits, airway structures, clearances from center.
Wake Turbulence	12b,c	2b	Not sufficiently trained on applying separation radar or nonradar to progress satisfactorily to higher skill levels. Repeated OJT required to meet minimum requirements.
Precision Radar	15b(1)	2b	Individual could not operate precision radar; totally unfamiliar with procedures. SSgt Doe stated he did not remember covering the subject matter during tech school.

19 Feb 8X	SSgt Joe Q. Smith	893-XXXX

AF FORM 1284

Figure 1–6. Sample, AF Form 1284.

2. List three requirements for the supervisor to complete AF Form 1284.

3. Personnel from training activities visit using agencies within how many months after the graduates are assigned?

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CHAPTER 2

Managing Activities and Resources

THE MANAGEMENT philosophy of the Air Force includes getting maximum efficiency for each dollar spent while reaching planned objectives. This means you must use human, material, and financial resources as effectively as possible to meet the organization's goals. As you supervise or work with people, ask and answer these two questions: "Is the job being done well?" and "Is there a better way to do it?"

The key to improving work isn't necessarily an attempt to speed it up by prodding people. Substandard work may be brought up to standard by planning projects better, improving material support, eliminating delays, and coordinating with other people. So plan your projects well with activities and resources in mind.

2-1. Managing Activities

The Air Force owns a tremendous amount of property that must be operated, maintained, and managed properly. To do this, the Air Force uses a program concept that is planned in advance. The program includes allotting materials and labor hours for work and services done by CE troops. Various management techniques and forms are used by CE personnel, and information is maintained in a computer. Printouts from the computer give data that helps CE managers make effective decisions.

009. Specify characteristics of the civil engineering management system.

Civil Engineering Management System. Have you ever heard the phrase "prior planning prevents poor performance"? Well, its true, particularly when its applied to civil engineering. Satisfactory job performance is possible when good planning—or good management—is exercised. Let's look into what the CE management system is like and how it works to meet the variety of base engineering needs.

Production control center. Although you won't find it on the BCE organizational chart, the production control center (PCC) is the nerve center of CE operations. It includes a variety of people, generally in one main location, who direct CE work activities. Personnel in the PCC include the chief of operations, chief of resources and requirements, programmers, schedulers, controllers, and superintendents. There is also the service call room and the customer service unit (CSU).

The PCC's motto could easily be "proper planning to ensure professional performance." Helping the BCE fulfill the responsibilities of effectively maintaining base facilities doesn't just happen, however. The PCC uses a variety of techniques to make sure work needs are identified and satisfied.

Facility survey. This is one of the main tools used by the PCC to identify work needed on base facilities. Facility surveys are made periodically on pavements, buildings, grounds, and utility systems to identify major work requirements.

The chief of planning usually picks surveyors who are familiar with the facilities and types of work involved. The surveyor records work requirements on AF Form 1135, BCE Real Property Maintenance Request, along with rough work-hour estimates by shop for each work request on the form.

After the form has been processed, the CSU reviews it and prepares the appropriate work authorization documents (we'll discuss these later in this chapter).

Recurring work. Of course, not all the work done by CE needs to be reported in a facility survey. When there is a series of jobs consisting of operations, recurring maintenance, service work, and other work for which the scope and level are known without an earlier visit to the job site, we call it *recurring work*. Recurring work includes such jobs as snow removal, pest management services, cleaning pavements, and cutting grass. Basically, this program encompasses all work of a normally recurring nature except utility operations and contracted services.

NOTE: You want to be careful about adding pest management operations to the recurring work program. There are many factors that can affect regular pest management schedules, such as the weather, the season, pest populations, the presence of nontarget animals, etc. In Volume 2, you'll learn about conducting pest management surveys and documenting your findings. Use these findings to determine if certain pest management functions in your shop should be included in the recurring work schedule.

For services and operations, the shop supervisor reports recurring work requirements on AF Form 1841, Maintenance Action Sheet. This form is then sent to the section superintendent for approval. The hours workers spend on recurring work are authorized on AF Form 561, Base Civil Engineering Weekly Work Schedule. Controller assignments are made and controlled either by daily or weekly work packages. The worker keeps the job completion cards together for each package until he or she reports that the jobs are completed. When the work is done, the worker calls the controller to report the completion time and the actual amount of time it took to do the work.

Inservice Work Plan (IWP). You've probably heard of IWPs, and there is much we could discuss about them. Their impact on you, however, is minimal. Briefly, IWPs are used to time phase work done by the shops and to make and keep commitments to BCE customers. It allots work hours to repairs, maintenance, operations, services, and CE-initiated minor construction work. The IWP programmer uses the report to ensure that workloads are adequate to keep all shops productively employed.

Base engineer automated management system. In civil engineering it is necessary to keep an enormous amount or records. These records include the amount and types of pesticides dispersed on base; amount of refuse disposed; labor hours required to operate water plants; and size, shape, condition, and cost of each facility. Many other records are required by law to be kept. Even your name and employee number are part of the records. When information of this sort is needed, civil engineering merely asks the computer in symbols it understands to furnish this information. In a matter of seconds the computer replies with up-to-date answers.

The name used to identify the automated data processing system is BEAMS. This abbreviation stands for base engineer automated management system. The computer used is the Burroughs B–3500. BEAMS provides a means of automating a large number of civil engineering records and files. These files are maintained with ease and efficiency. It is important that they provide information for a great variety of computer products that are available to managers on demand. These products are used by managers to make many important decisions. Actions of most all personnel within civil engineering affect the information within the computer files and records and, ultimately, influence the content of the management products. These influences are either direct, as are the actions of personnel who maintain cost, real property, work control, and programming record files; or indirect by the actions of personnel who report the labor hours and materials used to finish an assigned job. It is of utmost importance that all civil engineering people know that their actions directly or indirectly influence the accuracy of the information contained in the automated system and, consequently, the management products that the system produces. The reliability of their contribution builds their own faith in BEAMS and the decisions of those who use it.

Exercises (009):

Identify each true statement and correct the ones that are false.

_____ 1. The customer service unit is the nerve center of CE operations.

_____ 2. A facility survey is periodically made for each facility on base to identify major work requirements.

_____ 3. The facility surveyor identifies work requirements on AF Form 561, Base Civil Engineer Weekly Work Schedule.

_____ 4. Work for which the scope and level is known without an earlier visit to the job site is called inservice work.

_____ 5. Recurring work requirements are reported by the section superintendent and approved by the chief of operations.

_____ 6. Controller assignments for recurring work are made by either daily or weekly work packages.

_____ 7. As each work item is completed, the worker informs the controller as to completion time, actual time requirements, and materials used.

_____ 8. Work hours for maintenance, operations, services, and CE-initiated minor construction work are allocated in the inservice work plan.

_____ 9. The base engineer automated management system (BEAMS) is used to process civil engineering records.

010. Identify Air Force forms used for requesting given work orders.

Requesting Work. The requests for work to be done on an Air Force base far exceed the CE resources available. Resources for essential construction, operation,

1. TO (Base Civil Engineering): 58TH CES. NELLIS AFB, NEVADA
2. FROM: (Organization) 58TH CPS
3. REQUESTER'S NAME AND PHONE NO: Paul Grady / 2879
4. WORK REQUEST, WORK ORDER NO: 28656
5. DATE OF REQUEST: 15 Jun 82
6. BUILDING OR FACILITY NO.: 595
7. REQUIRED COMPLETION DATE: 1 Dec 82
8. OFFICE SYMBOL: SPOL
9. WORK REQUESTED: INSTALL DURESS ALARM SYSTEM IN THE SMALL ARMS STORAGE ROOM.
10. JUSTIFICATION: THIS DEVICE IS NEEDED TO PROVIDE ADDITIONAL PROTECTION TO THE SMALL ARMS STORAGE AREA.
11. DONATED RESOURCES: NONE
12. DATE SIGNED: 18 JUN 82
13. ORGN CODE: 605
14. NAME, GRADE, SIGNATURE OF ORGANIZATION COMDR: R. F. DARDEN, COL USAF — Robert F. Darden
15. COORDINATION (Office Symbol, Initials and Date)

FOR BCE USE ONLY

16. WORK CLASS	17. INSTALLATION PRIORITY	18. ESTIMATED HRS	19. TOTAL ESTIMATED COST	20. ESTIMATED FUNDED COST	21. PROJECT NO	22. JOB ORDER NO
MC	II	100	$3,750	$1,650	28656	

APPROVAL/DISAPPROVAL

23. BCE RECOMMENDATION: ☒ APPROVAL ☐ DISAPPROVAL
24. METHOD OF ACCOMPLISHMENT: ☐ CONTRACT ☒ IN-SERVICE ☐ SELF-HELP
25. DATE SIGNED: 19 SEP 82
26. SIGNATURE BASE CIVIL ENGINEER: Lawrence E. McGowan
27. ACTION TAKEN: ☒ APPROVED ☐ DISAPPROVED
28. ACCOMPLISHED BY: ☐ CONTRACT ☒ IN-SERVICE ☐ SELF-HELP
29. DATE SIGNED: 22 SEP 82
30. NAME, GRADE, TITLE AND SIGNATURE OF APPROVING AUTHORITY: JAMES E. CARROLL, COL USAF COMMANDER — James E. Carroll
31. REMARKS

AF FORM 332 AUG 79 PREVIOUS EDITION WILL BE USED — BCE WORK REQUEST (Use AF Form 1135 for Maintenance and Repair Requests) — SUSPENSE COPY

Figure 2-1. Sample. AF Form 332.

maintenance, repair, and services must be given first priority. If, for example, you want 150 feet of concrete sidewalk constructed near your shop, you would request this work on an AF Form 332, BCE Work Request (fig 2-1). Because of the large number of work requests, you must explain why the work is needed. You must also include an impact statement--that is, a justification concerning your organization and its mission if the work is not done. The approving authorities will use this justification to decide which work should be approved. Since the mission comes first, it is obvious that those requests that have the greatest impact on the mission have the best chance of being approved.

BCE Work Request (AF Form 332). There are a number of ways people may request work or services from civil engineering. One way is to use AF Form 332. This form may be used as a request for work and as a work approval or disapproval document.

Since you may desire to submit an AF Form 332 to request work, you should know the types of work that apply the form. The 332 is used to request:

a. Inservice construction or minor construction work.
b. Maintenance and repair work done by contract.
c. Work on leased facilities, except minor repairs.
d. Self-help work.
e. Locally manufactured supply or equipment items.
f. Minor construction work costing less than $2000 for base facilities or $100 for military family housing.

You should have no trouble preparing the work request since instructions are on the back of the form. Figure 2-1 is a completed copy of the front of the form. The description of the work requested (block 9) should be supported where possible by sketches, plans, diagrams, specifications, photographs, drawings or any other information that will provide a clear, complete description of the work you request.

Notice item 23 of figure 2-1. It is the BCE's recommendation. The approving authorities use this recommendation and other data on the form to decide its action or approval. If, for instance, the base civil engineer recommends disapproval because required resources are not available, it is highly probable that the board will disapprove the work request.

BCE Real Property Maintenance Request, AF Form 1135. Building custodians and facility survey inspectors use AF Form 1135 (fig. 2-2) to identify for CE routine maintenance and repair needs for the facilities. Examples of

BCE REAL PROPERTY MAINTENANCE REQUEST

Use to identify routine maintenance or repair requirements that are not an emergency or urgent in nature. Prepare and forward original and one copy to BCE for each facility on which work is requested. Keep the last copy for your file.

TO: Base Civil Engineering	FROM: *(Name, Grade, and Organization)* TSGT GUNNER 773 CES	RETURN TO: *(Office Symbol)* DEHP
1. FACILITY NO. OR MFH STREET ADDRESS 2483		2. PHONE NUMBER(S) 6234 / 6235

3. DESCRIPTION OF WORK REQUIREMENTS *(A thorough description of maintenance requirement(s) will minimize the need for CE personnel to visit the job site to determine what work is requested and what tools, equipment, and materials are needed, thereby completing the work on the first attempt. Answer these questions: What? Where? How many? Type/size? Color? Rate? Urgency? Time restrictions?)*

1. REPAIR PANIC HARDWARE ON EXTERIOR DOOR NE OF BUILDING

2. REPLACE DOOR KNOB ON INTERIOR DOOR OF ROOM 4.

FOR CE USE ONLY

9. DATE RECEIVED

10. ACTION

4. DATE OF REQUEST 17 March 83	SIGNATURE OF REQUESTOR Clinton Gunner	
5. REVIEW/ACTION BY CUSTOMER SERVICE	DATE	SIGNATURE
6. REVIEW/ACTION BY CHIEF PRODUCTION CONTROL	DATE	SIGNATURE
7. ASSIGNED FOR ACTION	A. FUNCTION/INDIVIDUAL	B. ACTION REQUIRED
8. CUSTOMER NOTIFIED	DATE	SIGNATURE

AF FORM MAR 79 1135 PREVIOUS EDITION WILL BE USED. STATUS COPY

Figure 2-2. Sample, AF Form 1135.

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this type of work are repairing a screen door on MFH, replacing cracked floor tiles in a building, and repairing a leaky cold water faucet in a latrine.

Service calls. The service call method of requesting work is used for emergency and urgent job orders. Examples of emergencies are:

a. Loss of steam in a steam-heated building.
b. Water flooding the floor in a kitchen.
c. Water pressure failure in military family housing.
d. Electrical power failure in a facility.
e. Clogged plumbing in a latrine.
f. Leak in a natural gas line.
g. A window knocked out in subzero weather.

When situations similar to the above occur, the service call is used to correct them. Under the service call concept, BCE uses two ways to meet emergency needs: the do-it-now (DIN) service call and the shop referred service call.

Do-it-now (DIN) service calls. If you must call the service call specialist (SCS) in CE regarding an emergency situation, such as a stuck latrine valve, the service call specialist will notify a DIN plumber by two-way radio and dispatch him or her to your location. The DIN plumber, like other shop workers, has a DIN vehicle stocked with parts, tools, and equipment needed to perform service call work.

The goal of service call management is to get the job done right the first time and every time. You should expect the DIN plumber to unstick the latrine valve and perform maintenance on it so that it will not stick again. CE expects DIN workers to complete the job on the first trip to the job site. To do this, the SCS must get all the information necessary to clearly describe the job to the worker. The SCS must be courteous but must find out if a danger exists; what the problem consists of; when, where, and how it happened; make, type, size, or color; urgency of need; and any time restrictions. Although there is not a time established for DIN calls, it is essential that the DIN capability be kept as mobile as possible.

Shop referred service calls. A service call can be referred to a shop only with coordination through the PCC. A service call would be referred to a shop for completion if it meets at least one of the following conditions:

a. If the work appears to be beyond the DIN capability.
b. If the DIN craftsman is unable to complete the work.
c. If the work would require more than a reasonable time to be completed by the DIN craftsman. (Not limited to one hour but should not be tied up for several hours.)

For any service call referred to the shop, the service call specialist prepares an AF Form 1879, BCE Job Order Record (fig. 2-3).

Exercises (010):

For each of the following written requests for work, indicate whether it should be submitted on AF Form 332 or AF Form 1135. Write the correct form number in the appropriate blank.

_____ 1. Request BCE to repair floor tile in MFH quarters.

FACILITY NO.	ACTIVITY OR STREET ADDRESS					DATE		TIME		JOB ORDER NO.
NAME AND GRADE OF REQUESTOR						PHONE NO./ALTERNATE		COLLECTION WORK ORDER NO.		
SERVICE REQUIRED							ZONE NO.	TYPE OF SERVICE: EMERGENCY / URGENT / ROUTINE		SMART / MFH / MC
							WORK ID CODE		ESTIMATED TOTAL TIME	
REQUIRED COMPLETION DATE			ESTIMATED COMPLETION DATE				CREW SIZE		ACTUAL TOTAL TIME	
AREA/FACILITY WHERE JOB IS LOCATED							REMARKS *(Tools, equip, materials, special craftsman multi-shop notes, etc.)*			
DANGEROUS CONDITIONS EXISTING *(if any)*										
RESTRICTIONS *(time, entry, security)*										
MAKE OF EQUIPMENT			TYPE/SIZE OF ITEM		COLOR OF ITEM					
ASSIGNED TO	DATE	TIME	COMPLETED BY	DATE	TIME	INITIALS	LUC 12	LUC		
REFERRED TO	DATE	TIME	COMPLETED BY	DATE	TIME	INITIALS	LUC 12	LUC		
DEFERRED TO	DATE	TIME	DISPOSITION		AUTHORIZED					

AF FORM 1879 PREVIOUS EDITION IS OBSOLETE. BCE JOB ORDER RECORD

Figure 2-3. AF Form 1879.

_____2. Request BCE to erect a new wall in an existing building.

_____3. Request BCE approval for you to paint your shop office and locker room using BCE-supplied paint and materials.

_____4. Request BCE to repair door hardware on an exterior metal door.

_____5. Request BCE to construct an equipment storage shelf for your shop.

Identify these statements as being true (T) or false (F). Correct the false statements.

_____6. Replacing two damaged roof shingles in an MFH should be requested through service call.

_____7. You should call service call if the backdoor of your shop won't lock at quitting time.

_____8. Service calls are used only for urgent and routine work.

_____9. If a DIN worker can't complete an emergency job, it will be referred to a shop.

_____10. If your MFH tub is stopped up, you should report it to service call.

011. Cite the work authorization form needed to perform various work actions.

Work Authorization Documents. All CE work must be authorized on official work documents; but AF Forms 1135 and 332 are *not* work authorizing forms in the strict sense of the word; they're work request documents. Even when they're approved, they are not the types of forms needed to spend Air Force resources.

You will come in contact with three Air Force Forms that authorize spending resources (materials or labor hours). They are BCE Job Order Record, AF Form 1879; Base Civil Engineer Work Order, AF Form 327; and BCE multi-Craft Job Order, AF Form 1219.

BCE Job Order Record, AF Form 1879. The BCE job order record is probably the one you see the most (fig. 2-3). It's used to authorize work that doesn't need detailed planning, special costing, close coordination between shops, or lots of materials. In addition to emergency and urgent service call type jobs, AF Form 1879 also authorizes:

a. Routine work work that should be done within 30 calendar days but doesn't qualify as emergency or urgent work.

b. Structural maintenance and repair team (SMART) work—read on, we'll discuss this later.

c. MFH work—minor work costing less than $100.

d. Minor construction work—work (not in MFH) costing less than $2000.

Base Civil Engineer Work Order, AF Form 327. This form is used to authorize work needing detailed planning, special costing, close coordination between shops, or large bills of material (fig. 2-4). Work authorized by this form isn't likely to *directly* affect you as a pest manager, but an AF Form 1879 may be submitted that calls for pest management work to support a larger operation covered by AF Form 327.

BCE Multi-Craft Job Order Record, AF Form 1219. This form is used to authorize structural maintenance and repair team (SMART) work and multiple family housing (MFH) renovation jobs (fig. 2-5). The SMART team has workers with various AFSCs who perform routine minor maintenance and repair work in high-use facilities such as MFH and dormitories. As you read earlier, AF Form 1879 can also be used to authorize SMART jobs. Here's the difference: The AF Form 1219 is the primary form for this type of work. But after it's approved by the PCC chief, if new SMART team work is needed in addition to what's listed on AF Form 1219, this new work can be authorized simply and quickly on AF Form 1879.

Exercises (011):

Indicate which form (AF Form 1879, 327, or 1219) should be used to authorize the following work actions. Write the correct form number in the given blank.

_____1. Apply pesticide to base headquarters for cockroach control.

_____2. Replace tile, paint walls, and repair bathtub plumbing in vacant MFH.

_____3. Apply new tile caulking to MFH bathroom.

_____4. Construct new parking lot next to control tower. Apply soil sterilant before pouring concrete.

_____5. Replace dryer receptacle, replace safety strips, and install new doorknob in dormitory laundry room.

_____6. Install three partitions, 10′ × 20 × 8′ each, with security wire from top of partition to ceiling.

1. INSTALLATION NAME	2. WORK REQUEST NO.	3. PROJECT NO.	4. REQUESTER'S NAME AND PHONE NO.	5. CHANGE ORDER NO.	6. LUC	7. WORK ORDER NO.
A. CONTROL SHEPPARD AFB B. OTHER			TSGT QUDDIA, 6559			24950

8. STATEMENT OF WORK

INSTALL 3 EA. PARTITIONS 10' x 20' x 8' WITH SECURITY WIRE FROM TOP OF PARTITION TO CEILING. PARTITION TO HAVE ONE SECURITY DOOR MADE OF METAL.

11. TOTAL ESTIMATED COST $1850.00

13. AUTHORIZATION: A. SIGNATURE; B. DATE

14. COMPLETION: A. SIG OF COST CENTER SUPVR; B. COST CENTER NAME; C. ACTUAL COMPLETION DATE

9. WORK ORDER MASTER FILE (Remote Input Format) (Card Columns 1–109)

TRANSACTION IDENTIFIER 1-7	8	CONTROL INSTL 9-12	CC 13	WORK ORDER NO. 14-18	YN 19	WI 20	NR SH 21-23	INSTL INDICATOR 24-27	WC 28	RRI 29-30	FACILITY I.D. NO. 31-35	FAC SUF 36-37	COST ACCOUNT 38-42	PR 43	CI 44	QO 45	WORK DESCRIPTION 46-75	SI 76	ORG CODE 77-79	TI 80
WCM-ADD	.	AAAA	A	24950	'	A	03	AAAA	C	E	01924		73001				INSTALL PARTITIONS			

9. CONTINUATION OF REMOTE INPUT FORMAT

WO OPENING DATE 81-86	EST. START DATE 87-92	EST. COMP. DATE 93-98	EST. NON-AF EXCESS MAT. 99-105	RC	DE	FI	OT	RES
820223	820418	820425						

10. INPUT FORMAT WHEN USING PSEUDO REMOTE

CARD COLUMNS 1-80—USE FORMAT ABOVE FOR TRANSACTION NO. 1
CARD COLUMNS 1-80—USE FORMAT BELOW FOR TRANSACTION NO. 2

REPEAT CARD COLUMNS 1 - 19 ABOVE 1-19	YN 20	WO OPENING DATE 21-26	EST. START DATE 27-32	EST. COMP. DATE 33-38	EST. NON-AF EXCESS MAT. 39-45	RC 46	OS 47	FI 48	RES 49-51	BLANK 52-80

11. WORK ORDER SHOP FILE (Remote/Pseudo Remote Input Format)

TRANSACTION IDENTIFIER 1-7	8	CONTROL INSTL 9-12	CC 13	WORK ORDER NO. 14-18	COST CENTER 19-21	22	NO. REQUIRED 23-25	ESTIMATED LABOR HRS. 26-30	ESTIMATED SHOP RATE COST 31-37	ESTIMATED DIRECT MATERIAL COST 38-46	ESTIMATED PROJECT CONTRACT COST 47-55	ESTIMATED SERVICES CONTRACT COST 56-66	ESTIMATED OTHER COST 66-75	BLANK 76+
WCN-ADD	.	AAAA	A	24950	451	.	015	01500	0067500	000037000				
WCN-ADD	.	AAAA	A	24950	451	.	004	00350	0021400	000001500				
WCN-ADD	.	AAAA	A	24950	451	.	006	00250	0026240	000007500				
WCN-ADD	.					.								
WCN-ADD	.					.								
WCN-ADD	.					.								
WCN-ADD	.					.								
12 TOTAL														

AF FORM 327 FEB 81 PREVIOUS EDITION IS OBSOLETE. BASE CIVIL ENGINEER WORK ORDER

Figure 2–4. Sample, AF Form 327.

BCE MULTI-CRAFT JOB ORDER			JOB ORDER NO
COST CENTER	COLLECTION WORK ORDER NO.	FACILITY NO.	DATE PREPARED
NAME OF INSPECTOR	USING AGENCY	INDIVIDUAL TO CONTACT *(Name & Phone No.)*	

WORK DESCRIPTION	LOCATION	MATERIALS			M/HR. EST.	CRAFT	INCOMPLETE WORK
		ITEM	QNTY	U/M			

AF FORM MAY 78 1219 PREVIOUS EDITION IS OBSOLETE.

Figure 2–5. AF Form 1219.

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QUALITY CONTROL EVALUATION			JOB ORDER/WORK ORDER NUMBER
This questionnaire is designed to improve Civil Engineering service to you. Answer all questions and place in base distribution			
TO: BASE COMMANDER BASE CIVIL ENGINEER In Turn	FROM: *(Base Address, include Bldg/Qtrs. No.)*		DATE SERVICE COMPLETED
SERVICE REQUESTED			
DUTY SECTION OF WORKER	WORKER'S SIGNATURE		

QUESTIONNAIRE *(Explain all no answers)*	YES	NO
1. BASE CIVIL ENGINEER PERSONNEL WERE COURTEOUS.		
2. BASE CIVIL ENGINEER RESPONSE WAS TIMELY.		
3. RECEIVED ADEQUATE NOTIFICATION AS TO WHEN THE WORKER WOULD ARRIVE. *(If applicable)*		
4. WORKER UTILIZED TIME EFFICIENTLY.		
5. JOB WAS COMPLETED.		
6. IF NOT, WERE YOU GIVEN AN ESTIMATED COMPLETION DATE FOR THE JOB?		
7. WORK WAS PERFORMED SATISFACTORILY.		
8. JOB SITE WAS CLEANED UP AFTER COMPLETION.		

REMARKS	
CUSTOMER'S SIGNATURE	DATE

AF FORM NOV 78 1255 PREVIOUS EDITION WILL BE USED. ☆U.S. Government Printing Office 1981—340-878/812

Figure 2-6. AF Form 1255.

012. Given necessary information, make appropriate entries on AF Form 1255, Quality Control Evaluation.

Monitoring Customer Satisfaction. What is the first thing you should do when you arrive at a new job site? Pump up your sprayer? Survey the area? Actually, you should give your customer an AF Form 1255, Quality Control Evaluation (fig. 2-6).

The purpose of this form is simple. It's to motivate you to give timely and quality service to BCE customers. It's also a management tool used to improve customer relations and your productivity. This form says to your customers that you care about your work and so does the BCE. By giving your customer this form at the beginning of the job, he or she knows on what to evaluate you as you do the work.

There are some entries you should make on this form before you hand it over, none of them having to do with the worker's good looks and charm. Specifically, you should include:

a. Job or work order number.
b. Description of the service requested.
c. Facility number.
d. Your name.
e. Your duty section.

After your customer completes the form send it to the base commander and then the BCE. Each month, IE gives the BCE statistics for all CE shops regarding notable evaluations (both good and bad). Operations superintendents and supervisors also get the results through the chief of operations.

Exercises (012):

1. Use figure 2-6 to complete this exercise. Use the following information to complete the parts of AF Form 1255 you are responsible for as a worker.
Job order number: 5826.
Customer name: SSgt Hipsley.
Building number: 1927.
Work requested: control rodents in basement.
Action taken: placed glue traps in basement.

013. Given necessary information determine appropriate entries on AF Form 561, part I.

Preparing Work Schedules. For recurring work to be scheduled, it must first be identified. To do this, the shop supervisor uses AF Form 1841, Maintenance Action Sheet (MAS). This is filled out for each shop having services or operations and serves to identify the nature, scope, and location of the work to be done. All of this should be completely accurate since it covers a whole month. The completed MAS is then reviewed and approved by the appropriate section superintendent.

At this point, all recurring work requirements are ready to be scheduled. This is done on AF Form 561, Base Civil Engineering Weekly Work Schedule (fig. 2-7). The scheduler and supervisor work together to complete this form, the supervisor being primarily responsible for Part I of the form. This gives the scheduler an estimate of the total work hours available in that shop. Later, at the CE weekly scheduling meeting, the scheduler and supervisor consolidate required maintenance actions by area and facility to help minimize travel and setup times. Then as the work is done, the scheduler completes Part II of the AF Form 561.

Now that you have an idea of how scheduling is done, look at the kind of information you put on AF Form 561, Part I. Refer to figure 2-7 as you continue the lesson.

Column A is a description of where your labor force comes from and what it spends time doing. Column C describes the number of hours people in your shop will spend on each type of work. For example, if you have six people assigned to your shop, each working an 8-hour day and 5-day week, you would enter "240" in line 1, column C ($6 \times 8 \times 5 = 240$). If you were experiencing lots of termites this season, you may have borrowed two workers from other shops for that week. Then you would enter "80" on line 2, Column C ($2 \times 8 \times 5 = 80$). After you come up with the total work hours available for that week, you would then space them out for the coming week as your work load dictated.

Get the idea? Find out by using the information you just learned to complete the following exercises.

Exercises (013):

1. Indicate the correct order in which the following steps are done by entering 1 through 5 in the appropriate space.

_____ (1) Scheduler and supervisor consolidate required maintenance actions.
_____ (2) Shop supervisor completes AF Form 1841, MAS.
_____ (3) As work is done, scheduler completes Part II of AF Form 561.
_____ (4) Section superintendent reviews and approves completed MAS.
_____ (5) Shop supervisor completes AF Form 561, part I, or gives the scheduler necessary information.

2. Use the following information to complete appropriate parts of AF Form 561, Base Civil Engineering Weekly Work Schedule in figure 2-8. Assume you are the shop supervisor.

(1) You have six other people assigned to your shop (don't forget yourself).

(2) For the coming week, you're borrowing one person from pavements and grounds for herbicidіng operations.

(3) You'll spend 20 hours next week on supervision.

(4) One airman will be on leave for 3 days, Monday–Wednesday.

On figure 2-8, enter the appropriate work hours in Column C for each category. Then enter your estimated schedule for the hours available in each category for the coming week.

014. State the purposes of labor-hour accounting, the two methods of time accounting, and the correct procedure to record labor hours expended.

Labor-Hour Accounting. A labor-hour accounting system is designed to provide a uniform method of maximum accuracy with minimum effort and cost. Labor-hour accounting provides CE management and base accounting and finance with direct labor costs against work order numbers. It also helps CE management direct and control manpower resources. There are two methods of time accounting, the actual time accounting (ATA) system and the exception time accounting (ETA) method. Each BCE uses one method or the other to report labor.

Actual time accounting (ATA). Cost centers of BCE using ATA report the total number of direct hours expended against each work order number by labor utilization code (LUC) and the total number of indirect hours charged to another LUC. An AF Form 1734, BCE Daily Work Schedule, is used by ATA cost centers to record labor hours daily. An AF Form 1734 is shown in figure 2-9.

The back of the form is used to record the indirect hours, such as leaves, etc., and to compute the total direct and indirect hours for the day. The back of the form is not shown in the figure.

BASE CIVIL ENGINEER WEEKLY WORK SCHEDULE (PART I)	WEEK ENDING	COST CENTER	APPROVED
	5 Aug 83	493	C. Nath

LINE NO.	DESCRIPTION A	LABOR UTIL. CODE (LUC) B	MAN/HRS. C	MANHOUR ALLOCATIONS MON SCHED	MON ACT	TUES SCHED	TUES ACT	WED SCHED	WED ACT	THU SCHED	THU ACT	FRI SCHED	FRI ACT	SAT SCHED	SAT ACT	SUN SCHED	SUN ACT
1	ASSIGNED		400	80		80		80		80		80					
2	BORROWED																
3	OVERTIME	38	16											16			
4	TOTAL AVAILABLE (total of items 1,2,and 3)		416	80		80		80		80		80		16			
5	SUPERVISION	31	40	8		8		8		8		8					
6	TRAINING	32	16							8		8					
7	LEAVE	33	24	8		8		8									
8	ALL OTHER	34															
9	LOANED LABOR	39															
10	TOTAL INDIRECT (total of items 5 through 9)		80	16		16		16		16		16					
11	AVAILABLE FOR WORK (Items 4 minus Item 10)		336	64		64		64		64		64		16			
	PART II (RESERVED MAN-HOURS)																
12	EMERGENCY JOB ORDERS	12															
13	DIRECT SCHEDULED WORK	16															

THE ITEMS BELOW COMPETE FOR AVAILABLE MAN/HRS. (SCHEDULED WORK)

WORK ORDER JOB ORDER NUMBER	DESCRIPTION A	(LUC) B	MAN/HRS REQ. C	MON SCHED	MON ACT	TUES SCHED	TUES ACT	WED SCHED	WED ACT	THU SCHED	THU ACT	FRI SCHED	FRI ACT	SAT SCHED	SAT ACT	SUN SCHED	SUN ACT
	RECURRING MAINTENANCE	11															
	OPERATIONS AND SERVICES	19															

AF FORM MAY 78 561 PREVIOUS EDITION IS OBSOLETE.

Figure 2–7. Sample, AF Form 561.

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BASE CIVIL ENGINEER WEEKLY WORK SCHEDULE (PART I)				WEEK ENDING				COST CENTER				APPROVED					
LINE NO.	DESCRIPTION	LABOR UTIL. CODE (LUC)	MAN/ HRS.	MANHOUR ALLOCATIONS													
				MON		TUES		WED		THU		FRI		SAT		SUN	
	A	B	C	SCHED	ACT	SCHED	ACT	SCHED	ACT	SCHED	ACT	SCHED	ACT	SCHED	ACT	SCHED	ACT
1	ASSIGNED																
2	BORROWED																
3	OVERTIME	38															
4	TOTAL AVAILABLE (total of items 1,2, and 3)																
5	SUPERVISION	31															
6	TRAINING	32															
7	LEAVE	33															
8	ALL OTHER	34															
9	LOANED LABOR	39															
10	TOTAL INDIRECT (total of items 5 through 9)																
11	AVAILABLE FOR WORK (items 4 minus item 10)																

Figure 2-8. AF Form 561, Part I (objective for 013, exercise 6).

This form will allow a maximum of 44 individuals' names to be printed on each page. It is desirable to have no more than 44 individuals assigned to any cost center or subcost center. The cost center foreman (CCF) coordinates with the appropriate controller who enters the following information on AF Form 1734.

a. The date labor is performed is entered at the top of the form in the space provided.

b. Names of individuals being borrowed from another cost center and those assigned to that cost center but not listed on the AF Form 1734 are handprinted on the form. They should be shown below the first group of names (military personnel) if they are military and below the second group (civilian personnel) if they are civilians.

c. If an individual is being loaned to another cost center, the control center code and cost center code of the gaining cost center are entered on the form.

d. Note that if an individual is borrowed from another cost center, the leading control center code and cost center code are not entered on the form. The individual will be reported as loaned by the CCF.

e. Personnel being loaned and/or borrowed between subcost centers within the same cost center are not reported as loaned or borrowed. Their names will be charged to the work order number against which it was expended.

f. Borrowed and loaned labor will always be reported when a change of cost center is involved.

g. If an individual is assigned to a cost center or subcost center but does not appear on the appropriate AF Form 1734, the administration section is contacted to make corrections of the situation.

Exception time accounting (ETA). Exception time accounting cost centers use an optional form to report exceptions from their anticipated work schedule. Those personnel assigned to cost centers whose duty is related to only a single BCE cost account code report their time on an exception basis only. Hence, normal duty will not be reported. All labor is assumed to be direct, under the LUC column, until reported otherwise.

Exercises (014):

1. What are the two purposes of labor-hour accounting?

2. What are the two methods of time accounting?

3. What form is used to record labor hours daily?

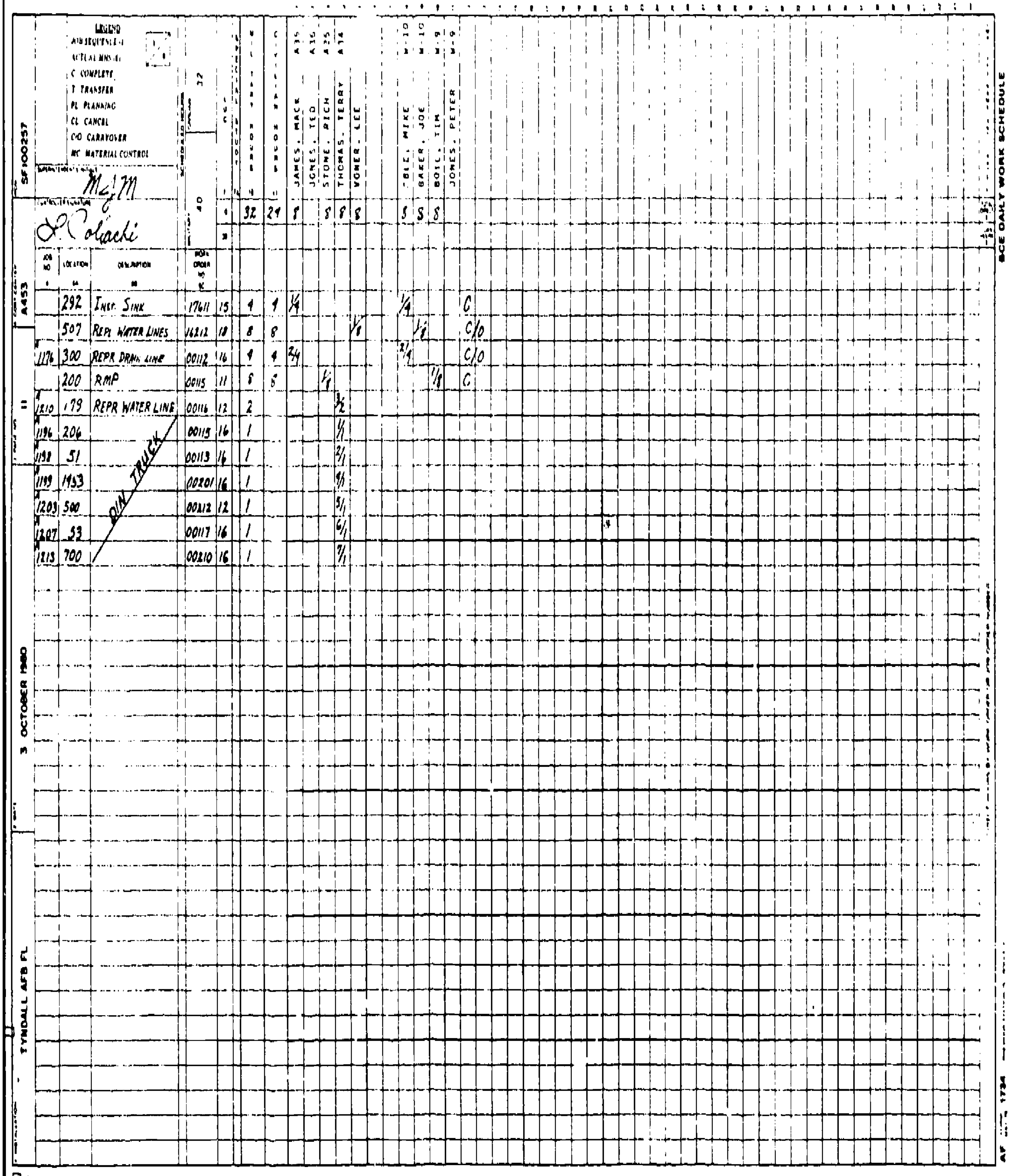
4. How and where would the entry be made for Sgt Joe A. Foyt who is borrowed from another cost center?

015. Specify requirements concerning pest management contracts.

Pest Management Contracts. As a pest manager, you are responsible for monitoring pest management contracts. These contracts may be entered into if it is in the best interest of the Government and in accordance with existing regulations.

The statement of work (SOW) for the contract is prepared by the base civil engineer, coordinated with the director of base medical services, then forwarded to the major command for approval before being submitted to procurement for bidding from commercial sources.

Causes that may require a pest contract to be initiated are lack of personnel or equipment to handle the situation adequately or the installation may be of a size that would not justify the manning of the AFSC.



JOB NO	LOCATION	DESCRIPTION	WORK ORDER NO				JAMES, MACK A35	JONES, TED A36	STONE, RICH A35	THOMAS, TERRY A34	VONER, LEE	IBLE, MIKE W-10	BAKER, JOE W-10	BOIL, TIM W-9	JONES, PETER W-9	
					32	24	8		8	8	8	8	8	8		
	292	INST. SINK	17611	15	4	4	1/4					1/4				C
	507	REPL WATER LINES	16212	18	8	8					1/8		1/8			C/O
1176	300	REPR DRAIN LINE	00112	16	4	4	2/4					2/4				C/O
	200	RMP	00115	11	8	8			1/8					1/8		C
1210	179	REPR WATER LINE	00116	12	2					1/2						
1196	206		00115	16	1					1/1						
1198	51		00113	16	1					2/1						
1199	1953		00201	16	1					4/1						
1203	500		00212	12	1					5/1						
1207	53		00117	16	1					6/1						
1213	700		00210	16	1					7/1						

Figure 2-9. Sample, AF Form 1734.

BEST COPY AVAILABLE

If it is in the best interest of the Air Force to use a pest management contract, a certified and competent pest manager will help the BCE prepare the contract. Your assistance is needed to make sure that the contractor is going to use only chemicals and equipment approved by the Air Force and chemicals that are registered by the EPA. It is necessary to ensure that contractor supervisory personnel employed are currently licensed as certified applicators.

Pest managers must supply certified Air Force personnel to monitor contractor services to ensure that the contractor is in compliance with safety standards and application procedures, while being cautious not to damage the environment.

Exercises (015):

1. The statement of work for a pest management contract is prepared by the ____________.

2. Who coordinates with the preparer of the pest management contract?

3. Who must approve a pest contract before bidding?

4. What requirements must contractor supervisory personnel meet for the Air Force?

5. Who monitors pest contract services?

6. The contractor is monitored for safe practices and being cautious not to damage the ____________.

2-2. Managing Resources

In order to get the job done, resources such as tools, materials, and equipment must be used. If proper management is not exercised, Government property may become lost, stolen, or abused. Since you work for the Air Force, it is just as important that you keep a protective eye on Air Force property as you do on your own. If you own a new sports car with a tape player and CB, you certainly know how to protect it. You should protect a Government vehicle or a test meter with the same diligence.

It is important that you understand your responsibility for Government property because there may come a time when the Air Force will ask you to pay for a piece of equipment that is damaged or lost. Your knowledge of the rules may make you conscious of your responsibility for its damage or loss.

016. Identify liability forms and concepts to various forms or to specific instances of property accountability and responsibility.

Accountability and Responsibility for Property. The organizational commander is responsible and accountable for all property issued to his or her organization, whether he or she signs for it or not. But because the duties of the commander make it very difficult to exercise personal supervision of the supply functions, a commander designates a person to act as supply officer. The commander or the supply officer may then designate other representatives to receive and sign for property. But delegation of duty does not make the commander exempt from financial liability for loss, damage, or destruction of property. Property responsibility is the obligation of each individual for the proper care of property belonging to the Air Force, whether or not such property has been issued to the person or to his or her unit. Such responsibility includes pecuniary liability.

When you buy an article from a store, the moment the sales clerk completes the transaction, the store drops its accountability. It then becomes your property, and you are accountable and responsible for whatever use you make of it. Similarly, when a stock clerk issues an Air Force item to you, accountability is dropped insofar as the issuing authority is concerned. However, you do not become the owner of the item; instead, the Air Force retains ownership; and you assume responsibility for the care and protection of the item.

Supervisory responsibility. Supervisory responsibility applies to any person who exercises supervision over property received, in use, in transit, in storage, or undergoing modification or repair. The supervisor is responsible for selecting qualified personnel to perform the duties under his or her control and for properly directing or training them. The supervisor instructs them in supply procedures to insure compliance with Air Force regulations governing property. The supervisor is also responsible for indoctrinating his or her people in supply discipline principles.

Custodial responsibility. Any individual who has possession of Government property has custodial responsibility for it. He or she is personally responsible for such property if it is for his or her official or personal use, whether or not this person has signed a receipt for it. The individual is also personally responsible for any property under his or her direct control for storage, use, custody, or safeguarding.

"Finders, keepers" may apply in some circumstances but not to Government property. If you find Government property that has apparently been lost, stolen, or abandoned, you must assume custodial responsibility for it and must protect or care for it until it can be returned to the proper authorities. Personnel may be relieved of responsibility for a particular piece of property in a number of ways, depending upon the circumstances. For example, property may be turned back to the base supply office as being excess to the unit's needs. Other items may be transferred from the responsibility of one person or organization to that of another. If you have custody of items that are damaged or lost through your carelessness, you may be held liable and may have to pay for them by deductions from your paycheck.

Pecuniary liability. The word "pecuniary" means money. Personnel having property responsibility also have pecuniary liability to make good property lost, destroyed, or damaged due to their negligence. Pecuniary liability may be shared by persons having command, supervisory, or custodial responsibility. If a person pays for an item of Government property, the property remains the possession of the Government. This keeps the supply system from becoming a source of supply for individual personnel.

Cash Collection Voucher. When pecuniary liability is admitted, the least troublesome way to settle a monetary obligation is to pay in cash. DD Form 1131, Cash Collection Voucher, is used for this purpose.

Statement of Charges. If airmen or civilian employees admit liability but do not have the money to pay cash for property damaged or lost, DD Form 362, Statement of Charges for Government Property Lost, Damaged, or Destroyed, is used. When either the Cash Collection Voucher or the Statement of Charges is used, the amounts involved must be less than $250. If $250 or more, then the Report of Survey is used.

Report of Survey. When an individual will not admit pecuniary liability or when the amount involved is $250 or more, an AF Form 198, Report of Survey for Air Force Property, must be prepared. Two officers are directly concerned in preparing a Report of Survey: the appointing authority and the investigating officer. The appointing authority is the commander or other officer with jurisdiction over the individual responsible for the property. The appointing authority appoints a survey officer (the investigating officer) whose duty it is to make a detailed and impartial investigation (survey) of the circumstances connected with the loss, damage, or destruction of the property. A survey officer is not necessary in every instance. In some cases, the appointing authority may make recommendations and forward the Report of Survey to the base commander for review and approval.

As a result of the findings, the person responsible for the property may or may not be required to pay for it. If the authorities decide from the evidence that the responsible individual is negligent in caring for the property involved, then he or she has to reimburse the Government by paying in cash (the Cash Collection Voucher) or authorizing a pay deduction (Statement of Charges).

Exercises (016):

1. Match the items in column A with the applicable responsibility or liability form in column B.

Column A	*Column B*
_____ (1) Make good the loss of property.	a. Supervisory responsibility.
_____ (2) Loss of property in excess of $250.	b. Custodial responsibility.
_____ (3) DD Form 1131.	c. Cash Collection Voucher.
_____ (4) Admit liability and pay for property lost.	d. Statement of Charges.
_____ (5) Indoctrination in supply procedures.	e. Report of Survey.
_____ (6) Detailed investigation concerning loss of property.	f. Pecuniary responsibility.
_____ (7) Admit liability but does not have the money to pay for the loss.	
_____ (8) Less than $250 involved in the loss.	
_____ (9) Least troublesome way to settle for loss.	
_____ (10) Take care of property you find.	
_____ (11) Means money.	
_____ (12) DD Form 362.	

017. State the correct use of AF Form 1297, Temporary Issue Receipt, and its period of use.

Temporary Issue Receipt. Figure 2-10 shows AF Form 1297, Temporary Issue Receipt (custody receipt), for items issued on a temporary basis (normally, 24 hours). Once done, however, this receipt can remain in force until surrendered by the unit supply officer. The form is sometimes called a custody receipt, or a hand receipt.

Exercises (017):

1. For what purpose is AF Form 1297 used?

2. Normally, how long is the AF Form 1297 used for items on a temporary basis?

018. State the purpose for inventorying Air Force property and identify rules of supply discipline.

Inventory of Air Force Property. Inventory of supplies and equipment is an important task in managing resources.

I acknowledge receipt of and responsibility IAW AFR 67-10 for the items described below and will return them by the return date indicated.

ISSUED TO: SIGNATURE	DUTY PHONE	ISSUED BY	
ISSUED TO: NAME, GRADE, ORGN *(Type or print)*	ORGN ACCT NO.	DATE OF ISSUE	RETURN DATE

STOCK NUMBER	DESCRIPTION OF ITEMS	U/I	QNTY

AF FORM SEP 82 1297 PREVIOUS EDITION WILL BE USED ☆ U S GOVERNMENT PRINTING OFFICE 1982 -380-479/244 TEMPORARY ISSUE RECEIPT

Figure 2-10. AF Form 1297.

An inventory is an actual on-the-spot check with your own eyes to see whether or not specific signed-for items of property are actually there. It also includes a check of expendable items (such as pesticide concentrate) to verify an amount on hand sufficient to perform the mission for a given period of time. The results of not checking can be seen in this hypothetical situation. Sergeant Brown was given the job of inventorying equipment. Without actually seeing all the property, he signed papers stating that the equipment shown on the records was on hand. Five days later when a C-141 cargo plane landed to pick up equipment for delivery to a hostile area, the portable water purification unit was missing. This equipment was urgently needed to provide drinking water for frontline troops. A court-martial investigation proved that Sergeant Brown could not possibly have seen the unit because it had been mistakenly shipped by an airman to another base. No need to stress that Sergeant Brown was in trouble. The point is that you are asking for trouble if you make such an inventory or falsify official papers. Certainly you wouldn't deliberately hurt anyone, but a false inventory can cause serious difficulties, and the one you hurt most may be yourself.

During an inventory, if you detect errors in description of property, in amount, capacity, measurement, or condition, make a note of it and take steps to correct the records. Most deficiencies are the result of minor human errors. They can be solved easily by coordinating with other people and by using common sense. Can you imagine the embarrassment to your supervisor if the Inspector General reports that your shop should have 12 cases of a restricted-use pesticide but only 2 are on the premises?

Many deficiencies in inventory records are caused by simple errors of addition or posting. An example of such error of addition can be seen in this hypothetical situation. Suppose that it takes 500 pounds of wettable powder herbicides each month to control weeds around runway lighting and that it takes 4 weeks minimum to get the herbicide when it is ordered. A specialist adding an inventory list added the following numbers.

375 lbs	herbicide A
125 lbs	herbicide B
5000	total lbs herbicide

Actually, only 500 pounds of herbicides are on hand. If this error is not discovered, a very serious situation will develop because in 25 days there will be no epoxy for the runway. This situation could even cause embarrassment when the base commander requests emergency funds and emergency deliveries from higher headquarters.

Supply Discipline. Supply discipline simply means obeying a set of rules necessary to conserve and protect Air Force equipment and supplies. To state it in another way "Play the game according to Air Force rules, not according to personal desires." To protect our country from our enemies, the Air Force must be ready to act at a moment's notice. The following rules will assure this state of readiness.

Rule 1. Air Force equipment must be operational. If it is broken down, you can't use it. Proper maintenance must be provided to keep equipment in a like-new state.

Rule 2. Adequate supplies must be on hand and in good condition. Do not hoard or requisition more supplies than you actually need. This practice results in shortages in some areas and overages in others. Overstocking and hoarding to meet unforeseeable needs places a wasteful demand on procurement funds by generating false requirements.

Inadequate stocking of supplies and equipment can be equally damaging. This condition may result from failure to maintain adequate records and from failure to correlate past experiences with present needs.

Rule 3. Use equipment and supplies for their intended purposes. Do not take them for personal use.

Rule 4. Safeguard equipment and supplies. Millions of dollars of Air Force supplies and equipment have been lost, stolen, or damaged in the past. This condition benefits the enemy, not the Air Force.

Rule 5. Keep accurate, current records of resources required, received, consumed, and on hand. Accurate accounting and records result in an even flow of resources to meet Air Force needs.

Exercises (018):

1. Briefly state the purpose for an inventory of Air Force property.

2. Define supply discipline.

3. List five rules of supply discipline.

4. For each of the following situations, determine which rule(s) is/are being violated by entering the rule number in the space provided. Some rules may be used more than once or not at all.

_____ a. The small equipment storage room is left unsecured.

_____ b. While working on a large piece of equipment, Sergeant Campbell uses a large wrench as a hammer.

_____ c. Sergeant Wheeler doesn't complete a herbiciding operation because a fan belt breaks on the hydraulic sprayer.

_____ d. A mist/dust blower engine needs oil, but Airman Lee doesn't add any because they ran out. As a result the engine throws a rod while the airman is applying insecticides.

019. Identify correct characteristics of the equipment authorization system.

Before starting work on a job, you must have the proper tools and equipment. The equipment authorized to your work center is based on two interrelated factors: the unit mission and the number of people. If the mission requires authorization for certain vehicles or similar major items, operator personnel must be authorized; as more personnel are authorized, quantities of other types of equipment are affected.

Equipment Authorization. Bases obtain supplies and equipment and issue them to units according to an authorization system. Although there are a variety of authorization documents, the most common one is the table of allowance (TA). Such tables are published to prescribe the exact items and quantities that each base or unit may draw (procure). The TA lists equipment on the basis of the needs of average Air Force units. The exact composition and mission of the unit, the number of facilities belonging to the unit, its geographic location, and many other factors affect the types and amounts of items a unit requires.

The master equipment management index (MEMI) is used in connection with the TAs. The MEMI (TA–001) is a consolidated listing of equipment items in accordance with the latest USAF Federal Supply Catalog. The items are cross-referenced to TA numbers for the particular equipment needs.

Suppose you need to find out how many desks a newly organized Air Force unit is authorized. First look up the item by name (desk) in the latest Federal Supply Catalog. This will give you the class number, 7110, in the descriptive portion, which will let you choose the desk suitable for your organization. At this point, you will find the complete stock number and the correct nomenclature (description) for the desk you want. Now look up the stock number in the MEMI, which lists stock numbers in numerical order. This will refer you to the correct TA number. This TA will tell you how many desks your unit is authorized. The table of allowance takes into consideration not only the kind of unit to be equipped but also the total labor force employed.

Exercises (019):

1. Identify the following statements that are correct by placing an "X" in the blank provided. Correct those that are wrong.

_____ (1) The unit mission and the number of people assigned are equipment authorization criteria.

_____ (2) The equipment authorization document is the AF Form 1297.

_____ (3) The nomenclature of an authorized equipment item is found in the MEMI.

_____ (4) The TA is based on average Air Force units.

_____ (5) TA-001 is the MEMI.

_____ (6) The MEMI and TA are cross-referenced.

_____ (7) The TA lists equipment authorized for a base.

_____ (8) The MEMI indicates the number of items of equipment a unit can procure for mission accomplishment.

020. Cite facts regarding how to request equipment and supplies.

Requesting Equipment. As a supervisor or equipment custodian, you'll probably need to order equipment for your shop. To do this, use AF Form 601, Equipment Action Request (fig. 2-11). This form is used to increase or reduce equipment authorization, to order new equipment items, and to turn in or replace old equipment.

Completing the form is simple because all the instructions are on the back. If you need more details than this, you would refer to AFR 67-23, *Standard Base Supply Customer's Guide*.

When equipment is received, the equipment custodian must sign for the item on the form. If an item is being turned in, the supply representative making the pickup gives you a signed copy of the form verifying receipt by base supply.

Ordering Materials. Materials are ordered by the planning section of BCE for all work orders requiring materials. Materiel control prepares the requisition when materials are required by service calls and job orders.

Figure 2-12 shows a completed AF Form 1445, Materials and Equipment List, which is used to order materials. There may be times that you will be told by your shop foreman to pick up work order or job order materials from the BCE holding area. When you go, you should take the AF Form 1445 with you and compare the materials you are picking up against the items listed on the form. Check the nomenclature to ensure that the item you are to pick up is the same as the one described on the form. Also, check the unit of issue to ensure that they agree; most important, you should ensure that the quantity you are to pick up agrees with that shown on the AF Form 1445. If these items do not agree, do not sign or accept any of the items. You should immediately notify your shop foreman so that he or she can take appropriate action.

Exercises (020):

1. What two sources provide information on completing AF Form 601?

2. What are two uses of AF Form 601?

3. What information on AF Form 1445 should be checked against the actual materials?

4. What is the purpose of AF Form 1445?

TO	FROM	SIGNATURE	DATE	ACTION TAKEN
				APPROVED ☐ DISAPPROVED ☐
				APPROVED ☐ DISAPPROVED ☐
				APPROVED ☐ DISAPPROVED ☐
				APPROVED ☐ DISAPPROVED ☐
				APPROVED ☐ DISAPPROVED ☐
				APPROVED ☐ DISAPPROVED ☐

1. CUSTODIAN REQUEST NO.: 900IV3061-0001

8. IN-USE DOC. NO.:

9. NATIONAL STOCK NO. OR PART NO.: 3740 00 434 6555

2. CMO	3. FAD	4. UJC	5. BUD	10. USE CODE	11. PRICE	12. U/I	13. ERRCD
ATC	III	b	9	B	$559.00	EA	NF2

6. CUSTODIAN SIGNATURE: Richard L. Burkett III

7. *I certify that I have evaluated this request and the action herein is required.*

14. EQUIP CODE:

15. NOMENCLATURE: Sprayer, insect AERO

SIG OF ORGN COMDR *(Not required for turn-in)*: Edward T. Lee, LT COL, USAF

16. ALLOWANCE IDENTIFICATION: ASC	COMPOSITION CODE: PART	SECT	SUBJECT	COL	17. QUANTITY: IN USE	CURR AUTH	NEW AUTH	NO REQ'D
483		C			0	0	1	1

18. ACTION REQUESTED

A. AUTHORIZATION: INCREASE ☐ ADD NEW ☒ REDUCE ☐ DELETE ☐

B. ISSUE/DUE OUT: ADVICE CODE ( ) INITIAL ISSUE ☒ REPLACEMENT ☐ CANCEL DUE OUT ☐

C. TURN-IN *(Complete all applicable blocks)*

CONDITION		STATUS	YES	NO
SERVICEABLE		COMPLETE *(List missing parts in Block 19)*		
REPARABLE		CALIBRATION REQUIRED		
CONDEMNED		CLEAN, PAINT, ETC		
UNKNOWN		DISASSEMBLY REQUIRED		

DATE AVAILABLE FOR PICKUP

19. JUSTIFICATION AND ITEM DESCRIPTION

This sprayer is needed by the Pest Management section to effectively manage flying insect pests. We cannot currently do this because of the recent cancellation of a contract for pest management services. If this pest management is not accomplished, this base will be in violation of Air Force and Environmental Protection Agency regulations.

20. REVIEWING AUTHORITY COMMENTS

21. ORGN			22. UKC			23. LEVEL			24. DET			25. WRM			26. EMOLOC			27. SUPPLY CONTROL NO.							28. CEMO CONTROL NO.							29. AFLC CONTROL NO.							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

AF FORM 601 NOV 81 — REPLACES AF FORMS 601A, APR 68 AND 601B, APR 70 WHICH WILL BE USED

EQUIPMENT ACTION REQUEST *(See Instructions on Reverse)*

Figure 2-11. Sample, AF Form 601.

AF FORM 1445, MAR 80, PREVIOUS EDITION WILL BE USED.

TRANSACTION IDENTIFICATION CODE (1) | DELIVERY DESTINATION (2)

MATERIALS AND EQUIPMENT LIST

INDEX (3)	STOCK NUMBER (4)	NOMENCLATURE	UNIT OF ISSUE (5)	QUANTITY (6)	UNIT COST	TOTAL COST	TRANS. SERIAL NUMBER (11)	DEMAND CODE (12)	IN STOCK YES	IN STOCK NO	DATE EXPECTED	REC. BY BCE	EXCESS MATERIALS QUAN.	EXCESS MATERIALS DISPOS.
	6840-01-087-0672	Insecticide, Bendiocarb	JR	00012	$41.00	$492.00	0015			✓				
	8105-00-401-2010	Bag, entomological specimens 12" x 16"	HD	00001	$8.50	$8.50	0016			✓				
	6515-00-982-7493	Mask, surgical disposable (Hospital supply item)	BX	00001	$6.22	$6.22	0017		✓					

ACTIVITY CODE (7): R | ORGANIZATION CODE (8): 911 | SHOP CODE (9): EN | DATE MATERIAL REQ. (10): 3120 | WORK ORDER NO. (13): A00034 | TRANSACTION EXCEPTION CODE (14): | MATERIAL CONDITION (15): A | FORCE ACTIVITY DESIG (16): | SYSTEM DESIGNATOR (17): A1 | PROJ. CODE (18):

DELIVERY PRIORITY (19): A6 | REQUIRED DELIVERY DATE (20): 210 | URGENCY JUSTIFICATION CODE (21): BW | FACILITY NO. (22): 01927 | INST. CODE (23): DJDB | JOB ORD. NO. (24): EN 0525 | PLANNER: Buddin | PAGE 1 OF 1 PAGES | HOLDING AREA BIN LOCATION

SHOP TITLE: PEST MGT | RECEIVED BY | MONTH | FOLLOW-UP DATA FOR BACK ORDERED MATERIAL 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | WORK, ORDER NO.

Figure 2-12. Sample, AF Form 1445.

021. State facts regarding BCE supply; and given a GSA catalog excerpt, determine an item name and stock number.

BCE Supply. Materiel control is the focal point in CE for all items of supply. This section is operated by supply personnel assigned to CE. They are the authority on procedures relating to getting supplies.

Materiel control is also responsible, jointly with base supply, for the establishment and restocking of all bench stocks, shops supplies, and rolling stock. Items on bench stock are limited to those used frequently and those that must be available in the immediate work area.

Before materiel control can order the materials you need to do a job, they must know exactly what you want. The best way to communicate with supply personnel is to attach a supply number to the item you want. Sometimes it is very easy to get a stock number; at other times it requires a joint effort between you and materiel control to determine a suitable stock number.

National stock numbers (NSN). The Air Force uses a system of 13 digits (numbers) to identify any item of supply in the Government's inventory. In the past, Federal stock numbers with 11 digits were used. The two additional digits are added in the fifth- and sixth-digit spaces. The new name "national" stock numbers, as the name suggests, refers to a national or geographical area. For example, 7110-00-273-8791 is furniture, office, chair, rotary, typist, steel, without arms. The 00 represents the United States as does 01. Other nations' double-digit numbers, for example, are 12 Germany, 14 France, 15 Italy, 21 Canada, 23 Greece, 27 Turkey, etc.

Numbers are used as a code to identify items. Some numbers can be used to identify what an item is. Others can be used to indicate its weight, size, shape, color, and even when or how it is to be used. Just as cost accounting personnel can communicate with the computer through the use of numbers and letters in specified positions on a keyboard, supply people can decode national stock numbers. The Government stocks millions of items of supply and equipment. Supply people can tell exactly what item is from the stock number. You no doubt will see many publications that still use Federal stock numbers. Do not let this concern you as they will be updated when the publications are republished.

Supply manuals and catalogs. Supply manuals and catalogs are useful in finding information related to equipment and supplies the Government purchases and keeps in inventory. Like a city phone book or a mail order catalog, instructions on their use are given in the information section. The supply publication that you will use more than any other are the General Services Administration (GSA) supply catalogs (see fig. 2-13). These catalogs contain items that are common to most organizations such as furniture, cleaning supplies, handtools, laboratory equipment, office machines, paint, and sports equipment.

Exercises (021):

1. What unit in CE is the contact point for ordering supplies?

2. What is the most important information you can furnish supply people if you want a laboratory flask?

3. What does the number 27 mean in national stock number 7210-27-221-0352?

4. Refer to figure 2-13. What is the name and stock number of the item shown in the illustration?

022. Specify directives and organizations responsible for pollution control and environmental protection.

Pollution Control. Concern for the environment has evolved at the Federal level over a period of years. Some of the laws passed by the Congress of the United States related to pollution control and environmental protection are:

a. Rivers and Harbors Act.
b. Federal Water Pollution Control Act.
c. Clean Air Act.
d. Solid Waste Disposal Act.
e. Resource Recovery Act.
f. National Environmental Policy Act.

These acts are not static but are updated according to the changing needs of the environment and the public good under the National Environmental Policy Act.

National Environmental Policy Act. This act declares a national policy that will:

a. Encourage productive and enjoyable harmony between people and their environment.

b. Promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man.

c. Enrich the understanding of the ecological systems and natural resources important to the nation.

d. Establish a council on environmental quality.

Air Force environmental protection committees are established at Headquarters USAF, each major command, and at each base.

Meaning of environmental pollution. AFR 19-1, *Pollution Abatement and Environmental Quality*, complies not only with the letter of the National Environmental Policy Act but with the spirit as well. This regulation explains environmental pollution as the presence of physical, chemical, and biological elements or agents that adversely affect human health or welfare.

Air Force Pollution Control Policy. AFR 19-1 states the Air Force policy you are expected to uphold. The Air Force actively supports environmental quality programs. As a means of enhancing the environment, Air Force activities are not only required to comply with Air Force directives but with criteria and standards of the Environmental

5180-Tools

Tool Kit, Crosscut Saw Reconditioning

4-piece. Consists of jointer raker tooth gage setting block set gage GGG-T-551
SE 5180-00-596-1488

Tool Kit, Diesel Injector Repair

Cleaning kit for use on N-type General Motors Detroit Diesel injectors on Dodge and International Harvester motor trucks Bacharach Instrument P/N 66 5102
EA 5180-00-112-9431

4-piece. Tool roll Kit consists of two brushes, one reamer, and one stone
SE 5180-00-596-1586

7-piece. Composed of special tools for repair and maintenance of fuel injector tubes on General Motors series 71 diesel engines Kent Moore P/N J-22525
SE 5180-00-596-8541

7-piece. Steel tool box Kit consists of body, pilot flaring die, tube tip refinisher reamers, pilot reamer
EA 5180-00-116-7463

15-piece. Steel tool case Kit consists of timing gages, spray tip reamer, bushing cleaner injector cleaner, socket wrenches, deburring tool brushes, sharpening stone, music wire
EA 5180-00-499-3495

Tool Kit, Electrician's

3-piece. Kit contains pocket knife lineman's pliers and leather two pocket tool carrier Parts list or packing list included
EA 5180-00-408-1859

6-piece. Use to maintain electrical wire connections on wheeled and tracked vehicles Wtr case Includes stripper and cutter removers terminal hand crimping tool
EA 5180-00-876-9336

18-piece. Cotton duck tool bag 18" long 9 " closed height Kit consists of hacksaw blade drill files, hacksaw frame hammer file handle line voltage indicator insulation tape socket head screw key set pocket knife, pliers rule screwdrivers wrenches Dated parts list included MIL T 3837
EA 5180-00-545-8645

22-piece. Metal tool case Kit consists of sockets handles, extensions, screwdriver wrenches
EA 5180-00-505-5923

24-piece. Canvas tool roll Kit consists of extension blade, screwdriver handles nutdriver blades pliers, tapered reamers, screwdriver blades, adjustable wrench
EA 5180-00-650-7821

46-piece. Metal box Contains inserts name plate instruction sheets contents chart extra storage areas, installing-removal tool removal tools extra tip for removal tool, installing tool universal position head, positioner, crimping tool frames, turret heads, service inspection gage hex wrench Daniels P/N DMC 87
EA 5180-00-178-0029

90-piece. Tool chest Dated parts list included Kit contains auger bit hand hacksaw blades soldering torch kit ratchet bit brace drill, brace bit extension files hand hacksaw frame, hammers file handle soldering iron handle, pocket knife indicator socket head screw key set pliers drive pin punch tools and accessories roll multiple fold rule nested saws flat tip screwdrivers nonelectric soldering iron sharpening stone wire stripper steel tape measuring tape wrenches socket wrench socket wrench set case hand electrical conduit bender
SE 5180-00-313-3045

Tool Kit, Electrical Repair

Kit consists of bag belt hacksaw-blade and frame chisel gloves hammer indicator tape lantern matting pliers puller screwdrivers stripper twine wrench GGG-B-60
EA 5180-00-391-1087

Tool Kit, Electronic System Maintenance

Consists of 13 components soldering iron desoldering head pliers screwdrivers Cooper P/N 100K
EA 5180-00-009-1970

Tool Kit, Engine Repair

6-piece. Includes spacer installer remover support block driver handle connecting rod holder
EA 5180-00-116-7467

Tool Kit, Gauge

[illegible] Ashcraft pressure gauges Furnished in [illegible] Kit consists of hand jack set screw driver [illegible] reamers two pin vise holders wig [illegible] Dresser Industrial Valve and Instrument [illegible]
EA 5180-00-873-3753

Tool Kit, General Mechanic's

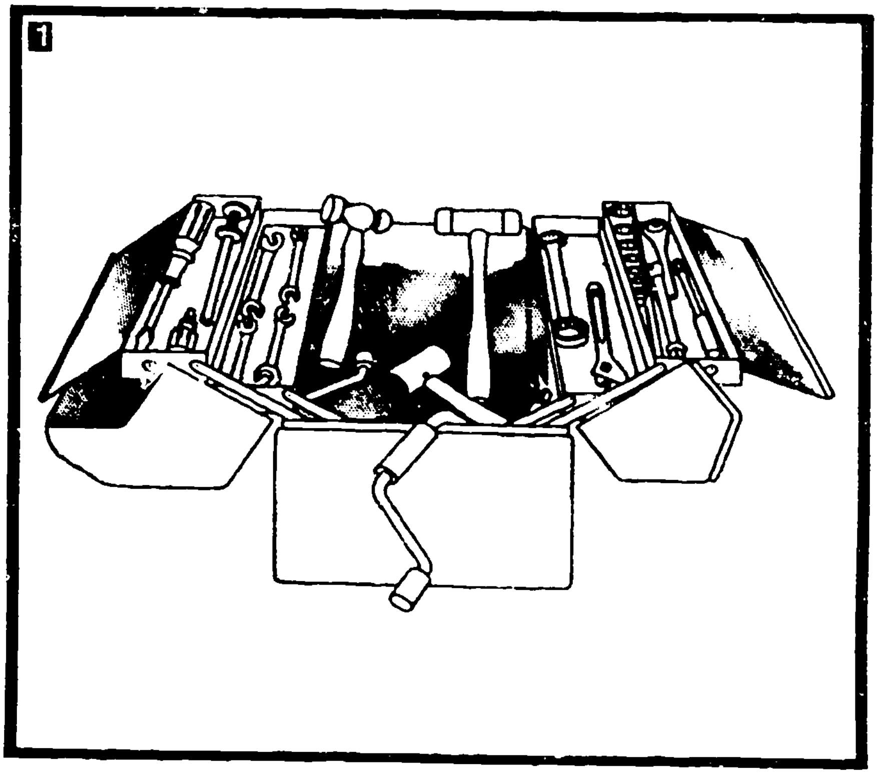
1

Kit consists of pry bar paint brush chisel hand file flashlight gage hammer kit set pocket knife pliers punches screwdriver shears socket wrenches portable tool box
EA 5180-00-177-7033

Rail and marine diesel engine Tool box includes pry bar, hacksaw blade paint brush scratch brush chisel file frame hammer key sets socket head screw [illegible] punches other components
EA 5180-00-629-9783

Tool Kit, Groundsman's Equipment

3 piece Kit contains industrial safety belt leather gloves and pliers
EA 5180-00-408-1242



CBC-029

Figure 2-13. Sample page from GSA catalog

Protection Agency (EPA) and State and local pollution abatement agencies in the area. Standards apply to buildings, installations, structures, public works, equipment, aircraft, and vehicles used by the Air Force.

Designs for buildings, facilities, weapon systems, etc., will include pollution controls. Corrective measures needed to prevent, control, or abate environmental pollution must be adopted on an accelerated basis. Air Force personnel should support and assist development of local community pollution abatement programs. If Air Force operations generate environmental pollution, action should be taken to control or eliminate the pollutants. Preventive pollution control can be provided by reducing or eliminating waste, selecting chemicals and other materials of low pollution potential, and including pollution abatement in specifications.

The discharge or disposition of pollutants must be done so that they will not expose people to substances hazardous to health; cause substantial harm to animals, fish, shellfish, or wildlife; cause economic loss by damaging plants or crops; or cause groundwater contamination. Waste disposal contracts must comply with local, State, or Federal standards. Municipal or regional waste disposal systems are preferred for disposing of waste from Air Force facilities. When Air Force waste systems must be installed, laboratory and other supporting facilities will be provided. Air Force pollution control facilities must be operated only by trained people capable of meeting operator certification requirements of the State. If no State requirements exist, operators must meet Air Force standards.

All materials, such as solid fuels, ashes, petroleum products, and chemical agents, must be stored, handled, and used to minimize water and air pollution. Engineering safeguards, such as dikes, catchment basins, and relief vessels necessary to prevent water pollution by accidental leakage of stored fuels, solvents, oils, and other chemicals, are required. Any discharge of radioactivity must meet Atomic Energy Commission and EPA regulations and requirements.

The environmental consequences of a proposed action must be assessed early in the planning process. Programs and actions are to be planned and carried out to avoid as much adverse effects on the environment as possible. Oversea installations must conform to the same pollution abatement policies as prescribed for domestic installations. Environmental protection matters are to be coordinated with all concerned agencies to avoid duplication and to insure timely solutions to mutual problems.

The base environmental protection committee operates under detailed instructions issued by the major command. The committee reviews environmental impact assessments and statements to insure that the intent of the National Environmental Policy Act and Executive Orders are carried out.

Exercises (022):

1. What Air Force document deals with pollution abatement and environmental control?

2. What congressional act deals with the national policy of productive and enjoyable harmony between people and their environment?

3. Where are Air Force environmental protection committees established?

4. State Air Force policy on cooperation with federal, State, and local agencies to control pollution.

023. Identify correct individual responsibilities for conserving resources and improving the environment.

Individual Responsibilities for Conserving Resources and Improving the Environment. There are many things you can do as an individual to conserve resources and improve the environment. A positive and helpful attitude is most important. Remember, what you do today will not only benefit you now but will be appreciated by those who are here when you are gone.

The following tips are useful things you can do to make your base, your community, and your Nation a better place in which to live. In our lifetime, we can truly have "America the Beautiful." These tips are general in nature. Local rules and commonsense, however, take precedence in each situation.

(1) Conserve all types of resources. This means don't waste materials, money, or time.

(2) Save newspapers for the Scouts or other collection groups.

(3) Buy returnable bottles. Throw-aways waste materials.

(4) Don't buy unnecessary electrical devices. They waste money and energy.

(5) Use your time wisely, on the job and at home. During slow periods, use the time for study rather than for goofing off.

(6) Requisition and store only the amount of materials required for the present and immediate future. An excess is a waste of resources.

(7) When possible, use recycling containers to dispose of cans, bottles, and paper.

(8) Cut down on the use of paper products. For instance, why use two paper towels to dry your hands when one will do? Reuse paper when practical. Write on both sides.

(9) Keep streams clean. Don't throw or discharge any waste into our water systems.

(10) Help keep the noise level down, especially at night.

(11) Soap eventually finds its way into streams; so use low-phosphate detergent soap.

(12) Use the smallest amounts of soap necessary for washers. Try one-half of the recommended amount. Often, it cleans as well as the full amount.

(13) Operate your washers only for a full load. Partial loads waste fuel and water.

(14) Take a shower instead of a bath. On the average, you use three times more water for a bath than for a shower.

(15) Turn faucets off tightly and repair leaky faucets. Each leak wastes a barrel or more of water per day.

(16) When watering the lawn, do not waste water by allowing it to run down the street.

(17) Use white rather than colored toilet paper. The dye in the paper may be harmful to you or to the stream it reaches.

(18) Do not pour substances in the sink such as poisons, drugs, greases, paints, and solvents. Instead, seal them in a container and place them in the refuse for burial.

(19) Avoid buying products wrapped with plastic made of polyvinyl chloride. It pollutes the air if burned and will not decompose if buried.

(20) Keep the air clean. Avoid hydrocarbon activated spray products. Use finger pump spray instead.

(21) Do not burn grass, leaves, or tree limbs. Make a compost pile and use it to improve the soil.

(22) Plant trees, shrubs, and grass. They filter dust from the air and consume unneeded carbon dioxide to produce needed oxygen.

(23) Walk or use a bicycle when traveling less than half a mile. The exercise will improve your health. Short drives in the car are harmful to the engine, as a cold engine produces and retains harmful acids. Also, the gasoline you burn is costly and adds pollution to the air.

(24) Use a litter bag in your car. To litter degrades not only the environment but also the person who litters.

(25) Use a small-engine car rather than a large one. The more horses you have, the more hay they eat.

(26) If you keep your car in a reasonable condition of maintenance, it saves you gas and lowers the pollution level.

(27) Combine your car trips so as to make less of them.

(28) Lead poisons the air. If possible, use lead-free gas and nonlead paints.

(29) Don't idle your car for long periods of time. Turn off the ignition when waiting.

(30) Conserve energy. In the summer, set the thermostat at 78°. In the winter, set it at 68°; then adjust your clothing to become comfortable, not your thermostat.

(31) When you leave an area, turn off the lights, radio, TV, air conditioner, or heater.

(32) Remove snow and ice with a shovel. Salt is harmful to streams, trees, grass, and the underside of your car.

(33) Remove clothes needing ironing from dryer while they are still slightly damp. There's no point in wasting energy to dry them thoroughly if they'll only have to be dampened again for ironing.

(34) Get the most lighting from the electricity you use. Paint walls white or light colored, and keep lamps and light fixtures clean. Dark walls and dirt absorb light.

(35) Reduce paperwork. If a formal reply is not required, use the phone or an informal note.

(36) Clean filters for air conditioners, heaters, clothes dryers, etc. To do so increases the efficiency of the units.

(37) Follow the manufacturer's instructions on operation and maintenance. Things will last longer and operate better.

Exercises (023):

Place a T for true in the following blanks that represent good individual practices for conserving resources and improving the environment. Correct any false statements.

_____ (1) Buy throw away soft drink bottles.

_____ (2) Buy electrical devices such as pencil sharpeners, knives, golf carts, etc.

_____ (3) Use white rather than colored disposable paper products.

_____ (4) Use finger pump spray products rather than hydrocarbon activated sprays.

_____ (5) Set your themostat at 68° in the winter and 78° in the summer.

_____ (6) Short drives in your car can be harmful to the engine.

_____ (7) Littering is a sign of immaturity.

_____ (8) Paint walls a dark color to save electricity.

_____ (9) A large engine uses less gasoline than a small engine in a car.

_____ (10) Follow the manufacturer's recommendations on machine lubrication.

Publications, Forms, and Security

YOUR JOB is of a critical nature and is highly dependent on the latest Government publications. This is especially true with regulations dealing with the impact of your work on the environment. Since Air Force forms are used to document the work you do and you use them to order supplies and equipment, they are important. Enemy agents continually try to get an insight into our operations. Security is denying the enemy this valuable data. Therefore, in this chapter we deal with publications, forms, and security.

3-1. Publications

Have you ever bought a bicycle or stereo unassembled? If you have, did you follow the instructions and sketches that were included in the package; or did you start out haphazardly to assemble the unit by trial and error? If you did not follow the manufacturer's instructions, the chances are that you had a tough time getting the pieces together correctly or that it did not operate accordingly to your expectations.

Instructions from the manufacturer pertaining to assembly, operation, and maintenance are called by various names such as assembly instructions, operator's manual, maintenance checklist, and other names. The Air Force has a system of publications that furnishes you with the information you need to do your job.

Your job in the Air Force is complex. You can understand this more fully as you study your job specialty description. To do this job, you must be able to perform many tasks in a proficient manner. Also, you must keep abreast of new developments in the technical and administrative fields.

No one is expected to retain all of the details of a job as complex as yours, so Air Force publications are available to you for this information. The two main types of publications available to Air Force personnel are standard publications and Air Force technical orders.

024. Identify the Air Force standard publication with the specific type of information contained in that publication.

Standard Publications. There are numerous types of standard publications. They are used to announce policies, assign responsibilities, prescribe procedures, issue instructions, and give information. Standard publications are in the form of regulations, manuals, supplements, and operating instructions, all of which are directive. Pamphlets, visual aids, bulletins, and staff digests are standard publications that are nondirective and are intended for information or instructional purposes. In this text, we will only cover those publications that you come in contact with most frequently: regulations, manuals, supplements, and pamphlets.

Regulations. Air Force regulations (AFR) are the primary administrative directives that are used for governing Air Force activities. They set the standards of management and control official business of the Air Force. Regulations also announce policies; assign responsibilities; direct actions; and, when necessary, prescribe brief procedural details. The policies outlined in regulations are usually permanent in nature. This means that the purpose or intent of the regulation will remain in effect until a major change in mission or objective has been established.

Manuals. Air Force manuals (AFM) contain permanent and detailed instructions, procedures, and techniques telling people how to do their jobs. A manual may be general and deal with principles or doctrine. It may be a combination of material related to an entire function. It may also be a step-by-step directive telling how to do a specific task or operation. Manuals may include policies or assign responsibilities when they do not repeat material in another Air Force publication. Manuals are often identical with regulations. The Air Force is in the process of phasing out manuals and republishing them as regulations. Many years may be required to complete this process.

Supplements. Webster defines a supplement as something that completes or makes an addition, a part added to the publication. For example, a higher headquarters issues a publication for all units under its command. A lower headquarters can issue an auxiliary publication dealing with the same subject but going into more detail. For instance, an Air Force publication dealing with storage of water makes general policy statements on the subject. A command in Florida and one in Alaska may supplement the regulation. Obviously the protection required against freezing will be different. With the use of supplements, a commander ensures efficient local application of directives issued by higher headquarters.

Pamphlets. Air Force pamphlets (AFP) usually contain information rather than directive material. They are normally issued as a booklet or brochure and may be written in an informal style. For instance, if you are being assigned overseas, you may receive a pamphlet concerning the customs, religions, and history of the country in which you will be stationed.

Exercises (024):

Match the type of publication in column B with the type of information in column A. Some items in column B maybe used more than once.

Column A *Type of Information*	*Column B* *Type of Publication*
_____ (1) Permanent and detailed procedures for performing duties.	a. Regulations.
_____ (2) Customs of a country.	b. Manuals.
_____ (3) Major command adds information to a directive.	c. Supplements.
_____ (4) Sets standards of management.	d. Pamphlets.
_____ (5) Announce policies and assigns responsibilities.	

025. From an excerpt shown in an Air Force standard publication, locate specific information pertaining to that publication.

An Excerpt from a Standard Publication. Air Force Regulation 91-21, *Pest Management Program*, contains much important information that affects every pest management job you do. Figure 3-1, which shows pages from this regulation, is representative of the types of information found in Air Force regulations. Refer to this figure as you complete the following exercises.

Exercises (025):

1. What is the purpose of AFR 91-21?

2. What type of vehicle is recommended for pest management operations?

3. For whom must protective clothing and equipment be provided?

4. Under what conditions may the aerial application of pesticides be authorized?

5. What AF regulation governs aerial application of pesticides?

026. Using an extract from a numerical and subjective index, locate the number or title of standard publications.

Indexes to Standard Publications. Suppose you were interested in buying a tent and had a mail order catalog. Would you page idly through the book until you happened to find tents, or would you go to the index and then turn directly to the indicated pages? From the standpoint of efficiency and time saved, the answer is obvious.

The situation is similar with Air Force standard publications. Much time would be lost and inefficiency would result if you had to search through all the existing publications to find a particular subject you need.

You are aware by now that the Air Force has a tremendous number of publications of various types with many and diverse uses. Naturally there must be a system for cataloging these directives. To identify them, the Air Force has adopted the following system.

Numerical and subject matter index. Air Force Regulation 0-2, *Numerical Index of Standard and Recurring Air Force Publication*, is a booklet about 80 pages long. The actual publications in the index reference may require a number of library-type cabinets to contain them. Your base has a publications reference library. More than likely there is a library of Air Force publications in the administrative section of CE. The library is there for your use—so learn how to use it.

The index lists about 100 subjects that are identified by series numbers.

Standard publications numbering system. As you learned in the last section, AFM 91-16 is a standard publication. The first number (91) before the dash (-) is the series number of the subject *(Real Property Operation and Maintenance)* of the publication. The first series number in the book is zero (0). The subject of 0 is indexes, 5 is publications management, 35 is military personnel, 85 is civil engineering general, 127 is ground safety, 161 is aerospace medicine, and 205 is security. Each of the hundred subjects is further identified by adding a dash number to the basic series number; for example, R 35-3, *Services Dates and Dates of Ranks* (of military personnel), and R 161-1, *Control of Vector-Borne Diseases*.

The major series of publications that concern work in CE range from the 85 to 93 series.

The series of these publications are titled as follows:

85 *Civil Engineering General*
86 *Civil Engineering Programming*
87 *Real Property Management*
88 *Facility Design and Planning*
89 *Facility Construction*
90 *Family Housing*
91 *Real Property Operation and Maintenance*
92 *Civil Engineering Fire Protection*
93 *Special Civil Engineering*

DEPARTMENT OF THE AIR FORCE
Headquarters US Air Force
Washington DC 20330

AF REGULATION 91-21

6 March 1981

Real Property Operation and Maintenance

PEST MANAGEMENT PROGRAM

This regulation states policies, responsibilities, and procedures for pest management at Air Force installations. It implements DOD Directive 4150.7, 6 November 1978. This regulation has been determined to be consistent with Occupational Safety and Health Administration (OSHA) standards 1910.95, 1910.133, 1910.134, 1910.135, 1910.136, 1910.141, 1910.242, 1910.1000, and with Air Force Occupational Safety and Health (AFOSH) standards 127-31, 161-1, 161-2, 161-6, and 161-8.

1. Pest Management Explained. The pest manager supervises and puts measures into effect to control pests that transmit diseases, annoy personnel, destroy or degrade the quality of real property, attack trees, turf, and ornamental plants, crowd out beneficial plants, and attract and provide cover for animal pests. Pests include numerous insects and related lower animals, terrestrial and aquatic plants (weeds), domestic and feral rodents, birds, feral predatory animals, snakes, nematodes, snails, algae, fungal plant diseases, marine wood borers, and other organisms, other than domestic animals, that are not desirable. Integrated pest management (IPM) procedures will be used when practicable, to reduce the reliance on chemicals as a control procedure. A partial list of IPM methods is in attachment 2. Pest management must make sure that pests are controlled effectively and economically, while contamination of the environment and risks to human health caused by pest control measures are held to a minimum. In general, pest management measures include

a. Applying insecticides, rodenticides, herbicides, fungicides, and other pesticides to control pests of medical and economic importance.

b. Conducting inspections to determine the need for, and the effectiveness of, pest control measures.

c. Recommending construction standards and maintenance techniques to make buildings resistant to termites, birds, rodents, and other pests.

d. Fumigating and applying other appropriate control measures to protect subsistence supplies, clothing, equipment, wood products, and other materials from pests.

Supersedes AFR 91-21, 10 February 1975. (See signature page for summary of changes.)
No. of Printed Pages: 20
OPR: HQ AFESC/DEVN (Lt Col S. M. Valder)
Approved by: HQ USAF/LEE (Maj General W. D. Gilbert)
Writer-Editor: M. M. Green
Distribution: F

29 CFR 1925 while on a US Air Force facility to assure safe working conditions for contract personnel and a safe environment for occupants of Air Force facilities.

c. The contractor must furnish the BCE labels of all pesticides used on the contract, as well as any other data necessary to prepare the installation Pest Control Summary Report (RCS: DD-M(A&AR)1080) and the Annual Review of Pest Control (RCS: DD-M(A) (formerly RCS DD-H&E(A))1224), as described in paragraph 9. Pesticide labels must be sent to the MAJCOM pest management professional within 30 days after contract award.

5. Safeguards in Handling Toxic Materials:

a. Strong boxes or other appropriate containers with locks must be used to ensure safe handling, storage, and transportation of pesticides.

b. Vehicles assigned to the pest management section must be used for pest management operations only. All pesticide dispersal equipment must be assigned to the pest management section. The pest management shop supervisor permanently maintains the vehicle keys. Vehicles must be equipped with locking compartments for storage of pesticides and other chemicals. For this purpose, a telephone maintenance truck (NSN 2320-00-801-9193) is recommended.

c. All prime movers used for fogging, misting, dusting, and ultra-low volume (ULV) application must be air-conditioned to protect the operator from excessive pesticide exposure. This information must be reflected in the ordering data provided by the using organization to their parent command.

d. Fumigants cannot be applied, and internal combustion or electrical power-driven spraying machines cannot be used for aerosol or mist sprays inside buildings without the director of base medical services and the base fire chief approval.

e. The BCE must start disposal action for all pesticides or pesticide containers that have deteriorated or are not suitable for return to depot stocks, according to AFR 19-1 or other existing policy and guidance.

f. Protective clothing and equipment must be provided for all persons engaged in mixing and applying pesticides. This clothing and equipment may include respirators, masks, gloves, safety shoes, and coveralls, as well as specialized fumigation equipment, if fumigation is performed. Guidance concerning respiratory devices for pest management use in AFOSH Standard 161-1 must be followed. Shop supervisors must keep the current copy of this standard in the shop and be familiar with its contents.

g. Pesticides that civilian communities accumulate and which have been designated as excess to their needs must not be stored on Air Force installations. Handling and repackaging problems associated with the storage of these pesticides create risks and add to the present disposal problem.

6. Aerial Dispersal of Pesticides:

a. When ground pest management measures fail, are not practical, or not possible, aerial pesticide dispersal may be authorized. Policies and procedures for applying aerial spray are in AFR 91-22. Requests for aerial spray are sent to the 355 Tactical Airlift Squadron (Aerial Spray Branch) at Rickenbacker AFB OH 43217. Aerial dispersal of a pesticide is performed only after its comparative practicability and effectiveness have been considered carefully. The possible harmful effect of the pesticide on beneficial insects, fish, wildlife, and vegetation in the area to be sprayed must be taken into consideration.

b. When aerial dispersal is required for pest control on an Air Force installation, the commander must coordinate with federal, state, and local authorities that have an interest in such control measures, as required by AFR 91-22. Before beginning these control measures, the commander must obtain a written agreement from these authorities which provides for right-of-entry and a waiver of claim for each owner of nearby land involved.

c. Application of pesticides—whether by aircraft or ground operating equipment—on other than military property is primarily a responsibility of the individual, group, governmental, or civil agency that owns or controls the property. Requests to do such spraying must be submitted and approved as directed in AFR 91-22. (In an emergency, requests may be made by telephone or message, but must be confirmed in writing as soon as possible.)

7. Air Force Participation in Civilian Pest Management Work:

a. When an Air Force installation and a civilian community have a joint interest in pest management problems, military participation must be proportionate to the military interest in the problem.

b. Assistance in pest management work for the sole benefit of persons, communities, states, or other federal agencies in the United States, including aerial spray, is given only when requested by the appropriate federal agency through DOD channels. In overseas areas, comparable assistance is given only when requested by the appropriate national public health authorities and approved by the MAJCOM.

8. Collection, Preservation, and Processing Insects for Identification. Identification of unrecognized insects and rodents may be obtained as necessary. Requests for services should be directed to one of the units listed in AFR 161-40, or to other appropriate DOD or civilian agencies. Adult and larval mosquitoes should be sent to USAFSAM/EKS, Brooks AFB TX 78235 for identification.

9. The Annual Review of Pest Control (RCS: DD-M(A)1224 (formerly RCS: DD-H&E(A)1224)). All Air Force installations must conduct an annual review of pest control.

a. The BCE must complete an AF Form 646, Pest Management Program Review, for each pest management project to be accomplished on the installation in the following year. A pest management project is a single chemical control measure taken to control a single pest, for example, diazinon for cockroach control, malathion for cockroach control, and malathion for fly control (each constitutes a separate project). A sample AF Form 646 and detailed instructions for completing it are provided as attachment 5.

Figure 3-1. Sample pages from an Air Force Regulation.

Number	Date	Title	OPR	Distr
M 91-12	19 Aug 71	Policies, Procedures and Criteria for the Management and Conservation of Utilities	*ESC/DEMM	F
Changes		1		
IMC		78-1		
M 91-13	16 Sep 70	Maintenance of Permanently Installed Storage and Dispensing Systems for Unconventional Fuels	*ESC/DEMM	F
Changes		1 2		
R 91-14	22 Dec 80	Mobile Airfield Marking Team	*ESC/DEMP	F
R 91-15	17 Dec 81	Snow and Ice Removal and Control	*ESC/DEM	F
M 91-16	Dec 71	Military Entomology Operational Handbook	*ESC/DEVN	F
Changes		1 2		
M 91-17	2 Mar 72	Electrical—Interior Facilities	*ESC/DEMM	F
R 91-18	29 Aug 72	Standard Maintenance and Installation of Appliance Connections	*ESC/DEMM	F
M 91-19	Aug 70	Herbicide Manual for Noncropland Weeds	*ESC/DEVN	F
R 91-20	7 Mar 72	Gas Supply and Distribution	*ESC/DEMM	F
R 91-21	6 Mar 81	Pest Management Program	*ESC/DEVN	F
R 91-22	26 Apr 76	Aerial Dispersal of Pesticides	*ESC/DEV	F
R 91-24	29 May 81	Energy Management and Control Systems (EMCSs)	*ESC/DEMM	F
R 91-25	19 May 59	Examining and Licensing Program for Electrical Power Generating and Heating Plant Operators	*ESC/DEMM	F
R 91-27	29 Jan 81	Corrosion Control	*ESC/DEMM	F
R 91-28	26 Oct 72	Permanently Installed Storage and Dispensing Systems for Petroleum and Unconventional Fuels	*ESC/DEMM	F
IMC		78-1 82-1		
R 91-29	10 May 71	Operating & Maintaining Installations Jointly or Solely Occupied by the Air National Guard	LEEP	F
R 91-30	2 Sep 81	Custodial Service	*ESC/DEMG	F
IMC		• 82-1		
M 91-31	30 Jan 74	Maintenance and Repair of Roofs	*ESC/DEMM	F
M 91-32	Jan 82	Operation and Maintenance of Domestic and Industrial Wastewater Systems	*ESC/DEMM	F
M 91-33	Jan 74	Maintenance of Trackage	*ESC/DEMM	F
M 91-34	Jun 78	Maintenance of Waterfront Facilities	*ESC/DEMM	F
M 91-36	3 Sep 80	Built-up Roof Management Program	*ESC/DEMM	F
M 91-37	Oct 81	Maintenance of Fire Protection Systems	*ESC/DEMM	F
R 91-38	25 May 82	Civil Engineering Consultant Program	*ESC/DEMM	F
92—CIVIL ENGINEERING—FIRE PROTECTION				
R 92-1	19 Nov 81	Fire Protection Program	*ESC/DEF	F
IMC		82-1		

BEG-555

Figure 3-2. Sample page from AFR 0-2.

The key to using a library is learning to find the publication you need. AFR 0-2 is that key. A typical page from AFR 0-2 is shown in figure 3-2. The series designations of standard publications in this figure are 90, 91, and 92. Notice on the left side of the figure the entries R and M. R means that the publication is an Air Force regulation, M—Air Force manual, and P (not shown)—Air Force pamphlet. Now for an example.

R 91-21 6 March 1981
R = Air Force Regulation
91 = Real Property Operation and Maintenance
-21 = Pest Management Program
6 March 1981 = Date of Publication

Exercises (026):

Refer to figure 3-2 and complete either number or title of the following standard publications.

Number	*Title*
1. AFR 91-14.	______
2. AFR 91-16.	______
3. AFM 91-31.	______
4. ______	*Herbicide Manual for Noncropland Weeds.*
5. ______	*Custodial Service.*
6. ______	*Civil Engineering Consultant Program.*

3-2. Forms

Someone once said of a squadron of fighter aircraft, "We can't get them off the ground until the paperwork is completed." Much of what we do in the Air Force must be placed on forms. Forms are used to requisition equipment and supplies. They are used to keep records of resources ordered, used, on hand, and projected for future use. Your training record is kept on a form. Your evaluation of workers is recorded on a form. Forms are used as official documentation of our activities in our jobs. They help us to remember what we have done so that we can do our future jobs even better.

027. Using an extract from AFR 0–9, *Numerical Index of Departmental Forms*, locate form number, title, date, and prescribing directive of given forms.

Index of Departmental Forms. Air Force regulation 0–9 may be very useful when completing forms. This index covers AF Forms, AFTO (Air Force technical order) forms, DD (Department of Defense) forms, and others. The regulation is published every 4 months. It gives you the department, form number, date of form, title, and prescribing directive.

Figure 3-3, a typical page from AFR 0–9, is a model of what the complete index is like. Let's assume you have to complete an AF Form 646. Go down the left column until you see 646. The black dot before the title means this form is new since the last index publication. The form's title is US Air Force Pest Management Program Review, and the prescribing directive is AFR 91–21 (how convenient). This regulation will descr e how the form is used.

Exercises (027):

1. Refer to figure 3-3 and complete either the title or number of these AF forms.

	Number	*Title*
a.	AF Form 611	______________
b.	AF Form 637	______________
c.	AF Form 629	______________
d.	______________	Charge Out Record.
e.	______________	Base Civil Engineer Schedule of Costs.
f.	______________	Clothing Request and Receipt—Female.

2. What is the current date of AF Form 623?

2. What is the prescribing directive for AF Form 635?

028. Cite necessary information needed to complete AF Form 764a, Requisition and Requirement Request, and indicate appropriate entries for the form.

How to Order Forms. Ordering forms is a simple matter of completing yet another form. Figure 3-4, Requisition and Requirement Request (AF Form 764a), is the form to use. On it, you put the following information.

a. Short title and date of the form needed.
b. Unit of requisition.
c. How many you normally use each month.
d. How many you have on hand.
e. How many you want to requisition.

For data on how to use it, refer to the previous section on the use of AFR 0–9. The prescribing directive that applies to a particular form is listed in the right column.

Exercises (028):

1. What information is typically entered on AF Form 764a?

2. Refer to figure 3-4 to complete the following.
   a. What is the date of the form you're ordering and where is it written on AF Form 764a in figure 3-4?

   b. How would you order four cases of the form for the coming year?

3-3. Security

Picture in your mind for a moment an enemy agent sent to your base to secure intelligence information. You probably see a sly looking individual who looks like a typical spy on television. Unfortunately, that is not what an enemy agent looks like. He or she would more than likely look and act like one of your coworkers or a neighbor. We know you wouldn't think of deliberately disclosing secret information to an enemy. But do you know that you can unintentionally disclose information that can become of possible intelligence value? For example, suppose you see a number of B–52 aircraft on the runway during your work. As far as you know this information is unclassified; however, the enemy can use bits of information to gain an insight into a classified plan. Your best bet is to cool it—that is, don't mention this information to the folks around you; for believe it or not, one of those "nice folks" can be an enemy agent. We repeat it, it is not suggested here that you or any other Air Force member would knowingly ever consider giving classified information or information of

AIR FORCE (AF) FORMS

Number	Date	Unit of Rqn	Title	Const Pkg	Func Code	Prescribing Directive
606	Feb 74	LA	ADPE Tape Identification	SH 18	2410	AFR 300-6
607	Jan 80	TG	Weapons Systems Pouch Tag	TG	1 10	AFR 182-2
608	Jun 71	ST	Nickname Assignment/Change/Cancellation Request	ST	5020	AFR 205-1
I 610	Nov 78	CD	Change of Address—Correspondents/Publishers	CD	4710	AFR 182-1
611	Nov 77	CS	Average Training Cost Per Graduate	CS	2140	AFR 173-7
612	Nov 77	CS	Variable Training Cost Per Graduate	CS	2140	AFR 173-7
613	Nov 77	CS	SAP Training Cost Per Student	CS	2140	AFR 173-7
614	Oct 71	CD	Charge Out Record	CD	4730	AFM 12-20
614a	May 71	CD	Charge Out Record (8" x 5-1/4")	CD	4730	AFM 12-20
615	Aug 80	CS	Unit Watercraft Operations and Cost Summary Report	CS	4400	AFR 75-58
616	Aug 81	CS	Request and Authority to Cite Funds	CS	1800	AFR 177-101
617	Aug 80	CS	Unit Watercraft Maintenance Summary Report	CS	4400	AFR 75-58
B 618	Mar 79	ST	Medical Board Report	ST	5400	AFR 168-4
I 620	• Jan 82	CS	Colonel Resume	CS	1110	AFR 36-23
621	Dec 54	CS	Report of Annual Financial Plan (LRA)	CS	2110	AFM 172-1V2
I 623	May 76	FL	On-The-Job Training Record	FL	5610	AFM 50-23
623a	Mar 79	CS	On-The-Job Training Record—Continuation Sheet	CS	5610	AFM 50-23
I 624	Dec 79	CD	Base/Unit Locator and PSC Directory	CD	4700	AFR 11-1
625	Apr 77	CS	Analysis of Unobligated Balances (Used by AFLC and AFSC only) (LRA)	CS	2110	AFM 172-1
626	Oct 80	CS	Hand Receipt for Lending Closet Items	CS	1200	AFR 211-24
627	Jan 72	ST	Application for Registration or Certification of Official Mail	CF 650	4730	AFR 182-2
628	Dec 81	ST	Diet Instruction Evaluation Checklist and Authorization	ST	5483	AFR 168-4
629	• Nov 1	CD	Small Arms Hand Receipt	SH 5	5050	AFR 125-37
630b	Dec 62	CS	Material Procurement Program Control Plan (LRA)	CS	4100	AFR 401-1
631	Nov 68	ST	Report of Separation from United States Air Force Academy (S&I HQ USAF/MPPA, Wash DC 20330)	ST	5622	AFR 53-3
633	Aug 80	CS	Managerial Potential Assessment (MPA)	CS	0960	AFR 40-110V1
• 634	Feb 82	CS	USAF Fraud, Waste, and Abuse Data Collection	CS	4900	AFR 123-2
•I 635	May 82	CS	USAF Fraud, Waste, and Abuse Disclosure	CS	4900	AFR 123-2
636	Dec 71	CS	B3500 Systems Change Release (LRA)	CS	2360	AFM 171-110V7
637	Jul 80	CS	BCE Job Order Log	CS	3900	AFR 85-1
638	Mar 68	CS	Refrigeration Unit Standard Temperature Chart	CS	3600	AFR 145-1
639	Nov 64	CS	Average Unit Operating Cost Worksheet (For use only by Industrially Funded Laundry & Dry Cleaning Operations & MAJCOMs having jurisdiction.)	CS	1700 4000	AFR 170-16
640	May 60	CS	Base Civil Engineer Schedule of Costs	CS	1700	AFM 170-27
641-4	May 63	ST	Position Survey	ST	0940	AFR 40-511
642	Sep 81	ST	Air Force Achievement Medal and Air Force Commendation Medal Justification	ST	0710	AFR 900-48
643	• Nov 81	CD	• Audio Visual Equipment Control and Use Record	CD	2510	• AFR 95-2V3
B 644	Sep 80	CS	Record of Dental Attendance	CS	5450	AFR 162-1
646	Jul 79	CS	• US Air Force Pest Management Program Review (LRA)	CS	3930	AFR 91-21
B 647	Dec 69	CD	Donation of Body Parts for Transplantation Purposes	CD	5400	AFR 160-12
648	Aug 70	CS	Certificate of Cost Incurred (LRA)	CS	1700	AFM 170-27
649	Jul 75	CS	Verification of Long Distance Telephone Calls	CS	4510	AFM 100-22
650	Jan 75	CS	Health Benefits Control Register (By Enrollment Code)(LRA)	CS	1813	AFR 177-104
I 651	Aug 78	CS	Hazardous Air Traffic Report (HATR)	CS	4900	AFR 127-4
652	Oct 80	ST	Request for Loan of Master Personnel Record (S&I, HQ AFMPC MPCDOP, Randolph AFB TX 78150)	ST	1150	AFR 31-4
I 653	Jul 76	CD	Flight Currency Record (Aero Club)(PA)	CD	1240	AFR 215-12
I 654	Jun 76	CD	PIC Safety Annual Currency Record (Aero Club)(PA)	CD	1240	AFR 215-12
I 655	Oct 79	ST	Clothing Request and Receipt—Female	ST	4240	AFM 67-1V1
I 656	Oct 79	ST	Clothing Request and Receipt—Male	ST	4240	AFM 67-1V1
I 656	Oct 79	CS	Clothing Request and Receipt—Male (S&I, AFROTC, Maxwell)	CF	4240	AFM 67-1
I 657	Mar 78	CS	Personal Clothing Record—Female Airmen (Air Force Reserve and Air National Guard)	CS	4230	AFM 67-1V1
I 658	Mar 78	CS	Personal Clothing Record—Male Airmen (Air Force Reserve and Air National Guard)	CS	4230	AFM 67-1V1
S 659	Dec 70	CS	Personal Clothing Claim	CS	4230	AFM 67-1
659PA	Sep 75	CS	Personal Clothing Claim (LRA)	CS	4230	AFM 67-1
660	Jun 67	CD	Daily Labor Time Card	BX 2000	1700	AFM 170-27
662	Jul 81	CS	Food Service Production Log	CS	3600	AFR 146-7
663	Nov 76	CS	Record of Daily Sales	CS	4230	AFM 67-1V1
666	Jan 74	CS	Certification of Charge Sales Accepted by the Finance Officer	CS	4230	AFM 67-1V1
667	Dec 64	CS	Inventory Report	CS	4220	AFM 67-1

BEG-554

Figure 3–3. Sample page from AFR 0–9.

(PRESS HARD WHEN USING BALL POINT PEN)

SHORT TITLE AND DATE	UNIT OF RQN	CLASS	SYMBOL	REQUISITION	REQUIREMENT
AF Form 346	CS				
TO: PDO 1234A Bldg 117	FROM: 900 IV Bldg 1927, Stop 43			FOR FORMS USE ONLY	
				MONTHLY USAGE 25	ON HAND 5
REMARKS				EMERGENCY	ONE TIME
				PB RESPONSE	
				FOLLOW UP/TRACER	
				MISSED SHORT ID	
				REQUIREMENT:	
				OTHER *(Specify)*	
				DATE PREPARED 30 Sep 83	
				SIGNATURE AND TITLE	

AF FORM 764a OCT 82 PREVIOUS EDITION WILL BE USED. ... AND RQMT REQUEST

Figure 3–4. Sample, AF Form 764a.

possible intelligence value to the enemies of our country; but many US citizens do just that, merely by talking too much. So, never discuss your duties, the place where you work, or the equipment you operate.

029. Specify basic facts about the operational security (OPSEC) program and its relationship to other security programs.

Definition and Purpose of OPSEC. OPSEC is a program that surveys and identifies items of information and physical security that are of intelligence value to an enemy. Items of information include unclassified small bits of information that lend themselves to revealing information concerning the what and how of actions to take place. Breaks in regular routines and new routines are examples. The types of information that should be protected are subjects such as:

- Objective of the mission.
- Location of operations.
- Date and time of the actions.
- Types and number of forces involved.
- Amounts and types of weapon systems and equipment used.
- Limitations of resources.
- Method of employment of troops and equipment.

The purpose of OPSEC is to prevent the disclosure of all information, including bits of information, that contain intelligence value, which can be used by the enemy to reduce the effectiveness of an operation. We must protect knowledge of our plans concerning a mission so that our side will have the advantage of surprise.

Relationship of OPSEC to Other Security Programs. Operations security, communication security, information security, and physical security are closely related to each other. Each of these four programs supports the others. However, OPSEC has broader applications in that it seeks to protect bits of unclassified information as well as that which is classified. It makes little sense to protect an operation by classifying some parts of it or to expand COMSEC resources protecting information about it when unclassified conversations, stereotyped procedures, and other readily available data could provide an enemy with the intelligence needed to predict an operation. An effective OPSEC program will eliminate or control many of the sources of intelligence.

Exercises (029):

1. What does OPSEC do?

2. List three types of information that should be protected under the OPSEC concept.

3. What is the main difference between OPSEC and other security programs?

030. Identify OPSEC vulnerabilities from a given list of situations.

Common OPSEC Vulnerabilities. The following is a list of intelligence indicators that may give insight into an operation. They are items of possible intelligence value and are operation security vulnerable. In one sense, vulnerable means open to attack.

a. Stereotyped sequence of events comprising various phases of the operation.

b. Coordination with other units that do not have proper safeguards for sensitive information.

c. Submission of unclassified reports at specific intervals to specific units of command.

d. Public information releases.

e. Posting of operational plan information in unsecure areas.

f. Posting of rosters, transportation schedules, and dining hall schedules in unsecure areas.

g. Distinctive emblems or paint on vehicles, buildings, or aircraft.

h. Markings on supplies that could reveal the location or starting date of the operations, such as nicknames, delivery deadlines, etc.

i. Logistics buildup or positioning of support materials and facilities.

j. Special briefings, meetings, or religious services.

k. The use of nicknames is particularly hazardous since these provide an easily recognizable flag for identification of an operation.

l. Exercising or testing portions of a plan.

m. Plain language communications associated with a planned operation and conducted during the planning, preparatory, and execution phases.

n. Use of unchanging or infrequently changing call signs and/or radiofrequencies.

o. Stereotyped message characteristics that are indicative of particular types of military activity.

p. A significant increase or decrease in message traffic volume.

q. Activities of new communications facilities in support of an operations plan.

Operations security is not limited to major combat operations but is important for any operation, including peacetime maneuvers.

Specific Vulnerabilities. In your job as a pest management specialist, you probably don't feel that you will have any information or be exposed to situations that would be vulnerable to OPSEC violations. Granted your job is not one that will continually expose you to classified information or equipment; however, you see and hear much that can be called intelligence indicators.

There will be occasions when you are required to enter areas that have classified equipment and materials. When in these areas, you may overhear conversations pertaining to this material. Whatever you hear or see, whether classified or not, could be of intelligence value to the enemy. If you work with Prime BEEF, you may have to use herbicides to destroy plant growth in jungle areas. This information may be critical for a planned mission. You should never tell a person without a need to know what you hear, see, or do on your job.

Another example of specific vulnerability is the location of herbicides and pesticides. Wouldn't that be a good place for enemy infiltrators to strike? They could dump these poisonous chemicals into the water supply. This is a way to put the base out of commission without firing a shot. Loose talk could give a trained agent a mental blueprint of your shop and a poison-laden water supply could be the result.

Knowing the exact location of components in your shop and the waterplant, duty schedules, and the number of personnel on duty could be very helpful to an enemy. Your job is extremely important and vulnerable so practice keeping your mouth closed about your job, particularly when you are not working.

Exercises (030):

Place an "X" in the provided space for each of the following situations that may result in a compromise of the OPSEC program.

_____ 1. A friendly stranger is very curious about your job.

_____ 2. While working in a restricted area, you:

_____ a. See a new equipment item being installed on an aircraft.

_____ b. Overhear flight crews discussing a training program.

_____ c. See equipment and materials being stockpiled.

_____ d. Notice an increase in physical security around an area.

3. You are assigned duties on a missile site.

Answers for Exercises

CHAPTER 1

Reference:

001 – 1. You should have placed a checkmark beside (2), (3), (5), (6), (7), (9), (10), (and (12.

002 – 1. (1) Mechanical.
(2) Sanitation.
(3) Resources and requirements.
(4) Operations.
(5) Pavements and grounds.
(6) Civil engineer.
(7) Industrial engineering.
(8) Civil engineer.
(9) Structures.
(10) Structures.

003 – 1. (1) a.
(2) b.
(3) c
(4) c.
(5) d.
(6) c
(7) g
(8) b.
(9) f
(10) c

004 – 1 Base engineer emergency force.
004 – 2. You should have placed a checkmark beside (1), (3), (5), (6) and (8).

005 – 1. AFSC 55211.
005 – 2. Basic Disease Vector Control Course
005 – 3. [illegible]
005 – 4. AFSC 55255, E–3, E–4, E–5.
b. AFSC 55170, E–5, E–6, E–7.
c. AFSC 56699, E–7, E–8, E–9.
005 – 5. Structural Superintendent, E–9.
005 – 6 Carpentry, masonry, metal fabrication, protective coating, and plumbing.
005 – 7. Engineering assistant.

006 – 1. (1) i
(2) g.
(3) b.
(4) d
(5) e.
(6) d.
(7) f
(8) c.
(9) e.
(10) h
(11) a.
(12) k.
(13) j.
(14) k.
(15) j.

007 – 1. (1) 7.
(2) 5.
(3) 5.
(4) 7.
(5) 5, 7.
(6) 5.
(7) 5.
(8) 5.
(9) 7.
(10) 5.
(11) 5.
(12) 7.
(13) 7.
(14) 7.
(15) 5.
(16) 5.
(17) 7.
(18) 5.

008 – 1. To determine the effectiveness of formal schools and Career Development Courses.
008 – 2. When the graduate can't meet the proficiency requirements of the STS, when the STS lists tasks not performed in that AFS, and when the STS code levels are too high.
008 – 3. Within 6 months.

CHAPTER 2

009 – 1. False. It is the production control center.
009 – 2. True.
009 – 3. False. Work requirements are identified on AF Form 1135, BCE Real Property Maintenance Request.
009 – 4. False. It is called recurring work.
009 – 5. False. They are reported by the shop supervisor and approved by the section superintendent.
009 – 6. True.
009 – 7. False The worker does not report materials used.
009 – 8. True.
009 – 9. True.

010 – 1. 1135.
010 – 2. 332.
010 – 3. 332.
010 – 4 1135.
010 – 5. 332.
010 – 6. F. AF Form 1135
010 – 7. T.
010 – 8. F. Emergency work also.
010 – 9. T.
010 – 10. T.

011 – 1. 1879.
011 – 2. 1219.
011 – 3. 1879.
011 – 4. 327
011 – 5. 1219.
011 – 6. 327.

QUALITY CONTROL EVALUATION	JOB ORDER/WORK ORDER NUMBER 5826

This questionnaire is designed to improve Civil Engineering service to you. Answer all questions and place in base distribution.

TO: BASE COMMANDER BASE CIVIL ENGINEER In Turn	FROM: *(Base Address, include Bldg/Qtrs No.)*	DATE SERVICE COMPLETED

SERVICE REQUESTED
Control rodents in basement, building 1927

DUTY SECTION OF WORKER	WORKER'S SIGNATURE
(Your duty section)	(Your name)

QUESTIONNAIRE *(Explain all no answers)*	YES	NO
1. BASE CIVIL ENGINEER PERSONNEL WERE COURTEOUS		
2. BASE CIVIL ENGINEER RESPONSE WAS TIMELY.		
3. RECEIVED ADEQUATE NOTIFICATION AS TO WHEN THE WORKER WOULD ARRIVE. *(If applicable)*		
4. WORKER UTILIZED TIME EFFICIENTLY.		
5. JOB WAS COMPLETED.		
6. IF NOT, WERE YOU GIVEN AN ESTIMATED COMPLETION DATE FOR THE JOB?		
7. WORK WAS PERFORMED SATISFACTORILY.		
8. JOB SITE WAS CLEANED UP AFTER COMPLETION.		

REMARKS

CUSTOMER'S SIGNATURE	DATE

AF FORM NOV 78 1255 PREVIOUS EDITION WILL BE USED. ☆U.S. Government Printing Office: 1981—340-078/612

Figure A-1. Objective 012, exercise 1.

013 - 1. (1) 4.
(2) 1
(3) 5.
(4) 2.
(5) 3

013 - 2 Your completed AF Form 561, Part 1 only, should look like this

BASE CIVIL ENGINEER WEEKLY WORK SCHEDULE (PART I)	WEEK ENDING	COST CENTER	APPROVED

LINE NO.	DESCRIPTION A	LABOR UTIL. CODE (LUC) B	MAN/HRS. C	MON SCHED	MON ACT	TUES SCHED	TUES ACT	WED SCHED	WED ACT	THU SCHED	THU ACT	FRI SCHED	FRI ACT	SAT SCHED	SAT ACT	SUN SCHED	SUN ACT
1	ASSIGNED		280	56		56		56		56		56					
2	BORROWED		40	8		8		8		8		8					
3	OVERTIME	38															
4	TOTAL AVAILABLE (total of items 1,2,and 3)		320	64		64		64		64		64					
5	SUPERVISION	31	20	4		4		4		4		4					
6	TRAINING	32															
7	LEAVE	33	24	8		8		8									
8	ALL OTHER	34															
9	LOANED LABOR	39															
10	TOTAL INDIRECT (total of items 5 through 9)		344	12		12		12		4		4					
11	AVAILABLE FOR WORK (Items 4 minus Item 10)		276	52		52		52		60		60					

(Column group C–SUN headed MANHOUR ALLOCATIONS.)

Figure A-2. Objective 013, exercise 6.

014 - 1. To provide a uniform reporting system and to identify direct labor cost against work orders.
014 - 2. ATA and ETA.
014 - 3. AF Form 1734.
014 - 4. Handprinted on AF Form 1734 below the first group of names.

015 - 1. BCE.
015 - 2. The director of base medical services.
015 - 3. The major command.
015 - 4. They must be currently licensed and certified personnel.
015 - 5. Certified Air Force personnel.
015 - 6. Environment.

016 - 1. e.
016 - 2. e.
016 - 3. c.
016 - 4. c.
016 - 5. a.
016 - 6. e.
016 - 7. d.
016 - 8. d.
016 - 9. c.
016 - 10. b.
016 - 11. f.
016 - 12. d.

017 - 1. For temporary custody of an item.
017 - 2. 24 hours.

018 - 1. To make a visual check to see if property listed on paper is actually there.
018 - 2. Obeying a set of rules necessary to conserve and protect Air Force equipment and supplies.
018 - 3. (1) AF equipment must be operational.
(2) Adequate supplies in good condition must be on hand.
(3) Use equipment and supplies only for their intended purposes.
(4) Safeguard equipment and supplies.
(5) Keep accurate records.
018 - 4. a. 4.
b. 3.
c. 5.
d. 1 and 2

019 - 1. X.
019 - 2. It's the table of allowances.
019 - 3. X.
019 - 4. X.
019 - 5. X.
019 - 6. X.
019 - 7. X.
019 - 8. EAs do this.

020 - 1. The back of the form and AFR 67-23.
020 - 2. Any two of the following apply: to increase or decrease equipment authorization, to order new equipment items, or to turn in or replace old equipment.
020 - 3. Nomenclature, unit of issue, and the number ordered.
020 - 4. It's used by the planning section to order materials needed to complete work orders.

021 - 1. Materiel control.
021 - 2. The NSN.
021 - 3. The item was made in Turkey.
021 - 4. Tool kit, general mechanic's, 5180-00-177-7033.

022 - 1. AFR 19-1.
022 - 2. National Environmental Policy Act.
022 - 3. HQ USAF, each major command, and each base.
022 - 4. Air Force policy is to comply with the nature and spirit of national policy and support and assist Federal, State, and local agencies in preventive pollution control.

023 - 1. False. Buy returnable bottles.
023 - 2. False. Don't buy unnecessary electrical devices.
023 - 3. True.
023 - 4. True.
023 - 5. True.
023 - 6. True.
023 - 7. True.
023 - 8. False. Dark walls absorb light.
023 - 9. False. A small engine uses less fuel.
023 - 10. True.

CHAPTER 3

024 - 1. b.
024 - 2. d.
024 - 3. c.
024 - 4. a.
024 - 5. a.

025 - 1. It states policies, responsibilities, and procedures for pest management at AF installations
025 - 2. A telephone maintenance truck.
025 - 3. All personnel engaged in mixing and applying pesticides.
025 - 4. When ground pest management measures fail, are not practical, or not possible.
025 - 5. AFR 91-22.

026 - 1. Mobile Airfield Marking Team.
026 - 2. Military Entomology Operational Handbook.
026 - 3. Maintenance and Repair of Roofs.
026 - 4. AFM 91-19.
026 - 5. AFR 91-30.
026 - 6. AFR 91-38.

027 - 1. a. Average Training Cost Per Graduate.
b. BCE Job Order Log.
c. Small Arms Hand Receipt.
d. AF Form 614.
e. AF Form 640.
f. AFR 123-2.
027 - 2. May 1976.
027 - 3. AFR 123-2.

028 - 1. Short title and date of the form needed, unit of requisition, how many you normally use each month, how many are on hand, and how many you want to requisition.
028 - 2. a. July 79 is written in the same block as AF Form 646.
b. Place the number 4 under REQUISITION.

029 - 1. It is used to survey and identify items of information and physical security that are of intelligence value to the enemy.
029 - 2. Any three of the following apply: mission objectives, location of operations, date and time of the actions, and types and numbers of forces involved.
029 - 3. OPSEC has broader applications in that it seeks to protect bits of unclassified information as well as that which is classified.

030 - 1. All spaces should be marked with an X

96

STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 01 27

INTRODUCTION TO CIVIL ENGINEERING

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the *best* answer to each question.

1. (001) In carrying out its primary mission, what activities are performed by the Base Civil Engineer (BCE) regarding real estate property?

   a. Acquisition, construction, and controlling.
   b. Acquisition, construction, and maintenance.
   c. Construction, maintenance, and controlling.
   d. Construction, maintenance, and utilization.

2. (001) Which of these functions is *not* a responsibility of civil engineering?

   a. Buy land to build military family housing.
   b. Construct and maintain pavements.
   c. Provide electricity to the base.
   d. Operate dining halls.

3. (002) Which of the following sections is next in the chain of command above pest management?

   a. Operations.
   b. Sanitation.
   c. Structures.
   d. Environmental support.

4. (002) In the CE structure, which command block is responsible to the BCE for all the CE shops?

   a. Resources and requirements.
   b. Industrial engineering.
   c. Squadron section.
   d. Operations.

5. (003) Which of the following correctly depicts the functions of the operations section?

   a. Direct, coordinate and control all cost accounting and real estate activities.
   b. Direct, coordinate, and control all work authorized to be done by the CE work force.
   c. Carry on an industrial engineering and financial management activities.
   d. Supervise all actions and programs of the engineering and environmental planning section.

6. (003) Which section would you contact for information regarding long-range work plans and approving work requests?

   a. Systems management.
   b. Resources and requirements.
   c. Industrial engineering.
   d. Financial management.

7. (004) Which of the following activities gives CE the ability to provide direct combat support to the AF mission?

   a. RED HORSE.
   b. Prime BEEF.
   c. Industrial engineering.
   d. Readiness and logistics.

8. (005) At what grade can you expect to become a pest management specialist?

   a. E-1
   b. E-2
   c. E-3.
   d. E-4.

9. (006) Which section would you contact to plaster holes in buildings as a method of rodent control?

   a. Carpentry section.
   b. Masonry section.
   c. Pest management section.
   d. Metal fabricating section.

10. (007) Identify the duty for which the pest management specialist is *not* responsible?

a. Conducting pest management surveys.
b. Maintaining pesticide use records.
c. Maintaining tools and equipment.
d. Making work assignments.

11. (007) Which of the following is a pest management specialist responsible for, as compared to a pest management technician?

a. Maintaining pesticide use records.
b. Solving complex pest management problems.
c. Maintaining records to account for costs.
d. Conducting OJT.

12. (008) A supervisor *must* complete and submit an AF Form 1284, Training Quality Report, for all of these situations *except* when

a. the graduate doesn't perform all the tasks listed in AFR 39-1 for his/her AFSC.
b. the graduate is not required to perform tasks listed in the STS.
c. a student doesn't meet the proficiency level specified for a task or knowledge listed in the STS.
d. the STS code levels or tasks exceed the requirements of the graduate's AFSC.

13. (009) Which of the following includes CE personnel such as superintendents and controllers, and acts as a nerve center for CE activities?

a. Inservice work plan section.
b. Resources and requirements section.
c. Production control center.
d. Customer service unit.

14. (009) The shop supervisor uses AF Form 1841, Maintenance Action Sheet, to report requirements for which type of work to the superintendent?

a. Recurring work.
b. Inservice work
c. Emergency and urgent job orders.
d. Work indicated by facility surveys.

15. (009) Within CE, the Base Engineer Automated Management System (BEAMS) is used to

a. automate work planning methods.
b. process civil engineering records.
c. evaluate personnel assignments.
d. develop the inservice work plan.

16. (010) Which of these forms would you complete to request work?

a. AF Forms 327 and 332.
b. AF Forms 322 and 1135.
c. AF Forms 332 and 1849.
d. AF Forms 327 and 1879.

17. (010) Which kind of work would be requested on AF Form 1135, BCE Real Property Maintenance Request?

a. Routine repair needs.
b. Urgent repair needs.
c. Emergency repair needs.
d. Any of the above.

18. (010) When is a shop-referred service call used?

a. In almost all emergency situations.
b. When no special equipments is required.
c. When work would take more than an hour.
d. When the work is beyond the DIN capability.

BEST COPY AVAILABLE

19. (011) Which of these forms is used to authorize work which does *not* require detailed planning or special costing?

a. AF Form 327, BCE Work Order.
b. AF Form 332, BCE Work Request.
c. AF Form 1135, BCE Real Property Maintenance Request.
d. AF Form 1879, BCE Job Order Record.

20. (011) Which of these forms is used to authorize accomplishing several small jobs in high-use facilities?

a. AF Form 1879, BCE Job Order Record.
b. AF Form 1219, BCE Multi-Craft Job Order.
c. AF Form 327, BCE Work Order.
d. AF Form 332, BCE Work Request.

21. (012) Which of the following is *not* a purpose of AF Form 1255, Quality Control Evaluation?

a. [illegible] customer relations.
b. Improve worker productivity.
c. Motivate timely and quality service to BCE customers.
d. Increase management participation in setting shop standards.

22. (012) Which of these entries is *not* made by the worker on AF Form 1255, Quality Control Evaluation?

a. Description of service requested.
b. Worker's duty section.
c. How worker utilized time.
d. Job or work order number.

23. (013) Which of these forms is used to schedule work on a weekly basis?

a. DD Form 561.
b. DD Form 156.
c. AF Form 561.
d. AF Form 156.

24. (014) Which of these forms is used to record labor-hours expended daily by Actual Time Accounting (ATA)?

a. AF Form 561.
b. AF Form 1734.
c. AF Form 1842.
d. AF Form 1879.

25. (014) How is a person's time put on an AF Form 1734, BCE Daily Work Schedule, when his/her name is *not* printed on the form?

a. Print the name on the front of the form.
b. Print the name on the back of the form.
c. Show it against a person on leave.
d. Show it against indirect labor.

26. (015) A reason that would justify a pest management contract is that

a. it is the BCE's preference.
b. the base has a minor pest problem.
c. the base is too small to justify manning the AFSC.
d. there is a lack of interest in pest management at the facility.

27. (015) When you monitor a pest management contractor, you should ensure all of the following *except*

a. use of certified workers.
b. use of approved equipment.
c. compliance with safety standards.
d. use of EPA-registered chemicals.

28. (016) What is the supervisor's responsibility for Air Force equipment and material?

a. Only materials in his/her unit.
b. Anything not signed for by somebody else.
c. All equipment under management's control.
d. Personnel indoctrination in supply discipline.

29. (017) When you issue material on AF Form 1297, Temporary Issue Receipt, what is the normal time period for issue?

a. 12 hours.
b. 24 hours.
c. 5 days.
d. 30 days.

30. (018) If a herbicide application job isn't completed due to a broken hose, what supply discipline rule is violated?

a. Keep adequate supplies on hand.
b. Use equipment for intended purposes.
c. Make sure equipment is operational.
d. Safeguard equipment and supplies.

31. (018) Which rule of supply discipline is violated if a shop supervisor does *not* keep up with the amount of pesticides used?

a. Use supplies for intended purposes.
b. Safeguard supplies and equipment.
c. Keep adequate supplies on hand.
d. Keep accurate records.

32. (019) What is the purpose of the Table of Allowance (TA)?

a. Prescribes items and their numbers a unit can have.
b. Specifies the number of personnel authorized.
c. Prescribes the cost of authorized vehicles.
d. Specifies the amount of bench stock required.

33. (019) What publication is used in conjunction with Tables of Allowances (TAs)?

a. Stock catalog.
b. Supply catalog.
c. Master Equipment Management Index.
d. Master Personnel and Equipment Index.

34. (020) When picking up materials ordered on AF Form 1445, Materials and Equipment List, you should check all of the following *except* the

a. nomenclature of the materials.
b. unit of issue for each item.
c. purchase funding code.
d. number ordered.

35. (021) Within the organizational structure, what section handles supply problems for CE?

a. Material control.
b. Base supply.
c. BCE supply.
d. Work control.

36. (021) If you need an equipment item but *cannot* locate a stock number for it, what should you do?

a. Look for a substitute equipment item for which you have a stock number.
b. Call another pest management shop to see if they have it.
c. Contact material control and request their help.
d. Refer to base supply.

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57. (032) Air Force environmental protection committees are established at all of the following levels *except*

a. wing.
b. base.
c. MAJCOM.
d. HQ USAF.

58. (032) Which Air Force publication covers AF pollution policy?

a. AFR 1-9.
b. AFR 11-9.
c. AFR 19-1.
d. AFR 91-1.

59. (033) Which of the following is *not* considered a method of conservation?

a. Using lead-free gasoline.
b. Planting trees, shrubs, and grass.
c. Taking showers instead of baths.
d. Burning grass, leaves, and tree limbs.

60. (034) In which type of standard publication would you look to find detailed techniques on how to perform a job?

a. Regulation.
b. Supplement.
c. Manual.
d. Pamphlet.

61. (034) What are the primary administrative directives governing AF activities?

a. Regulations.
b. Pamphlets.
c. Manuals.
d. Supplements.

62. (035) Where would you find the function of a regulation listed?

a. In AFR 0-2, Numerical Index of Standard and Recurring Air Force Publication.
b. In AFR 0-9, Numerical Index of Departmental Forms.
c. After the regulations' title.
d. Immediately following the table of contents.

63. (036) What is the regulation number of the Numerical Index of Standard and Recurring Air Force Publications?

a. AFR 0-2.
b. AFR 0-5.
c. AFR 0-8.
d. AFR 0-9.

64. (036) Which regulation index should you refer to if you need to know the title of AFR 161-1?

a. AFR 0-9.
b. AFR 0-7.
c. AFR 0-4.
d. AFR 0-2.

65. (037) Which index would you use to determine the prescribing directive for AF Form 656?

a. AFR 0-9.
b. AFR 0-7.
c. AFR 0-4.
d. AFR 0-1.

66. (038) Which type of entry is appropriate for entering on AF Form 746a, Requisition and Requirement Request?

a. Recommendations for a new form.
b. Average number of the form used monthly.
c. Obsolete forms being turned in.
d. Changes needed to a current form.

67. (039) What program does the Air Force use to prevent disclosure of all types of information of possible intelligence value?

a. COMSEC.
b. PUBSEC.
c. AFSEC.
d. OPSEC.

48. (029) What is the main difference between OPSEC and other security programs?

a. OPSEC is broader in scope.
b. OPSEC is more narrow in scope.
c. OPSEC applies only to enlisted personnel.
d. OPSEC is mandated at lower echelons of command.

49. (030) In support of operations security, you can discuss problems regarding pesticide storage with

a. anyone.
b. anyone senior in rank.
c. your commander only.
d. only people having a need to know.

50. (030) Which of the following is OPSEC-vulnerable information?

a. Aircraft loading schedule.
b. Prime BEEF personnel roster
c. Location of pesticide storage area.
d. All of the above.

END OF EXERCISE

MAIL TO: ECI, GUNTER AFS AL 36118-5643

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012. PRINCIPAL PURPOSE: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package, and used by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's inquiry. Failure to provide all information would result in slower action or inability to provide assistance to the student.

CORRECTED OR LATEST ENROLLMENT DATA

1. THIS REQUEST CONCERNS COURSE (1-6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7-15)	6. GRADE/RANK	7. NAME (First initial, second initial, last name)
_ _ _ – _ _ – _ _ _ _		(17) – (18) – (19-32)

8. ADDRESS
OJT ENROLLEES: Address of unit training office with zip code.
ALL OTHERS: Current mailing address with zip code.

(33-53)

(54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33-39)

II. REQUEST FOR MATERIALS, RECORDS, OR SERVICE

Place an "X" through number in box to left of service requested.

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X	
1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction. *(Provide Old or Incorrect data here)* _____
4	Request Grade/Rank change/correction.
5	Correct SSAN. *(List incorrect SSAN here.)* *(Correct SSAN should be shown in Section I.)*
6	Extend course completion date. *(Justify in "Remarks")*
7	Request enrollment cancellation. *(Justify in "Remarks")*
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 10 Originals were: [ ] Not received [ ] Lost [ ] Misused
9	Send course materials. *(Specify in "Remarks")* [ ] Not received [ ] Lost [ ] Damaged
10	Course exam not yet received. Final VRE submitted for grading on _____ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 10 not yet received. Answer sheet(s) submitted _____ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on _____ (date).
13	Previous inquiry ([ ] ECI Fm 17, [ ] ltr, [ ] msg) sent to ECI on _____ (date).
14	Give instructional assistance as requested on reverse.
15	Other *(Explain fully in "Remarks")*

16	
G	33
K	VOL 33-35 / GR 36-38
M	33-34 / 35-40
N	33-35
P	VOL 33-35 / TC 36-37 / 38 / DOE 39-45
Q	33-34: ØØ / 38: 1 / MC 39-42

REMARKS *(Continue on reverse)*

OJT STUDENTS must have their OJT Administrator certify this record.

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I certify that the information on this form is accurate and that this request cannot be answered at this station.

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ECI FORM 17 DEC 84 PREVIOUS EDITION WILL BE USED.

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REQUEST FOR INSTRUCTOR ASSISTANCE

NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

VRE ITEM QUESTIONED:	MY QUESTION IS:
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VRE FORM NO ______	
VRE ITEM NO ______	
ANSWER YOU CHOSE ______ *(Letter)*	
HAS VRE ANSWER SHEET BEEN SUBMITTED FOR GRADING?	
[ ] YES [ ] NO	
REFERENCE	
(Textual reference for the answer I chose can be found as shown below.)	
IN VOLUME NO ______	
ON PAGE NO ______	
IN [ ] LEFT [ ] RIGHT COLUMN	
LINES ______ THROUGH ______	

REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

ECI FORM 17, DEC 84 *(Reverse)*

56650 02 8408

CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 2

Introduction to Pest Management

Extension Course Institute
Air University

1

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Preface

THIS SECOND volume of CDC 56650 was written to give you knowledge on these subjects: introduction to entomology; pest management planning and coordination; and safety, protective equipment, and first aid. To become certified as a pest management specialist, you must know these subjects as well as those you'll cover in later volumes.

In Chapter 1, you'll learn about several aspects of pest biology; such as pest taxonomy (how pests are classified), morphology (their form and structure), and physiology (their internal functions).

Chapter 2 will discuss several general aspects of pest management; such as, surveying, collecting, identifying, and preserving pests; integrated pest management; and records and reports. All of this will be a foundation on which you can build a more complete knowledge as you progress in the course.

Chapter 3 will give you information on how to protect yourself—both physically and legally—from the dangers inherent with your position. You'll learn about Federal, State, and local statutes and their impact on your work; how to handle pesticides safely; protective equipment; pesticide poisoning symptoms; and finally, first aid.

Appendix A is bound in the back of this volume. Use it as the text directs.

Code numbers appearing on figures are for preparing agency identification only.

This volume is rated at 33 hours (11 points).

Material in this volume is technically accurate, adequate, and current as of February 1984.

Acknowledgement

PREPARATION OF this volume was aided through the cooperation and courtesy of Harcourt Brace Jovanovich Publications, publishers of the *Scientific Guide to Pest Control Operations*, 3rd edition, and *Pest Control* magazine. Information from these publications helped in developing text regarding pheromones used in insect management programs; crack and crevice treatment methodology; insect development, classification and identification; and entomological principles. Permission to use these materials from Harcourt Brace Jovanovich is gratefully acknowledged.

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Contents

Introduction to Entomology

PEOPLE HAVE BEEN in contact with different types of insects and pests during the human race's entire existence. These insects and pests exceed 2 million known species, and scientists are constantly discovering new ones during their scientific studies and explorations. The results of these studies and explorations indicate that when all insects are known, their number will exceed 7 million species.

Today, as we frequently come in contact with insects, most of us look upon them as pests, but not as either harmful or beneficial. We seldom stop to consider the many insect-borne diseases or the many insect-produced products on the market. Do you know that honey, silk, lacquer, and many other commercial products come from insects? You may not like the thought, but some insects are edible. In contrast, many species of insects, rodents, and related pests seriously affect man. They affect military operations by spreading disease, reducing efficiency of personnel, or destroying property.

You might ask, "Why do people know so much about insects?" Well, insects have pestered people so long that we were forced to study their habits to find ways to control them. The knowledge we gained soon became a factor in our fight for health and survival. To adequately control an insect, humans need to know its characteristics and breeding habits. So began the study that is known as entomology.

Entomology is the science that deals with insects, which make up the majority of our economic pests. These insects and pests are of many species and varieties and live practically everywhere except on the open sea. They live and breed in most of the materials used by people: soil, water, and air. The factors determining their survival are the variations of climate and the lack or surplus of food, water, and shelter; however, many insects can adapt amazingly to change in environment.

The science of entomology is divided into two major categories: economic and medical. The economic category has been subdivided into five branches which group insects according to their destructive activities. The medical category (to be discussed later) establishes the insect-borne diseases and the insects responsible for them.

For the present, these are the five major groups of the economic category:

(1) Agricultural. The agricultural branch deals with the growing of field and truck crops. This area includes many types of insecticides which cause death to insects from eating, direct contact, or breathing.

(2) Horticultural. This branch deals with the wooded plants which are attacked by insects.

(3) Veterinary. Veterinary entomology is closely associated with medical entomology and deals with the control of insects that attack domestic animals. This branch is divided into two areas. One area deals with insects that infest the animal internally, and the other deals with those that bite, sting, or otherwise irritate the animal.

(4) Stored-product pests. This field is concerned with the control of insects that attack foodstuffs, and the method by which the food may be guarded and the insects eradicated.

(5) Household pests. These pests are the same as the stored-product group and can be controlled by the same methods.

In addition to entomological functions, you will be concerned with activities pertaining to botany (the science of plants) and zoology (the science that deals with animals). Therefore, this CDC will give you an understanding of the fundamental principles and procedures involved in the identification, control, and eradication of arthropod, vertebrate, and vegetative pests. In this chapter we discuss systematic biology, the animal kingdom, orders of common insects, and the arthropods.

Remember, you will be working with apprentice pest managers and other specialists and technicians to accomplish the functions mentioned above. The procedures used for a job to be done are established by the civil engineer or your supervisor as we have already discussed.

1-1. Arthropod Taxonomy

It is impossible to determine the scientific name of an insect without the aid of an orderly arrangement or classification of species.

This section deals with the procedures in which the naming of living organisms occurred. The word "taxonomy" is defined simply as the science of classification.

As pest managers we must have a knowledge of the system used in naming or classifying living organisms and the method used in writing and recognizing these names. Believe it or not, at one time there was no recognized standard system of classification. Imagine how confusing this must have been, having no recognizable name.

200. Define systematic biology and state why the binomial system of nomenclature evolved.

Systematic Biology. Systematic biology is the arrangement of living things into groups having similar characteristics. Our discussion here should help you

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understand (1) the beginning of systematic biology, (2) the binomial system of nomenclature, and (3) the animal kingdom.

Even from the early beginning, people have attempted to harness nature and its resources, but they found that it was only through the knowledge of things (animal and plant) that people could satisfy their needs and subsist in their environment. People also learned that once the identity of a living thing (plant or animal) was established, they could further describe it, learn more about it, and use this knowledge to obtain their own ends. Animals needed standardized and universally accepted names so people would know which animal they were talking about. The identity of the animal became the key to all knowledge pertaining to it.

Because of the large numbers of living things, people discovered it was impossible to identify them without an orderly system of classification; therefore, the systematic biology system of identification and arrangement began.

In 350 BC, Aristotle, a Greek philosopher, suggested a classification of plants and animals. This was accepted throughout the Middle Ages. In the first attempts to describe and relate living animals, only generalized body structure and habits were considered. With increased knowledge and the rapid discovery of new species, a better system of classification was evolved—the binomial system of nomenclature.

Exercises (200):

1. Define systematic biology.

2. The manner that provides an orderly system of classification is called what?

3. As knowledge increased and humans discovered new species, what system evolved?

201. Define the binomial system of nomenclature and identify the genus and species in examples provided.

Binomial System of Nomenclature. The binomial system of nomenclature was proposed in 1758 by Carl Vonlinne, a Swedish naturalist, when he published the first practical and extensive book on animal nomenclature. It was a systematic means of applying two names to an organism and became the foundation of modern systematic biology. This publication named and described 4379 species of animals. Our present system of nomenclature is based on the 10th edition of this publication, and all scientific names listed have been accepted to the present day.

Now that you know the term "binomial system of nomenclature" means applying two names to an organism, you must know what two names are used, the method by which it is written, and how it can be recognized in other publications, remembering that this is a standard procedure and is universally recognized. The two words used, genus and species (which we will discuss later in this section), constitute a scientific name. When the scientific name is written, the first name refers to the genus and always begins with a capital letter. The second name refers to the species and begins with a small letter. The genus usually is the noun and the species is the adjective, which is a common occurrence in Latin. The scientific name can be recognized in publications by being printed in italics, with the first letter of the genus being capitalized and the first letter of the species being a small letter. When the scientific name is written without being italicised, both names are underlined along with the first letter of the genus being capitalized and the first letter of the species being a small letter, so as to appear in this manner: <u>Anopheles quadrimaculatus</u>.

Although it is very important to know what constitutes a scientific name and how to recognize it, this course deals primarily with common names.

A common name is a name in English of an undefined number of words, usually descriptive of the animal's structure, coloring, or habits. Common American arthropod pests have been assigned standardized names by the American Association of Economic Entomologists; these names are published by this organization for interested persons.

NOTE: Most arthropod pests and vector studies in this CDC have correct and standardized common names. Only in a few cases will you be responsible for their scientific name, for example, *Anopheles*. *Culex*, etc. Colloquial names (those used in certain areas of the country) are actually considered unsuitable in systematic biology and (if seen in this volume) are included only to identify types of insects that you have seen before. These colloquial names, if used, will be enclosed in quotes ("popping bugs," "daddy longlegs," "devil horses," etc.).

Exercises (201):

1. Define binomial system of nomenclature.

2. Identify the genus in the following example by circling the appropriate word. *Culex irritans*

3. Identify the species in the following example by circling the appropriate word. *Musca domestica*

4. Combining the two names, genus and species, constitute a ________ .

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202. Identify the classification divisions of the animal kingdom.

Divisions of the Animal Kingdom. All living things are classified according to their sexually mature structure and are divided into the plant and animal *kingdoms;* however, there are some living things (viruses, rickettsiae, and spirochaetes) which cannot be assigned definitely to either kingdom and are recognized as members of the undefined kingdom. The animal kingdom is made up of a number of major divisions, or PHYLA (singular, PHYLUM). The phylum Chordata contains all the animals with a backbone, including humans and other mammals, birds, reptiles, and fish. The phylum Arthropoda contains about 86 percent of all described animal species. Members of this phylum have segmented bodies, jointed appendages, and an exoskeleton. The arthropods are divided into CLASSES including class Hexapoda—insects; class Arachnida—ticks, mites, spiders, scorpions, and others; class Crustacae—crabs, shrimp, copepods, and others; class Chilopoda—centipedes; and class Diplopoda—millipedes. Each class is comprised of a number of major groupings called ORDERS, such as the order Diptera, or true flies, Each order is made up of FAMILIES, such as the family Culicidae, or mosquitoes. Each family has one or more GENERA, such as the genus Culex, and each genus has one or more SPECIES, such as *pipiens,* the house mosquito, which has several SUBSPECIES, such as *Culex pipiens pipiens*, the northern house mosquito.

Understanding the classification divisions is simplified if you compare them to a pyramid, because beginning at the top there are only a few divisions, and as you descent the scale the divisions get much broader. The following paragraphs will reiterate these divisions of the animal kingdom beginning at the top.

The animal kingdom is divided into universally recognized groups of closely related animals. This kingdom is one of three basic groups of natural objects that comprise all living and extinct animals. The animal kingdom contains several phyla.

Phylum. Phylum is the first major taxonomic unit comprised of organisms sharing a fundamental pattern or organization and presumably a common descent. This is the largest group of animals and contains many classes.

Class. There are many classes involved in a single phylum, and within each class there are many orders.

Order. Classes are divided into major groups identified as order. Living things which have common major characteristics are placed into a specific order. Features which are generally used for placement into a specific order are presence or absence of wings, number of wings, type of wings, type of mouthparts, and type of metamorphosis. We will discuss this in more detail later in "arthropod morphology."

Family. Family is still a further breakdown in the animal kingdom. Within each order there may be numerous family groups of which there will be basic similar characteristics which place it in a particular family. Family names can most often be recognized and distinguished from other divisions by the word ending with "idae."

Genus. Genus is the next step in classification, and at this point, identification is almost complete. Familiarization with this nomenclature division is very essential for you to identify a specific organism.

Species. Species is the last major division in the classification system. This final (in most cases) identification process is most important, since habits and habitats of various species of the same genus may vary greatly, thus affecting the type of control measure you wish to use. This is a distinct group of animals that have well-defined characteristics in common with each other and are capable of producting offspring with the same characteristics.

Subspecies. When individual species vary from their normal form in structure, coloration, habits, et . they are often referred to as subspecies, strain, or race.

Exercises (202):

1. The factor with most bearing on how all living things are classified is ____________ .
2. The first step in classification is placing an organism into the proper ___________ .
3. A group that is comprised entirely of orders within the classification division is identified as a _______ .
4. The group that is entirely made up of species is called a ______________ .
5. Arthropoda represents a _______ in the animal kingdom.

1-2. Arthropod Morphology

Morphology is a branch of biology that deals with the from and structure of animals and plants. Morphology defined is a study of the forms, relations, metamorphosis, and phylogenetic development of organs apart from their functions.

This section will enable you to understand more fully the principles discussed in the previous section on taxonomy and will identify characteristics that place an organism into a particular group. We will be primarily concerned with the animal kingdom; especially the phylum Arthropoda, because the greatest majority of pests that we are concerned with are within this group.

203. State the prerequisites for clasifying an organism as an animal and identify differences of specific phyla or orders.

Physical Comparison Between Insects and Higher Animals. Everyone knows that we, as humans, are different from insects, and we also know that we are classified as the highest animal form; but many do not know what constitutes the difference in the physical structure. Like it or not, insects are placed in the same kingdom as we are (animal kingdom), but at this point there are many differences; thus, a separation begins within the classification system. Table 1-1 illustrates the divisions by

TABLE 1-1
CLASSIFICATION COMPARISON OF MOSQUITOES AND HUMANS

Name of Category	Mosquitos	Humans
KINGDOM	ANIMAL--capable of motion; no chlorophyll.	ANIMAL--capable of motion; no chlorophyll.
PHYLUM	ARTHROPODA--jointed appendages; exoskeleton; dorsal heart; ventral nerve cord; cold blood.	CHORDATA--jointed appendages; endoskeleton; ventral heart; dorsal nerve cord
CLASS	HEXAPODA--three pairs of legs; one pair of antennae; wings usually present.	MAMMALIA--mammary glands for suckling young; hair; four-chambered heart; warm blood.
ORDER	DIPTERA--two wings; second pair of wings modified into halters or balancers; sucking mouthparts; complete metamorphosis.	PRIMATES--Limbs elongate, "hands" and "feet" enlarged, often with a thumb, each of five digits with flattened or cupped nails.
FAMILY (Note family names end in idae in zoology)	Culicidae--The true mosquitoes. Adult with scales on wings, elongate proboscis, wings usually longer than abdomen	Hominidae--The family of man.
GENUS	Culex (Latin for mosquito) (note that the generic name of any animal is capitalized and written in italics)	Homo (Latin for man)
SPECIES	pipiens (note that the species name is always written in small letters and in italics). This species name refers to the piping or whining sound of the flying mosquito.	sapiens (Latin for learned)
SUBSPECIES	fatigans	sapiens
AUTHORITY	Wiedemann, 1828	Linnaeus, 1758

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comparison of man and mosquito, which is an insect. Both man and mosquito are classified as animal because both are capable of motion and neither has chlorophyll, which is a prerequisite for placement in the animal kingdom. Using the binomial system of nomenclature, man is identified as *Homo sapiens* (which is Latin for learned man). Looking at table 1-1, the mosquito discussed is scientifically named *Culex pipiens* (which is Latin for whining mosquito). Notice the characteristics which lead to the final classification. In each case, both are classified according to a specific characteristic using Latin words for these characteristics. In almost every case, Latin words are used in the scientific naming process.

People and insects, as you have already seen, are within the same kingdom; but from this point on, there are many differences, and the further we move down the classification system the broader the differences become. Phylum is the next step in the classification system that we'll discuss. The mosquito is placed in the phylum Arthropoda because it has jointed appendages and exoskeleton (skeleton on outside). Humans are placed in the phylum Chordata which has jointed appendages and endoskeletons (skeleton on inside). Even though humans and insects are in different phyla, they are still closely related, with exception to the type of skeletal system each one has (comparison shown in fig 1-1). Class is the next major division of the classification system, and here the mosquito is placed in the class Hexapoda. This class includes all animals that have three body regions; three pairs of walking legs, one pair of antennae, and usually wings. Humans are in the class Mammalia, which means that they must have mammary glands and hair; of course, there are other qualifications that must be met, such as having a four-chambered heart and warm blood. But remember, we are only concerned with the physical structure in this section. The order is the last comparison that we will make between the mosquito and man, because the basic differences should be fully realized and understood before we go on with the breakdown.

The mosquito is in the order Diptera which means having two wings with a second pair of wings modified into halteres or balancers, sucking mouthparts, and complete metamorphosis (development process).

Humans come under the order of Primates because they have long limbs, enlarged hands and feet, often have thumbs, and each of the five digits has flattened or cupped nails.

Exercises (203):

1. Referring to table 1-1, what are the prerequisites for an organism to be classified as an animal?

2. What is the primary difference in the physical structure between the phyla Arthropoda and Chordata?

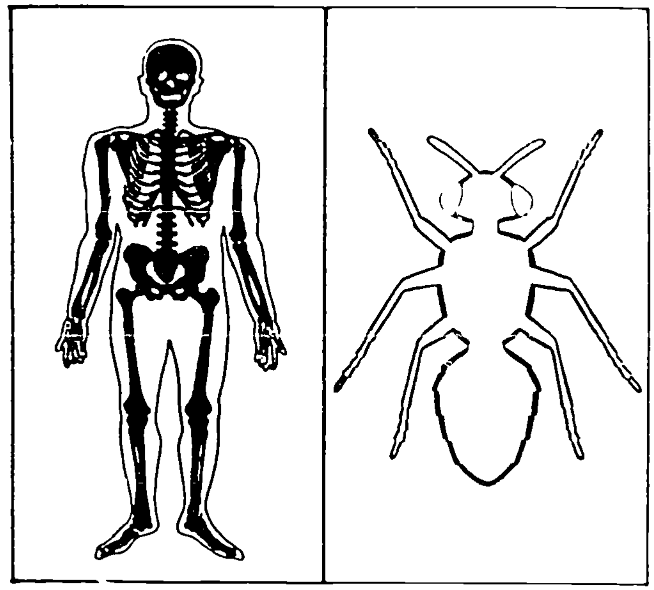

Figure 1–1. Exoskeleton and endoskeleton.

3. What are the characteristics of the order Diptera?

024. Cite characteristics of arthropods and identify body parts of each class.

The Phylum Arthropoda. An arthropod, as you have learned, is an animal that has jointed appendages and an exoskeleton. In addition to these features, it also has a segmented body, meaning his body is divided into two or more sections. There are more animals in the phylum Arthropoda than in any other phylum. Arthropods can be found everywhere, and they can live in water, on ground, in the ground, or in the air. From the standpoint of human suffering and economic loss, the phylum Arthropoda presents the most concern to humans.

This phylum is generally divided into five classes: Crustacea, Chilopoda, Diplopoda, Arachnida, and Hexapoda. Many arthropods help people by providing food and materials, but many compete with us for food; destroy lawns, shrubbery, and homes; and transmit diseases. Throughout this course you will be concerned primarily with the classes Hexapoda and Archnida; the remaining classes, Chilopoda, Diplopoda, and Crustacea are less important.

In the next few paragraphs we'll look at the physical structures of come classes of arthropods. We'll explain the characteristics of each to help you understand the basis for placing an organism in a particular class.

The class Arachnica (scorpions, spiders, ticks, and mites). The arachnids are common wherever insects occur and are often mistaken for insects. They may be distinguished easily by the fact that they have no antennae and bear four pairs of walking legs in their adult stages. Figure 1-2, the spider, illustrates the fact that the first two body regions (head and thorax) are fused to form a cephalothorax. Some arachnids, such as mites and ticks, have only one body division. They breathe by means of booklungs, or tubular tracheae, or by both types of respiratory systems. Their reproductive organs open near the front of the abdomen.

This class ranges in size from microscopic (mites) to 3 or 4 inches (scorpions and spiders). Its habits are highly variable; there are aquatic and terrestrial, parasitic, predaceous, and vegetarian forms. Some are highly active and some remain in one place through life. Some produce living young (scorpions) and some lay eggs (ticks, mites, and spiders). With most arachnids, the young resemble the adults. The class Arachnida is the second most important class of this phylum to humans. It contains serious human disease vectors (ticks and mites) and venomous species (scorpions and the black widow spider). Many varieties are parasitic on birds, animals, and humans (ticks). Many are predaceous or harmful and destructive insects (scorpions and spiders).

The class Chilopoda (centipedes). Centipedes (fig. 1-2) are know as hundred leggers, although most species have

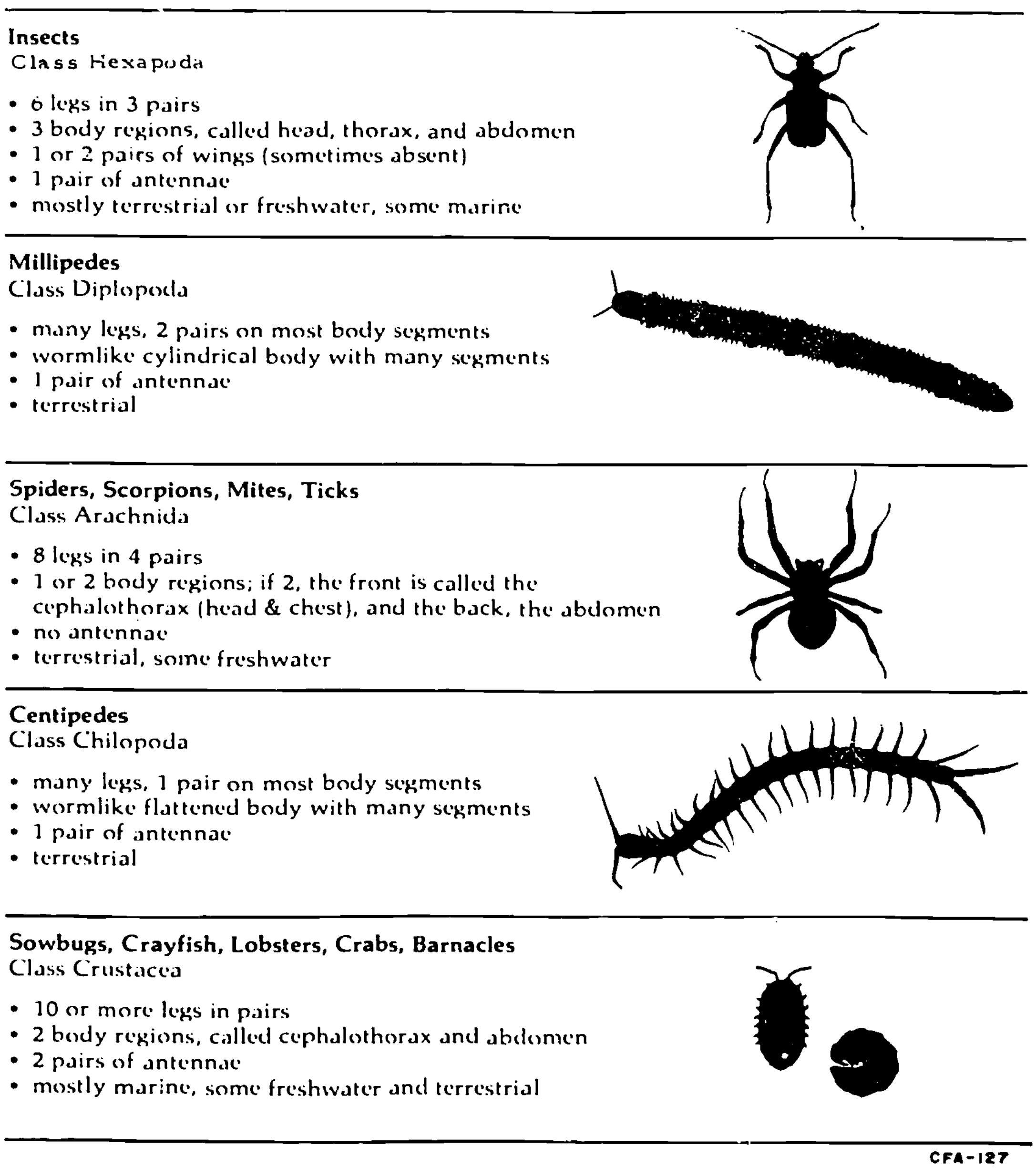

Figure 1–2. Five classes of arthropods.

fewer than this number of legs. The centipede has a head with one pair of antennae and a group of similar segments called a trunk. Each trunk segment has one pair of legs.

Centipedes range in size from small specimens less than 1 inch long to specimens in the tropics reaching 10 inches. They are fast, nocturnal, secretive predaceous, and terrestrial. Most species lay eggs. The young closely resemble the adults but sometimes have fewer leg pairs. They are beneficial to humans because they feed on many harmful insects. However, some species are capable of inflicting painful bites with their paired poison claws (modified first leg pair), but no dangerous species are found in the United States.

The class Diplopoda (millipedes). Millipedes (fig. 1-2) have one pair of antennae and two body regions, the head and trunk. They differ from centipedes in that each apparent trunk segment has two pairs of legs. Millipedes usually do not hurt people but may damage some plant crops.

Millipedes range in size from less than 1 to 5 or 6 inches. They are slow moving, despite numerous legs, and are nocturnal, secretive, vegetarian, and terrestrial. They lay eggs, and the young resemble the adults but have fewer abdominal segments and only three pairs of walking legs. They may be accidental parasites of humans, inhabiting the intestinal and urinary tracts. When distrubed, some produce offensive fluids from paired glands located in the abdomen and have been known to produce a dermatitis in humans.

The class Crustacea (crabs, shrimp, lobsters, sowbugs, and copepods). Crustaceans (fig. 1-2) differ from insects in having five or more pairs of walking legs, two pairs of antennae in typical forms, two body regions (cephalothorax and abdomen), no wings, reproductive organs opening at the base of the walking legs, no trachae, and great variations in shape.

This class is the least related to the insects of any of the other related classes in this phylum. It ranges in size from microscopic forms, such as the copepods, to crabs more than 3 feet long. The animals in this class are relatively active, diurnal, predaceous, parasistic, and vegetarian. They are usually aquatic or semiaquatic, and many are both diurnal and nocturnal. Eggs are usually carried in sacs inside or outside the body. The immature stages may look like the adults (crayfish) but may look very different from the adults (copepod). Many are beneficial to humans as food (crabs, lobsters, shrimp, etc.). Some are intermediate hosts of parasites, attaching tapeworms, flukes, and guinea worms. Some are marine boring organisms such as the gribble (Limnoria sp). Pillbugs and sowbugs are occasionally greenhouse pests.

The class Hexapoda (true insects). The insects are the most important members of the phylum Arthropoda. Typical adult insects have one pair of antennae, three pairs of walking legs, and three body regions: head, thorax, and abdomen (fig. 1-3). many insects, but not all of them, have wings. None of the other classes of arthropods have wings. The reproductive organs open at the posterior end of the abdomen.

We'll discuss the specific habits and life histories of the insects of importance to people in later paragraphs. Learn the identifying characteristics of each class of the phylum

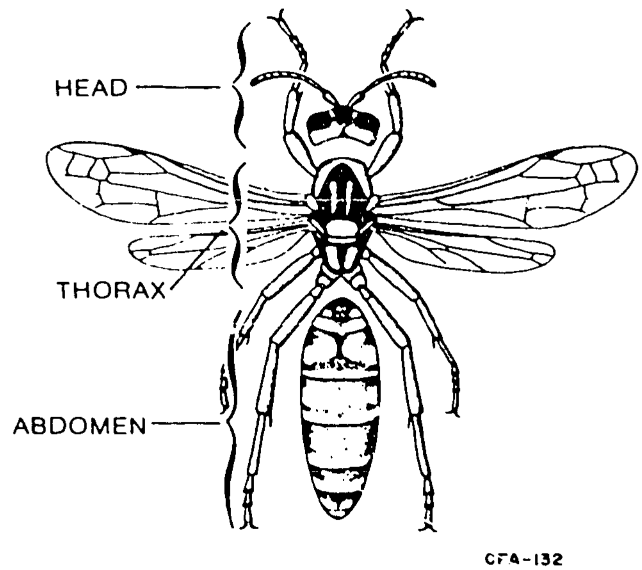

Figure 1–3. The three main parts of an insect's body (paper wasp).

Arthropoda, for these features will help you understand the individual insect species and their habits.

Exercises (204):

1. For an arthropod to be placed in the class Hexapoda it must have wings. (True/False)

2. From the standpoint of human suffering and economic loss, which phylum is of the most concern to people?

3. The most important classes of arthropods discussed in this lesson are represented by which two groups?

4. Which class is least related to insects but is still in the same phylum?

5. Match each class of arthropods in column B with its proper description in column A.

Column A	Column B
_____ (1) Have one pair of antennae, two body segments (head and trunk), and two pairs of walking legs on each trunk segment.	a. Arachnida.
_____ (2) The adult stage has no antennae or wings, has four pairs of legs, and may have one or two body regions.	b. Crustacea.
	c. Chilopoda.
	d. Diplopoda.
	e. Hexapoda.

Column A	Column B
____ (3) Have five or more pairs of walking legs, two pairs of antennae, two body regions, and no wings.	
____ (4) Have one pair of antennae, three pairs of legs, three body regions, and may or may not have wings.	
____ (5) Have one pair of antennae, two body regions (head and trunk), and one pair of legs on each trunk segment.	

205. Identify structural features and developmental processes of the class Hexapoda.

Inset Structure. You need a basic knowledge of insect structure to correctly identify insects. This is the first step we'll take in our study of insect biology or control.

Insect body. The insect body is generally a more or less elongated tube with appendages, such as legs, wings, or antennae on either side. Each side is like the other. This arrangement is referred to as bilateral symmetry. The body is segmented, or jointed, with segments being grouped into the head, thorax, and abdomen.

In adult insects the eyes, antennae, and mouthparts are on the head. Legs and wings are attached to the thorax. The appendages on the abdomen, when any are present, are usually on the last segment only. Abdominal appendages are usually sex organs, or hairs, or bristlelike extensions known as cerci. Most appendages on the insect body are segmented.

The skeleton of the insect is on the outside, rather than on the inside as with man and other mammals, thus serving not only as an outer covering of the body but also as the firm portion of the body to which muscles are attached. Such muscle attachment makes it possible for an insect to have overall strength out of all proportion to its size.

The body wall is composed of two principal layers, a cellular epidermis, or outer skin, and a nonliving cuticle. The cells of the epidermis produce a hard outer layer called the cuticle. In addition, certain specialized cells produce surface hairs and glandular secretions that are also found on the surface of the insect body.

The cuticle itself is made up of three principal layers (see fig. 1-4). The endocuticle and exocuticle contain the material chitin and sclerotin which are typical of the insect skeleton and contain any coloring matter that may be present. The epicuticle is a very thin, waxy layer that protects the insect body so that moisture does not evaporate from it. This layer is important to the pest control specialist because insecticides that work through the body wall must be able either to penetrate or to dry up this layer in order to be effective.

The body wall completely covers the insect. In some portions, it is hardened to form plates or sclerites; in others it is soft and flexible forming membranous sutures between the sclerites. This body wall is always in one piece with hard and soft portions being merely variations in the same structure. For example, the usual insect abdomen is quite firm because of its segmented rings, or sclerites, which extend around it; it is also flexible and expandable because of the flexible sutures that connect these sclerites to each other and join the parts of each sclerite to the other parts.

Head. The typical insect head is a hollow capsule made up of a number of segments which have been solidly fused together and which cannot easily be distinguished. The head is usually quite hard.

Sense organs. The antennae are appendages of the head, and they are nearly always made of many segments. The shape, number, and relative size of the segments are characteristics frequently used to identify an insect. Antennae are sense organs having the functions of touch, smell, and in some cases, hearing. There are many different kinds of antennae, a few of which are listed below (see fig. 1-5).

- Filiform—threadlike (cockroach).
- Setaceous—tapering (dragonfly).
- Moniliform—beadlike (some bark beetles).
- Serrate—sawlike (drugstore beetle).
- Clavate—clubbed (ladybird beetle).
- Capitate—having a head (some powder-post beetles).
- Lamellate—leaflike (June beetle).
- Pectinate—comblike (pyrochroid beetle).

Most adult insects have a pair of relatively large compound eyes located on the head. The surface of these eyes is made up of many small lenses, each of which is the lens to a single portion of the compound eye. In addition, most insects also have simple eyes located on the upper part of the head between the compound eyes. Some insects have

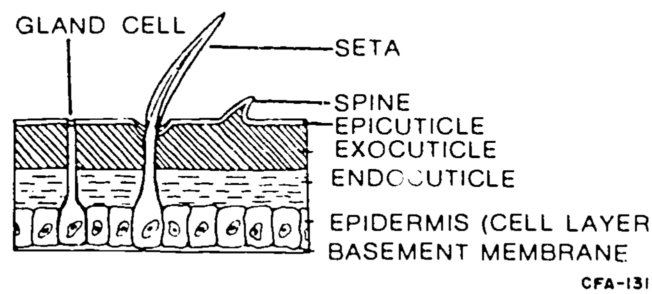

Figure 1-4. Lateral view of an insect's body wall.

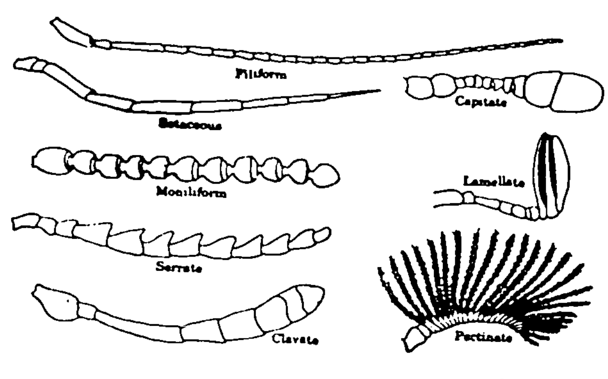

Figure 1-5. Some typical insect antennae.

no simple eyes in the adult stage, but among those that do, the number may be one, two, or three depending upon the kind of insect. In many adult insects, simple eyes function as supplementary light-perception organs. They do not perceive images.

An insect does not get as clear an image of objects as do humans and other vertebrates, and its ability to distinguish form is not very well developed. However, it is usually very sensitive to motion. As far as color perception is concerned, insects see farther into the ultraviolet than humans, but they do not see as far into the red part of the spectrum.

Mouthparts. An insect's mouthparts are made up of extensions of the original head segments and are located, usually, on the bottom of the head although on some insects the head is held so the mouthparts extend forward. Variations in insect mouthparts are characteristics that are frequently used in the identification of insects. The type of mouthparts also serves to tell something of the food habits of the insect and may well make it possible to tell where to find the insect by looking for a suitable source of food.

The structures that make up the mouthparts of insects vary greatly in shape and function. In many insects they are formed for biting off and chewing solid foods, such as leaves, wood, fabrics, or kernels of grain. In others they are formed for piercing the skin of animals or the epidermis of plants and sucking up blood or plant sap from beneath the surface. In still others they are formed so the insect can feed on exposed liquids such as water and nectar.

Based on the form of their food and the method by which they obtain it, the mouthparts of adults may be divided into 6 principal types or kinds: Chewing, rasping-sucking, piercing-sucking, sponging, siphoning, and chewing-lapping.

Chewing type. This is the most primitive and therefore the most basic type; it is found in insects such as cockroaches, termites, beetles, and chewing lice which feed on solid food. In this type, the mouthparts are made up of 7 well-defined structures, most of which are found in insects with other types of mouthparts, but they are usually greatly modified in form (see fig. 1-6).

Structures found in the chewing type of mouthparts are as follows:

a. Upper lip (labrum). This is a simple flap which covers the upper jaws, much as our upper lip covers the upper teeth.

b. Upper jaws (mandibles). There are two upper jaws, each of that is a solid structure which has toothlike projections on the inner side. The jaws move from side to side, or transversely, and are used to tear or bite off the food and chew it.

c. Tongue (hypopharynx). This is a fleshy organ found inside the mouth.

c. Lower jaws (maxillae). There are a pair of these, each of which is made up of several parts. Attached to the outside of each is an antennalike structure called a maxillary palpus which may contain organs of taste, touch, and smell. The lower jaws move from side to side as do the upper jaws.

e. Lower lip (labium). The lower lip is made up of several parts and bears a labial pulpus on either side which has the same functions as the maxillary palpi.

Rasping-sucking type. Insects that possess this type of mouthpart lacerate or rasp the epidermis of plants with three needlelike organs, the stylets, until the sap flows out. They then retract these stylets and suck up the exposed sap. The only insects that possess this type of mouthparts are the thrips.

Piercing-sucking type. In this type, the parts have been modified so the insect can pierce the skin of animals or the epidermis of plants and suck up the blood or plant sap from beneath the surface.

There are many varieties or sub-types of the piercing-sucking type. Basically, there is a proboscis, or snout, which is a slender, tubular beak. Within the snout are enclosed four long, slender stylets. These stylets are used to pierce the tissue and suck up the liquid food. Although this is the general arrangement found in the various insects with piercing-sucking mouthparts, there are numerous modifications of it in mosquitoes, biting flies, fleas, and lice (fig. 1-7).

Sponging type. Some flies, such as house flies, blow flies and fruit flies, are unable to pierce the skin of animals or the epidermis of plants and, therefore, must feed on exposed liquids. In these flies, the lower lip is elongated to form the outer covering of the beak. Within this beak are two slender structures that form a salivary duct and a food channel (fig. 1-8). The tip of the lower lip is enlarged into a sponging organ which has a series of grooves radiating from the center. When the fly dips the end of its beak into liquids, the liquid flows up these grooves until it comes in contact with the food channel. The food is then sucked up through this channel into the esophagus.

Siphoning type. In moths and butterflies a part of each lower jaw is elongated. The parts are interlocked to form a long, slender tube through which exposed liquids, such as nectar and water, are sucked. This tube or "tongue" is coiled up like a watch spring when it is not being used.

Chewing-lapping type. In some bees and wasps the mouthparts are formed both for the chewing of solids and the sucking up of exposed liquids, especially nectar. The upper lip and the upper jaws are of the same form as the chewing-type mouthparts. The lower jaws and the lower lip are elongated to form a "tongue" with which the insect can suck or lap up liquids.

Mouthparts of immature insects. Some immature forms of insects have the same type of mouthparts as their parents, while others do not. In insects that develop without metamorphosis (for example, silverfish) or with gradual metamorphosis (cockroaches) or incomplete metamorphosis (dragon-flies), the immature forms have the same type mouthparts as their parents. That is, if the adult has piercing-sucking mouthparts, as in the case of some lice, the immature forms will also have piercing-sucking mouthparts.

Larvae, the growing stage of insects with complete metamorphosis (butterflies). may or may not have the same kind of mouthparts as their parents. The larvae of beetles, moths, and butterflies may or may not have the same kind of mouthparts as their parents. In addition, the larvae of beetles, moths, butterflies, and some of the bees have typical chewing mouthparts although the various parts may be reduced. The larvae of fleas and some flies, such as

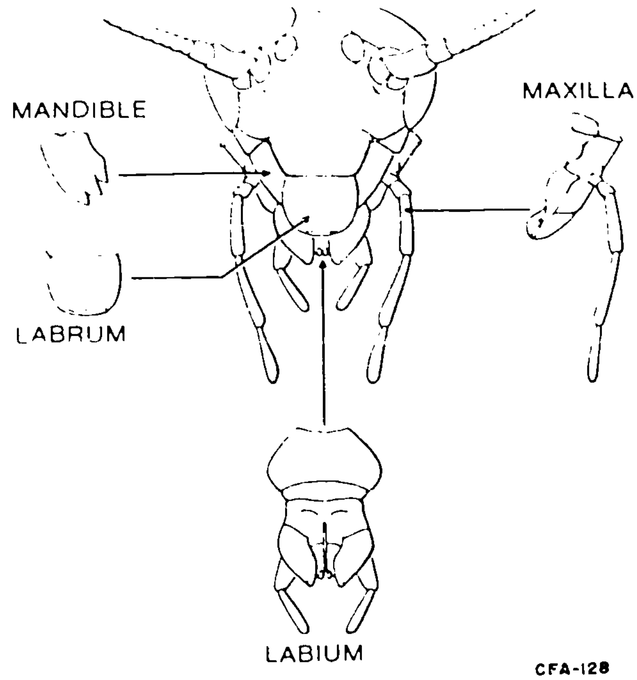

Figure 1–6. Typical chewing mouthparts of a cockroach.

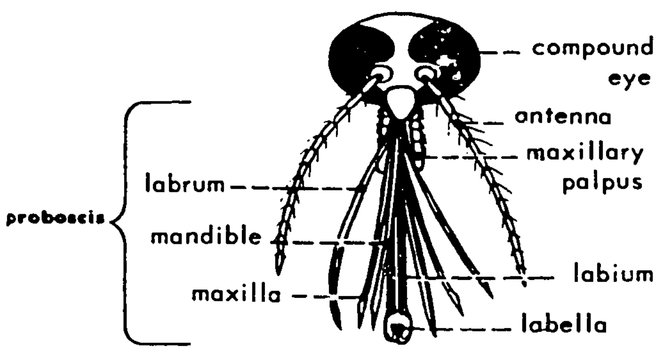

Figure 1–7. Piercing-sucking mouthparts of a mosquito.

mosquitoes, deer flies, and black flies, also have chewing mouthparts, but they are not as well developed as in the above insects.

The head of the larval form of flies, such as house flies, blow flies, and fruit flies, is greatly reduced and withdrawn into the thorax. Their food has to be in liquid form. Although the immature stages of some flies have no true jaws, there are usually two mouth hooks present which enable the larvae to lacerate tissue.

Mouthparts of the larvae of bees, ants, and wasps are much reduced. In general they are of the chewing type. However, the larvae of many of the ants and bees are fed liquids.

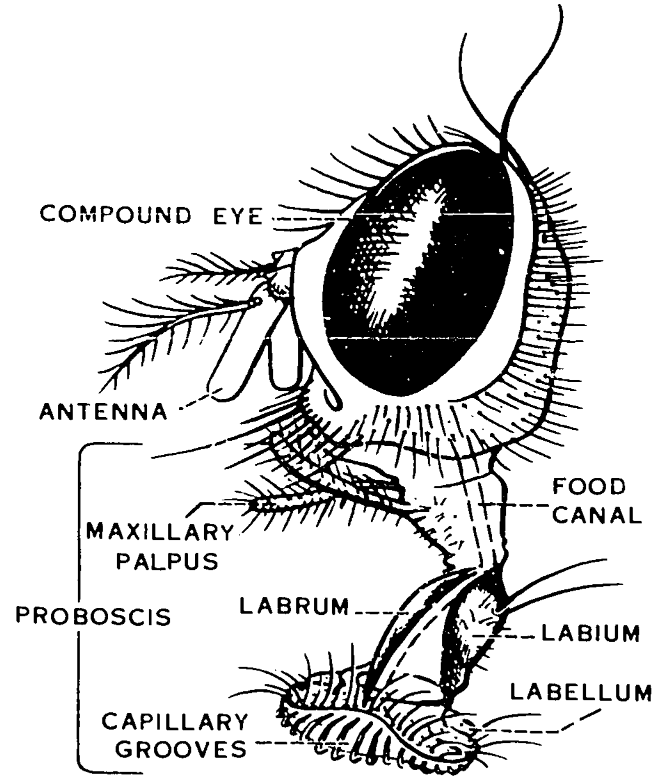

Figure 1–8. Sponging mouthparts of a housefly.

Thorax. The middle region of an insect body is known as the thorax. It is made up of three segments to which the legs and wings are attached, whenever they are present (fig. 1-9). The segments of the thorax are usually quite hard and are frequently fused solidly together to provide a firm base for the many muscles necessary to operate the wings and the legs. The thorax is connected to the head by a membraneous neck region called the cervix.

Legs. An insect leg is always jointed and consists of 6 parts: coxa, trochanter, femur, tibia, tarsus, and pretarsus.

The coxa and trochanter are the two parts that connect the insect leg to the body, with the trochanter being between the coxa and the femur. The femur corresponds more or less to the thigh of a human, and the tibia to the lower leg. The tarsus is composed of several joints and corresponds to the foot. The last tarsal segment usually bears a pair of claws and frequently pads or lobes between the claws. These claws and pads together form the pretarsus.

Variations in the size and shape of the leg segments are characteristics by which a pest control specialist can tell a great many things. The legs are modified for running, jumping, grasping, digging, and in many other ways that give a good insight into the habits of the insect (fig. 1-10). Variations in the leg are also used in identification.

Wings. Insect wings are an outgrowth of the body wall on the last two segments of the thorax (fig. 1-11).

Most adult insects have two pairs of wings but some have only one pair and a few have none. Most insect wings consist of a thin membrane; in some insects, however, the

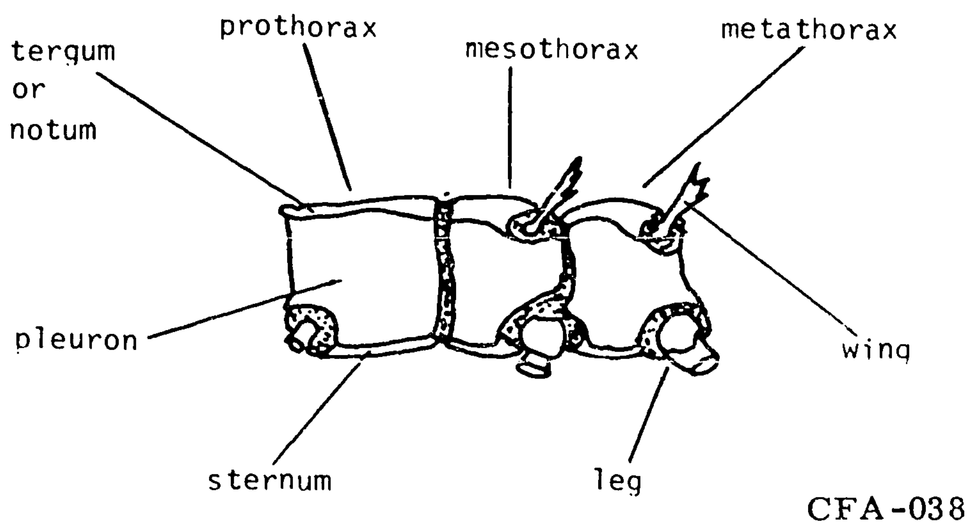

Figure 1–9. Insect thorax.

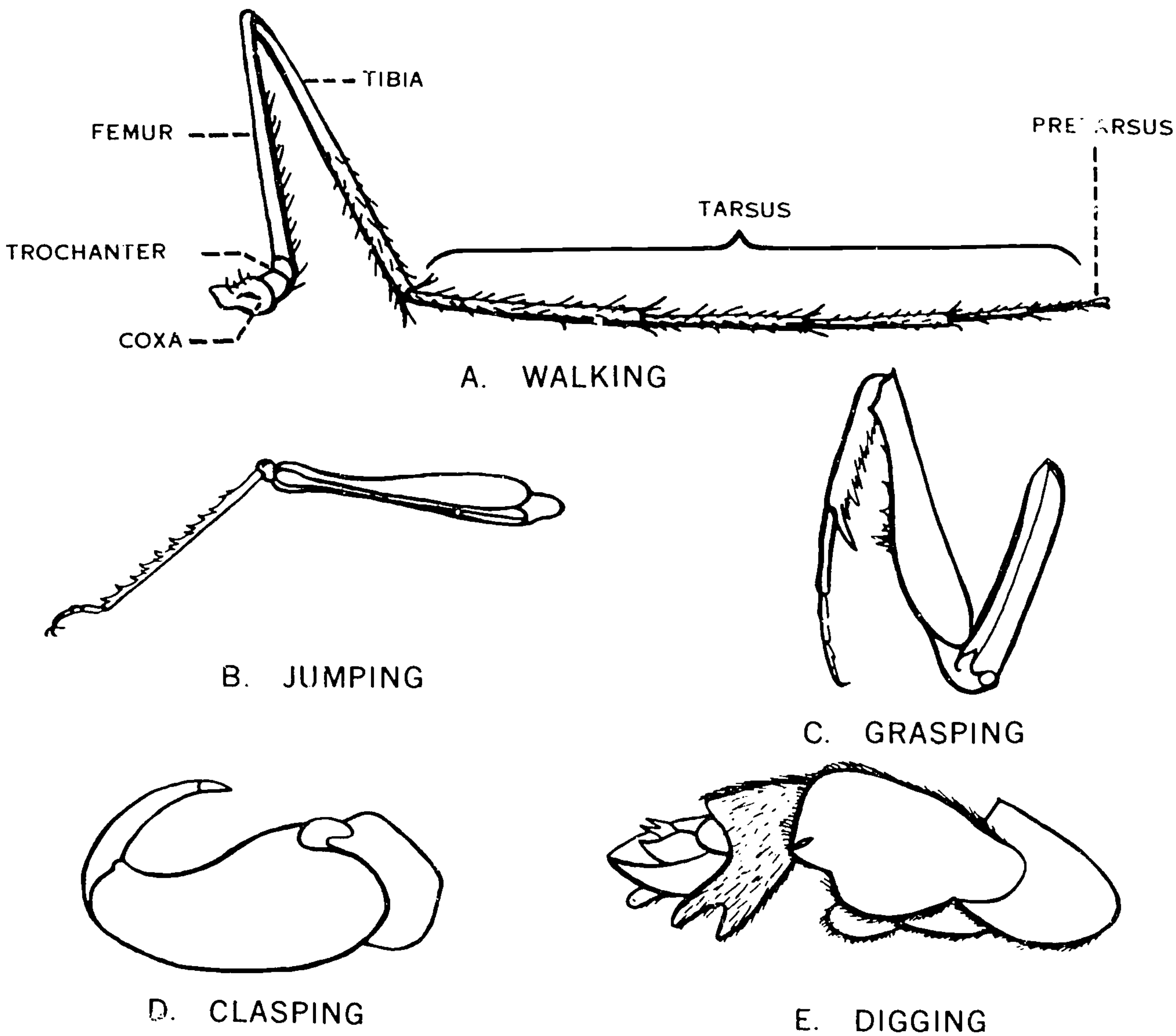

Figure 1–10. Insect legs.

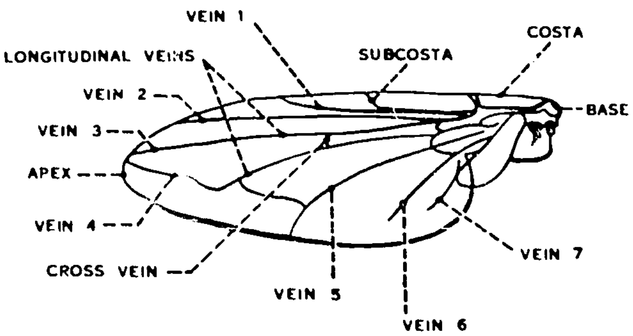

Figure 1–11. Insect wing.

front pair of wings are thickened and leathery or hard. The variation in the number of wings, their size, shape, texture, arrangement of veins, and rest position are also identification characteristics.

Abdomen. The insect abdomen is composed of 11 segments, although the last segment is usually so reduced in size, or so modified, that only 10 segments are easily visible (fig. 1-12). In some insects several segments may be fused together so there appear to be fewer than 10. A small holelike opening is on either side of each of the first 7 or 8 abdominal segments when 10 are present. Here, the spiracles open into the internal respiratory system. Various appendages may appear on the last segment of the abdomen. Of these appendages, the most noticeable on many insects are the cerci, which extend from the last abdominal segment. Genital appendages may be lacking but, when present, the most conspicuous organs are the claspers of the male and ovipositor of the female. These genital organs may be present externally or may be totally enclosed within the abdomen so that they are not visible. All of the appendages on the last abdominal segment perform sensory functions, primarily in the reproductive process.

Insect Development. The life cycle begins with the fertilization of the egg and is completed when the adult stage is reached. The term "lifespan" refers to the entire length of life of the insect. Some insects, such as tropical termite queens, may live 15 or 20 years; and the periodical cicada lives for 14 to 17 years. Mayflies may live only a few days as adults, although they may spend 2 or 3 years in the developing immature stages.

Small animals have relatively greater surface areas in proportion to their body weight and volume than large ones. This results in increased evaporation of water vapor from the body and requires the development of complex waterproof body coverings. The hard plates in the cuticle also serve as protective armor, as well as body support, and as the framework for muscles of locomotion.

The development of this armorlike exoskeleton and wings has complicated the growth of insects. The molting process is a means by which an immature insect may shed this protective skeleton, the linings of the respiratory system and of the foregut and hindgut. A molting fluid is produced between the old exoskeleton and the new soft cuticle of the insect. Air or water is swallowed until the body swells, bursting the old cuticle on the dorsal surface in most cases. The insect gradually extracts itself; and a new cuticle hardens on its expanded body, thus accomplishing a stage of growth. The number of molts is small and constant in most species, such as the three molts of the housefly; or it may be large and variable as in the 12 or more molts of the American cockroach. For a period varying from a few hours to a day after molting, the body of an insect may be soft and pale colored, leading some laymen to refer to it as an "albino." However, during the first day after molting, there is a progressive hardening and coloring of the integument, and for this reason, most entomologists allow newly emerged adult insects to remain in rearing containers for 12 to 24 hours before killing and pinning them. For example, if mosquitoes are killed soon after they emerge, their abdomens will shrivel before the integument becomes hardened, making it difficult to identify them.

Metamorphosis refers to changes in form or structure of an insect during its development. A few primitive insects develop without metamorphosis (fig. 1-13). The young possess all of the obvious structures of the adult and differ from them merely in size, color, and sexual maturity. The springtails (Collembola) and silverfish (Thysanura) develop without metamorphosis. Both are small wingless insects. Thysanura grow and molt throughout life so that there is no distinct adult stage.

Insects with gradual or incomplete metamorphosis pass through three stages during their life: egg, nymph, and adult, as illustrated in figure 1-14. Insects in this group change gradually while going through a succession of molts to become adults. The young resemble the adult insect except for their smaller size and for the absence of wings in wingbearing species. The young, or nymphs, are immature sexually and may bear wing pads in the latter stages of their development. Some important orders with gradual metamorphosis are:

DICTYOPTERA	cockroaches, walking sticks, and praying mantids.
ANOPLURA	sucking lice, including the crab and body lice.
MALLOPHAGE	biting lice.
HEMIPTERA	true bugs including the bedbug and kissing bug.
DERMAPTERA	earwigs.
PSOCOPTERA	book lice and psocids.

Insects with complete metamorphosis have four stages: egg, larva, pupa, and adult as illustrated in figure 1-15. Insects with this type of life history are greatly different in the immature and adult stages. Typical larvae are the wigglers of mosquitoes, the maggots of flies, or the caterpillars of butterflies and moths. The pupal stage is an important evolutionary development during which the simple larva undergoes many external and internal changes to become the complete adult.

Most of the insects with complete metamorphosis have wings as adults, but some species, such as the fleas, are completely wingless. Normally the wing buds first appear in the pupal stage. When the young adult first emerges from the pupal shell, the wings are crumpled and useless. Hydrostatic pressure of the blood within the insect body forces the saclike wings outward, and the two membranes collapse against each other to form the single membranous structure.

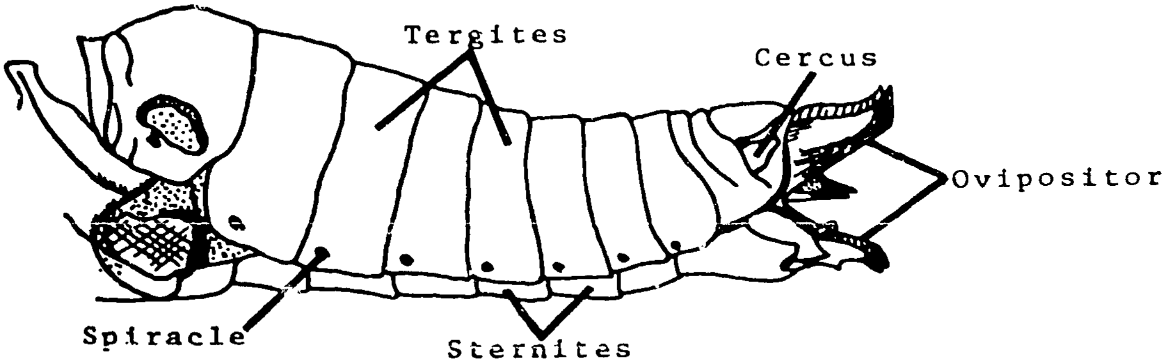

Figure 1-12. Insect abdomen.

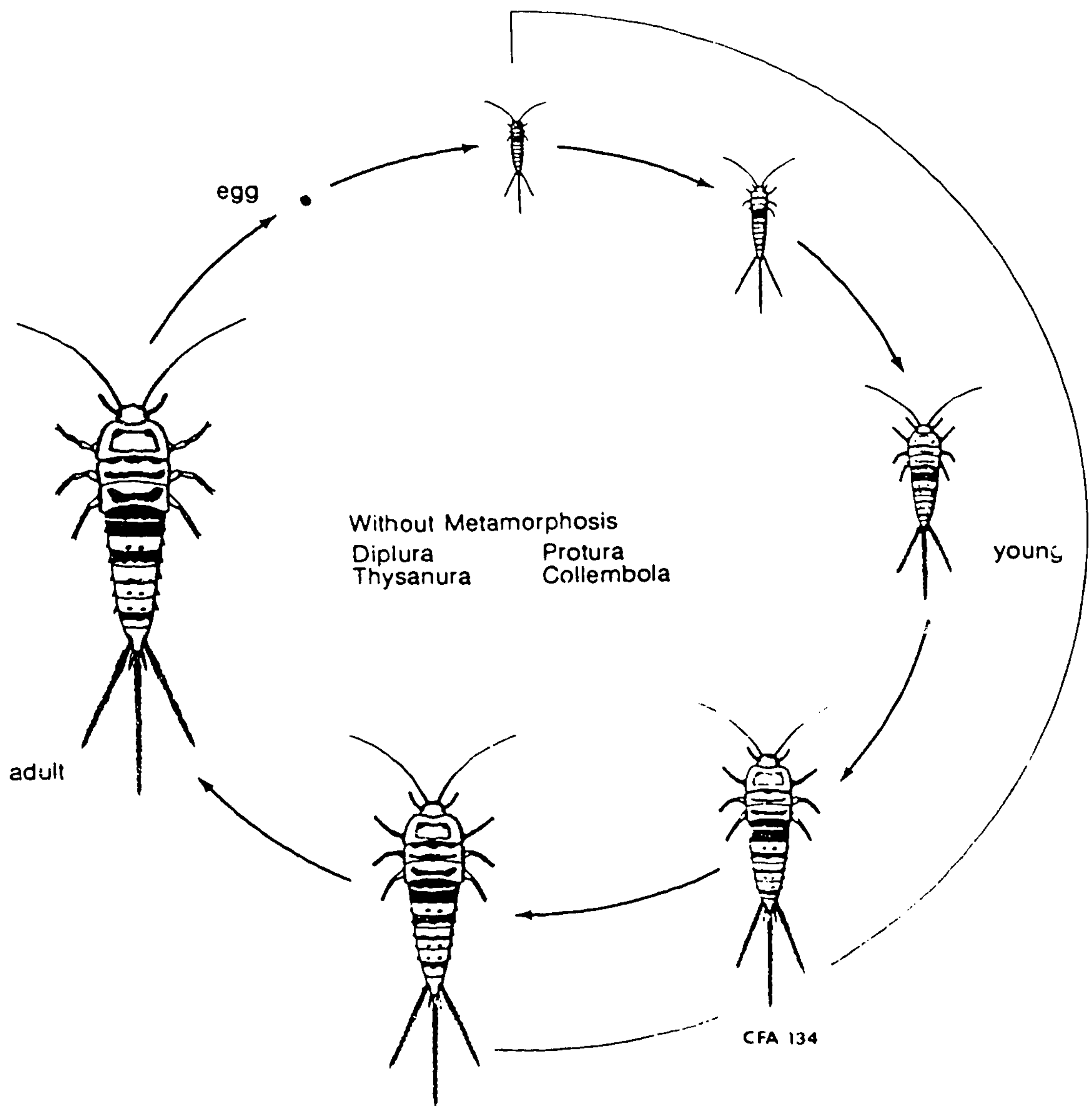

Figure 1-13. No metamorphosis.

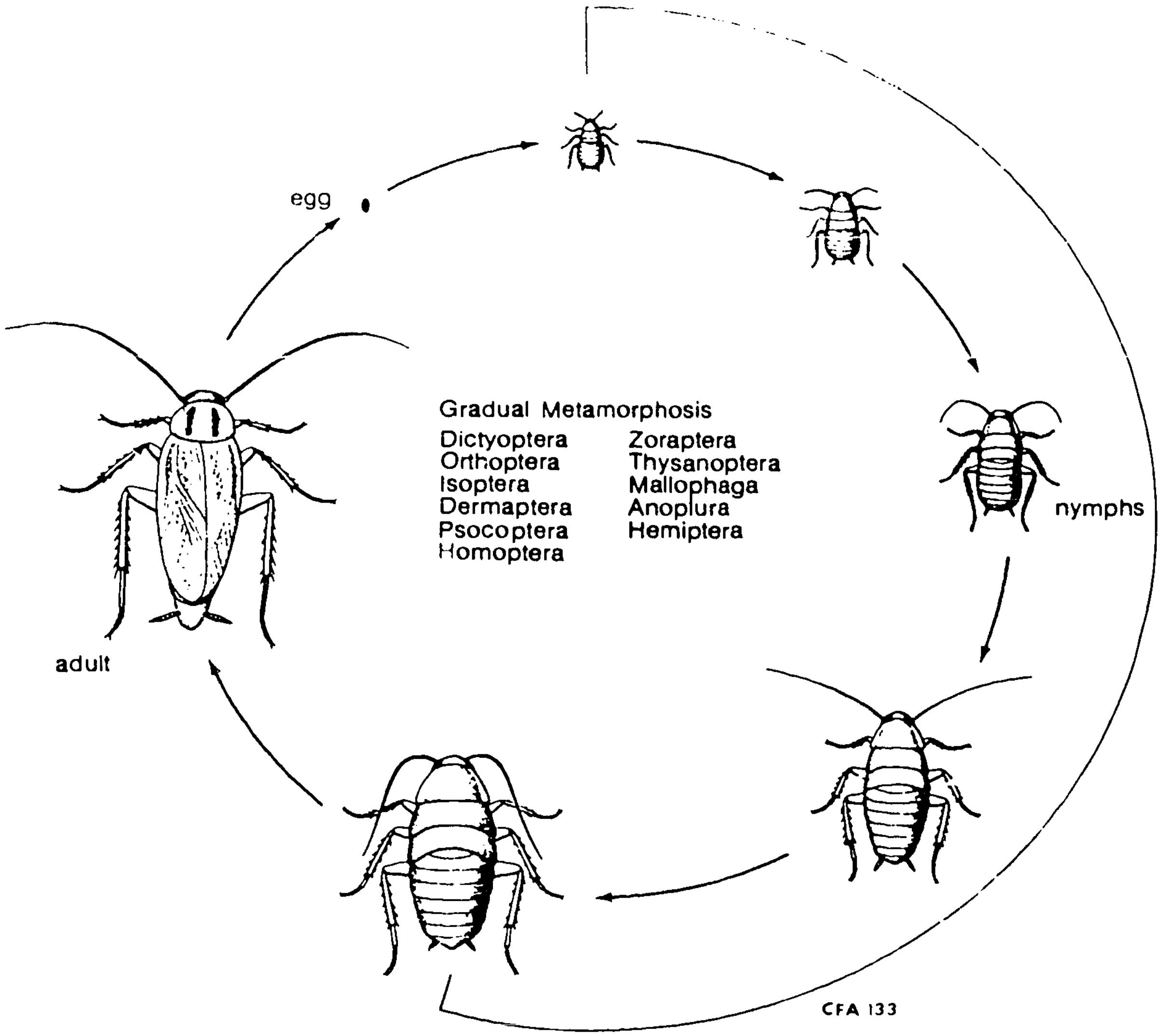

Figure 1–14. Gradual or incomplete metamorphosis.

There are many orders of insects having complete metamorphosis. Five of these orders of most importance to pest managers are listed below:

DIPTERA	flis, mosquitoes, midges, and punkies.
SIPHONAPTERA	fleas.
LEPIDOPTERA	moths, butterflies, and skippers.
HYMENOPTERA	ants, bees, and wasps.
COLEPTERA	beetles, and weevils.

Exercises (205):

1. What are the three main regions of an insect's body?

2. On which main body region are each of these parts located?

   a. Reproductive organs ____________ .

   b. Legs ____________ .

   c. Antennae ____________ .

   d. Spiracles ____________ .

   e. Wings ____________ .

3. Hardened plates on an insect's body are called ____________ .

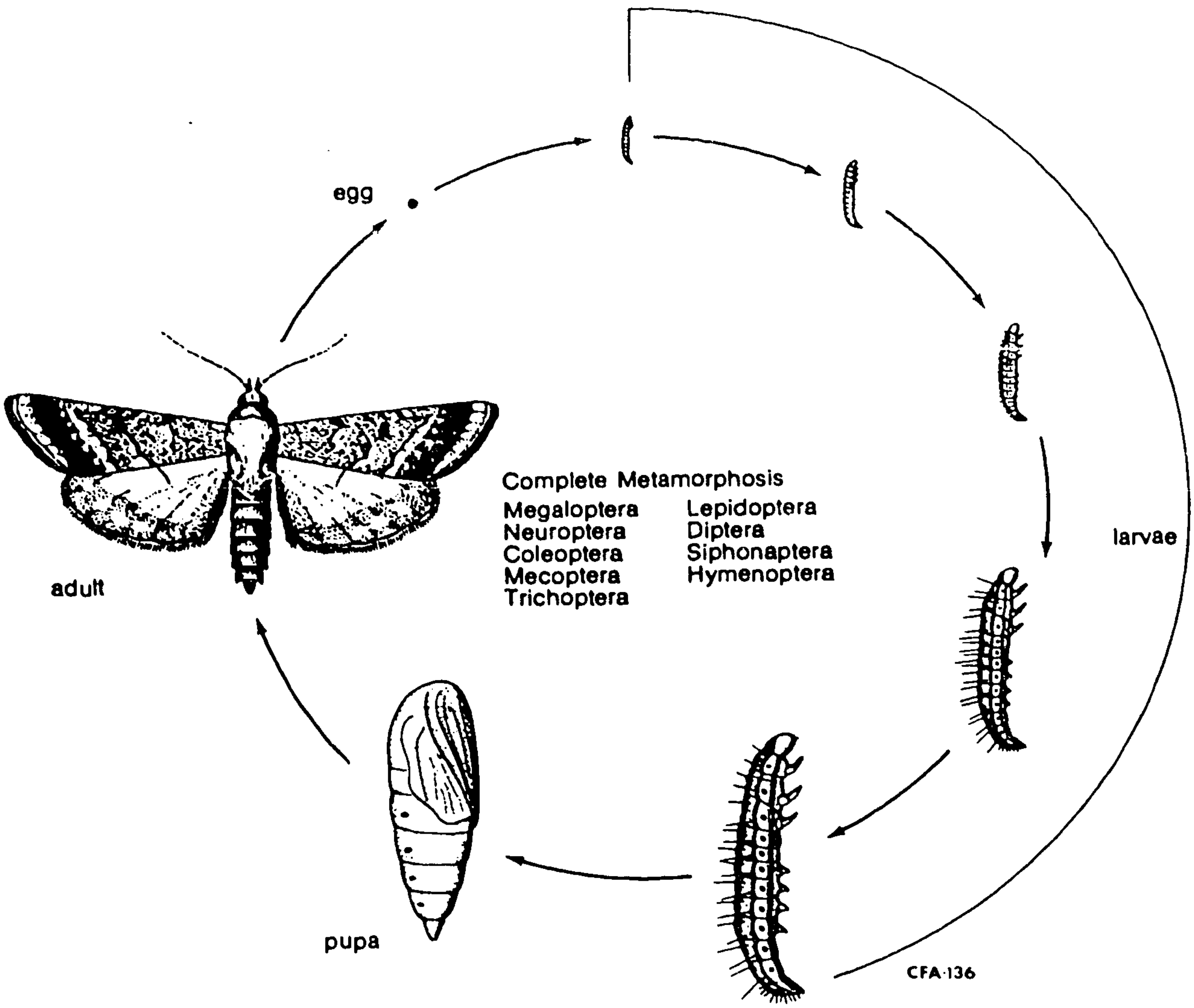

Figure 1–15. Complete metamorphosis.

4. Soft, flexible parts between these plates are called ______________________ .

5. What are the functions of an insect's antennae?

6. Name the six types of insect mouthparts and give an example of an insect with each type.

Mouthparts	*Insect*
(1) ______________	______________
(2) ______________	______________
(3) ______________	______________
(4) ______________	______________
(5) ______________	______________
(6) ______________	______________

7. How many pairs of wings do most insects have?

8. When a change of form or structure occurs during an insect's development, what is it called?

9. Insects that pass through three stages in their development are known as having ______________ .

10. Insects that experience four stages in their development are known as having ______________ .

206. Identify distinguishing characteristics of various orders of insects.

Important Orders of Insects (Part I). The class Hexapoda is divided into 20 to 40 major groups or orders by different authorities. Members of each order have certain features in common that distinguish them from all other insects; primarily, the type of mouthparts, the number of pairs and types of wings, and the kind of metapmorphosis.

You will not be expected to learn the genera or species of all insects with which you come in contact, but you should learn whether they are flies, beetles, or moths. These words are used loosely by many people, and reports will come in stating that a quarters is infested with "flies" when it is really infested with cereal moths or "beetles." The main orders of common insects and a brief description of their characteristics are given in the following paragraphs.

Order Anoplura (unarmed tail). The sucking lice (fig. 1-16) are small, wingless, flattened insects that are bloodsucking parasites of man and other mammals. The species most important to public health are the body louse, the head louse, and the crab louse. Their mouthparts, which are usually retracted within the head, are modified for piercing and sucking. Their eggs, or nits, are attached to the body hairs or (in humans) to the undergarments. Development is by gradual metamorphosis.

Order Coleoptera (sheath, wing—beetles and weevils). In the adult stage, the beetles and weevils (fig. 1-17) have four wings. The front pair are heavy and shell-like and serve as wing covers, called elytra, which protect the hindwings and the abdomen. The hindwings are membranous or cellophanelike and fold underneath the forewings. The mouthparts are extended into a snout. (These are the true weevils.) Beetles have complete metamorphosis.

Order Dermaptera (skin wing—earwigs). Earwigs (fig. 1-18) are rather small, dark-colored insects with a long, narrow body and a prominent pair of cerci, or forceps, at the posterior end. The head bears chewing-type mouthparts and relatively sort antennae. The forewings are short, leathery structures which protect the delicate semicircular hindwings that are pleated like a fan. Earwigs are primarily vegetarians but will invade houses by the thousands, and if crushed, they give off an offensive odor and can be severe household pests. Despite their name, "earwigs" are not

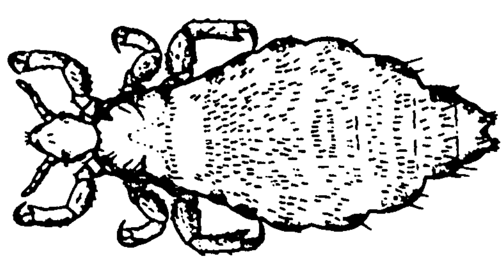

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Figure 1–16. Order Anoplura, a body louse.

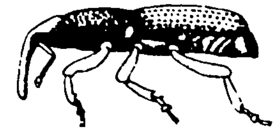

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Figure 1–17. Order Coleoptera, a grain weevil.

guilty of entering the human ear and stinging a person to death, as related in some old wives' tales.

Order Diptera (two-winged—flies and mosquitoes). The flies (fig. 1-19), mosquitoes, gnats, midges, and punkies make up this large order of two-winged insects. A pair of knobs, or halteres, occurs in place of the second pair of wings. Dome forms, such as the "sheep tick," or ked, lack both wings and halteres. Mouthparts are fitted for sucking or lapping. These insects undergo complete metamorphosis, and the larvae are called maggots, or wigglers, depending upon the species. Some diptera are beneficial; many are neutral to man, and many are serious pests and vectors of disease.

Order Hemiptera (half-winged—true bugs). This large order comprises the true bugs (fig. 1-20), the only insects properly called by that name. The young, or nymphs, go through a series of molts before reaching the adult stage, and thus develop by gradual metamorphosis. The adults generally have two pairs of wings. The forewings of these bugs are diagonally divided into two parts, the forepart and the hindpart. The forepart is thickened and the hindpart is membranous. Not all of these insects have wings but may have rudimentary (partial) wings. The bedbug is an example of this. Bugs have a scutellum, a triangular body area between the bases of the overlapping forewings. The mouthparts are modified into a beak for piercing and sucking.

Order Homoptera (same wing—aphids and scale insects). This name is not a very good guide, because some have no wings (the nonreproductive generations) and others have dissimilar wings (leaf hoppers). The Homoptera (fig. 1-21) share certain characteristics with the Hemiptera (half-wings) with which they were once grouped. They have piercing, sucking mouthparts which are like jointed tubes. They have incomplete metamorphosis.

Order Hymenoptera (membrane winged—ants, bees, and wasps). Hymenoptera (fig. 1-22) are distinguished from most other insects by their four small membranous wings with few veins. The hindwings are smaller than the forewings. The mouthparts are suited for chewing or lapping. Many species have the apparent first segment of the abdomen reduced to a slender waist, as in the ants. The abdomen joins onto the thorax by a narrow waist, or "petiole" (PEE-tee-ole) from which we get the expression "wasp-waisted." The common ant is an immature, wingless female called a worker. However, the mature male and some female ants do have wings. Some wasps do not have wings (the so-called velvet ants, or cow killers) but

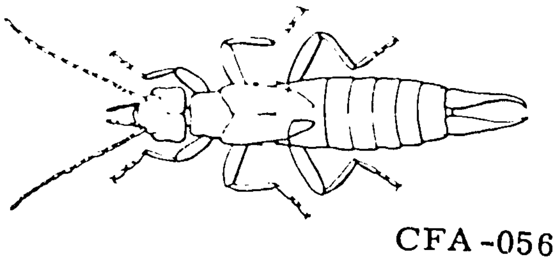

Figure 1–18. Order Dermaptera, an earwig.

Figure 1–19. Order Diptera, a housefly.

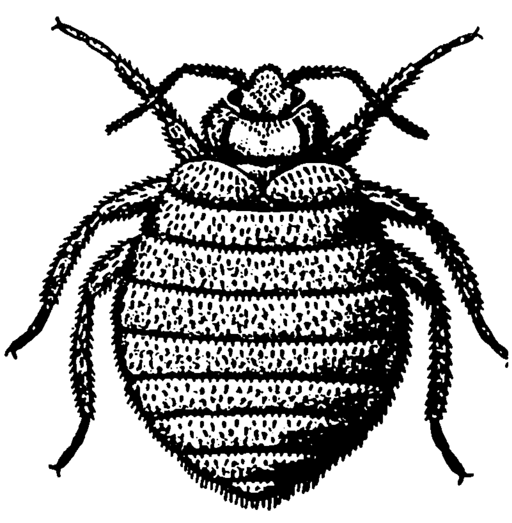

Figure 1–20. Order Hemiptera, a bedbug.

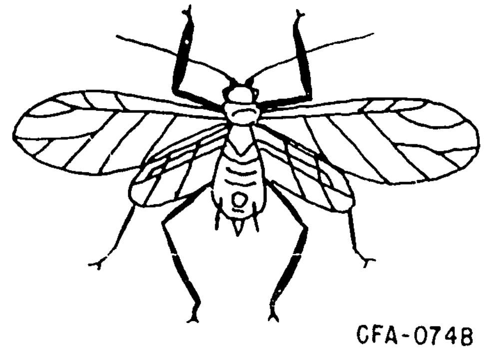

Figure 1–21. Order homoptera, an aphid.

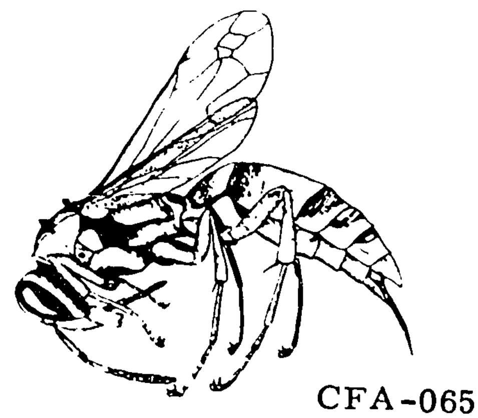

Figure 1–22. Order Hymenoptera, a wasp.

are hairy and have infinitely painful stings. Wasps, hornets, mud daubers, and bees are all relatives in their order. However, only the immature female worker, the queen ant or queen bee, the female of the mud dauber, and the carpenter and solitary bees can sting. This is made possible by modification of the egg-laying apparatus which forms the stinger. The Hymenoptera are the most beneficial of all insects, only a few being harmful. They furnish food for human and pollination for fruit and grain products.

Order Isoptera (equal winged—termites). Termites (fig. 1-23) in the immature or work stages or in the soldier caste do not have wings, but the mature male and female have identical wings. When wings are present, there are two pairs which are membranous with reduced venation, and both pairs are the same size and shape They have mouthparts adapted for chewing and undergo gradual metamorphosis.

Exercises (206):

1. Match the distinguishing characteristics in column B with the order of insects they describe in column A

Column A

___ (1) Anoplura.
___ (2) Coleoptera.
___ (3) Dermaptera.
___ (4) Diptera.
___ (5) Hemiptera.
___ (6) Homoptera.
___ (7) Hymenoptera.
___ (8) Isoptera.

Column B

a. This order has piercing-sucking mouthparts which are similar to jointed tubes. Some insects in this order have no wings while others have dissimilar wings.
b. Small, wingless, glattened insects with mouthparts usually retracted within the head and modified for piercing and sucking.
c. Insects in this order are wingless in the adult stage and have chewing mouthparts. Adults spend their entire life on animal hosts.
d. Two-winged insects with halteres which replace the second pair of wings, and mouthparts adapted for sucking or lapping.
e. This order of insects has chewing mouthparts that may be extended into a snout. The front pair of wings are heavy and shell-like, and the hindwings are membraneous or cellophanelike and fold underneath the forewings.
f. As adults, insects in this order have two pairs of membraneous wings which are identical in length. The mouthparts are adapted for chewing.
g. These are small dark-colored insects with long, narrow bodies and a prominent pair of cerci at the posterior end. They have chewing mouthparts and relatively short antennae.
h. Distinguished from other insects by having four small membraneous wings with few veins. Hindwings are smaller than forewings. Mouthparts are adapted for chewing and lapping and in many species the apparent first abdomenal segment is reduced to a slender waist.
i. This order includes adult insects, generally with two pairs of wings. The forewings are diagonally divided into two parts; the forepart being thickened, the hindpart, membraneous. This order has a scutellum and mouthparts modified into a beak for piercing and sucking.

207. Identify various orders of insects.

Important Orders of Insects (Part II). The lesson continues.

Order Lepidoptera (scale winged—butterflies and moths). Moths (fig. 1-24) and butterflies are distinguished from all other insects by their large, showy wings. The wings are usually completely covered with very small colored scales which rub off as a fine powder when the specimens are handled. Mouthparts are of the sucking type, resembling a coiled watch spring beneath the head. The larvae are caterpillars, and metamorphosis is complete.

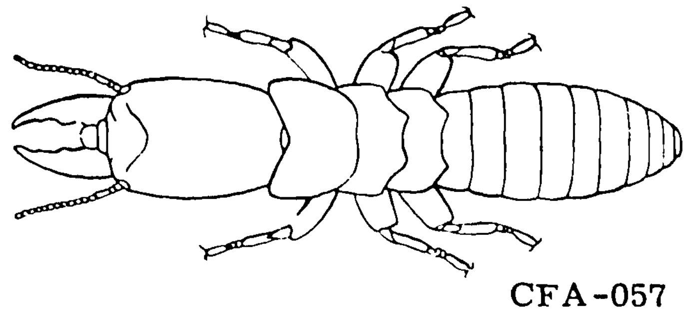

Figure 1–23. Order Isoptera, a termite.

Order Mallophaga (wood eater—chewing lice). Biting lice (fig. 1-25) are external parasites, chiefly on birds (hence one name, bird lice) although a few live on mammals. They are wingless and have chewing mouthparts for feeding on scales, feathers, hair, or oily secretions from the skin. The eggs are glued to feathers or hairs, and the young lice, called nymphs, and the adults spend their entire lives on the host animal. Development is by gradual metamorphosis.

Order Dictyoptera (straight winged—cockroaches). The cockroaches (fig. 1-26), walking sticks, praying mantids, and other species belong to this order and have chewing mouthparts. When wings are present, the forewings are thickened and leathery and have a net venation, while the hindwings are folded beneath the forewings like a fan. Cockroaches have long antennas and legs modified for running. Their bodies are flattened from top to bottom, an adaptation that enables them to hide easily in cracks or under furniture. These primitive insects develop through a series of nymphal stages by gradual metamorphosis.

Order Psocoptera (small winged—psocids). Psocids (fig. 1-27) are very small, soft-bodied insects which may or may not have wings. When wings are present they may be long or short, depending upon specie, and normally there are two pairs. The forewings are a little larger than the hindwings. When this insect is in a resting position, the wings are folded back in a rooflike fashion over the abdomen. Psocids have chewing mouthparts and the metamorphosis is complete.

Ord:r Siphonaptera (tube and wingless—fleas). Fleas (fig. 1-28) are wingless bloodsucking parasites on birds and mammals. They are very small, and their bodies are compressed laterally so that they are quite narrow from side to side. The head bears piercing-sucking mouthparts and antennas, and it may, or may not, bear a pair of eyes. The legs are well developed and fitted for jumping. Many species have black combs, or ctenidia, on the thorax and head. Fleas go through complete metamorphosis, with four life stages: the egg, a wormlike larva, the pupa in a silken cocoon, and the adult.

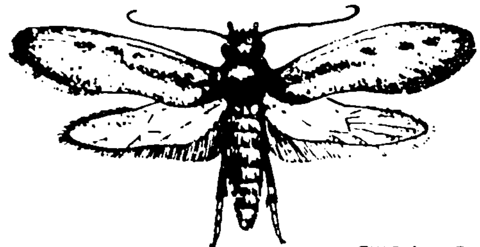

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Figure 1–24. Order Lepidoptera, a grain moth.

CFA-058

Figure 1–25. Order mallophaga, a biting louse.

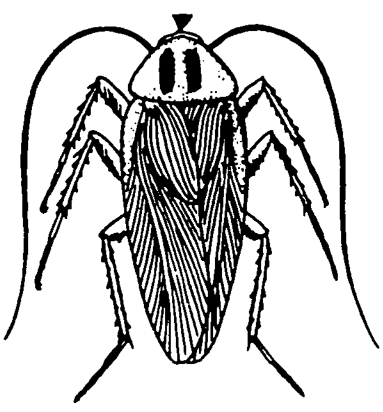

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Figure 1–26. Order Dictyoptera, a cockroach.

Order Thysanoptera (fringe wing—thrips). Thrips (fig. 1-29) have piercing-sucking mouthparts which are cone shaped. The wings when present are very hairy, which give them their feathery appearance; there are two pairs. The metamorphosis is somewhat complicated in that their development is intermediate between gradual and complete.

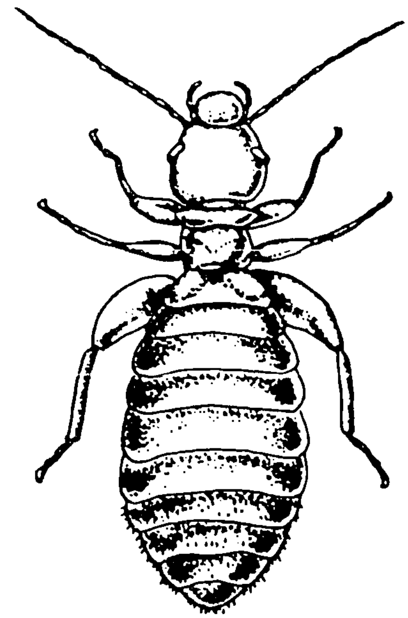

Figure 1–27. Order Psocoptera, a psocid.

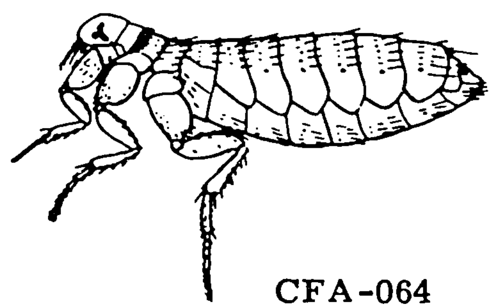

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Figure 1–28. Order Siphonaptera, a flea.

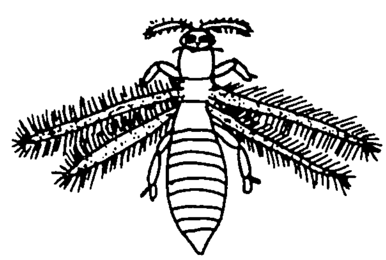

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Figure 1–29. Order Thysanoptera, a thrips.

Order Thysanura. Silverfish (fig. 1-30) and firebrats have chewing mouthparts, scales on their bodies, and three long appendages at the posterior end of the body. The young possess the obvious structures of the adults and differ from them chiefly in size, color, and sexual maturity.

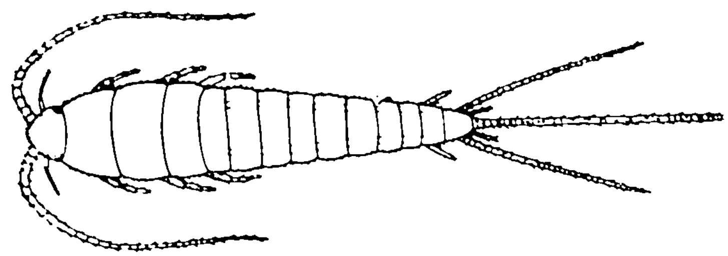

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Figure 1–30. Order Thysanura, a silverfish.

The order of insects just described do not represent all of the insect orders, only the orders of the more common insects. The probability of your coming in contact with these insects makes it important that you learn to identify them individually as well as by order.

Exercises (207):

For each of the following statements, specify which order and types of insects are described.

1. Insects in this order are very small, wingless, and parasites of birds and mammals. They have piercing-sucking mouthparts, their bodies are compressed laterally, and their legs are adapted for jumping.

2. This order of insects, described as being very small and soft-bodied, may or may not have wings. When present, the two pairs of wings are folded back in rooflike fashion over the abdomen when in a resting position. Mouthparts are adapted for chewing.

3. This order of insects has chewing mouthparts with bodies flattened dorso-ventrally and legs adapted for running. If wings are present, the forewings are thick and leathery and have a leaf venation; the hingwings are folded beneath the forewings like a fan.

4. This order includes insects with cone-shaped, piercing-sucking mouthparts. When wings are present, they are very hairy and seem to be feathery.

5. These insects have chewing mouthparts, scales on their bodies, and three long appendages on the posterior end.

6. This order contains insects that are wingless in the adult stage and have chewing mouthparts. Adults spend their entire lives on host animals.

7. This order can be distinguished from all other orders by its large, showy wings which are usually covered with very small, colored scales. The mouthparts are adapted for sucking and are coiled beneath the head.

208. Classify distinguishing characteristics of orders within the class Arachnida.

Important Orders of Arachnids. Although there are several orders in the class Arachnida, we are interested in only three: Scorpionida (scorpions), Araneida (spiders), and Acarina (ticks and mites).

Order Scorpionida (scorpions). Scorpions (fig. 1-31) are arachnids with the segmented abdomen broadly joined to the cephalothorax and ending in a stinger. The long, slender tip of the abdomen bears a stinger, enclosing a venomous gland, which is used to paralyze prey and as a defensive weapon. The large pincerlike palps used to catch and hold prey are borne in front of the first pair of legs.

Order Araneida (spiders). Spiders (fig. 1-32) differ from Other arachnids in having the cephalothorax joined to the abdomen by a slender waist, known technically as a *pedicel*, and having the abdominal segmentation either indistinct or absent. Spiders are generally harmless and serve a useful purpose in destroying flies, mosquitoes, and other insects. However, some species of Widow spiders, which have an hourglass marking on the underside of the abdomen (genus *Latrodectus)*, have a very venomous bite that is known to kill people. The bites of spiders in the genus *Loxosceles* in the Americas can cause skin gangrene and sometimes death.

Order Acarina (ticks and mites). Ticks and mites (fig. 1-33) have the head, thorax, and abdomen combined into a single body region, and are often saclike in form. Most

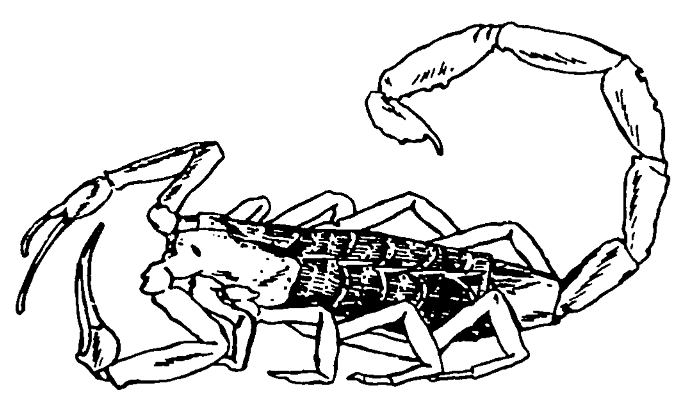

Figure 1–31. Order Scorpionida, a scorpion.

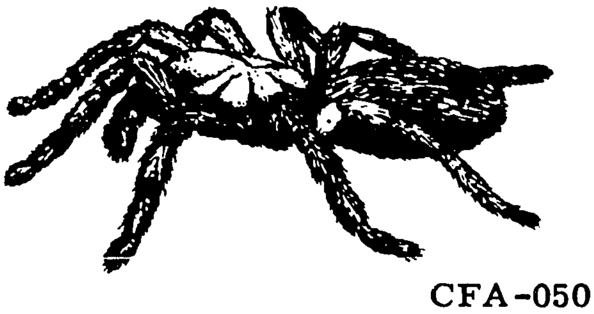

Figure 1-32. Order Araneida, a spider.

ticks bear a *hypostome* provided with recurved teeth, which is used as a holdfast organ after the mouthparts, called *chelicerae*, have made an incision into the flesh of most mammals, birds, reptiles, and amphibians in order to obtain blood. Mites are usually much smaller than ticks, and the hypostome, if present, is not armed with teeth. Ticks and mites have three pairs of legs in the first or larval stage, but typical nymphs and adults have four pairs of legs. Next to the insects, ticks and mites are the most important arthropod vectors of human diseases.

Exercises (208):

1. Match the proper order in column A wit adult characteristics of the class Arachnida in column A.

Column A	*Column B*
____ (1) The head, thorax, and abdomen are combined to form a single body region.	a. Scorpionida.
____ (2) The abdomen is segmented and broadly joined to the cephalothorax and ends with a stinger.	b. Araneida.
____ (3) The cephalothorax is joined to the abdomen by a slender waist.	c. Acarina.

1-3. Arthropod Physiology

Physiology is the branch of biology that deals with the functions of living organisms and their parts, such as cells, organs, and tissues.

Why should you study insect physiology? For starters, because life processes and sensory abilities in insects are different from those in higher animals. Also, today there are many more methods of pest management than we used just a few years ago—methods that attack a variety of the pest's internal systems. By being mindful of these systems and processes, you can design better control programs and get better results.

209. Identify the internal structures and life processes of insects and state the functional characteristics of their main body systems.

Internal Structures and Systems of Insects. Insects have all the major body systems that are found in higher animals. Insects and humans differ not only in their skeletal system but also in the arrangement of their major internal organ systems. The positions of the "heart," or chief circulatory organ, and the nervous system are the exact opposite in the insect and in man. In the insect the "heart" is on the dorsal, or upper side, and the central nerve cord is on the central, or underside. In man, by contrast, the heart is on the central side and the main nerve cord is encased in the spinal cord on the back, or dorsal side.

The circulatory system. The insect circulatory system is an "open" one in the sense that the blood is not enclosed in blood vessels but circulated freely through the body. The blood seeps into the heart or dorsal blood vessel through valves (ostia) and is pumped into the head region through the anterior part called the aorta (fig. 1-34). From the head region the blood flows backwards, bathing the various tissues. In the legs and antenna, small pulsating organs help circulate the blood. Typically, the blood is colorless or greenish yellow. In only a few insects, such as the bloodworm midge larvae (Chironomus), does the blood have a reddish color due to hemoglobin. The blood does not bear oxygen and carry off carbon dioxide and serve as a part of the respiratory system as in the higher animals. One of its main functions is to remove waste products from body cells and carry them to the malpighian tubules. Insect blood contains phygocytes that perform the usual function of destroying foreign matter and plugging wounds in the body wall.

The nervous system. The insect nervous system (fig. 1-35) contains nerve tissues and organs much like those found in the higher animals. The brain lies in the head above the esophagus and is connected to the subesophageal ganglion by two nerve cords encircling the esophagus. A double nerve cord extends backward along the ventral surface of the body cavity. In primitive insects each segment of the thorax has a nerve center or thoracic ganglion. They also have a ganglion (plural, ganglia) in each abdominal segment, but these have been reduced in most of the higher insects.

The respiratory system. Air enters the insect body through spiracles, or external openings on the body wall, into large tracheal trunks which usually extend the length of the body. Many tracheae branch off these main trunks and carry air to the tissue through their finely branched tracheoles (fig. 1-36).

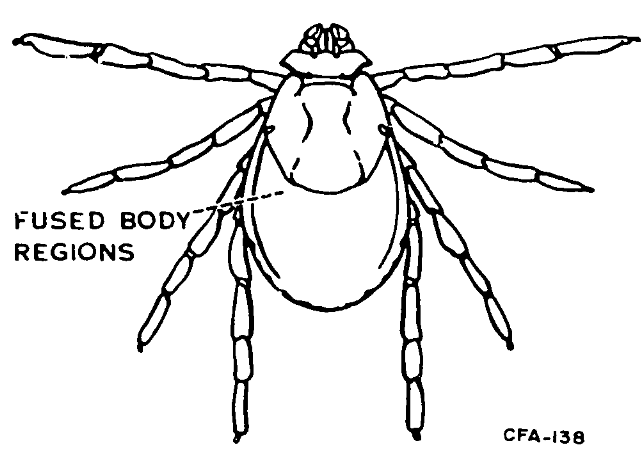

Figure 1-33. Order Acarina, a tick.

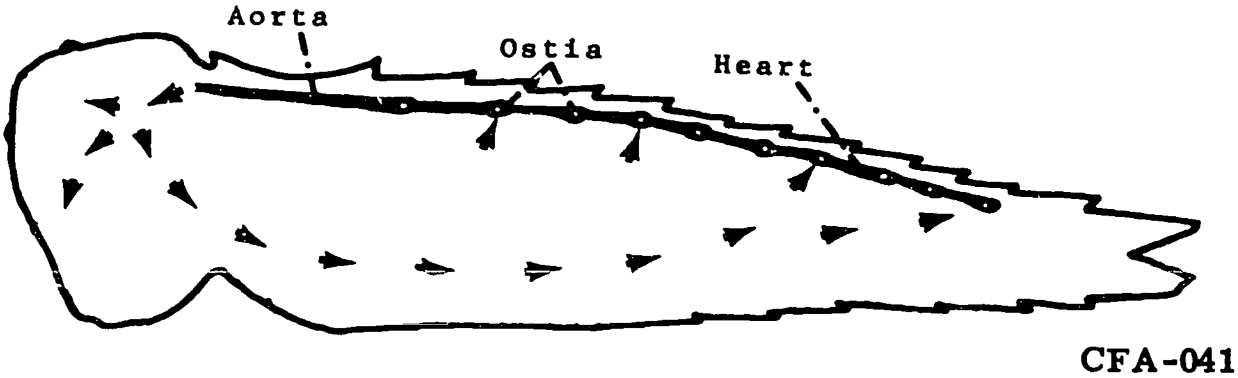

Figure 1-34. Insect circulatory system (diagrammatic).

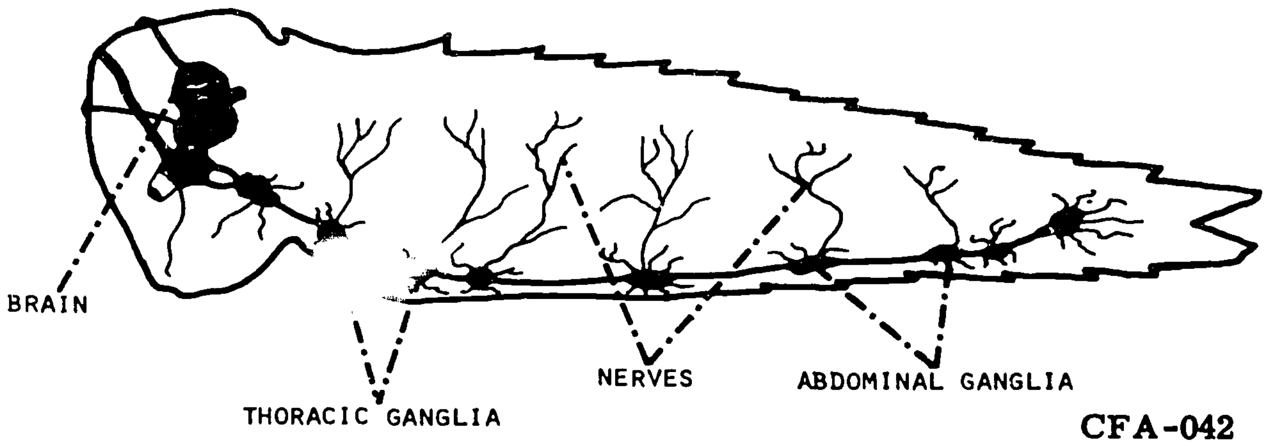

Figure 1-35. Insect nervous system (diagrammatic).

Respiratory movements of the insect body alternately compress and expand the large tracheal trunks, thereby ventilating the main branches of the respiratory system. Some insects are able to regulate the flow of air, taking it in through anterior spiracles and expelling it through posterior spiracles. Mosquito larvae breathe air through two openings, at the tip of the air tube in culicine or on a spiracular plate in aneopheline larvae.

Oxygen is carried to all parts of the insect body by these tracheal tubes. This same system also acts to carry waste carbon dioxide from the body tissues.

The respiratory system is important to the pest control specialist because of the fact that some dry dusts, which are otherwise nontoxic, can clog up the spiracles and thus deprive the insect of necessary oxygen. Many insecticides, particularly those used as fumigants, are also actually diffused into the insect body through the spiracles, permitting internal penetration through the tracheae and tracheoles.

The digestive system. Insects feed on a variety of foods, such as blood, animal tissue, stored foods, green grass, plant juices, and wood. the mouthparts and digestive system are adapted to changing these complex foods into simple carbohydrates, fats, a[illegible] in[illegible] at will nourish the body cells. The digestive system consists of an alimentary canal, which is basically a tube running from the mouth to the anus. It is divided into a foregut, midgut, and hindgut corresponding to its embryological origin (fig. 1-37). The food taken into the mouth passes through the esophagus to the crop, which is an enlarged portion of the foregut that is used for food storage. Some insects have a proventriculus, or gizzard, where food may be ground into finer particles. The food then passes into the stomach, or midgut, where digestion takes place. The undigested food then passes out through the intestine and anus as feces. Most insects have salivary glands and gastric caeca to provide enzymes for food digestion.

The excretory system. An arthropod's undigested food is expelled from the body as feces; whereas the excretions of true body wastes, the byproducts of growth and metabolism, are carried by the blood and the malpighian tubules and discharged into the intestine near the junction of the midgut and the hindgut (fig. 1-37).

The reproductive system. Most insects have two sexes, which must mate before eggs are produced. An insect usually produces large numbers of eggs, although some species produce very few eggs and other may produce living larvae. Insects laying eggs are said to be oviparous, while those species depositing larvae are said to be larviparous. The Tsetse fly, for example, gives birth to larvae already full grown and ready to pupate.

A few insects have only one sex, the female, which can produce young without fertilization by a male, as in the Surinam cockroach. This type of reproduction is called parthenogenesis, or virgin birth. These insects are not hermaphrodites, since no male organs are present.

The male reproductive system. This system (fig. 1-38) consists of a pair of testes in which sperm cells are developed and ducts, or vas deferens, leading to the penis or ejaculatory organ. The seminal vesicle serves as a reservoir for storing sperm cells until mating occurs. The accessory glands secrete a liquid substance to serve as a vehicle for the sperm cells.

The female reproductive system. This system (fig. 1-39) consists of a pair of ovaries, which produce eggs (ovum), and the oviduct through which the eggs pass into the vagina, where they may be fertilized by male sperm cells stored in the spermatheca (or spermathecae). Some species have accessory glands that secrete an adhesive coating for the eggs. A single copulation usually supplies the female with enough sperm to fertilize a large number of eggs, whether she lays them all at one time or at intervals over a long period.

The skeletal system. We have mentioned the skeletal system in previous sections dealing with classification; but at this point, we need to find out just what the skeletal system is composed of. Because of the role it plays along with the muscle system, it warrants further discussion.

The insect's exoskeleton (fig. 1-1) is the supporting framework for the outside body. The exoskeleton actually surrounds the body of an insect. This exoskeleton is composed of protein-carbohydrate material known as chitin (pronounced KIT-en), which is secreted by the cells of the epidermis or skin. The chitin is first a liquid when secreted and then becomes hardened, which forms the exoskeleton. It will not bend or stretch after it hardens upon secretion. The adult insect body is only capable of movement because of soft, flexible tissues (intersegmental membranes) between the body segments.

The muscular system. The insect's muscular system is the companion of the skeletal system. It allows movement and is an important characteristic of animal life. The muscular system is supported by and attached to the exoskeleton and serves to move the appendages of the body and operates the organs of the body which carry on the life processes, such as the heart, spiracles, and intestines.

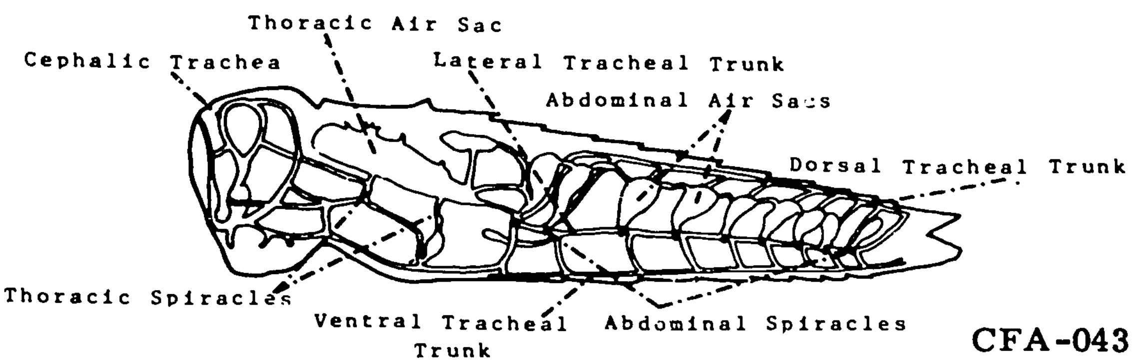

Figure 1–36. Insect respiratory system (diagrammatic).

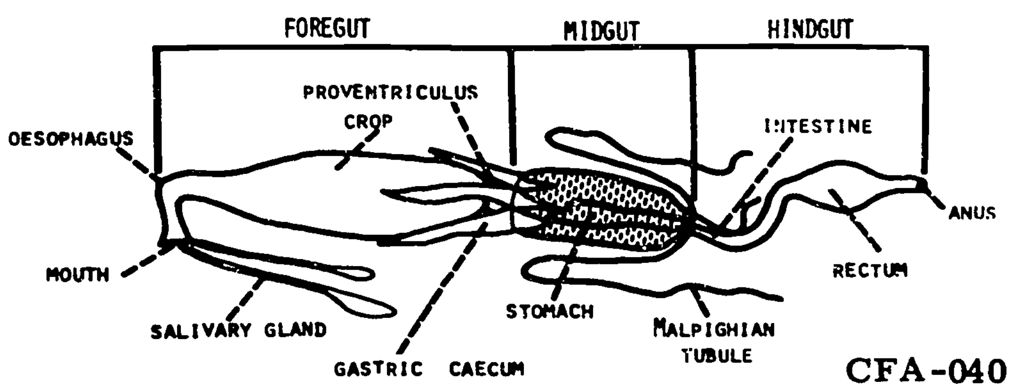

Figure 1–37. Insect digestive and excretory system (diagrammatic).

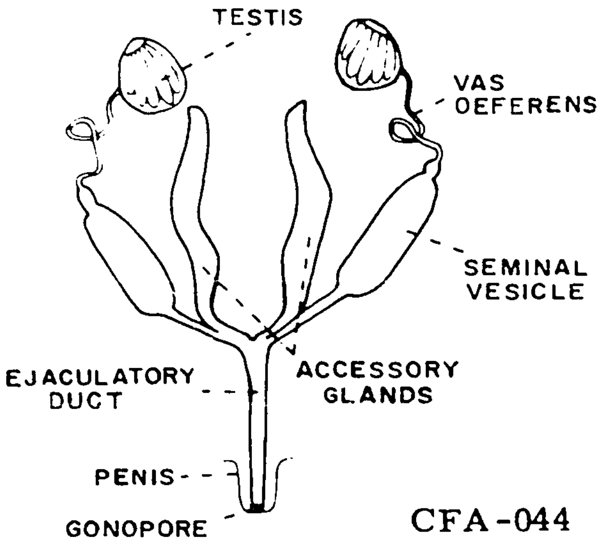

Figure 1–38. Male insect reproductive system (diagrammatic).

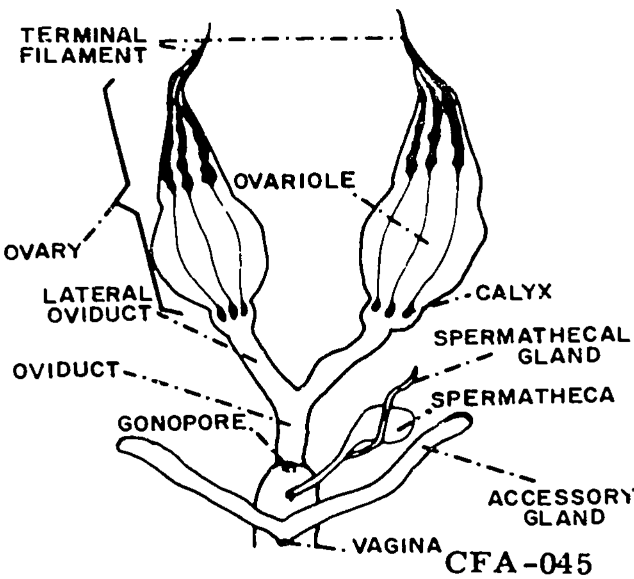

Figure 1–39. Female insect reproductive system (diagrammatic).

Exercises (209):

1. Match the organs in column B by placing the appropriate letter beside each function in column A.

Column A	*Column B*
____ (1) An insect organ that helps remove body waste.	Trachea.
____ (2) This organ allows air to enter the body.	a. Ganglion.
____ (3) The insect's nerv center.	b. Spiracles.
____ (4) The organ that transfers air throughout the insect's body.	c. Proventriculus.
____ (5) An organ possessed by some insects to help in digesting food.	d. Malpinghian tubules.
	e. Ostia.

2. Describe the type of circulatory system insects have.

3. What other body system is the muscular system most dependent upon?

4. Inscets that rcproduce by laying eggs are called what?

5. What is the term for the type of reproduction by insects where only one sex is involved?

210. Cite characteristics of the various insect senses.

The Senses of Insects. Insects have the same senses that are associated with man. There are the five primary senses of touch, taste, smell, hearing, and sight and other auxiliary senses such as the sense of balance and, possibly, a sense or orientation.

Touch. Because of its hardened cuticle, the insect's skin is not sensitive to contact. The sense of touch is, therefore, served by sensory hairs occurring over most regions of the body. Figure 1-40 compares the sensory hair with an ordinary hair, illustrating the nerve which is stimulated if hairs are bent or distored.

The antennae, or feelers, are important organs of touch. The tarsi and cerci are important organs of touch. The tarsi and cerci are also sensitive to contact, and insects react very quickly to pressure on these organs.

Taste and smell. Chemical stimuli resulting from the presence of odors and substances with a taste are usually perceived by small rodlike organs projecting from the body surface. Taste is usually perceived by the mouth, the mouthparts, the palps, or the front feet. The sense of smell is localized mainly in the antennae, although palps also bear olfactory organs. The sense of smell is highly developed in insects. It is used to locate food, to find a mate, and to locate suitable places for depositing the eggs.

Hearing. The sense organs and degree of sound preception are different among insect groups. Insects do not generally respond to miscellaneous sounds but only to specific noises, such as sounds made by the opposite sex. This may be due to discrimination by the insect rather than to the lack of sound perception. Sound waves may be picked up by fine sensory hairs or by special organs such as the auditory drum that appears on the side of the abdomen or the lower part of the front legs. Flies and mosquitoes are believed to hear by means of a cuplike organ on the second antennal segment which responds to sound waves picked up by the rest of the antennae.

Sight. The principal organs of sight are the compound eyes and ocelli. Fly maggots do not have eyes but are able to detect the presence of light by means of sensitive tissue underlying the cuticle. This sense is of value to the mature

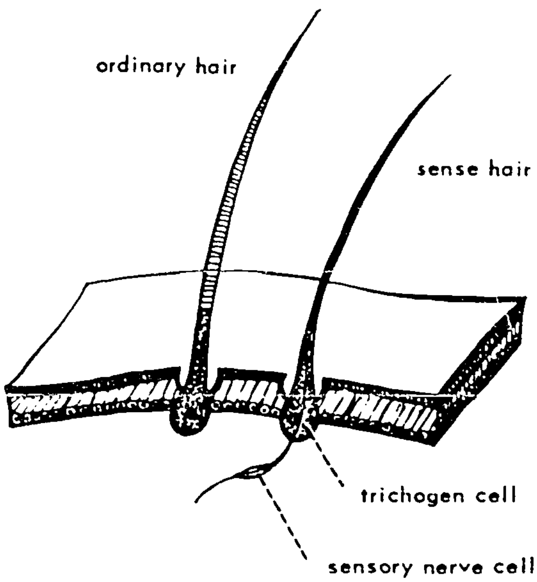

Figure 1–40. Insect ordinary and sensory hairs.

maggot when it leaves its feeding site and burrows into the ground to pupate.

The compound eyes and facets are provided with nerves which transmit stimuli to the brain. Insects can perceive movements very readily, and visual powers usually vary according to the demands made on them by the habits of the insect. Laboratory tests have proved that insects are able to distinguish colors, whereas some of the higher animals, such as rats, are color blind. The insect can neither move its eye nor focus them. However, the praying mantid can rotate its head 180° and is thought to have a good sense of vision.

There is some speculation that insects are able to reason. Although there is no proof that can substantiate this, many of their complex instinctive actions simulate the results of reasoning. For example, a wasp deposits an egg upon a spider that has been paralyzed by a deft sting in one of the main nerve centers. The spider is then buried in a small cavity in the ground and covered with earth where the egg incubates. The wasp then uses a large grain of sand as a hammer to tramp the earth over her nest.

Insect behavior appears to be a series of reflex actions or automatic responses to certain stimuli. Most insects feel secure if their feet are touching the ground or some solid object. Some bugs and beetles turned over on their backs will struggle violently to regain their feet; but their struggles cease if they are given a small object to hold. The honeybee is able to return to its hive by orienting its flight according to the declination of the sun. It performs a dance in the hive which indicates to other worker bees the location of flowers with nectar in relation to the declination of the sun and the distance from the hive. Despite these complex instinctive actions, it is believed that virtually all insect behavior arises from responses to simple stimuli such as light, heat, gravity, hunger, and smell.

The only animals that can fly are birds, bats, and insects. The ability to fly enables insects to escape many of their enemies, to locate their food, to find their mates, and to populate the earth. Insects such as the grasshopper have extremely strong muscles devoted to flight. The flight muscles of the housefly comprise 10 percent of the body weight. They activate the wings indirectly by distortion of the body wall. Housefly wings often vibrate at the rate of about 200 strokes per second. In one cycle they beat downward and forward and then turn vertically with edge uppermost and move backward. Some insects are able to hover and even fly backward.

Exercises (210):

1. Insect antennae give some sense of touch, but the main sense they give is that of ________________ .

2. Special hairs on most regions of the insect body provide the sense of ______________________ and also aid in the sense of _________ .

3. Insects can rotate and focus their eyes. (True/False)

4. Insect skin provides for their sense of touch. (True/False)

5. Small rodlike organs that project from the body surface provide the sense of _______________ .

6. Smelling in insects is used to locate food, find a mate, and also to find suitable places for ___________________ __________ .

7. Unlike people, insects can readily perceive movements with their _________ _________ .

8. It is believed that virtually all insect behavior arises from responses to _________ _________ .

Pest Management Planning and Coordination

AS AN AIR FORCE pest manager, you must understand how to plan and coordinate effective pest management programs. Planning effective programs involves many aspects most people don't consider. Pest management programs must be effective, practical, and safe. This chapter will explain the procedures you can use to plan effective and safe pest management programs and will identify organizations and agencies that may be involved in pest management with whom you should coordinate.

2-1. Surveying and Collecting Pests

The first step in the pest management planning phase is to conduct pest surveys. These are necessary to detect actual or potential breeding sources of pests so you can prepare recommendations for the prevention or elimination of such sources. Such surveillance involves operating light traps; locating and mapping breeding sources; and making biting and landing counts, resting station collections, population estimates, and sanitary inspections. The proper handling, packaging, and submitting of specimens to designated laboratories, in a condition which will allow identification and isolation of disease agents, is often required. This is particularly important in the detection of vector agents that might be used in biological warfare attack.

In this section, you will learn the types of surveys, when and how the surveys are conducted, information gained from conducting surveys, and pest collection methods and equipment.

211. List the types of pest surveys, state the purposes for surveying, and select methods of surveying for given pests.

Pest Surveys. After you complete this objective you'll understand why pest surveys are important, and you'll know the types of surveys you use and what you should look for in them.

Why survey? Even though getting out and looking for flies, rodents, and other pests may not be your idea of a good time, there are some sound reasons for conducting and recording results of surveys. You can detect population shifts more easily and thereby concentrate your management efforts in areas where they're needed the most. Nonchemical controls can be applied more effectively because you have more precise knowledge of what problems exist and where they're located. And, of course, chemical controls work better for the same reasons.

Have you ever encountered somebody who thought that "spraying" was the answer for every pest from ants to skunks? If you haven't, you will. If you have, then you can readily appreciate how good survey records can help you educate people and gain support from higher base officials and residents.

Sooner or later, most pest managers run into a very complex pest problem and must consult with a command pest management professional or others on how to handle the situation. Coming to a solution can be much easier and quicker if you've collected and documented all the information relevent to the problem.

Finally, you can use survey information to plan ahead—determine schedules and order necessary pesticides and supplies—in anticipation of seasonal problems.

Types of surveys. There are two basic types of surveys, each determined mainly by when you conduct it.

Basic survey. The basic survey is the first one you make before you plan your pest management program. It's the only thing you're doing at that time. The scope of a basic survey can vary. You may be making your first detailed tour of a new base, or you might be concentrating on specific areas you've surveyed before. Either way, it's still a basic survey.

Of course, you need some specific goals in mind as you perform your basic surveys. Ask yourself these questions as you go along:

(1) Is there a prevalence of beneficial or detrimental plants and/or animals in the area?

(2) What are these beneficial or detrimental features?

(3) What conditions are helping pests establish themselves in the area?

(4) If there is no current pest problem, what condition could result in future pest infestations?

After you've answered these questions sufficiently, analyze the information to decide what type of pest management program you should start. What preventive measures can you take? What corrective controls are the safest and most effective? Do you have the resources needed to do the job?

Operational survey. If a basic survey is preparatory in nature, then logically, an operational survey is one you use as your control program is being conducted. Operational surveys are vital to the safety and efficiency of your program. They can help you:

(1) Obtain new information about the questions you asked during the basic survey.

(2) Identify unsafe or improper conditions that could prevent you from taking control measures.

(3) Make sure you adequately treat the facility or area during your operations.

(4) Identify any undesirable side effects of your program.
(5) Determine if your program met its objective at the end of your operations.

If your program didn't do the job adequately, or if it had side effects, study the situation more carefully and consider getting help from other sources.

Survey methods. You can conduct pest surveys in many ways, depending upon the pest you want to survey for and the information you want to get. Here are six basic pest survey methods.

Visual inspection. Visual inspections are useful for checking conditions that exist on base and areas close to base property. You can check for sanitary conditions; low-lying areas that retain water; rodent runways, gnawings, and droppings; artificial containers that hold water; interior walls for cockroach and fly fecal material; structures for termites, fungi, and wood borers; and ornamental shrubs, trees, and grasses for unusual coloring or damage.

Trapping. Trapping is a survey method that is used principally for collecting mosquitoes, ornamental and turf pests, and rodents. Use trapping to collect live specimens to determine if they are carrying diseases, or to collect specimens simply for determining identity and prevalence of certain pests.

Dipping. Dipping is used to conduct mosquito larval surveys. Since all mosquitoes develop in water, bodies of water—small or large—can be dipped near the edges to locate breeding areas before mosquitoes become adults.

Skimming. Skimming is another survey method used for certain mosquito larvae. This method is used for detecting mosquito species that lie parallel to the water surface.

Biting and landing counts. Biting and landing count surveys are used for sampling populations of flies and mosquitoes. When performing these surveys, conduct them at the same time of day, for the same period of time, and using the same subject. The subject may be human or other animal, and in the case of nonbiting flies, dead baits may be used.

Probing. Probing is used to detect damage caused by structural pests such as termites, fungi, and wood borers. This method can also be used for taking random samples of packaged stored foods for the detection of stored food pests.

Remember, these are not all of the pest survey methods, but these are the methods used most often. Other survey methods will be discussed later, along with discussions concerning specific pests.

Exercises (211):

1. What advantages are offered by conducting and maintaining records of pest surveys.

2. What are the two main types of surveys?

3. State two reasons for conducting basic surveys.

4. What are three reasons for conducting operational surveys?

5. What type of survey is used for taking random samples of stored foods to detect stored food pests?

6. To detect mosquito larvae lying parallel to the water surface, which survey method should you use?

7. Which survey method helps you determine the identify and prevalence of ornamental and turf pests?

212. State the purposes for collecting pests and list collection methods and equipment required for collecting identified pests.

Pest Collection. Pest collection and survey methods are most generally accomplished together, but your purpose and methods may be somewhat different.

Why collect pests Specific information of medically important pests is often very useful, and in many cases, most essential in determining the management technique you should use in their control. Since there are many different species, exact determination of a specimen frequently requires a specialist. The collection and processing techniques you use will depend upon whether your purpose is to monitor and identify vectors or to detect and identify disease agents. In the latter case, live samples must be forwarded, after special processing, to an appropriate detection and identification laboratory. Bear in mind, living specimens can't always be sent in the mail.

How to collect pests. You can collect pests in many ways, and there is a variety of equipment you may use; however, this text will only discuss the most common methods and equipment.

Trapping. Trapping is an effective way to collect adult insects such as mosquitoes, flies, and ornamental and turf pests; and for collecting cockroaches, rodents, predatory animals, and birds. Traps may be used for collecting specimens that must be kept alive for research or for collecting specimens simply for identification, determining the quantity present within an area, or for preservation. Trapping can be done by using various types of light traps, such as the communicable disease center miniature light trap (fig. 2-1), black light trap (fig. 2-2), and the American light trap (figs. 2-3 and 2-4). These traps are mainly used at night so the light will attract certain night-flying insects, such as most species of mosquitoes and many ornamental and turf pests.

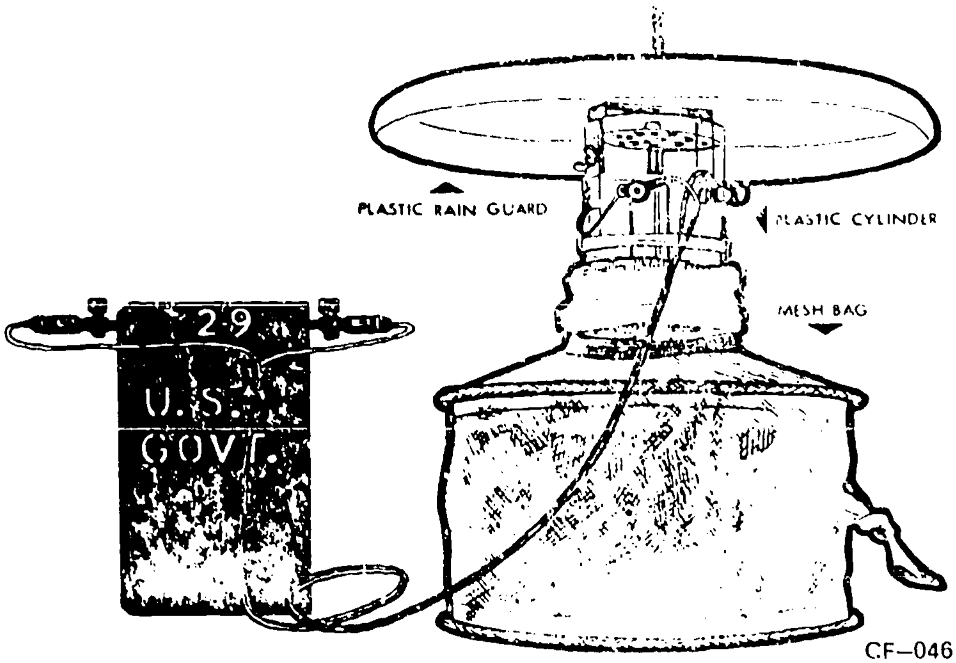

Figure 2-1. Communicable disease center miniature light trap.

Cage traps of various sizes are used for collecting live specimens such as flies, mosquitoes, rodents, predatory animals, and birds. Most generally, cage traps are baited with decaying matter, live animals, or carbon dioxide to attract desired specimens. Cage traps are especially beneficial for collecting specimens that must be kept alive for research and collecting ecotoparasite hosts. Figures 2-5, 2-6, 2-7, and 2-8 illustrate the various types of cage traps.

Use open-mouthed jar traps to collect crawling pests such as cockroaches and pests of lawns. These traps are usually baited to attract pests. Once the pests have entered the jar, exit is prevented by an oil coating which you should apply around the inner surface of the jar lid. Jar traps used in lawns should be buried with the jar lip level with the surface.

Dipping and skimming. Dipping and skimming are two methods used to collect mosquito larvae. This is done with a standard dipper. To help you identify types of larvae, the dipper should be white porcelain, and it should have an extension handle. Figure 2-9 illustrates the dipper with an extension handle.

Biting and resting station collections. Biting and resting station collection methods are conducted by using aspirators and killing tubes. An aspirator is constructed from a section of plastic or glass tubing about 12 inches long with an inside diameter of about 3/8 inch. One end of the tube is covered with a fine wire screen and then inserted into a piece of rubber tubing 2 to 3 feet long. The aspirator is illustrated in figure 2-10. The aspirator is used for collecting small flying insects (as they are biting or resting) by placing the end of the rubber tubing in your mouth and placing the end of the glass tubing over the insect and sucking in a quick breath. Once the insect has been sucked into the glass tube, remove the glass tube and place your finger over the end. The specimen can now be emptied into a killing tube and later transferred into a pillbox. Killing tubes (fig. 2-11) are constructed from glass vials about 6 inches long and 1/2 inch in diameter. The bottom of the vial is filled with chopped rubberbands 1 inch deep. Then a perforated plastic disc is placed into the vial directly on top of the shredded rubber. Cotton is then placed on top of the disc, and a second perforated disc slightly larger than the vial diameter is placed on top of the cotton. The vial is charged by pouring chloroform into the vial level with the top of the rubber. The vial is stoppered with a cork. Insects are collected by removing the stopper and placing the open end over the specimen as it is biting or resting. Hold the vial over the specimen until the specimen relaxes and falls into the tube, then stopper. The specimen can later be transferred to pill boxes.

Cloth drags. Cloth drags (fig. 2-12) are used to collect ticks. A piece of white flannel cloth, 1 yard wide and 1½ yards long, is attached to a rod, 1 yard long, and dragged along trails for a few yards. The cloth is then inspected, and ticks that have become attached to the cloth are removed with tweezers and placed in vials of 70 percent alcohol.

Combing, brushing, swirling, and picking. Combing, brushing, swirling, and picking are effective methods of collecting ectoparasites (fleas, lice, ticks, and mites) from rodents, predatory animals, and domestic animals.

CAUTION: Always wear laboratory gloves while using this collection method.

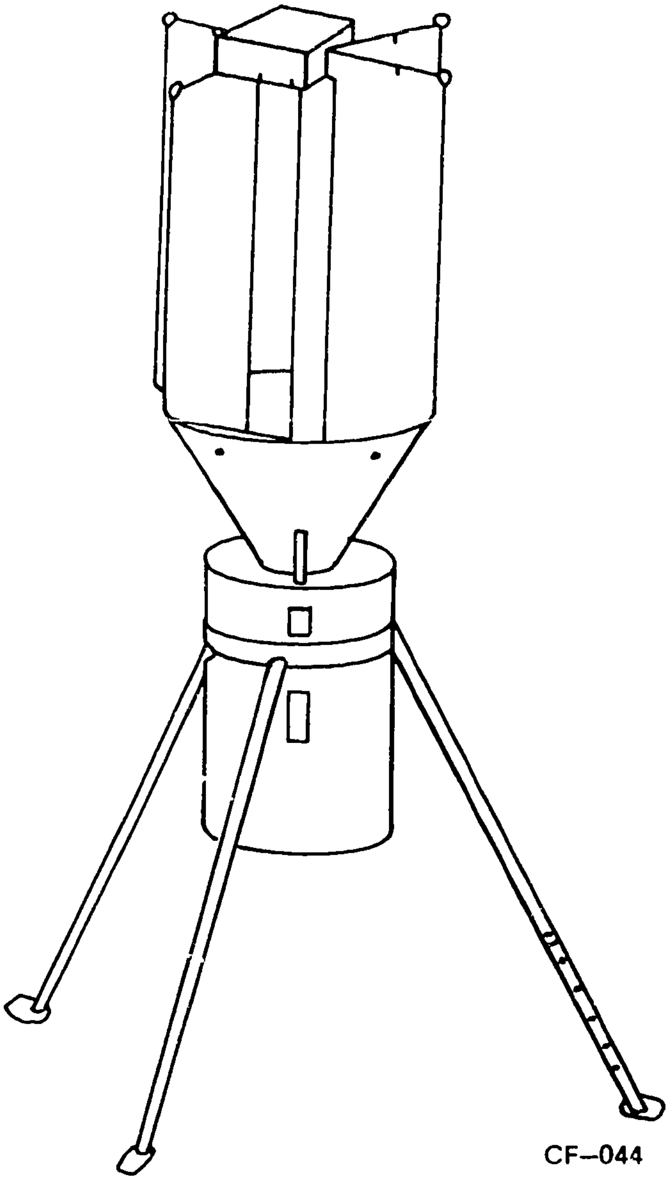

Figure 2–2. Black light trap.

Ectoparasite hosts must be trapped in cage traps so they don't die. If the host dies, ectoparasites will leave as soon as the host body temperature cools. Once the host is trapped it's removed and anesthetized (temporarily put to sleep) or killed. If combing or brushing methods are to be used, immediately pick the animal up by the tail and hold it over a pan and begin brushing or combing with downward strokes.

NOTE: The ectoparasites will not jump or crawl out of the pan because they are anesthetized too. Once the ectoparasites have been removed, they are transferred from the pan, using a small art brush or applicator stick, to vials of alcohol. This collection method is illustrated in figures 2-13 and 2-14.

Pick ectoparasites from anesthetized hosts (fig. 2-15) by using tweezers and drop ectoparasites into vials of alcohol. This is the only method that can be used for removing ticks and sticktight fleas.

Collecting ectoparasites by swirling is accomplished by placing the anesthetized host into a jar or tub that contains a warm soap-water solution and swirling through the solution. After this has been accomplished, remove the host and slowly pour the solution through filtering paper. Then transfer ectoparasites from the filter to vials of alcohol. Figures 2-16 and 2-17 illustrate the swirling method of collection.

Digging. Digging is used mainly to collect ornamental and turf pest's larvae and fly larvae. This is done by digging the soil in suspected areas. Embed the entire length of the

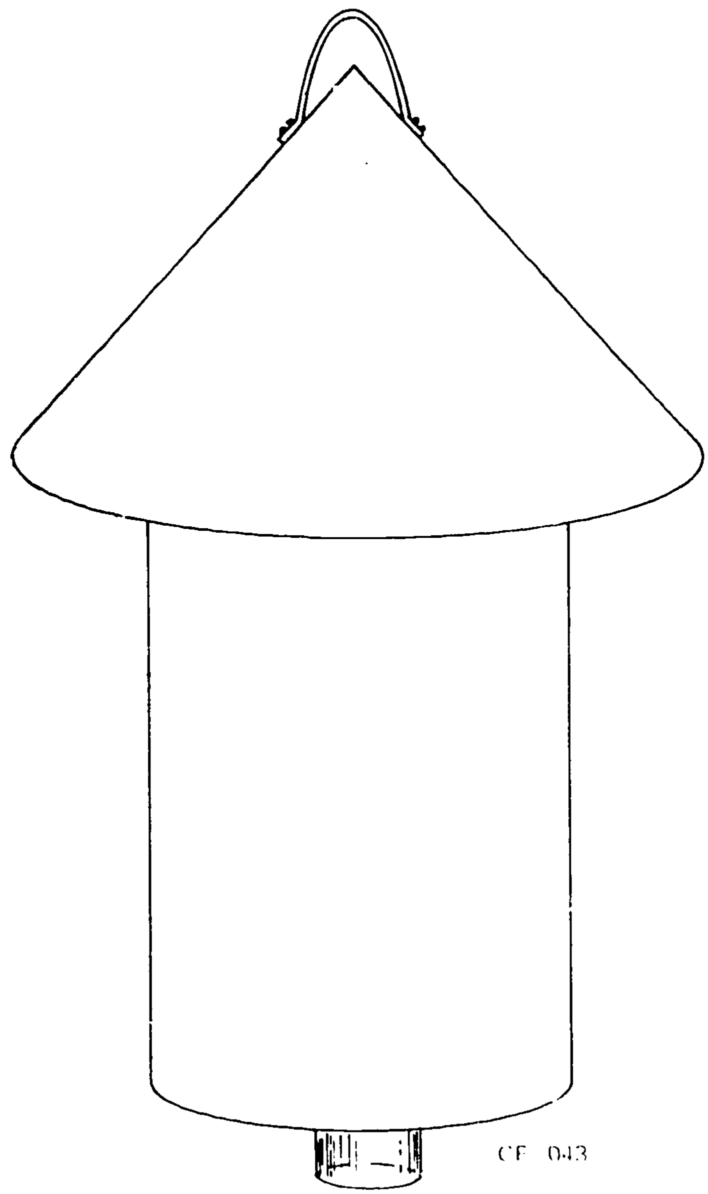

Figure 2–3. American light trap.

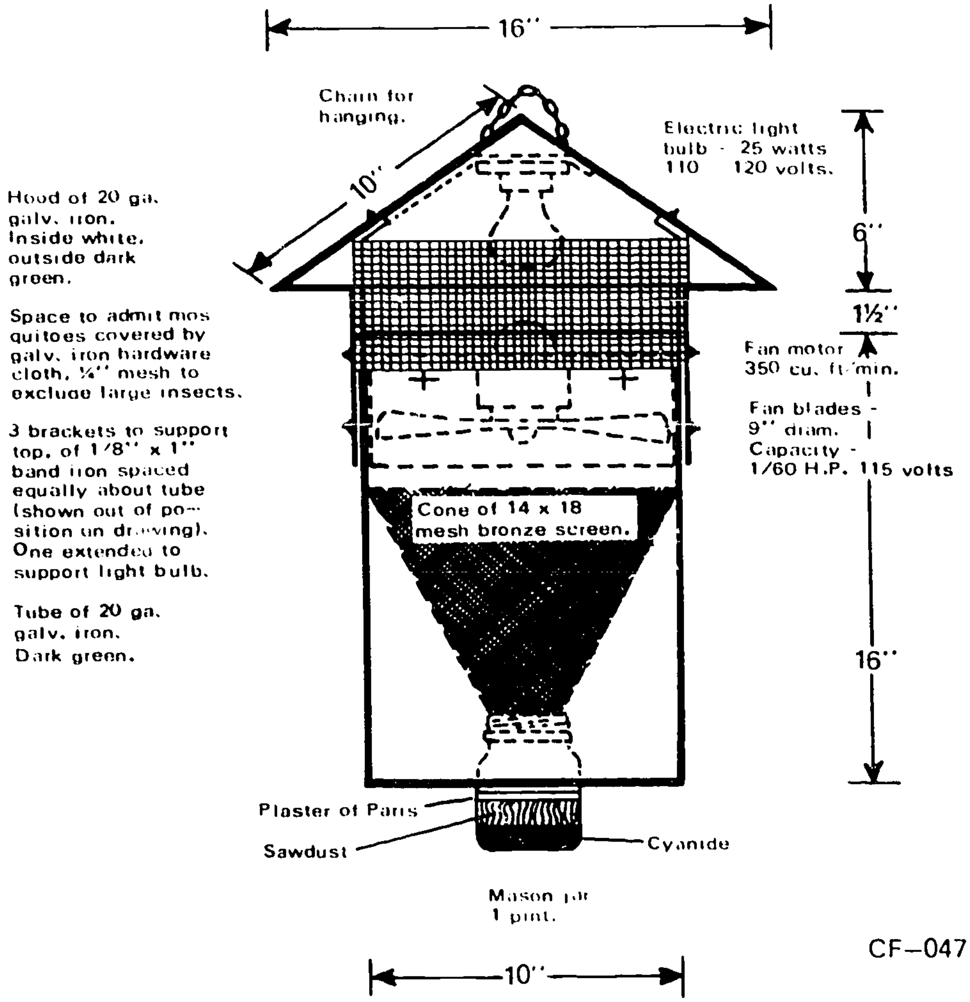

Figure 2–4. American light trap (exploded view).

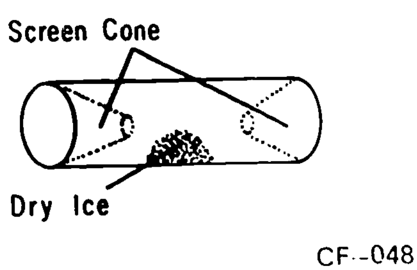

Figure 2–5. Carbon dioxide trap.

shovel blade into the soil several times to form a circle and remove the loosened clod. Pull the clod apart (as though looking for earthworms) and inspect for grubs (beetle larvae) or maggots (fly larvae).

Exercises (212):

1. State two reasons given in the text for collecting pests.

2. State the primary purpose for using live collection methods.

3. Using information in the text, list the method or methods and equipment used to collect identified pests.

Pest	*Collection Method*	*Collection Equipment*
a. Mosquitoes (adult).	(1) ________	(a) ________
		(b) ________
	(2) ________	(a) ________
b. Ticks.	(1) ________	(a) ________
	(2) ________	(a) ________
c. Flies (adult).	(1) ________	(a) ________
d. Mosquitoes (larvae).	(1) ________	(a) ________
	(2) ________	(a) ________
e. Fleas.	(1) ________	(a) ________
	(2) ________	(a) ________
	(3) ________	(a) ________
	(4) ________	(a) ________

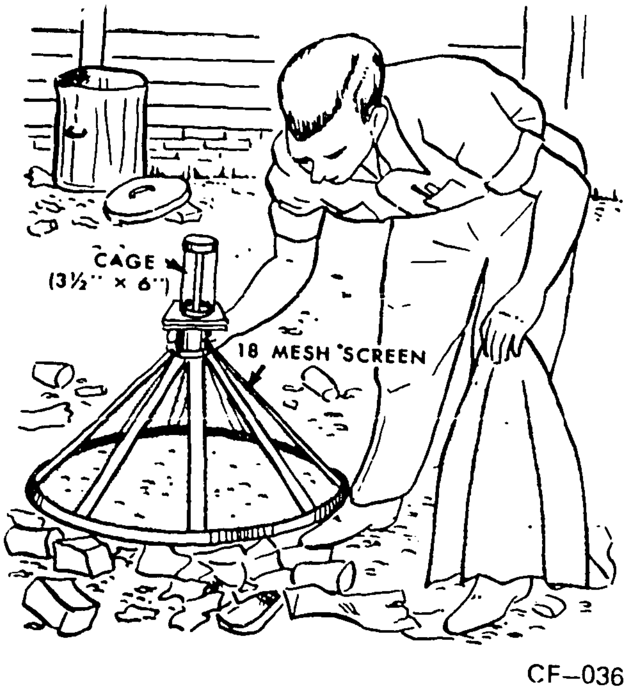

Figure 2-6. Fly cone trap.

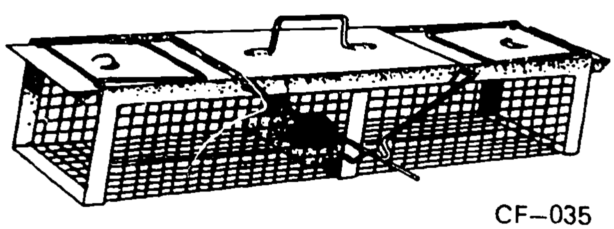

Figure 2-7. Live animal trap.

2-2. Identifying and Preserving Pests

In reading Chapter 1 you learned that insects belong in the animal kingdom and that they are divided into major groups. Obviously, there are many characteristics used to place arthropods into a particular class and order, but it doesn't stop here. You must be able to take a specimen and classify it as to family, genus, and species.

To fully understand this section, you must be very familiar with the illustrations provided in Chapter 1, Section 1-2 (Arthropod Morphology), so you will be able to recognize terminology applied to the various regions of the anatomy and appendages of arthropods.

General appearance, spot characters, and identification keys are the three general methods used in identifying arthropods.

The process of identification using the general appearance method simply means knowing a specimen by sight. This requires extreme knowledge and practice.

When using the spot character approach, you recognize certain characteristics that are common to a particular species; however, this method is not very reliable because other species may be very similar. This approach may be used in placing a specimen in its order.

This section describes the types of keys used in the process of identification, use of identification keys, use and maintenance of microscopes, and methods for preserving and maintaining specimens.

213. Identify the two types of identification keys and use keys to list the steps followed in identifying specified pests.

Identification Keys. You can accurately identify pests only if specimens have been collected carefully and undamaged; in addition, you must thoroughly know arthropod structures and you must have complete sets of identification keys. This objective is devoted to making you aware of common types of identification keys, explaining their use, and enabling you to use them properly.

In most situations, identification with family, genus, and species requires the use of a microscope (discussed later), a good set of keys, and a specimen that is properly mounted and in very good condition.

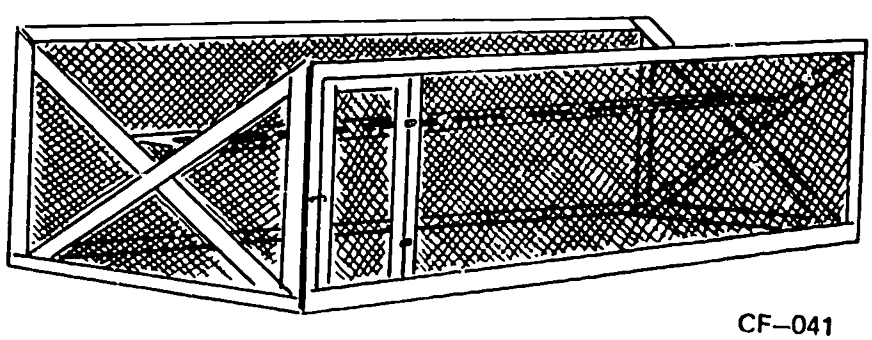

Figure 2-8. V-drop bird trap.

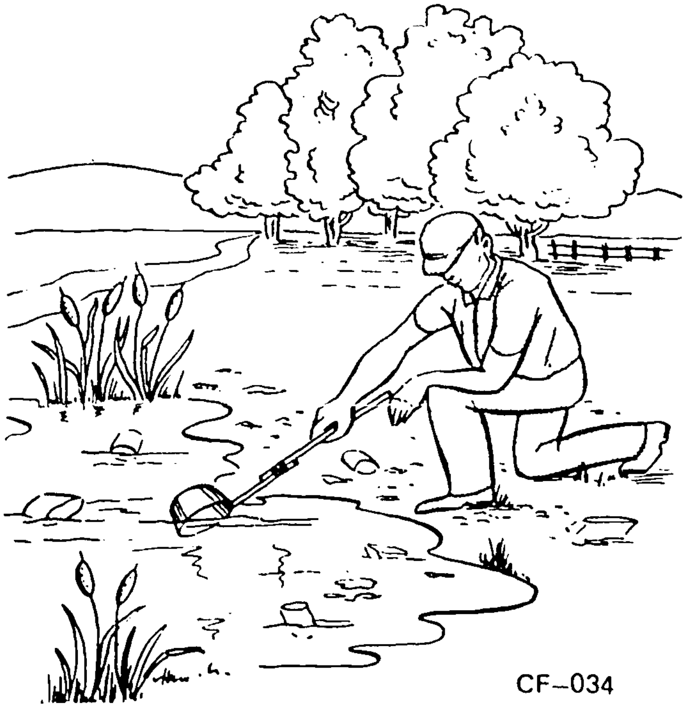

Figure 2–9. Dipper for collecting mosquito larvae.

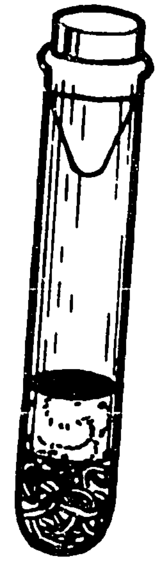

Figure 2–11. Killing tube.

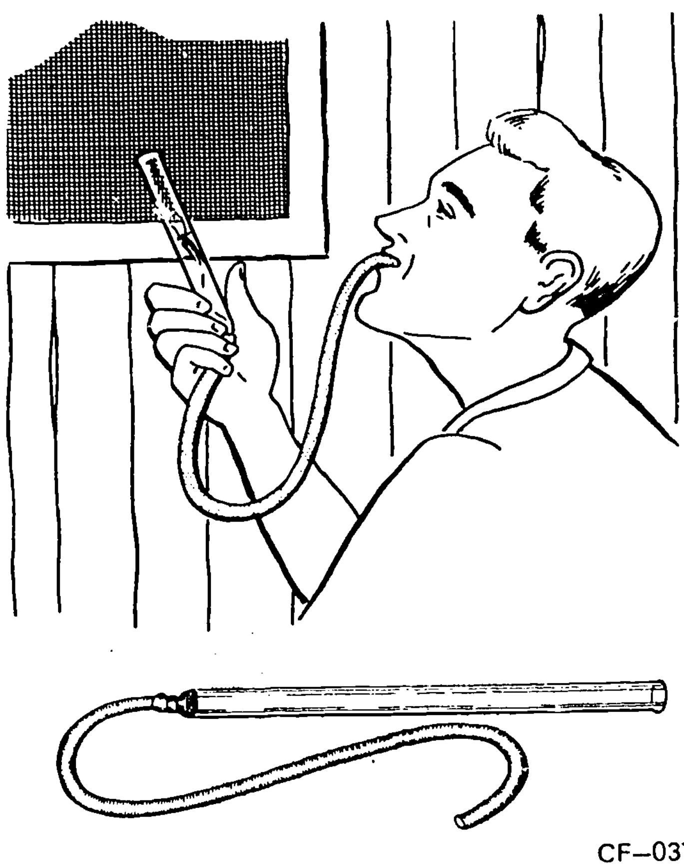

Figure 2–10. Aspirator for collecting adult mosquitoes.

Figure 2–12. Tick drag.

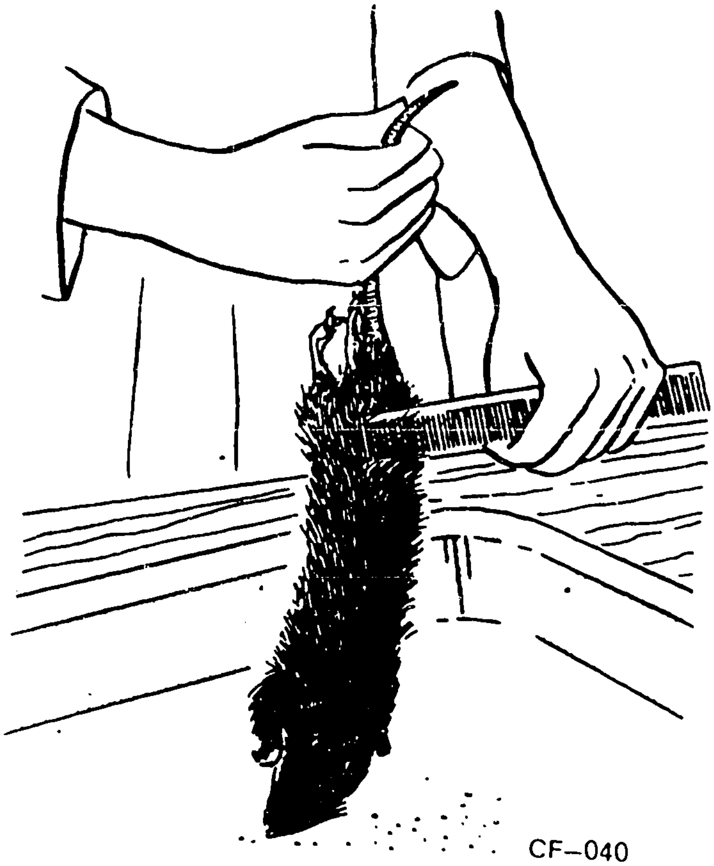

Figure 2–13. Combing for extoparasites.

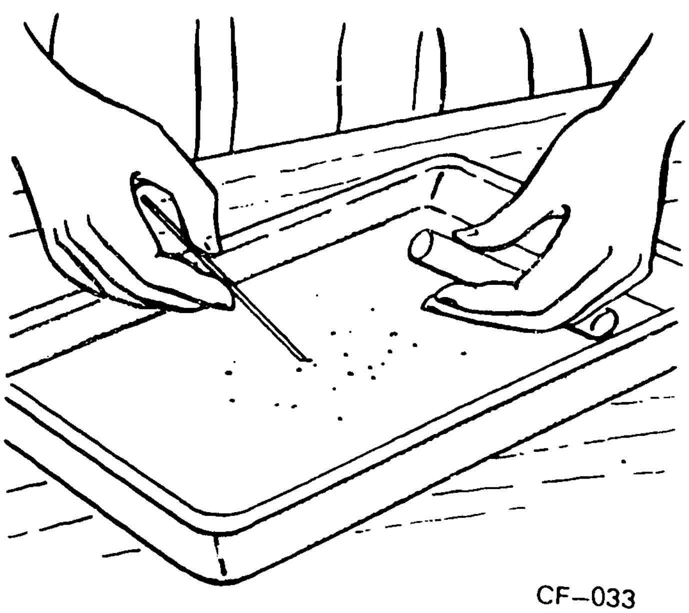

Figure 2–14. Transferring extoparasites.

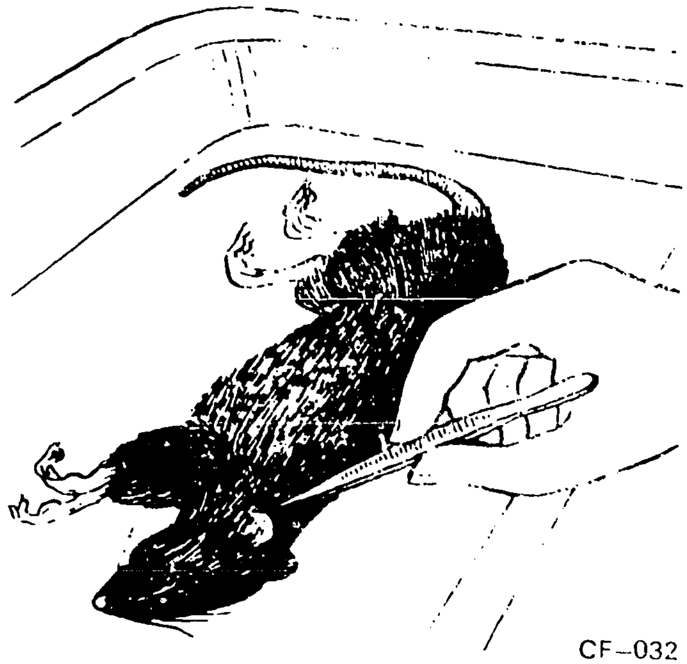

Figure 2–15. Picking ectoparasites.

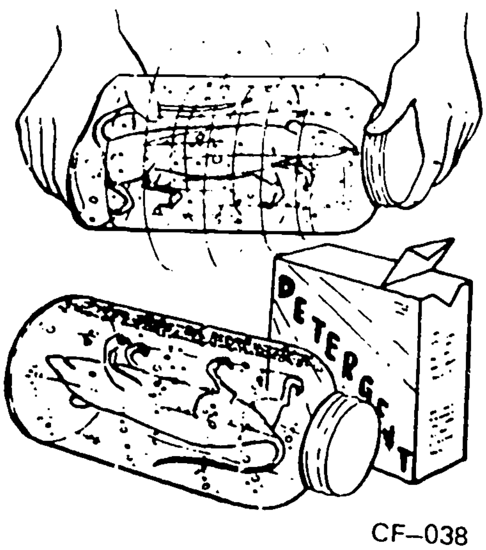

Figure 2–16. Swirling for ectoparasites.

After you have had experience in identification. you will most likely establish a preference as to the type of key most suitable for your use. There are two basic types of keys commonly used (dichotomous. or couplet. and pictorial), and each has its own merits. Identification keys work by using a process of elimination in which the number of possibilities is gradually reduced. When making identificatior you should keep in mind that a key does not positively prove anything; it only suggest possibilities.

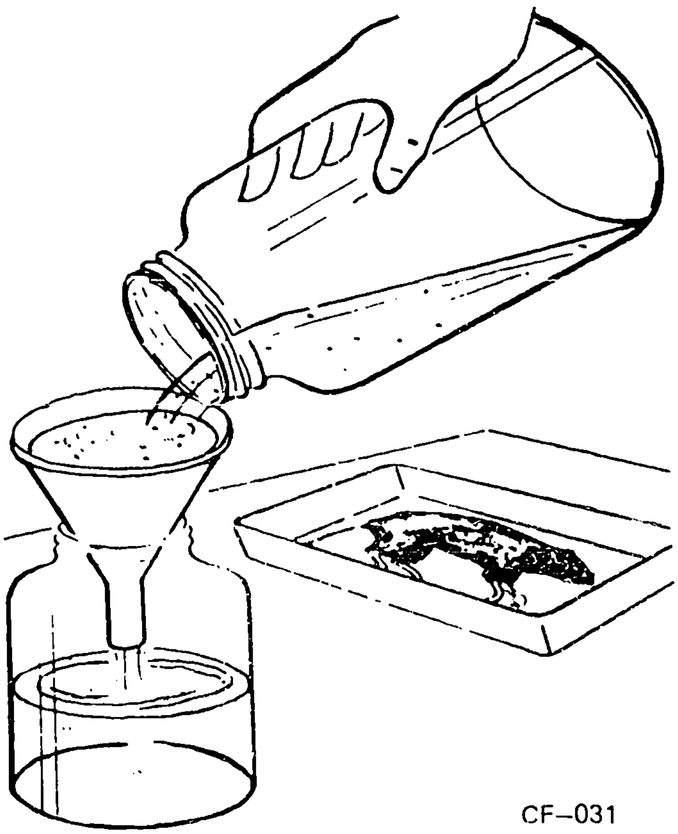

Figure 2–17. Filtering of ectoparasites.

Dichotomous or couplet keys. Dichotomous or couplet keys are so named because they provide two alternatives from which to choose. Using dichotomous or couplet keys (both are same type), you must begin with couplet 1, which will give you two choices as illustrated in example 1. In this example you must make a choice between the number and type of wings the specimen has.

Example 1: Couplet 1

1. Two pairs of membranous wings -------- 2
   Only one pair of membranous wings, the other pair being either hardened into wing cases, or absent -29

In this situation, assume that your specimen has two pairs of membranous wings, so couplet 1 tells you to proceed to couplet 2. If the second choice had been correct then you would have proceeded to couplet 29, skipping couplets 2 through 28.

To continue the identification process using dichotomous keys, another example is given using couplet 2. Observe example 2, couplet 2, and study its relation to example 1, couplet 1.

Example 2: Couplet 2

2. Forewings and hindwings alike --------- 3
   Forewings and hindwings different---------18

Continuing the case situation, assume that your specimen has forewings and hindwings alike. From information contained in example 2, couplet 2, you now know that you should proceed to couplet 3, since your specimen does not have different forewings and hindwings. This same process of elimination between two choices continues until you reach the final identification.

To recognize when identification is complete, another example is provided. Up to this point, you have identified your specimen from couplets 1 and 2 as having two pairs of membranous wings and both pairs of wings are alike. Referring to your case situation, assume that after reading couplet 3, it was determined that you must proceed to couplet 35. Finding couplet 35, illustrated in example 3, you have a different situation.

Example 3: Couplet 35

35. Abdomen with forceps ----------------Earwig
    Abdomen without forceps ------------------Beetle

Assuming that your specimen has an abdomen with foreceps, you realize that it is an earwig. Identification is now complete. However, if your specimen had an abdomen without foreceps it would have been identified as being a beetle according to the example. Naturally, there are many beetle species, so you would have to obtain identification keys that pertain to the appropriate order, which is Coleoptera.

Now that you have seen how dichotomous keys are used, take a look at another type of identification key.

Pictorial keys. These are keys that give illustrations showing specific points of interest and comparisons of various pests. This type of key is preferred by many individuals and is probably more simple to use by the less experienced person.

At the top of each pictorial key there are two or more statements with accompanying illustrations that show exactly what the statements are referring to; of course, only one of the statements will apply to the specimen being identified. A typical pictorial key is illustrated in figure 2-18; however, this key has been modified with the addition of capital letters at the top and small letters on the left side to reflect a grid situation. This modification is designed to better illustrate its use.

Before you begin to utilize the pictorial key provided in figure 2-18, read case situation 2–1. This case situation provides you background information, and it describes the specimen to be identified.

Case Situation 2–1

The specimen you are identifying has already been identified with its order, and it has been determined that the specimen is a fly. The next step is to determine the genus and specie of the fly. Your specimen has a dull thorax and a shiny abdomen as observed through the microscope.

In order to identify your fly specimen, refer to figure 2-18 and read each of the three statements provided across the top directly above each of the three files. When you have found the statement that describes your specimen, the identification of your specimen should be complete because square B-a identifies your specimen as to genus and specie.

Now, using case situation 2–2 and figure 2-18 test your skill in using the pictorial key once more.

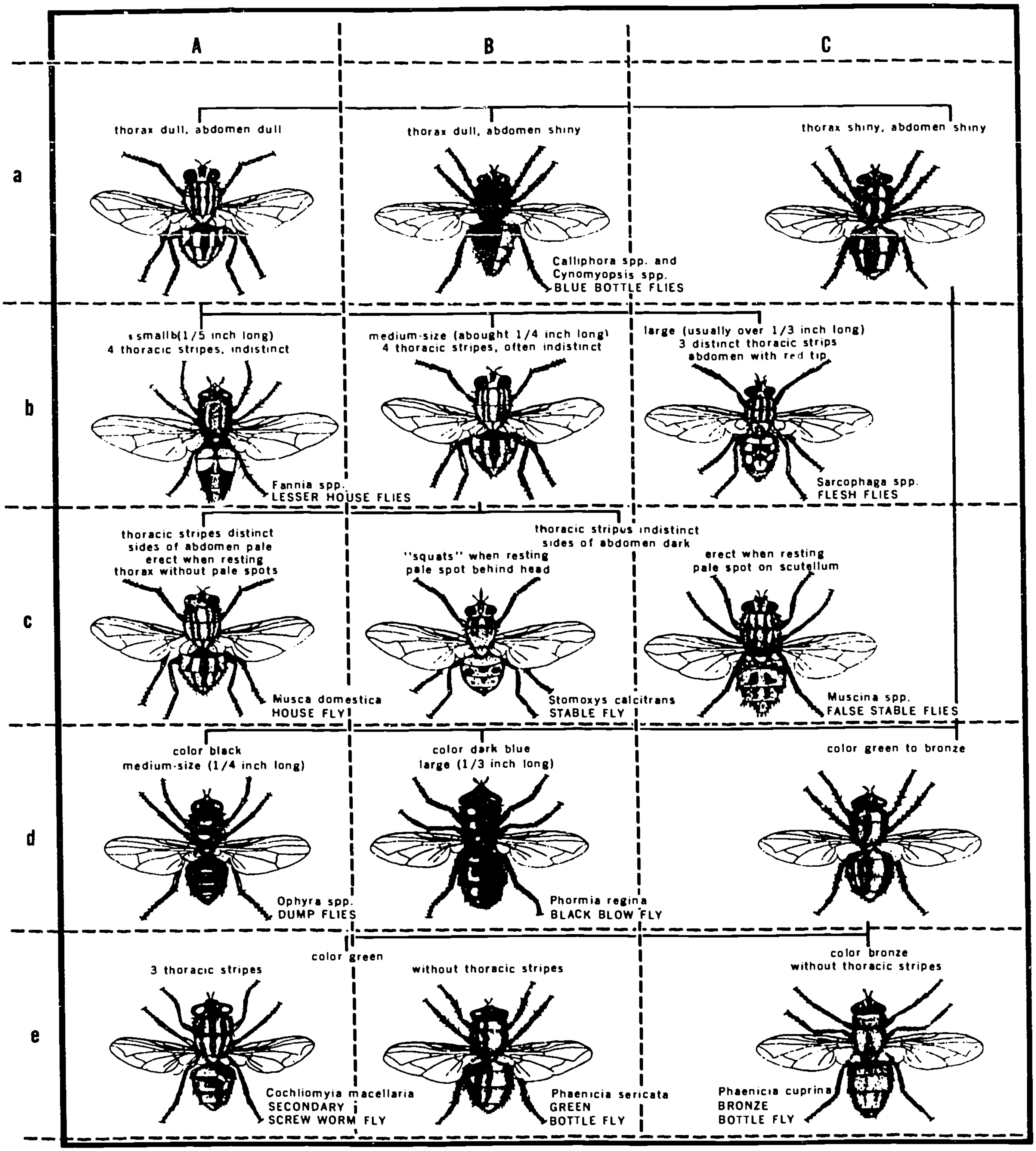

Figure 2–18. Typical pictorial key.

Case Situation 2–2

, in case situation 2–1 your specimen is a fly and, as you view through the microscope, you see that it has the following characteristics: dull thorax and dull abdomen; medium size (about one-fourth inch long) four distinct thoracic stripes; sides of abdomen pale, erect when resting, thorax without pale spots.

To identify the specimen as described in case situation 2–2 and using the pictoral key illustrated in figure 2-18, you should begin at the top. Reading across the top, the fly and statement you select should be square A-a because your specimen has a dull thorax and a dull abdomen.

Now, as you can see, there is a line extending down and across from square A-a which means identification is not complete and you have three more choices to select from.

Reading the statements and viewing the illustrations across row b you find that square B-b best matches your specimen because it is medium size (about one-fourth inch long) and has four distinct thoracic stripes. Now, you may say wait a minute; square B-b describes the specimen as having four thoracic stripes that are often indistinct, but my specimen has four distinct thoracic stripes! You are correct, but in comparing your specimen with the other two choices you will find that it matches square B-b better because it is not a small fly with four indistinct stripes and it is not a large fly with only three distinct thoracic stripes.

Again, there is a line that extends down from square B-b and across to the left and right. As you can see, there are three more choices to select from.

You should follow the same procedures as before by reading the statements and viewing the illustrations provided in row c of figure 2-18. Square A-c describes your specimen perfectly; so, identification is complete and you now know that it is a *Musca domestica* (scientific name), or housefly (common name). If you will notice, there are no lines extending down from either of the three choices in row c, so your specimen would have had to have been one of the three, or it would have indicated that you had made an error previously.

In specimen identification, people commonly make one of two mistakes, the first being overly cautious (taking every word literally), and the second is refusing to go on if the specimen does not agree with the choice made. Remember, insects and other arthropods have their individualities just as people do.

If you happen to arrive at a point where you can't decide which of the alternatives is correct, don't give up! First, consider if it is neither; for instance, if the alternatives describe wing structures and your specimen has no wings, you have probably arrived at a wrong point in the key, or else the specimen is one that is not provided for by the key. Second, if there is more than one alternative which could be considered correct, try each alternative until you have made your decision. By using this process, you can normally get back on the right track.

Dichotomous and pictorial keys of important arthropods are provided in Appendix A of this volume.

Exercises (213):

1. The two types of identification keys commonly used are __________ and __________ .

2. An identification key that provides two statements from which to choose is the ____________ key.

3. An identification key that illustrates certain identifying characteristics and provides two or more choices is a ___________ key.

4. Using Appendix A, "Arthropods of Public Health Importance: Key To Common Classes and Orders," and information contained in this lesson, identify each of the arthropods described below with its order and common name; list each step consecutively that is used in the identification process as per example.

Exercise Example: An arthropod that is described as having three pairs of walking legs, wings present and well developed, one pair of membranous wings without scales is identified to:
(1) The Order *Diptera*.
(2) With the common name of *fly*.
(3) The steps used in identification are , , , ,and .

a. An arthropod described as having three pairs of walking legs, chewing mouthparts, two pairs of well-developed wings with the front pair of wings being leathery with distinct veins and serving as covers for the second pair is identified to:
(1) The Order __________ .
(2) With the common name of ______________ .
(3) The steps used in identification are ____ , ____ , ____ , ____ , and ____ .

b. An arthropod described as having four pairs of walking legs, a well-developed abdomen that is not distinctly separated, body with very little or no hair, and hallers organ is identified to:
(1) The Order _______ .
(2) With the common name of _______ .
(3) The steps used in identification are ____ , ____ , ____ , ____ , ____ , ____ , and ____ .

214. Given problem situations regarding microscope use, identify the proper corrective action and state methods of maintaining microscopes.

Using and Maintaining a Microscope. Most arthropods cannot be identified to genus and specie without the aid of a microscope. Each pest management section should have a microscope to identify pests common to the area and to monitor possible disease vectors and economic pests collected. Microscopes are also essential in calibrating certain types of pesticide dispersal equipment and conducting on-the-job training for pest identification. However, microscopes are of no use unless you know how to use and maintain them properly, which is the basis for this objective.

Focusing. Microscope focusing methods will vary with the type of microscope used and the manufacturer. For this reason, a specific type must be identified so that focusing techniques can be discussed. The microscope discussed in this objective is one that is authorized for pest management sections and is Federally stock listed. This microscope is a binocular type with zoom focusing ability which is most suitable for viewing solid objects such as arthropod specimens. Figure 2-19 illustrates the binocular zoom-focusing microscope with identified external parts.

To focus the binocular zoom microscope follow these procedures:

(1) Place the object to be viewed on the stage plate and insert a pair of eyepieces in the eyepiece adapters.

NOTE: If you wear glasses, wear them while using the microscope.

(2) Direct light on the subject being viewed by adjusting the mirror beneath the stage plate or by using other illumination devices which are available as accessories.

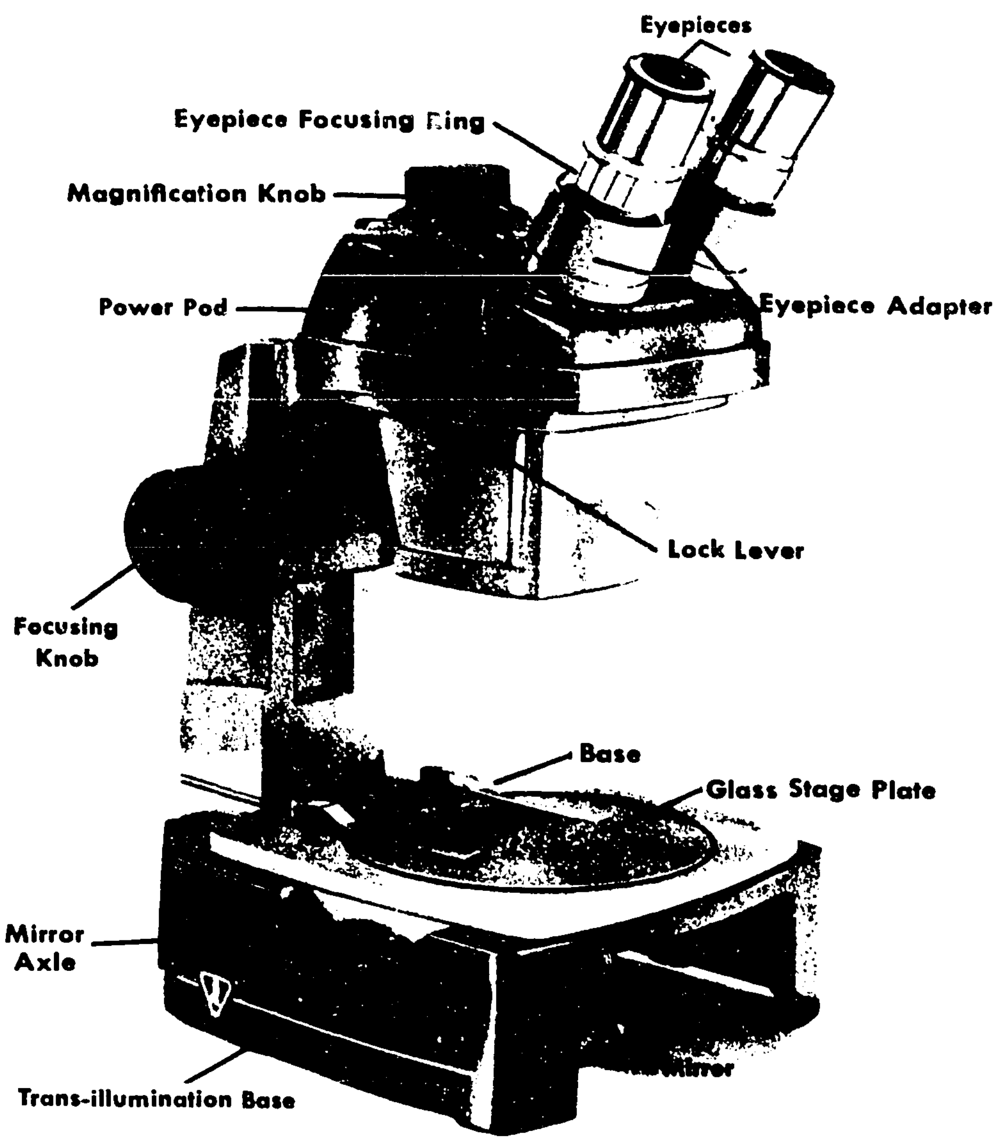

Figure 2–19. Binocular microscope (identified external parts).

(3) Adjust the eyepiece adapters to the proper width for your eyes so both fields are viewed as one. Proper width can be checked by closing one eye and then the other, with both fields being visible separately without moving the head.

(4) Set the magnification knob to the highest power.

(5) Using only the right eye and right eyepiece, focus on a flat-surfaced object that is centered on the stage and adjust the focusing knob until the image is sharp.

(6) Now, reset the magnification knob to the lowest power.

(7) Using the left eye and left eyepiece, adjust the eyepiece focusing ring clockwise or counterclockwise until the image is sharp.

NOTE: You should do this without disturbing the focusing knob.

If these microscope focusing procedures are carefully followed, the magnification may be set at any value within its range without having to refocus. When changing specimens, only slight readjustments of the focusing knob are needed to maintain sharp image focus.

NOTE: Always make sure the microscope is focused to suit the right eye first and then focused to the left eye using the eyepiece adjusting ring.

The magnification knob, located on top of the microscope, lets you change the power to give the best magnification for each specimen at lower power and to concentrate on a particular detail of the specimen by increasing the power.

Microscope maintenance. Maintaining a microscope is a simple process if you remember one basic point. *Always cover the microscope when not in use.* Since cleaning is practically all that is required in maintaining microscopes, cleaning techniques will be discussed first.

a. Clean external surfaces of eyepieces and bottom surface of the pod by flowing with a syringe, or with a moist cotton swab on a stick.

b. Keep eyepieces in place at all times to prevent dust settling on the eyepiece dust shields. If the eyepiece dust shields do require cleaning, clean them in the same manner as the external surfaces of the eyepieces.

c. Use a cotton swab moistened with a soap or detergent solution to remove body oil smears from external surfaces of eyepiece lenses or glass stage plate, and dry with a cotton swab.

d. Clean the focusing slide occasionally with a solvent such as xylol or alcohol.

e. Clean rack teeth occasionally with a small stiff brush.

f. Lubrication is required only after the focusing slide has been cleaned. Lubricate the focusing slide by applying a light coating of petroleum jelly.

g. Adjusting the tension of the focusing mechanism is the only time mechanical maintenance should be performed on the microscope unless you are an experienced microscope repairman.

A microscope is effective only if you know how to use and maintain it properly. When carrying it, always use both hands and handle it with care because it is fragile and very expensive.

Exercises (214):

1. While viewing an object through a microscope, it appears as a double vision. Identify the corrective action to be taken.

2. While viewing an object through a microscope, it appears clear and sharp, indicating good focus. You then change objects and the vision is blurred. Identify the action you have failed to take.

3. Identify the action to be taken before making microscope adjustments other than adjusting the eyepiece adapters.

4. The microscope is always focused to suit which eye first?

5. State the action required to remove grease smears from external surfaces of eyepiece lenses.

6. To remove dust from external surfaces of eyepieces you would use a detergent solution. (True/False)

215. Specify techniques, materials, and equipment needed to preserve dry specimens.

Preserving Dry Specimens. To maintain a display of pests common to the area, there are certain techniques you should learn. Pest specimen displays should be prepared in a manner that you will be very proud to display. These displays are kept in pest management to let interested people become familiar with pests common to the area, and they are often used for display in base open-house ceremonies, Boy and Girl Scout tours, student tours, and country fairs.

There are four basic methods used in displaying pest specimens and each method requires certain techniques, supplies, and equipment. Each of the four methods will be discussed individually.

Preserving specimens dry is probably the most common method of preservation and is generally the most useful for insects that have strongly chitinized exoskeletons because they can be dried naturally without offensive decay and discoloration.

Specimens preserved dry should be pinned while they are still fresh to allow easy manipulation of various appendages, thus reducing the chance of breakage. Specimens that have become dried are very hard and brittle and should never be touched other than by handling the mount.

To delay hardening, specimens can be placed in containers of ethyl acetate or laurel leaf vapors. You may find this is not always advisable because over time it may cause discoloration or a mushy effect. Other methods for keeping the specimens soft include keeping them in a tin container with green leaves or moistened blotting paper, but this may lead to the specimens' becoming molded.

If you want to dry-preserve specimens that have a large amount of body fluids, drain the fluid from the abdomen immediately after the specimen has died. The best way to do this is to cut off the abdomen at the base, lay it on a flat surface, and squeeze the fluid out by rolling a small round object from abdomen tip toward the cutoff portion. This must be done with great care to prevent damage to the abdomen section. Removing the abdomen from specimens that are bulky is not required at all times. The fluids from some specimens may be extracted simply by gently rolling a round object over the abdomen, beginning at the base and rolling toward the tip.

Cleaning the specimens is required at time, especially the bulky ones that have been drained of body fluids; however, it is best to avoid cleaning whenever possible because this may cause discoloration. Remove dust by using a small camel's-hair brush; but remember to use gentle strokes to avoid scratches and breaking. Clean specimens that are very fragile or dry and rigid by immersing them in a synthetic detergent and water solution. Specimens which become greasy from fatty material that has oozed out can be cleaned by using an organic solvent such as ethyl acetate, benzene, or ether.

Bulky and fleshy specimens you have drained must be returned to the original shape. Do this by blowing air into them, using a small pipette; or if it is a large area, it can be stuffed with cotton wool that has been moistened with ethyl acetate or phenol. After this, mend the specimen with mending cement. This will involve reattaching the inflated or stuffed abdomen if it was removed for draining.

Now that you have your specimen soft, clean, and repaired, it is ready for setting. Setting a specimen correctly is probably the most difficult and rewarding part in preparing your specimen displays. It must be set so that it is appealing to the eye and so important appendages can be easily seen. Once you have arranged it in the position you want, let it dry. Setting specimens requires the use of setting boards. These boards are designed to allow adjustment of the sides to increase or decrease the width of the groove, depending upon the thickness of the specimen abdomen. The sides of the board should be covered with a layer of cork or balsa wood to allow easy pinning. A typical setting board is illustrated in figure 2-20.

If you desire to dry-preserve specimens that are soft bodied without draining the body fluids, this can be done by preserving them in a solid state. This technique is much slower than the conventional way because each phase requires a certain amount of time; however, it is a very good technique to use for larvae. Dry preserving in the solid state is done by placing fresh larvae into a solution that contains 95 percent alcohol. The larvae must remain in this solution for at least 1 week; the larger the specimen the more time required. Following the week's (minimum) stay in the first solution, the larvae are then transferred to a pure alcohol solution and must remain in this solution for 24 hours. The larvae are then transferred to a fresh solution of pure alcohol two more times for a period of 24 hours each. After these phases have been completed, the larvae tissues should be completely dehydrated; however, preservation is not complete.

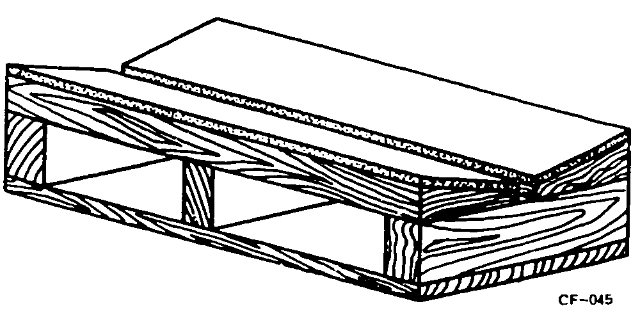

Figure 2-20. Typical setting board.

Reabsorption of moisture must be prevented. This is done by putting the larvae into a solution containing one part of xylor to 2 parts of pure alcohol for 1 day, then transferred again to a solution of 2 parts of xylol to 1 part of pure alcohol for 1 day. The larvae are then transferred to pure zylol, kept there 1 day, and removed and blotted dry. The specimens are now ready to be pinned.

Larvae that have become hardened or dry can also be dry preserved in a solid state, but they must be resoftened first. To do this, place specimens in a solution of 2 percent caustic potash or a strong solution of synthetic detergent for 2 days. Then transfer larvae successfully to solutions for at least 1 week in each solution. After this, the larvae must be treated to prevent reabsorption of moisture in the same way as previously explained for fresh larvae.

Pinning dry-preserved specimens can be done in four ways. Direct pinning is a method used for specimens that have tough cuticles or integruments and are not very small. Pins that are used for direct pinning are called continental pins and are generally long, thin, and sharp. Staging is a method that involves pinning a relatively small specimen to polyporous. The polyporous serves as the stage and is supported by "English pins." However, the pins used for attaching the specimens to the stages are "points." Points are very thin and short and may be used by inserting the pin through the specimen and into the polyporous stage or by gumming the specimen to the blunt end. Carding is a term used when specimens are gummed directly to a piece of stiff, white card,board rectangular in shape, and supported by English pins. This method is quite adequate for displaying small beetles. Pointing is the best method for mounting the very small dry-preserved specimens. Points are made from thin, white cardboard and are cut into small triangular pieces. These pieces may be pointed or blunt, depending upon the specimen being mounted and your preference. Points can even be turned up or down at the tip and the specimen gummed to the side, if you desire.

Now that you have your dry-preserved specimen pinned, it is time to discuss specimen labeling.

Specimen labeling is very important because each specimen should be labeled as to where, when, and how the collection was made, the collector's name, the scientific name of the specimen, the name of the scientist who first described the species, and the date determination of the species was made.

Labels are made from thin, white cardboard material such as index cards, and every label should be a rectangular shape and have almost the same dimensions. Each dry-preserved specimen should have two labels pinned beneath the specimen. The lower label should rest on top of the surface to which the specimen is pinned and should contain the scientific name of the specimen, the name of the scientist (or author), and the date it was first described. The second label should be spaced in the middle between the specimen and the lower label and should contain information as to where, when, and how the specimen was collected, and the name of the collector. Labeling techniques are illustrated in figure 2-21. Be as specific as possible when describing the location where the specimen was collected. It is not advisable to use initials because they

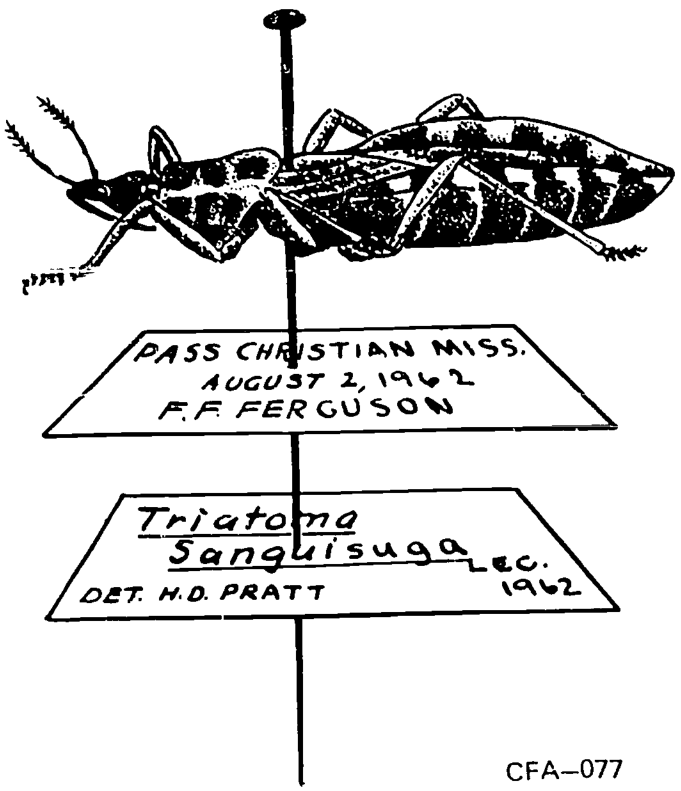

Figure 2–21. Labeling technique for dry specimen.

can lead to confusion. Print information on labels using pencil or India ink.

Storage of dry-preserved specimens is important in preventing specimen damage and enhancing displays. Specimens can be stored in almost anything from cigar boxes to specially designed specimen trays. However, specimens should be separated into specific orders, protected from pests that attack preserved specimens, and arranged for easy viewing. Storage boxes should be durable, lined with cork on the bottom for ease in pinning, and capable of holding paradichlorobenzene or napthalene to ward off pests that feed on specimens. Store your specimens in an area with low humidity when possible.

Exercises (215):

1. What is the primary purpose for collecting, preserving, and maintaining pest specimens within a pest management section?

2. The most common method used in preserving specimens for display is the ____________ method.

3. Specimens that have become hardened can be resoftened by using a solution of _____ _____ _____ or a strong stolution of _____ _____ .

4. State the best method for draining body fluids from specimens that are being preserved dry.

5. Dust can be removed from dry specimens by using a _____ _____ _____ .

6. List three organic solvents that can be used for cleaning greasy specimens.

7. List the four methods used in pinning dry specimens.

8. List the information that is provided by the lower label contained on dry specimens.

9. Dry-preserved specimens can be protected in storage from pests that attack preserved specimens by using __________ or __________ .

216. Specify the suitability, techniques and materials for preserving specimens in spirits.

Preserving Specimens in Spirits. This method is probably considered to be the best for preserving specimens that are soft bodied, such as larvae, nymphs, and some adult species. You can preserve specimens in ethyl alcohol, Pampel's fluid, and chloral hydrate. You should then sort them in small laboratory test tubes with rounded bottoms. Several small specimens of the same species that are collected at the same place and time can be stored in the same tube, but large specimens may require individual tubes for storage. Make labels for spirit-preserved specimens by cutting long, thin strips of white cardboard material. Card strips should be about 1 inch shorter than the length of the tube and should be wide enough to allow sufficient bend in the card when you place it inside the tube. You only need one strip, but it should contain the same type of information as the two labels in the dry preservation method. Print labels in pencil because ink will tend to smear when placed in spirits. Once you put specimens and labels in the spirits, seal the tube with a spirit-resistant rubber stopper. Then, store them in specially designed double-layered trays that have small round holes cut out of the top layer for inserting the tube, or store them in a glass jar to allow easy viewing. Store these specimens in a cool, dark area away from all sources of heat to prevent accidental fires and evaporation. After all, wouldn't you hate to have to tell the fire inspector that it all started when you dropped your grub collection beside the gas heater?

Exercises (216):

1. Preserving specimens in spirits is considered to be the best preserving method for __________ specimens.

2. What spirits are generally used in preserving specimens?

3. State the storage precautions that must be observed for spirit-preserved specimens.

4. Information provided on labels to be used in spirits is printed in pencil to prevent __________ .

217. Describe techniques and materials needed to preserve specimens in plastic.

Preserving Specimens in Plastic. This method of preserving specimens is a relatively new concept and is very appropriate for large, bulky specimens. When you do it properly, this preservation method makes very attractive displays, and they can be handled without damage to the specimen; however, care must be taken to avoid dropping because the block can break. There are several techniques you can use to preserve specimens in plastic, depending upon how the specimen was originally preserved. The techniques discussed here are based upon the specimen being fresh or originally dry preserved. A specimen being preserved in plastic should be presoaked in uncatalyzed resin for about 24 hours to remove air bubbles from the surface and insides of the specimen. Make sure the specimen is completely immersed (weighted down if necessary) and the container is covered. After the specimen has soaked long enough, get a glass or smooth metal container that is big enough for your specimen. After you have your mold, determine the amount of liquid ounces required to fill the container to a level just below the top. Now convert the liquid ounces into cubic centimeters because you will be working with very small amounts. Once you have converted the ounces into cubic centimeters, divide this amount by 3, because the plastic block is constructed in three equal layers. (Fluid oz $\times$ 1.8 = cubic inches. Cubic inches $\times$ 16.4 = cubic centimeters.)

Apply a mold release compound to the entire inner portion of the container to prevent the resin from sticking and to provide easy release.

Now that you have determined the cubic centimeters or resin required for the first layer and you have prepared your mold, pour the resin into a disposable container and add catalyst to the resin at a ratio of 4 drops of catalyst to 5 cubic centimeters of resin. Stir this mixture smoothly and thoroughly for about 1 minute (being very cautious not to create bubbles in the mixture), pour into the mold, and cover in a tentlike fashion to prevent dust from settling on the resin and allowing volatile fumes to evaporate. Let this mixture set for at least 2 hours, and it should set until the mixture is just to the point of being a tacky gel.

The first layer is now prepared to support the specimen. Remove with tweezers the specimen from the resin in which it has been soaking and let the excess resin drain off. Place the specimen in the center of the mold upside down and allow it to set for a couple of hours under a tent cover. This will prevent the specimen from floating when the second layer of resin is poured. Mix catalyst with enough resin to make up the second layer and slowly pour the mixture into the mold from one end. This will allow the fluid to push all air away from the specimen. Let this layer dry under a tent to the point of being tacky, and then mix and pour the third layer. Allow to dry under a tent cover for about 12 hours at room temperature and then place the mold in a "light bulb oven." The mold should cure for about 4 hours at 140° Fahrenheit. After the mold has cured for the recommended time, turn off the light bulb and let the mold stay in the oven until it returns to room temperature. The plastic-preserved specimen is now ready to be removed from the mold; however, it is not in a finished condition.

The plastic block must be ground and polished for it to be in a display condition. To grind the block, lay a sheet of coarse emery paper (180 grit) on a moistened smooth surface with the grit up. Pour a small puddle of water in the center of the paper and grind the six sides of the block, using back and forth motions in the water. After you have ground the six sides of the block using the coarse grit paper, follow the same procedure using an intermediate grit, and then use a fine grit paper. After you have completed the grinding process, place a very small amount of liquid abrasive on a felt polishing board and rub all six sides of the block in the abrasive, using back and forth motions. At this point the block should be becoming much more smooth and transparent.

Next, place a very small amount of liquid polish on another felt board and follow the same procedures that were used with the liquid abrasive. Your plastic preserved specimen is now complete and ready for display.

Exercises (217):

1. What is the purpose for presoaking specimens in uncatalyzed resin?

2. The ratio of catalyst to resin is ________ drops of catalyst to __________ cubic centimeters of resin.

3. When grinding the plastic block for finishing, what type of motion is used?

4. List the procedures for determining the cubic centimeters of resin required for each layer when measured in ounces.
   a.

   b.

   c.

218. State the suitability, techniques, and materials for preserving specimens on slides.

Preserving Specimens on Slides. The preservation of specimens on slides is an ideal method to use when very small specimens are to be viewed. This method is very difficult, and you need a lot of experience to get professional results. Although you may not be experienced at preparing slides, you can still prepare appealing slides by following these procedures.

Before you mount a specimen on a slide, you must first prepare it. The specimen must be soft to prevent breakage, and it must be cleared of internal body tissues to make it transparent. To do this, place it in a cold solution of 10 percent caustic potash in water for about 12 hours. Remove the potash solution by using an eyedropper (being careful not to lose the specimen) and replace the potash solution with plain tap water still using the eyedropper. Repeat the rinse several times to insure that all of the potash solution has been cleared from the specimen. Now, examine the specimen under a microscope to make sure all internal tissues have been completely dissolved. If the tissues have not dissolved, return the specimen to the potash solution and allow it to soak again (it may be necessary to boil the solution for about 5 minutes if the specimen is large), following the procedures previously mentioned.

After the specimen is rendered free of all internal tissues and thoroughly rinsed, it is ready to be dehydrated and cleared. Select two small dishes that have wide bottoms and pour a small amount of glacial acetic acid (dehydrating fluid) in one and a small amount of clove oil (cleaning fluid) in the other. *Keep the fluids covered tightly at all times except when it is necessary to open them for transferring the specimen.* If the specimen appears to be too dark to be transparent, it should be bleached by immersing it in a weak bleach solution along with a couple of drops of glacial acetic acid for about 5 minutes before you begin the normal dehydration and clearing process.

Now place the specimen in the glacial acetic acid. If the specimen is too transparent it can be darkened by adding a few drops of solution containing acide fuchsin and 20 percent alcohol to the glacial (acetic acid) and leaving it there for 5 minutes. Use foreceps to remove the specimen from the acetic acid and place it on blotting paper; then pick it up and place it in the clove oil. Let the specimen remain in the clove oil for 5 minutes and remove it.

Reexamine the specimen under a microscope to check for cloudy blotches. If blotches appear, this indicates that all the water has not been removed and you must return the specimen to the acetic acid and again to the clove oil. However, if there are no blotches, the specimen is now ready for mounting on the slide.

Place the specimen on the slide and arrange it in the way you want to display it. Blot the excess clove oil off the specimen and slide with a piece of blotting paper and then drop a very small amount of Canada balsam on the specimen; add a drop or two of zylol and let it dissolve naturally. After you've applied the balsam to the specimen, cover them both immediately with a cover slip that's large enough for the specimen. Place the cover slip on the slide one side at a time; be very gentle. Don't drop the cover slip on the specimen because you'll trap air bubbles.

Once the specimen is mounted on the slide, handle it with care and keep it in a horizontal position for several weeks. It takes this long for the balsam to dry. Before you put it away to dry, prepare two labels with the required information previously discussed and place one label on each end of the slide as illustrated in figure 2-22.

Exercises (218):

1. To soften a specimen being prepared for mounting on a slide, the specimen is placed in a cold solution of __________ __________ __________ for a period of __________ .

2. A weak bleach solution is used to ________ specimens that are to be mounted on slides.

3. What fluid is used for cleaning internal tissues of specimens being mounted on slides?

4. To darken a specimen that is to be mounted on a slide, a few drops of solution containing ________ __________ and 20 percent alcohol are added to the glacial.

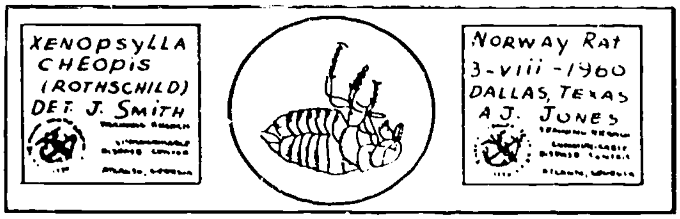

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Figure 2-22. Labeling technique for slide-mounted specimen.

5. Upon reexamining a specimen under a microscope, the appearance of blotches indicates that all the __________ has not been removed.

6. Glacial acetic acid is used to __________ specimens for slide mounting.

7. To dissolve the internal tissues of specimens to be mounted on slides, a solution containing 10 percent __________ __________ is used.

2-3. Integrated Pest Management

For many centuries, human settlements—both agricultural and urban—have had to contend with many unwanted or harmful insects, weeds, microorganisms, rodents, and other organisms—collectively, "pests." In the past, the only tools people could use to control these pests were plowing, planting, burning, and watering schedules and primitive repellants such as smoke. Toward the turn of the century, the first pesticides, such as sulfur and arsenic compounds, came into use. In the last 40 years, chemical pesticide use became the primary method people used to control these pests; as a result, pesticide production increased from less than 500,000 pounds in 1951 to about 1.4 *billion* pounds in 1977.

In the late 1960's, there was a rising public concern over pesticide buildups in the environment, with resulting adverse impacts on fish, wildlife, and people. Largely as a result of this concern, there was an increased national and international interest in integrated pest management (IPM) as an economically efficient, environmentally preferable approach to pest control.

This renewed interest focused mainly on the agricultural aspects of IPM, but there were other important uses of this approach, such as IPM for disease vectors. Today, new techniques of IPM continue to develop, so now we have many new ways to control a wide variety of pests in all types of situations.

219. Define the categories of integrated pest management (IPM) and specify to which category specific techniques belong.

Categories and Techniques of IPM. Have you ever been diagnosed as having a bad cold? Chances are the doctor told you to go to bed, drink lots of juices and other liquids, and take medicine to reduce your symptoms. If you think of that cold as a "pest," you can see that the doctor employed integrated pest management to help you get rid to it; by going to bed, you conserved energy your body needed to fight the virus, drinking lots of fluids increased your resistance and prevented dehydration, and the medicine was a type of chemical control.

Integrated Pest Management is defined as a combination of control techniques designed to prevent, eliminate, or suppress pests. Its objective is to reduce our dependence on pesticide and keep their use to a minimum. We will discuss five different categories of IPM. These are:

- Cultural controls.
- Mechanical/physical controls.
- Biological controls.
- Autocidal controls.
- Chemical controls.

Cultural controls. We can define *cultural control* as the deliberate manipulation of the environment to reduce a pest's access to food, water, and shelter or making it more favorable to natural enemies. The key word here is sanitation and it's the most important aspect of your program. When high levels of sanitation are applied, elements essential to the pest's survival are eliminated or substantially reduced. This will have one of three effects on that pest: it will die, it will have to go elsewhere to get its life requirements, or its life will have more stress, so it has to take more risks in order to meet its needs; as a result, it may be exposed to other elements in your integrated program. Cultural controls are often all that's needed in a preventive control program, because the number of attractions are kept at a minimum. In a corrective control program, however, you can't generally expect 100 percent elimination since the pests are already established in the area.

Cultural controls can be applied in an area as small as a one-room building or as large as an airfield. Techniques include:

- Basic good housekeeping to control cockroaches, mice, rats, silverfish, and other household pests.
- Storing food in insect-proof containers at home or in food warehouses.
- Improving water drainage in areas where mosquitoes are breeding.
- Promoting healthier grass growth where hazardous or pest birds feed on weed seeds.
- Promoting healthier grass growth just to get rid of the weeds.

Mechanical/physical controls. These are direct or indirect nonchemical measures used to destroy pests outright or to make the environment unsuitable for their entry, dispersal, survival, or reproduction. Like cultural controls, they exploit weak links in the pest's life cycle or specific behavioral patterns. These controls are mostly corrective in nature because you're using equipment that makes a direct physical impact on the pest involved. Because of this equipment, and the time spent maintaining it, mechanical/physical controls are often more expensive than other categories of IPM. Examples of mechanical/physical controls are:

- Rattraps and mousetraps (snap, cage, or sticky traps).
- Sealing off cracks and crevices where cockroaches may harbor.
- Removing and destroying wasp nests from building eaves.
- Applying polyethylene over areas where no vegetation is wanted.
- Using screens to keep adult mosquitoes out of buildings.
- Controlling moisture under buildings to prevent the growth of wood-destroying fungi.

Biological controls. Biological controls are those that involve the regulation of pest organisms by their natural enemies. With insects, for example, there is a growing number of parasites, pathogens, and predators we can use to control a given pest population. When these actions occur in nature with no human assistance, it's called *natural control*, but there are differences. People can use native species to control a pest population; this is basically how it happens in nature. But people can also introduce new "control" species from other parts of the world, an action which isn't likely to happen naturally. We can also introduce much higher numbers of the control species than what would normally be produced in nature.

In recent years, biological controls have improved to the extent that they can be easily used, are highly effective, and environmentally safe because the control organisms are very "species-specific." This means they attack only the organism for which control is needed without impacting desirable animals or vegetation. Examples of biological controls are:

- Using predatory fish, such as *Gambusia affinis*, to feed on mosquito larvae.
- Using falcons or other predatory birds to scare smaller birds away from airfields.
- Releasing flea beetles to feed on alligatorweed, which clogs waterways in the southern U.S.

Autocidal controls. Autocidal control involves rearing and releasing insects that are sterile or are altered genetically in order to suppress members of their own species that are causing pest problems. Two similar methods are being used and developed: the sterile-male method and genetic control.

Sterile-male method. The sterile-male method involves artificially sterilizing large numbers of insects by irradiation or chemical sterilants so that after being released into an area inhabited by a wild population, the sterile males mate with wild females. If the wild population is flooded with large numbers of sterile males and they outcompete the wild fertile males, the wild females produce substantially fewer offspring than they normally would. Repeating this procedure for several consecutive generations may eventually annihilate the wild population. This is one of the most ingenious pest control methods yet developed; it has been widely publicized, primarily because of its successful application against the screwworm fly.

Application of the sterile-male method necessitates procedures for economically rearing and liberating large numbers. To be effective, the released insects must readily mate with the wild members and disperse throughout the area inhabited by the wild target population.

The possibility that the sterile-male method can literally eradicate an entire pest population from an area, thus providing a permanent solution to the particular pest population under consideration, has attracted a great deal of interest. However, the high cost and difficulties with rearing, sterilizing, and liberating the sterile insects are currently prohibitive except against a few insect pests.

Genetic controls. Like the sterile-male method, genetic control involves release of reared insects for mating with wild populations. However, whereas sterile males produce inactive or inviable sperm, genetic control involves genetically altered insects whose sperm is active, carrying genes that make the wild populations less vigorous, less prolific, or genetically sterile as a consequence of hybridism. At this time, genetic control has no practical application in urban control programs.

Chemical controls. It's easy for us to think of chemical control as using pesticides to kill pests. This, of course, is largely true, but now we have chemical weapons which serve to trap insects, confuse them, repel them, and regulate their growth.

Pheromones. Pheromones are chemical substances insects secrete as part of their communication process. Each insect has a complete repertoire of these chemical signals. Pheromones cue mating, aggression, mass attack, fear, and serve as territorial boundary markers for the insect world.

The female insect secretes very small amounts of sex-attractant pheromone during her mating periods. Male insects up to a mile away can detect this scent and travel to her. These species-specific scents are now being isolated and commercially developed for many of our more economical pests.

There are three main ways we can use pheromones to control insect populations. The first way is to monitor insect activity in food warehouses. Extremely small amounts are placed on a sticky board, attracting the male which then becomes permanently stuck. When pest populations increase to a certain point, we can take necessary control actions.

The second way is to use pheromones in mass traps with much larger amounts of the attractant. This way, tremendous numbers of insects are caught and die, reducing the population to a less harmful level.

The third way we can use pheromones is by what's called the confusion method. Here, small amounts of pheromone are scattered around a warehouse (or forest, depending on your needs) to confuse the male insect so he cannot find a female. As a result, successful mating is highly unlikely and birth control of the given insect population is achieved.

Repellents. Repellents are chemicals used to prevent damage to plants, animals, ourselves, and materials such as fabrics and lumber to render them unattractive, unpalatable, or offensive to pests. These chemicals include a wide range of natural and synthetic materials for personal, household, industrial, and other uses.

Some repellents are effective against bloodsucking and nuisance pests like mosquitoes, ticks, chiggers, and gnats. Skin repellents were used in the South Pacific during World War II as a chief component in the military's antimalaria program.

Insect-susceptible packaging materials for some food products are treated on the outer surface to prevent insect penetration. Repellents are also frequently used on kraft paper multiwall bags; they will give protection against insect attack for up to 1 year.

Growth regulators. Chemical growth regulators, used extensively against weeds, are now being developed for insect control.

Many organic herbicides act as plant regulators or synthetic hormones. These are generally used at concentrations that inhibit weed growth but have little or no effect on the crop plant, thus performing as selective herbicides.

A major problem in weed management is the extreme persistence of most weed species resulting from the longevity of propagules (seeds, dormant buds, or other dormant plant parts). Some seeds may survive in a dormant condition for 80 years. Dormancy, germination, and other related plant functions are controlled by hormones. Germination inhibitors to prevent propagule development could provide very effective weed control. Conversely, a germination stimulant to break dormancy in all propagules could be used for weed control during the noncropping season. In either case, a significant link in the life cycle of weeds could be broken to provide a new approach to weed management.

Growth and development in insects are regulated by two types of hormones,: juvenile hormones which maintain immature status, and ecdysones, which regulate molting; a number of both types have been identified for insects and also for plants. Synthetic hormones have been evaluated for use against insect pests. Methoprene has been approved by EPA for control of mosquitoes, fleas, and other insect pests.

Unlike insecticides, hormone chemicals are not conventional toxicants; rather, they interrupt normal processes associated with growth. As a result, their impact on the environment is extremely small, if at all.

As the name implies, IPM involves a mixture of control techniques from different categories so pest management programs will have the desired impact on the pest population. Before you begin a management program, work to ''integrate'' a variety of techniques and principles to get both maximum results and environmental protection. As a result, your programs will have greater sophistication and potency than ever before.

Exercises (219):

1. Define each of the following IPM categories:

   a. Cultural control:

   b. Mechanical/physical control:

   c. Biological control:

   d. Autocidal control:

   e. Chemical control:

2. For each of the following techniques of pest management, indicate the category to which it applies:

   a. Repairing holes in walls where rodents can enter a building.

   b. Applying a residual dust to cracks and crevices for cockroach control.

   c. Removing old lumber from under a building to eliminate a food source for termites.

   d. Pruning trees to reduce bird perching and nesting opportunities.

   e. Putting a cat in a warehouse to kill rats.

   f. Spraying a sex attractant material to forest areas to reduce moth breeding.

   g. Placing traps in rodent burrows.

   h. Releasing thousands of sterile-male fruit flies to reduce future populations.

   i. Releasing parasitic wasps to prey on defoliating caterpillars.

j. Installing net curtains to keep birds out of hangers.

220. Specify sources of information available in determining pest management program requirements and describe the uses for each source.

Determining Pest Management Requirements. One often-used method for determining pest management needs is an after-the-fact situation. This is nothing more than starting a management program after the pests have become established. Clearly, this is *not* the best approach. Pest management requirements can most often be determined long before the pests become established. Being capable of predicting a problem and establishing preventive measures to ward off the problem is the sign of a professional pest manager. This objective describes the methods used in predicting pest problems.

Local data and records. There are many sources available, on and off base, that will give you enough information to make reliable predictions as to the type of pests that may cause problems, areas that may require special attention, and the time of year that problems will most likely exist.

The U.S. Air Force meteorological office and the National Weather Service. These are sources of information on rainfall, temperatures, wind speed, and wind directions.

These agencies can give you data that depicts the average rainfall and temperature for each month of the year based upon many years of recordkeeping. This data alone will give you a good idea as to the types of pests most likely to be prevalent within the area and when the problems will most likely occur. These agencies can also give you information about the average wind direction and speed during certain times of the year. You can use this information to recognize when pests may be blown in from areas surrounding the base, where they're known to be or suspected of being prevalent, and which direction to travel when space spraying for mosquitoes.

Now, you may be asking yourself, how am I to know what pests are prevalent off base? This question may be answered by the following.

County extension office. The county extension office maintains and distributes pamphlets and bulletins concerning agricultural and other pests in the area. It also has experts who can tell you about pest population trends and movement patterns.

County health office. The county health office is normally responsible for managing health-related pests and can give you information about medically important pests in the area. This office can also give you information as to the terrain conditions in areas near your base where disease vectors may be breeding.

Pest management program review. Of course, there are several good sources of information within your organization you can use to determine pest management requirements, such as past pest management program reviews. We'll discuss their completion later in this chapter, but their uses include:

- Identifying specific pest management projects for the following year.
- Identifying why a program is required.
- Indicating when, where, and how the work will be done.

You can also use past copies of this report to give you support when you make predictions regarding future pest problems.

Pest summary report. Use DD Form 1532, Pest Management Report, to get facts on pests that have been controlled most often in the past, and how much time and material was used in the process.

Pest management maintenance record. DD Form 1532(en1, Pest Management Maintenance Record, can be used similarly to the pest summary report, but it applies to individual areas and buildings instead of the entire installation.

Basic survey. Last, but certainly not least, is the basic survey you learned about in objective 211. Review that lesson before you complete the following exercises.

Exercises (220):

1. You've been on base for 2 months and must prepare your mosquito control plan for the coming year. What are five information sources you can use to determine program requirements?

   (1)

   (2)

   (3)

   (4)

   (5)

2. What types of information would you expect to get from each of the following for your mosquito control program?

   a. National Weather Service.

   b. County extension office.

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c. County health office.

d. Past pest management program review.

e. Basic survey.

221. Match the process of selecting pest management procedures with the factors to be considered in each process.

Basis for Selecting IPM Procedures. Selecting pest management procedures is not an easy task and you certainly can't do it without considering many aspects. We will thoroughly discuss and analyze these aspects in this objective.

Pest to be controlled. The first step you must take in each situation is to identify the pest. In most cases pests must be identified to species because many pests within the same genera have different habitats and habits, thus requiring different control techniques.

After you've identified the pest, consider another point: is the pest more detrimental than beneficial? This question may raise another question: how can a pest be beneficial? To help you in understanding this let's define the word pest. A pest can be any undesirable plant or animal. This depends largely on the animal's location. A plant or animal can also be very beneficial, but in a particular place and at a particular time, the same beneficial plant or animal can be a pest.

If the pest is more beneficial than detrimental, then try to use management techniques other than killing as much as possible.

Location of pests. After you have identified the pests, you must consider the pests' location. The location of the problem is very important because this determines the urgency, materials, equipment, and personnel required for managing the pests.

An example of this would be honeybees in the wheel well of an alert aircraft. In this situation, the bees must be removed quickly with pesticides. However, if the same honeybees had located in an abandoned automobile they could have been removed by gathering the queen bee and transporting her to another area, causing the others to follow.

If the pests are located on vegetation you must use control measures that won't be detrimental to the vegetation. Oil solutions must certainly be avoided in this instance.

Managing pests that are located in aquatic areas is still another problem you must handle with great care, especially if this aquatic area happens to be a stream, pond, or lake. During the planning stage for developing pest management programs related to all aquatic pests make sure you know Federal and State laws governing environmental protection. There are certain aquatic pest management procedures you can't use; for instance, some states will not allow chemical treatment of aquatic areas in controlling aquatic breeding pests and aquatic vegetation. With this in mind, you must know other control measures you may use to deal with the problem.

NOTE: Types of controls and control measures will be discussed separately within this section.

Take a look at another situation where pest location determines the management procedure even when dealing with the same pest species. To manage German cockroaches in a base dining facility, you can only apply pesticides to cracks and crevices, but if these same cockroaches were located in a billeting facility you could apply a pesticide residual to baseboards, walls, and ceilings.

Taking this example a little further, assume that these same cockroaches are located in an electrical panel box in a base billeting facility. In this situation, base policy requires two people for the job when entering billeting facilities. In addition, it would require a pesticidal dust formulation to reduce fire and electrical hazards.

Here is another example that will illustrate the importance of the pests' locations that involves a different type of pest. A base facility is heavily infested with dry-wood termites and if not treated very soon, the damage will spread to such a degree that the facility will be unsafe. Knowing this you must treat it at once. Having knowledge of dry-wood termites, you also know that they must be managed by performing fumigation operations which require a fumigant, specialized equipment and materials, and at least two people. In this example, you have seen the job was urgent to preclude further damage and spread of infestation, and you also noticed that it dictated the materials, equipment, and personnel required to perform the operations.

Environmental conditions. Environmental conditions play a major role when you choose pest management procedures. In some situations, winds predict the time, place, and type of control you use. Generally, outdoor spraying operations will not be performed when wind speeds of over 8 mph create drift hazards. You should never do outdoor ultralow-volume dispersal operations if wind speeds exceed 8 mph because chemicals would be blown away, wasting materials, time, and effort and increasing environmental hazards.

Moderate winds can be quite helpful when you treat areas such as ponds and tall trees that you otherwise can't treat with normal pesticide dispersal equipment.

Rain can wash away residual sprays you've applied to trees, shrubs, and grasses and make reaccomplishment necessary. In view of this, residual spraying operations outdoors should not be done if you suspect rainfall. Rains will sometimes necessitate your redoing mosquito larvicide operations in some cases. In other cases the rain may act as a natural control by causing an overflow of water holding areas that contain mosquito larvae, thus eliminating the need for applied controls.

Rains can also bring problems with pests you don't normally encounter during dry weather. During continuous rainy conditions there seems to be an overabundance of mosquitoes, snails and slugs, flies, cockroaches, earwigs, crickets, and rats and mice, along with many other pests causing unusual concern to building occupants during rainy periods. At the same time, fungi causes great concern because they thrive on moisture.

Considering environmental conditions as a basis for selecting pest management procedures involves much more than just the wind and rain. You must consider all aspects of the environment. The terrain and presence of all beneficial plants and animals must be considered at all times to prevent contamination of water sources and damage to nontarget organisms.

Need for permanent or temporary controls. You must give consideration to the long-range plans for your installation when you decide whether permanent or temporary controls will be emphasized. If there are long-range plans for the base or installation to be in existence, permanent controls should be emphasized.

Initially, permanent controls may be more expensive than temporary controls but most often will be less expensive in terms of repeated use of materials, equipment, and work-hours spent on temporary controls. Permanent control measures can often be coordinated with other base activities. For instance, if an area is being excavated, arrangements can be made to use the earth to fill mosquito breeding areas as long as it doesn't violate environmental protection policies within the area.

Temporary controls must be considered on the basis of merit. These controls offer no long-term benefits, but they are normally less expensive at first. Temporary controls are required in situations such as reacting to emergency pest problems and operating on an austere budget. When temporary controls are used understand that they only offer immediate relief, and you should be thinking of permanent controls that would prevent reoccurrences of the same problem.

When selecting permanent or temporary pest management procedures, consider the following elements:

- Urgency of the problem.
- Environmental protection laws.
- Available resources such as personnel, time, materials, and equipment.

Although permanent control programs are generally difficult to sell to higher management, they are the best and least expensive in the long range. Stress this, but keep in mind, selling this program to the higher levels of management requires strong justification and is entirely dependent upon your ability to present all the facts.

Available resources. Your selection of pest management procedures is partially based upon the resources available to you. Some pest management programs you would like to start may be impossible if you can't get the right equipment or materials. Other barriers that might be in your way are a shortage of personnel and funds.

When confronted with these problems, it is your responsibility to get the resources you need to select and develop an alternative pest management program that will be safe and effective.

Safety and effectiveness. The safety and effectiveness of pest management procedures are the two most important aspects you must consider, and all phases of pest management planning must be based upon them.

Safety is the first and most important aspect to consider. If you think a program can't be done safely, then it should be abolished and an alternative method used, even though it may be less effective.

There are many programs you can use effectively to manage pests, but when selecting a program that is safe and still effective, it may reduce your choices considerably.

Exercises (221):

1. Match the factors to be considered by placing the appropriate letter or letters in Column B beside the applicable numbered statement in Column A. More than one factor may be considered for each statement.

Column A	*Column B*
____ (1) Pests to be controlled.	a. Beneficial or detrimental aspects of pests.
____ (2) Location of pests.	b. Availability of funds.
____ (3) Environmental conditions.	c. Tpopography of the area.
____ (4) Permanent or temporary controls.	d. All phases of the program.
____ (5) Available resources.	e. Material and equipment requirements.
____ (6) Safety and effectiveness.	f. Wind speed and direction.
	g. Types of pests causing the problem.
	h. Personnel requirements.
	i. Other plants and animals in the area.
	j. Future base plans.

222. Specify which organizations you should coordinate with when completing certain IPM activities.

Pest Management Coordination. One of the basic facts about IPM is that no one person or section is responsible for conducting all phases of a pest management program--you can't possibly carry out *all* of the steps involved on your own even in the simplest programs. Because of this, not only must you maintain close coordination with other civil engineer (CE) shops and activities, you must also communicate effectively with other organizations and building occupants to get control of household and other pests. And don't forget off-base activities; keep in mind the material you learned in lesson 220 when you're planning or conducting your programs, and use it when you need.

The quantity and quality of support by various activities will be greatly dependent on your knowledge of their responsibilities and capabilities, and also your ability to be tactful and efficient. Now let's look at what these activities are and how they can help you.

Base and command activities and responsibilities. There are many activities within your own organization that can render immense support, upon approval, in pest management from the very beginning (planning stage) to the end (pests being managed).

The *financial management section* becomes involved in every pest management program; this involvement depends on the scope of each pest management program. If pest management can be accomplished with a service call, this section may only need to record the expenditures, location, and type of treatment performed; however, if it requires work order accomplishment, then they become much more involved. With your help, financial management section must then develop a program to identify the location and urgency of the job, type of work to be performed, materials and equipment required, other sections to be involved, and sequence of events. Based upon this information, they estimate the total cost of your program, get the materials and equipment you need, schedule the sequence of events, and monitor all phases of the program.

The sections within your own career ladder that can offer support are the *refuse collection and disposal* and *environmental support sections*. The refuse collection and disposal section can make your job much easier by exercising proper techniques in collecting and disposing of base refuse. This way breeding matter, food sources, and harborages for pests are eliminated, thereby reducing conditions which promote pest infestations.

The environmental support section can often help you in maintaining pumps on pesticide dispersal equipment. In doing this, maintenance expenses are reduced and your efficiency is increased. While on the subject of equipment maintenance, take a look at the other sections within your own organization that can offer assistance.

Power Production can be very instrumental in performing maintenance on many four-cylinder engines on some equipment items; whereas Pavements and Grounds can help maintain two-cylinder engines. Protective coating can help recondition your equipment by removing corrosion and deteriorated paint and applying new paint. Metal fabrication can straighten and repair most metals associated with powered pesticide dispersal equipment and fabricating certain metal items used for equipment modifications. In addition, this section can fabricate bait stations and shields to be used in pest proofing base facilities.

The carpentry and masonry sections within CE play a very important role in many pest management programs. They are responsible for removing portions of structures when necessary to help you get to the source of pest problems; then, they will replace or repair portions removed or damaged. These sections can also help pest proof base facilities by repairing or replacing doors, windows, and screens and by filling in or covering up cracks and crevices in walls and ceilings and around pipes that enter the building.

The plumbing and heat systems sections are important in identifying the location of water, steam, and fire-extinguishing lines in all areas of the base. This often becomes necessary when you're treating for subterranean termites.

The interior electric section is an invaluable source for [illegible]ng information about the location of electrical wiring [illegible] panel boxes. Many pest management situations require electrical power to facilities be shut off before you can [illegible] your work. When fogging or aerosoling indoors, electrical power must be shut off to reduce explosion and fire hazards.

The equipment section, along with pavements and grounds, becomes involved when pest management programs include excavating or filling to eliminate mosquito breeding areas and to give an appropriate grade allowing water to drain away from buildings to resolve conditions that would be conducive to decay, fungi, and termites.

As you have seen, almost all sections within your own organization have a hand in pest management every now and then to make your job easier and more professional; but there are even more helpful activities on base.

Environmental health personnel are responsible for conducting surveys for health-related pests on base and for making recommendations as to the management programs to be implemented against medically related pests. They also monitor the types of pesticides used on base and the management techniques employed. This section monitors industrial-related health hazards and performs physicals on individuals who work in areas that have been identified as hazardous or in food-serving facilities.

As a pest manager, you must have occupational physicals performed periodically by these individuals to test your hearing and to determine the levels of toxic chemicals within your body.

The base veterinary section insures that base facilities are kept clean at all times, especially base dining and food service facilities. Through the combined efforts of you and the base veterinarian, many pests can be managed effectively and safely by identifying unsanitary conditions and taking actions to correct them. The base veterinary services also helps detect stored-product pests and identify diseases transmitted by dogs, cats, skunks, and other animals on base.

The ground safety office can help you get safety items to help protect you during pest management operations. This office also performs periodic inspections to detect unsafe working practices and conditions. If your shop is not adequate for storing and mixing pesticides or if it is not properly lighted, the ground safety office is the place to go if you can't get support within your own organization.

The Traffic Management Branch becomes involved when you must clear railcars fumigated with Phostoxin. The freight section must notify you upon the arrival of a fumigated railcar, and they must conduct the actual removal of the securing seal.

Other branches such as Traffic Management and Vehicle Maintenance can support you in obtaining additional transportation when you need it. They will maintain the vehicle assigned to your section, with the exception of performing operator maintenance, which is your responsibility.

Of course, there are many more activities on base that you will need to coordinate with from time to time such as the base information office and field maintenance organization; but, the ones that have been discussed are the activities you will coordinate with most often.

Coordinating with major commands is generally restricted to problems that cannot be accomplished at base level concerning pest management and to certification/recertification of pest managers. If you have questions concerning any pest management situation that you feel has not been answered adequately from sources on base, then you should request assistance from the command pest management professional or representative of that function using the proper chain of command.

Coordination with the major command is required anytime you think that pesticides must be applied by aircraft. There are many pest management programs and pesticides that must be approved at major command level prior to their use. Be sure that the programs you plan are safe and approved before you implement them.

The U.S. Public Health Service has funds that are available for controlling malaria, typhus, and other diseases that appear on private property adjacent to Air Force bases. If these disease-carrying pests constitute a menace to the health of Air Force personnel, the base commander may request, through proper Air Force command, that the Public Health Service make a survey of the surrounding area. If the survey shows the existence of a dangerous condition, the agency will perform the work at its own expense.

Many of the management procedures now used to combat pests have been developed by the Bureau of Entomology and Plant Quarantine of the U.S. Department of Agriculture. Personnel from this department may assist the civil engineer in the control of termites, Japanese beetles, grasshoppers, etc. However, the request for assistance must be sent directly to the Department of Agriculture.

The Fish and Wildlife Service of the U.S. Department of Interior may give, upon request, technical aid in controlling rats, mice, ground squirrels, other rodent pests, and coyotes.

State, county, and city control agencies are very important to the Air Force, because they carry on active mosquito control operations and cooperate in keeping down the occurrence of rats, flies, and other pests off base. On the other hand, it is the responsibility of the base civil engineer to eliminate base conditions which may adversely affect the surrounding community. Close cooperation, both on and off base, is essential if effective results are to be obtained in the war against pests.

Exercises (222):

1. Match the activity or activities in column B with the problem situation in column A by placing the appropriate letter of letters beside the applicable number.

Column A	Column B
____ (1) A pump on the powered dispersal equipment needs repairing.	a. Base Information Office.
____ (2) The location of panel boxes and wiring needs to be identified inside a facility before you perform pest management operations.	b. Environmental Health.
____ (3) An additional vehicle is required to accomplish a specific type of pest management operation.	c. Environmental Support.
____ (4) A pest problem exists on base and the only way it can be brought under control is by aerial dispersal of pesticides.	d. Ground Safety.
____ (5) Assistance is required from sources off base to control Japanese beetles.	e. Interior Electric.
____ (6) Assistance is required in overhauling a four-cylinder engine on a mist-dust blower.	f. Major Command.
____ (7) Surveys are needed to determine the presence of medically important pests.	g. Power Production.
____ (8) Additional information is needed concerning the safety aspect of a particular pest management program.	h. Traffic Management.
____ (9) A basewide pest management program is to be started, and all base personnel must be advised as to when the program will be conducted and the actions they must take.	i. U.S. Dept of Agriculture.
____ (10) Technical assistance is required for controlling coyotes that have become established on base.	j. U.S. Department of the Interior.
____ (11) Support is needed in demanding that unsanitary conditions indoors be corrected.	k. Base Veterinary Services.
	l. Exterior Electric.
	m. Protective Coating.
	n. U.S. Public Health Services.

2-4. Methods of Applied Pest Management

Now that you understand the principles and background of IPM, we need to carry our classification process one step further and study the various methods involved in just one IPM category—chemical controls. We'll begin by reviewing basic pesticide dispersal methods and then explore various chemical treatment methods for arthropods and vegetation.

223. Specify the best pesticide dispersal method for given situations.

Pesticide Dispersal Methods. Although we have several basic methods for dispersing pesticides, one method is usually better for a specific control situation than any other. Your ability to select the best method requires a thorough understanding of the basic principles involved. The basic principles of chemical control methods most commonly used are described below.

Fumigating. Fumigation involves using gaseous poisons (fumigants) to kill plant and animal pests. The lethal (deadly) activity of fumigants depends on their being drawn into the body through the respiratory system. Because of their extremely small particle size you must use fumigants in airtight or nearly airtight spaces. This is necessary to prevent dissipation before an adequate exposure period elapses.

Fumigation includes using vacuum chambers at major supply depots, calcium cyanide for fumigating rodent burrows, paradichlorobenzene (PDB) or naphthalene for protecting clothing, and the limited use of methyl bromide in atmospheric fumigation bags and chambers.

Hydrogen phosphide fumigation is used by the Armed Forces using aluminum phosphide fumigant. This is very beneficial for intransit fumigation of stored foods to rid the commodities of stored-food pests and has taken the place of many fumigants in inplace fumigation.

Although structural fumigation is most often accomplished by contract, you should be aware that methyl bromide and sulfuryl flouride are two fumigants that are commonly used.

Aerosoling. Aerosols (including ultralow-volume dispersal) may be defined as assemblages of solid or liquid particles suspended in air. Based on the mode of production, there are two main types of aerosols, cold and thermal. Cold aerosols are usually produced by combining an insecticidal agent with a very low-boiling liquid and discharging it by its vapor pressure through a small orifice. Thermal aerosols are produced by atomizing a liquid insecticide solution with either hot gases or superheated steam. This insecticide dispersal method is called fogging.

The advantage of ultralow-volume dispersal is the capability of dispensing small volumes of concentrated pesticides, as an aerosol, over large areas rather than the conventional diluted formulations.

When pesticides are dispersed as aerosols, the size of the particles range from 0.1 to 50 microns with 80 percent of the particles being less than 30 microns.

Aerosols are generally used indoors for controlling flying insects with exception to the ultralow-volume (ULV) application method and when aerosols are used for the purpose of flushing pests from their harborages.

The aerosols are used frequently in the disinsection of aircraft to prevent introduction of pests uncommon to various regions of the world.

BI Misting. Mists are dispersed pesticides with intermediate size particles ranging in size from 50 to 100 microns. They are effective methods for outside space treatment. With care, they can be used to considerable advantage for indoor treatment and, because of the large particle sizes, can be used under a wider range of weather conditions than aerosols. Penetration of dense vegetation is less satisfactory with mists than aerosols; however, mists give more residual effect than aerosols.

Mists can be used quite effectively for treating small ponds, lakes, and marshy areas in adulticiding operations because the particles will carry much farther in the wind than spray particles.

Spraying. Spraying is defined as the application of liquid pesticides. However, with the appearance of the new methods of application (aerosoling and misting), spraying is now confined to the application of liquids atomized into droplets of 100 microns in diameter. Because of the larger sizes, spray particles "fall out" more rapidly than mist particles; as a consequence, sprays are principally used for insecticide application to body surfaces or surfaces that pests will contact or ingest at some later date.

Sprays are used in treating food-handling facilities to apply residuals to cracks and crevices and can also be used to apply residuals to interior and exterior surfaces of other base facilities.

Sprays are used extensively in termite treatment operations such as sub-slab injection, soil poisoning, trenching, and for applying herbicides to terrestrial and aquatic vegetative pests.

In addition to the uses already mentioned, sprays can be used for treating sewage-trickling filter beds and for applying residuals to vegetation for controlling pests of vegetation.

Brushing. Using a paint brush or another bristle brush is becoming an increasingly popular method for applying liquid pesticides. Brushing puts the pesticide only where you want it to go. Spraying, by comparison, doesn't always put down a uniform band of chemical and there may be spattering or dripping.

Dusting. Dusting is the dispersal of pesticides in the form of solid particles. Generally, the sizes of dust particles are practically the same as liquid particles. Dusts are very effective against crawling insects, particularly those confined to limited areas. If properly applied, dusts are less hazardous to domestic plants and animals than gaseous and liquid pesticides because they are less readily absorbed. If not disturbed, dusts retain their effectiveness longer than liquid applications. For contact killing, dusts take longer to act than volatile liquid materials; they do not adhere well to surfaces; and they do not form a continuous layer over surfaces as liquid applications do.

You should always apply dusts to areas that present electrical hazards such as electrical panel boxes, outlets, and motorized equipment.

Dusts can be applied to indoor and outdoor areas; but if you use them indoors, generally put them in areas where they cannot be seen due to the unsightly appearance. In outdoor areas, dusts are very effective in controlling pests of vegetation and ectoparasites.

Granulating. Granules or pellets impregnated with the desired pesticide has certain advantages over dusts or liquids. You can use them to penetrate heavy vegetative cover. The granular material is designed to liberate the pesticide slowly for longer lasting effectiveness. Granules have been used successfully to release larvicides and herbicides below the water surface for control of mosquito larvae and weeds. This places the pesticide where the greatest benefit will be obtained and avoids loss of the materials by wind action when dust is applied on the water surface.

Granules can also be used to control grubs and many other pest larvae that develop below the earth surface because of the slow dissipation rate. In addition, granules are often used for controlling vegetation in many areas.

Baiting. You can prepare baits as solids or liquids or, as is most commonly done, purchase premixed baits which are generally used in rodent control programs. Baits are prepared by mixing toxicants with many types of food substances, depending upon the substance preferred by the pests you desire to control.

In addition to the use of baits for controlling rodents, baits are increasingly being used for controlling cockroaches, ants, flies and snails.

When baits are used they must be checked and replenished frequently and should be placed in out-of-the way susceptible areas.

Exercises (223):

1. What pesticide dispersal method would probably be most appropriate for treating small lakes and ponds to control adult mosquitoes?

2. Which method should you use to treat a large outdoor area to control crawling insects, without harming vegetation?

3. To kill stored-products pests within food commodities, what would the best dispersal method be?

4. What dispersal method would you prefer to flush many types of insect pests from their harborages to conduct a survey or to get a more rapid kill?

5. What dispersal method is used to treat rodent burrows and get a quick kill?

6. Which dispersal method gives the best penetration of heavily vegetated areas?

224. Identify characteristics of the two arthropod treatment categories.

Treatments for Managing Arthropods. The type of treatment you can use to manage arthropods is a major determining factor for selecting equipment (see Volume 3) and getting optimum control of insect pests. The types of treatments fall into two broad categories—*residual* and *space* treatments. Each of these types includes several pesticide dispersal methods.

Residual treatment. This term refers to applying pesticides that can remain effective for several days, weeks, or months on surfaces where pests may feed, rest, or merely crawl. As a result, the pests don't have to be present when you apply the chemical since they'll be killed after having contacted treated surfaces. (Additionally, you don't have to lay eyes on every bug you kill.)

The length of time a residual treatment remains effective depends on several factors, including:

- Type of pesticide.
- Type of surface.
- Exposure to weather.
- Effects of cleaning operation.
- Dosage rate.

You can apply residuals as solutions, emulsions, technical grade pesticides, suspensions, dusts or granules by any dispersal method designed to handle your desired formulation. Another advantage is that residuals can be used in both preventive and corrective control programs.

The equipment you pick for residual treatment will depend on where you apply the pesticide, the size of the area you treat, the type of formulation you use, and your method of application. For example, you wouldn't choose a manually operated piece of equipment to treat two outdoor acres, nor would you use a large equipment item to treat small indoor areas. Furthermore, you can't use some formulations in certain equipment items because damage may result or the equipment may not be able to handle the mixture. As an example, since suspensions are often corrosive and gritty, some pesticide pumps may be damaged or strainers, lines, and nozzles may become clogged.

Space treatment. This term applies to dispersing pesticides into the air, either indoors or outdoors. Space treatments kill pests that are present at the time of treatment or shortly after the treatment.

You can use emulsions or solutions for space treatments, which usually involve aerosols. Solutions are preferred most of the time since the solvent oil helps give a quicker knockdown of flying insects.

Here are some advantages of using space treatments:

- Immediate knockdown and kill.
- Rapid applications to large areas.
- Relatively small amount of chemical needed.

Space treatments are more effective indoors since there is much less air movement; this lets the fine spray particle remain suspended in the air for a longer time than outside treatments. On the other hand, a major disadvantage of space treatments in general is that there is no residual effect, so your efforts are only corrective in nature, not preventive. Finally, only the pests present at the time of treatment are affected.

As you learned earlier in this lesson, residual and space treatments are the two main categories of chemical control measures. These have further breakdowns, however, and we'll spend the rest of this lesson discussing them.

Crack and crevice treatment. This term applies to treatments where you apply small amounts of pesticides into cracks and crevices where insects hide, or through which they may enter buildings. It's used primarily in food-handling facilities where food is received, prepared, stored, and served, except in the dining area where the food is under the control of the person eating it. Openings where you apply the chemical include:

- Expansion joints.
- Between different elements of construction.
- Between equipment and floors.

- Inside hollow walls.
- Equipment legs and bases.
- Conduits.
- Motor housings.
- Junction or switch boxes.

Crack and crevice treatments have some very important advantages over other spraying or dusting techniques. Possible contamination of food, utensils, serving lines, and dining crew is greatly reduced. Less chemical is used. Assuming you do a proper job, you get better control because you're putting the pesticide where it can do the most good—where the insects live and breed. Finally, your residual lasts longer because the chemical is away from contact by cleaning operations.

You can use solutions, emulsions, or dusts for crack and crevice treatments, but don't stop there; also use aerosols to flush or speed up the kill of pests living in these areas.

Baseboard treatment. This term applies to using liquid residual pesticides on baseboards, door facings, and room corners in a facility. It's a very common treatment, and you possibly use it more than any other type of indoor treatment, other than where food is prepared and served. However, since crack and crevice treatments have so many benefits, think twice before you conduct baseboard treatments. Ideally, you should use baseboard treatments only where the pests' habits and other factors warrant them.

Spot treatment. This term can apply to both crack and crevice and the baseboard applications or any other residual treatment that is not a complete treatment of an entire area. The spot treatment term is probably more often referred to when speaking of an incomplete treatment of a facility to manage cockroaches, termites, ants, and wasps.

Vaporization. This term more often refers to the use of dicholorvos impregnated pellets, tablets, and resin strips for space treatment of warehouses and retrograde cargo. This vaporization type treatment is a form of the fumigation treatment and provides the same results.

Larviciding. This term usually refers to the application of chemicals to water for the control of mosquito larvae but may also refer to any such treatment designed to kill larvae of other insects. Equipment that produces either a fine mist or a coarse spray may be used, depending upon whether a heavy, longlasting residual treatment, or a light application, which will kill only the mosquito larvae, is desired. Larvicides may be applied as liquids or dusts from the ground or air or may be added to the water by other means, such as drip applicators, pellets, or granules.

Soil poisoning. The soil in which certain insects live during all or part of the life cycle is sometimes poisoned in attempts to control damage to plant roots or to prevent emergence of the adults. A surface treatment with a water emulsion may be suitable for insects living just under the soil or lawn surface. Deeper penetration is often difficult to btain in some soils and may not be satisfactory. Termite oil poisoning requires great thoroughness in application, and several types of equipment have been devised for this purpose. Large quantities of dilute formulations applied as coarse sprays are normally used in soil poisoning.

(1) Sub-slab injection. This term is often used to denote the type of treatment employed in poisoning the soil beneath buildings that have concrete flooring that rests directly on the soil surface.

(2) Rodding. This term also applies to soil poisoning and is often used in reference to the insertion of perforated jointed pipe tubings directly beneath flooring and above the soil surface to treat the soil beneath buildings as preventive or corrective control measures for termites.

Baiting. The use of poison baits is one of the oldest methods of pest control. The treatment of foliage, upon which insects feed, with chemicals that kill by stomach-poison action is another old and common method of treatment. Success with this method depends upon thorough coverage of the leaves with the insecticide. Dilute formulations, containing spreaders and stickers, applied as coarse sprays were used originally, but in recent years there has been a very great increase in application of concentrated formulations as mists with many types and sizes of mist blowers.

Systemic poisoning. The most recent development in the control of plant feeders is the systematic poison. That is, a chemical is taken up by the plant and distributed throughout the plant tissues. This is particularly effective against sucking insects that do not feed on the leaf surfaces. The same principle has been applied to the control of ectoparasites on animals by feeding chemicals that are harmless to the host but kill the bloodsucking parasites.

Exercises (224):

1. Match the proper treatment in column B with the characteristics in column A.

Column A	Column B
____ (1) No value as preventative control.	a. Residual treatment.
____ (2) Provides preventative and corrective chemical control.	b. Space treatment.
____ (3) Effectiveness dependent upon type of surface.	
____ (4) Normally dispersed as an aerosol.	
____ (5) Rapid application and immediate control.	
____ (6) Equipment used dependent upon area of application.	
____ (7) Use of small amounts of chemicals.	
____ (8) Insects do not have to be present at time of application to be effective.	
____ (9) Baseboard treatment.	
____ (10) Spot treatment.	
____ (11) Larviciding.	
____ (12) Soil poisoning.	
____ (13) Baiting.	
____ (14) Systemic.	
____ (15) Vaporization.	

225. Identify the types of treatment used to control pest vegetation.

Treatments for Controlling Vegetation. You can chemically control many types of pest vegetation, depending on the types and locations of the plants. As with arthropod control measures, the types of treatment you use will influence the type of equipment you select.

Foliage treatment. You can use this method to control existing vegetation by applying the chemical directly to top growth as contact sprays. This causes a burning of plant tissues or affects hormones that control plant growth.

Basal-bark treatment. This is making herbicide applications to the base of tree trunks that are 6 inches or less in diameter. The spray, usually oil-based, is applied to a height of 2 or 3 feet on the trunk. This treatment is well suited for uncut brush and regrowth from cut brush or trees, particularly for selective control.

Stump treatment. Use this treatment on freshly cut trees to prevent regrowth. You can either saturate the stump on top and all sides to the ground line, or drill holes in the stump and put the herbicide in them.

Cut-surface treatment. This type of treatment includes the application of herbicides to frills, girdles, cups, or notches that have been made to individual trees.

Treatments to frills and girdles should be accomplished by using a liquid herbicide formulation; however, when treatments are to be made to cups and notches, the herbicide formulation should be crystalline.

Soil treatment. This type of treatment is used to apply herbicides around the base of grasses, trees, and brush when it is desired that the chemical be absorbed through the roots. This type of treatment can be selective or nonselective in form and can be accomplished as a preemergence or postemergence treatment.

a. Selective treatment. This term is used when herbicides are applied to control specific types of vegetation without harming other vegetation that may be mixed in with or within the immediate vicinity of the vegetation to be controlled. This type of treatment is commonly used to control undesirable vegetation that exists in established turf grasses, such as lawns, golf courses, and parade grounds.

b. Nonselective treatment. This term is used to denote the application of herbicides to kill all vegetation within a specific area. This type of treatment is commonly used to control vegetation along roads, railroads, and fence rows; beneath utility lines; and around storm drains, culverts, utility poles, and sign posts.

c. Preemergence treatment. As the term implies, this type of treatment is performed to prevent seed germination, thereby preventing the establishment of vegetation.

d. Postemergence treatment. This term is used when herbicides are applied to control vegetation that has already become established.

Ditchbank treatment. This term is often used to distinguish the type of applications being made to irrigation and drainage systems. This, as the term implies, means that herbicides are only being applied to the sloped sides and not in the bottom of the irrigation and drainage systems.

Ditchbottom treatment. This method is used to control aquatic vegetation in ditchbottoms. Soil sterilants are usually used. Before you use this control method, you should insure dry conditions for at least 10 days.

Exercises (225):

1. Match the types of treatment in column B with the proper descriptions in column A.

Column A	*Column B*
____ (1) Preemergence application to prevent seed germination.	a. Foliage.
____ (2) Applied to freshly cut stumps.	b. Basal-bark.
____ (3) Applied to drainage systems.	c. Stump.
____ (4) Crystalline formulation applied to notches.	d. Cut-surface.
____ (5) Applied to base of trunk.	e. Soil.
____ (6) Used to control aquatic vegetation in ditches.	f. Ditchbank.
____ (7) Applied to existing vegetation.	g. Ditchbottom.

2-5. Records and Reports

The success and continuity of a sound pest management program is determined by the availability of accurate operational records and reports. Timeliness of control measures. justifiable estimates of funds and personnel needs, and concise requirements for supplies and equipment can only be available by regularly maintaining a' 'uate records. Work accomplished and results achieved n 'lso be uniformly measured and periodically co' ed to provide a sound basis of support for the value of ventive control actions.

This section is devoted to identifying records and reports directly related to operational pest management programs you must maintain; it also provides maintenance instructions for each.

226. Specify the purpose and use of DD Form 1826, Certificate of Competency, and state information needed to obtain the form.

DD Form 1826, Certificate of Competency. As outlined in DOD Directive 4150.7 and AFR 91-21, *Pest Management Program*, all personnel engaged in direct field supervision of pest management operations or those who operate independently of direct supervision must be technically competent and thoroughly familiar with all phases of pest management being performed.

Purpose. The purpose for DD Form 1826 (fig. 2-23) is to certify individuals who have proven they are competent to handle pesticides in accordance with Federal laws and to insure they are aware and knowledgeable of current policies relating to all phases of pest management.

There are eleven categories in which you may be certified, depending on your experience and test results. These categories and their description are shown in figure 2-24. Testing is required for all individuals coming under the Federal Environmental Pesticide Control Act (FEPCA) of 1972.

Obtaining DD Form 1826. When you or one of your workers has demonstrated technical knowledge and ability and been proved competent in pest management operation, a letter requesting certification or recertification is forwarded through proper channels to the designated certifying official.

The Department of Defense

Certificate of Competency

ATC-163
Certificate No.

is Awarded to

31 MAR 89
Expiration Date

ARDRAH L. BUDDIN, III

in Recognition of the Completion of Requirements for Certified Applicator in the following Pest Control Categories

Ornamental and Turf Pest Control
Aquatic Pest Control
Right-of-Way Pest Control
Industrial, Institutional, Structural
and Health Related Pest Control
Public Health Pest Control

as prescribed by Department of Defense Standards

This Certificate authorizes the recipient to select and apply pesticides

Clifford J. Novosad — 31 Mar 82 — James T. Carroll

Certifying Official
CLIFFORD J. NOVOSAD
COMMAND AGRONOMIST
HQ ATC/DEV

Date

Commanding Officer
JAMES T. CARROLL, Colonel, USAF
Commander, 3770 Tech Tng Gp

DD FORM 1 MAR 77 1826

Figure 2-23. Sample, DD Form 1826.

CERTIFICATION CATEGORIES*

Category Number	Category Name	Includes
1.	Agricultural Pest Control	a. Plant: Using, or supervising the use of, pesticides on grasslands and noncropland weeds. b. Animal: Using, or supervising the use of, pesticides on animals and on places on or in which animals are confined.
2.	Forest Pest Control	Using, or supervising the use of, pesticides in forests, forest nurseries, and forest seed producing areas.
3.	Ornamental and Turf Pest Control	Using, or supervising the use of, pesticides to control pests of ornamental trees, shrubs, flowers, and turf.
4.	Seed Treatment	Using, or supervising the use of, pesticides or repellants on seeds.
5.	Aquatic Pest Control	Using, or supervising the use of, any herbicides purposefully applied to standing or running water.
6.	Right-Of-Way Pest Control	Using, or supervising the use of, pesticides in the maintenance of roads, electric powerlines, pipelines, railway rights-of-way, or other similar areas.
7.	Industrial, Institutional, Structural, and Health Related Pest Control	Using, or supervising the use of, pesticides in, on, or around food handling facilities; human dwellings; institutions such as schools and hospitals, industrial establishments, including warehouses, and any other structures and adjacent areas; and for the protection of stored, processed, or manufactured products.
8.	Public Health Pest Control	Using, or supervising the use of, pesticides in public health programs for the management and control of pests having medical importance.
9.	Regulatory Pest Control	Using, or supervising the use of, restricted pesticides to prevent the movement of pests into or out of quarantine areas.
10.	Demonstration and Research Pest Control	(1) Individuals who demonstrate to the public, the proper use and techniques of applying pesticides or supervising such demonstration. (2) Persons conducting field research with pesticides, and in doing so, using or supervising the use of pesticides.
11.	Aerial Application Pest Control	Using, or supervising the use of, pesticides dispersed by aircraft.

*According to 40 CFR 171.3 and DOD Plan for Certification of Pesticide Applicators.

CF.074

Figure 2–24.

When requesting initial certification for an individual, the body of the letter should contain the following information:

a. Category of certification requested.

b. Name of an individual, rank/grade, and social security number.

c. Training accomplishments and length of time performed in the career field.

This letter should be signed by the base civil engineer, and copies of recent training certificates related to pest management received by the individual should be forwarded as attachments with the letter.

Recertification of individuals who presently hold a certificate of competency is required every 3 years if performing in either of the capacities outlined.

Requests for recertification are prepared and processed in the same manners as for certification, with only the contents of the letter body changed to provide the following information:

(1) Category of certification requested.

(2) Name of individual (last—first name—middle initial).

(3) Rank.

(4) Social security number.

(5) Present certification number and expiration date.

(6) Recent career field training accomplishments.

Upon receipt of certification or recertification request, the major command pest management professional will approve or disapprove the request. If the request is approved on its own merits, a certificate of competency will be forwarded to the individual; however, if the certifying official needs further justification, instructions identifying additional actions to be taken will be forwarded.

When certification is approved, the person being certified will receive DD Form 1826 and DD Form 1826–1, a "pocket copy" of the diploma. The individual must keep this small card with him or her at all times when pest management operations are being conducted.

A roster listing each certified individual, certification number, and expiration date must be maintained within civil engineering to act as a reminder and to identify certified individuals to other concerned individuals.

Exercises (226):

1. What individuals must possess DD Form 1826, Certificate of Competency?

2. How often must individuals who disperse pesticides be recertified?

3. What is the purpose of DD Form 1826?

4. When an individual is thought to be properly prepared for certification, what is the first action to be taken?

5. List the information that must be provided to request initial certification.

227. Cite the purpose, use, and disposition of DD Form 1532–1, Pest Management Maintenance Record, and make necessary entries on the form based on a given situation.

DD Form 1532–1, Pest Management Maintenance Record. Air Force Regulation 91–21 requires you to maintain this form (fig. 2-25A and 2-25B) for each facility and area you treat to control pests. The main purpose of this card is to help you maintain a complete record of all pest problems and the procedures used to deal with those problems, whether you use chemical or other control techniques. In effect, it gives you a pest management history of the area or facility. This, in turn, helps you make adjustments to your control program as needed. Additionally, the form lets you identify people who previously worked at the location and saves you the trouble of producing local forms or logbooks, which serve the same purpose. Workers should take the cards with them and make necessary entries after control measures are conducted.

Filling out the card is very simple, but there is one "glitch." When you indicate the amount of pesticide, it must be recorded in *dry ounces* of active ingredient rounded off to the nearest whole number (for a large area, you can list it in dry pounds). Refer to table 2-1 to see how to convert pesticide amounts to dry ounces.

When you've completed both sides of this form, start a new one by transcribing the information from the top four blocks of the old form to the new one. You can plan on the old cards being around for a long time on most buildings since you must keep them until 2 years after the treated building is destroyed.

Exercises (227):

1. What is the main purpose of DD Form 1532–1?

2. When should entries be made on the form?

3. When can completed cards be destroyed?

BUILDING/AREA					SIZE	TYPE OF CONSTRUCTION	USE DESIGNATION				
Date	Units Serviced	Work Origin	Unit of Measure	Target Post	Control Operation	If Pesticide is Used				Labor Time	Applicator Initials
						Name	EPA Reg	% Conc	Amount		

DD FORM 1532-1
82 JAN

PEST MANAGEMENT MAINTENANCE RECORD

MEASUREMENT UNITS

MSF = 1,000 square feet
MCF = 1,000 cubic feet
LFF = Linear feet
AC = Acres

ORIGIN OF WORK

SW = Scheduled work
WR = Work request
SC = Service or trouble call
R = Routine inspection

TYPE OF CONSTRUCTION

CO = Concrete
BL = Block
BV = Brick veneer
ST = Steel, sheet metal
WO = Wood
OT = Other

Figure 2-25A. DD Form 1532-1 (Front).

Date	Units Serviced	Work Origin	Unit of Measure	Target Post	Control Operation	If Pesticide Is Used				Labor Time	Applicator Initials
						Name	EPA Reg	% Conc	Amount		

REMARKS	

(Attach additional card to continue record)

Figure 2-25B. DD Form 1532-1 (Back).

TABLE 2–1
CONVERTING LIQUID PESTICIDE AMOUNTS TO DRY OUNCES

Situation:		You're working with a pesticidal concentrate containing 4 pounds active ingredient (AI) per gallon. You dilute it to field strength by adding 2.5 ounces of concentrate to one gallon of water.
Other Necessary Facts:		There are 128 fluid ounces in a gallon of water. There are 16 dry ounces in a pound.
Working the Problem:		Since tne concentrate has 4 pounds AI per gallon:
	Step 1	16 dry ounces x 4 lbs 1 gal = 64 dry ounces *per 128 fluid ounces.
		* "per" always means "divide", therefore:
	Step 2	64 dry ounces divided by 128 fluid ounces= .5 dry ounces per fluid ounce.
		Since you added 2.5 fluid ounces of concentrate to the water:
	Step 3	2.5 fluid ounces x .5 dry ounces per fluid ounce = 1.25 dry ounces.
	Step 4	Round off to the nearest whole ounce 1.0 dry ounces entered on DD Form 1532-1.

CF-073

4. Refer to figure 2-25A and make further entries on the form using the following information:

On 22 March 84, you receive a call from MSgt Michael M. Kelley in the administration section in Building 1624. Since you treated all the other rooms, his area was invaded with cockroaches and he wants them controlled. You returned to the building the next day and, as you surveyed the section, you noticed a coffee pot area that was poorly maintained and workers routinely kept candy and other foodstuffs in their desks. After you explained the need for higher sanitation standards, you used two gallons (3 dry ounces) of Diazinon EC. Your total labor time was 1 hour. (Check your entries with those in the answer section.)

228. State the purpose, use, and disposition of DD Form 1070 and determine necessary entries cn the form based on a given situation.

DD Form 1070, Termite and Wood Decay Inspection. A DD Form 1070 must be maintained for each facility that is constructed completely or partially of wood on all Federal installations. This includes virtually all facilities, regardless of preventive measures used in the construction.

Purpose. Each facility that is constructed completely or partly of wood must be inspected for signs indicating the presence of structural pests and conditions within and around the facility that would be conducive to structural pests. These inspections must be accomplished no less often than annually for each facility and should be inspected at least semiannually. This form serves as a record of these inspections and provides information pertaining to building conditions and actions taken.

Completion procedures. The DD Form 1070 is shown in figure 2-26 with entries provided to illustrate its use. This form is not difficult to fill out, but you must insure that the entries made on the form indicate true conditions found during the inspection of the facility. You must also insure that recommendations are annotated correctly, and when recommendations or other actions have been accomplished, the form must be annotated to reflect these actions.

Looking at figure 2-26, you will notice that the top portion is used to identify the number, type, and location of the facility; the date of the inspection; and the inspector's name. If you happen to be the inspector, you are responsible for the information entered or not entered on this form; therefore, the true conditions found inside, outside, and beneath a facility must be accurately and completely recorded.

Part I is used to indicate conditions within and around the facility that are conducive to structural pests' infestations. As an example, Xs have been placed in this part to identify the conditions found during an inspection conducted on a facility, and an additional comment has been entered in the block identified as "other."

Part II is used to identify the location where structural pests are actually found during the time of the inspection. If you will observe, no Xs have been placed in any of the blocks in this part, which indicates there were no structural pests present at the time the inspection was conducted.

Parts III and IV are used to identify the type of termite and fungi, respectively, found during the inspection. Since there were no termites or fungi observed, no entries were made in any of the blocks in either of these parts.

TERMITE AND WOOD DECAY INSPECTION	DATE INSPECTED	BUILDING NUMBER
	7 Jan 77	501

INSTALLATION	TYPE BUILDING	INSPECTOR
Sheppard Air Force Base	Q PERM / TEMP	Robert R Martin

I. FAVORABLE TERMITE AND FUNGI INFESTATION CONDITIONS

X	WOOD IN CONTACT WITH SOIL	X	POOR VENTILATION UNDER BUILDING
	FORM BOARDS LEFT IN CONCRETE	X	WATER COLLECTIONS UNDER BUILDING
	WOOD MEMBERS SET IN CONCRETE FLOOR		VINES AND SHRUBS AGAINST BUILDING
	WOOD STEPS IN CONTACT WITH SOIL	X	LEAKY PLUMBING IN BUILDING
	WOOD STEPS WITHOUT SHIELDS		WOOD SCRAP PILED UNDER BUILDING
	WOOD SIDING IN CONTACT WITH SOIL		LOOSE WIRE IN CONTACT WITH SOIL
X	PIPES IN CONTACT WITH SOIL AND WOOD		OTHER *(Specify)* Rain gutters improperly suspended allowing waterto flowdown the sides of the building.
X	NO SHIELDS ON FOUNDATION		
	FAULTY TERMITE SHIELD		

II. LOCATION OF INFESTATIONS

	FOUNDATION TIMBERS		BASE BOARDS
	WOOD PILLARS		DOOR FRAMES
	SILLS		WINDOW FRAMES
	CROSS BEAMS		STEPS
	FURNITURE		ROOF
	FLOOR JOIST		OTHER *(Specify)* *
	FLOOR		
	STUDS		

III. TYPE OF TERMITE		IV. TYPE OF FUNGI		V. DAMAGE		
SUBTERRANEAN	NONSUBTERRANEAN	WOOD DECAY	WOOD STAINING	STRUCTURAL WEAKENING	SUPERFICIAL	ESTIMATED COST

VI. REPAIR AND TREATMENT

TYPE	RECM	ACCOMP	TYPE	RECM	ACCOMP
REMOVAL OF WOOD FROM SOIL CONTACT	X		REPAIR OF TERMITE SHIELDS		
SEALING CRACKS IN CONCRETE			REMOVAL OF CONCRETE FORMS		
POINTING UP POOR MORTAR			REMOVAL OF VINES AND SHRUBS		
LOWERING GRADE LEVEL			REMOVAL OF WOOD TRASH		
CAPPING CONCRETE FOUNDATION			OTHER *(Specify)*		
IMPROVING DRAINAGE UNDER BUILDING	X		Place termite shildes around pipes*.	X	
IMPROVING VENTILATION UNDER BUILDING	X				

VII. CHEMICAL CONTROL

APPLICATION OF POISON DUST TO SHELTER TUBES ☐ YES ☐ NO	CHEMICAL USED
SOIL POISONING ☒ YES ☐ NO	TRENCH DEPTH: 1 ft; LINEAR FEET: 900; CHEMICAL USED: Chlordane
REPLACEMENT OF DAMAGED WOOD ☐ YES ☐ NO; NO. OF WOOD FEET REPLACED; UNTREATED	DIPPED; SOAKED; SPRAYED; PRESSURE TREATED
DRILLING AND FLOODING TREATMENTS ☐ YES ☐ NO	CHEMICAL USED
WOOD INJECTION FOR DRY WOOD TERMITE ☐ YES ☐ NO	CHEMICAL USED

VIII. COST

LABOR	MATERIAL	OTHER	TOTAL
$380.00	$45.75		$425.75

IX. TREATMENT EFFECTIVENESS

DATE	REMARKS	INSPECTOR

DATE	TITLE OF INDIVIDUAL EFFECTING REPAIR AND TREATMENT	SIGNATURE
12 Jan 77	Pest Management Tech	

*
1. Repair plumbing
2. Repair rain gutters
3. Apply chemical to soil on each side of foundation

Figure 2–26. Sample, DD Form 1070.

If termites or fungi has been observed, then part V would have been used to identify the type of damage incurred by the pests and the estimated cost of the damage.

Part VI is used to reflect repair and treatment recommendations and the actual accomplishment of recommendations. Still looking at figure 2-26, observe the entries in part VI and compare them with the entries in part I. Note that part VI should reflect recommendations to correct the conditions annotated in part I in all possible situations, as has been done in the illustration provided. It is the inspector's responsibility to initiate action to accomplish service calls and/or job orders as applicable.

As you can see, an asterisk has been placed in the portion identified as "Other" to denote that additional recommendations are identified elsewhere on the form (in this case, on the bottom) due to the lack of sufficient space. These additional recommendations are used to further support the finds identified in part I. Note footnote number 3. This was added as a recommendation to correct the situation identified in part I in reference to "no shields on foundation." Since it would be almost impossible and very impractical to install termite shields after the building has already been constructed, the most practical thing to do is treat the soil on both sides of the foundation, if not previously accomplished, which applies in this situation.

Upon completion of each recommended action, the form must be annotated in part VI to reflect the actual accomplishment of recommended actions.

Part VII is used to identify the type, quantity, and method of chemical control implemented to manage termites and/or fungi, and it is also used to identify measures taken to correct damaged portions of the facility.

As you have probably noticed in viewing figure 2-26, entries have been made to indicate that soil poisoning was accomplished and that chlordane was applied to a trench 1 foot in depth and 900 linear feet.

Part VIII is used to identify the cost of accomplishing recommended actions. Entries are made to reflect the cost of materials, labor, and other possible expenditures as shown in the illustration.

Part IX is used to identify the date that chemical treatment was accomplished and the person who was responsible for the treatment.

This information is entered in the bottom blocks as shown in figure 2-26. The remaining blocks in this part are used for inspections accomplished to record treatment effectiveness.

Disposition. As outlined in AFM 12-50, *Disposition of Air Force Documentation*, Table 91-5, DD Forms 1070 for each type of facility previously described must be maintained indefinitely and must not be destroyed unless the building is disposed of or installation is inactivated and dropped from real property accounts.

Exercises (228):

1. What facilities require that a DD Form 1070 be maintained?

2. How often must facilities be inspected?

3. What is the purpose of DD Form 1070?

4. When can a completed DD Form 1070 be destroyed?

5. Using the illustrated DD Form 1070 provided in figure 2-27, properly complete the form by entering the appropriate information provided below in the applicable spaces on the form.

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TERMITE AND WOOD DECAY INSPECTION

DATE INSPECTED	BUILDING NUMBER		
INSTALLATION	TYPE BUILDING: PERM / TEMP	INSPECTOR	

I. FAVORABLE TERMITE AND FUNGI INFESTATION CONDITIONS

	WOOD IN CONTACT WITH SOIL		POOR VENTILATION UNDER BUILDING
	FORM BOARDS LEFT IN CONCRETE		WATER COLLECTIONS UNDER BUILDING
	WOOD MEMBERS SET IN CONCRETE FLOOR		VINES AND SHRUBS AGAINST BUILDING
	WOOD STEPS IN CONTACT WITH SOIL		LEAKY PLUMBING IN BUILDING
	WOOD STEPS WITHOUT SHIELDS		WOOD SCRAP PILED UNDER BUILDING
	WOOD SIDING IN CONTACT WITH SOIL		LOOSE WIRE IN CONTACT WITH SOIL
	PIPES IN CONTACT WITH SOIL AND WOOD	OTHER (Specify)	
	NO SHIELDS ON FOUNDATION		
	FAULTY TERMITE SHIELD		

II. LOCATION OF INFESTATIONS

	FOUNDATION TIMBERS		BASE BOARDS
	WOOD PILLARS		DOOR FRAMES
	SILLS		WINDOW FRAMES
	CROSS BEAMS		STEPS
	FURNITURE		ROOF
	FLOOR JOIST	OTHER (Specify)	
	FLOOR		
	STUDS		

III. TYPE OF TERMITE		IV. TYPE OF FUNGI		V. DAMAGE		
SUBTERRANEAN	NONSUBTERRANEAN	WOOD DECAY	WOOD STAINING	STRUCTURAL WEAKENING	SUPERFICIAL	ESTIMATED COST

VI. REPAIR AND TREATMENT

TYPE	RECM	ACCOMP	TYPE	RECM	ACCOMP
REMOVAL OF WOOD FROM SOIL CONTACT			REPAIR OF TERMITE SHIELDS		
SEALING CRACKS IN CONCRETE			REMOVAL OF CONCRETE FORMS		
POINTING UP POOR MORTAR			REMOVAL OF VINES AND SHRUBS		
LOWERING GRADE LEVEL			REMOVAL OF WOOD TRASH		
CAPPING CONCRETE FOUNDATION			OTHER (Specify)		
IMPROVING DRAINAGE UNDER BUILDING					
IMPROVING VENTILATION UNDER BUILDING					

VII. CHEMICAL CONTROL

APPLICATION OF POISON DUST TO SHELTER TUBES ☐ YES ☐ NO	CHEMICAL USED			
SOIL POISONING ☐ YES ☐ NO	TRENCH DEPTH	LINEAR FEET	CHEMICAL USED	
REPLACEMENT OF DAMAGED WOOD ☐ YES ☐ NO / NO. OF M BD FEET REPLACED / UNTREATED	DIPPED	SOAKED	SPRAYED	PRESSURE TREATED
DRILLING AND FLOODING TREATMENTS ☐ YES ☐ NO	CHEMICAL USED			
WOOD INJECTION FOR DRY WOOD TERMITE ☐ YES ☐ NO	CHEMICAL USED			

VIII. COST

LABOR	MATERIAL	OTHER	TOTAL

IX. TREATMENT EFFECTIVENESS

DATE	REMARKS	INSPECTOR
DATE	REMARKS	INSPECTOR
DATE	REMARKS	INSPECTOR
DATE	TITLE OF INDIVIDUAL EFFECTING REPAIR AND TREATMENT	SIGNATURE

Figure 2–27. DD Form 1070 (objective 228, exercise 5).

On 17 January 1984, Building 302 at Bayou AFB was inspected for termite and wood decay by SSgt Thomas T. Tony. This building happens to be a permanent building but is several years old.

The inspection revealed superficial damage to the rafters caused by dry-wood termites that had entered through deteriorated screens over the attic vents. There were no other conditions favoring termite or fungi infestation.

After a thorough inspection and extreme consideration, it was determined that the screens for the vents must be replaced and the rafters injected with pentachlorophenol to arrest further damage.

The total cost of corrective measures was $330. The screen and chemical cost $73, and a special item of equipment to do the job cost $30.

After the treatment was performed it was reinspected on 20 January 1984 by SSgt Thomas T. Tony, who is the section supervisor.

229. State completion procedures and the purpose for AF Form 290, Transcript for Pest Report, and complete the provided form.

AF Form 290, Transcript for Pest Report. As outlined in AFR 91–21, this report is to be prepared on a daily basis by pest management personnel.

Purpose. The AF Form 290 (fig. 2-28) is used to record daily pest management activities and is the source document for creating a pest file, which is used to provide a complete record of all preventive and corrective pest management programs.

Completion procedures. Preparation of the AF form 290 is accomplished by transcribing longhand information pertaining to pest management activities into codes and abbreviations on a daily basis to provide keypunch capability.

For installations that use the B3500 computer system, which includes most installations, instructions for completing the AF Form 290 are found in AFR 91–21, Pest Management Program, AFM 171–200, The Base Engineer Automated Management System; and AFM 300–4, Data Elements and Codes. Codes and specific instructions are contained in AFM 300–4, Volumes IV, VI, and XII and AFM 171–200, Part 10.

The information you enter on this form must reflect all pest management activities where pesticides are used. Individual activities are recorded on DD Form 1532–1; then at the end of the day these activities are categorically separated and compiled. This compiled information is then transcribed onto the AF Form 290

Since the information contained on this form is used for keypunch operations, the information must be coded and separated into three sections which identify the information as pertaining to Pest Control Operations, Pest Surveys, or Herbicide Control.

This coded information is then keypunched onto cards identified as Pest detail cards (1/80, 2/80, and 3/80). The Pest detail card 1/80 is the Pest control operation card that contains all the information pertaining to arthropod pest control operations except for the hours spent on surveys. The Pest detail card 2/80 is the Pest survey card which reflects the hours expended conducting surveys during a day's time. The Pest detail card 3/80, herbicide control card, contains all information pertaining to herbicide control operations with the exception of the hours expended on surveys.

To see how information concerning daily pest management activities is transcribed and entered on a typical AF Form 290, refer to the following case situation and illustrations of the handscribed information for the situation.

Case Situation 2–1

On 14 May 1984, you and another pest manager conducted an adulticiding operation to control mosquitoes in a 300-acre area. You used ½ gallon of chorpyrifos, an organophosphate solution concentrate containing 6 pounds of active ingredient per gallon. Two man-hours were spent preparing for the job and 12 man-hours doing the job for a total of 14 man-hours in conduting surveys.

Refer to figure 2-28 and study it carefully, because this illustration of the completed AF Form 290 will be used throughout this lesson. Note the manner in which the form is separated into data elements to identify the information (pest name, pest control operation, etc.) that is entered in the columns.

Since parts of the information in this situation must be coded, codes are provided to you in tables 2-2 through 2-5.

Looking at figure 2-28, you can see that the first data element to be entered on this form is the Pest Name. The pest that was identified in the case situation was adult mosquitoes; therefore, referring to table 2-2, you can see that adult mosquitoes are identified by the data code DVMS1. This code is entered in columns 1 through 5 on the form.

The next data element is the Pest Control Operation, which was identified as an ultralow-volume operation to control adult mosquitoes. Scanning over the pest control operation data codes provided in table 2-3, you will see there's no specific code for ULV operations, so the code used is ADZZ. This code is entered in columns 6 through 9 on the form.

The data element Area Treated contains eight columns for entering the total number of square feet or acres treated. Although there are eight columns provided for this data element, you don't have to use all of them. Since this data element requires the entry of a number or numbers, you would only use the columns needed to enter the total number of digits that appear in the number of square feet or acres treated.

NOTE: The number of acres or square feet entered for this data element must be whole numbers. Parts of acres or square feet cannot be entered.

Referring to the case situation, you will find that 300 acres were treated. Therefore, this number would be entered in columns 15–17, as illustrated in figure 2-28. (NOTE: All zeros must be slashed in order to seperate zeros

TRANSCRIPT FOR PEST REPORT

PEST NAME	PEST CONTROL OPERATION	AREA TREATED	UNIT OF MEASURE	BLDG TERRAIN	PESTICIDE NAME	PESTICIDE FORM	PESTICIDE QUANTITY	UNIT OF MEASURE	SUPPLY SOURCE	MAN-HOURS LABOR	MAN-HOURS SURVEY	RESERVED	INSTALLATION	MONTH	CARD CODE
DVMS1	ADZZ	3ØØ	AC	2	SNOP99	SOLU	3	LB	S	14			VNVP	Ø5	1

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Figure 2-28. Sample, AF Form 290, example 1.

TABLE 2–2
PEST NAME DATA CODES

Data Codes	Data Items and Explanations:	Data Item Name
	Attacking Vegetation Pests	
AVBBØ	Bark Beetles	BARKBEETS
AVBRØ	Borers	BORERS
AVDJØ	Defoliators and Juice-Sucking	DEFOLJUSU
AVSRØ	Soil and Root Infesting	SOIL-ROOT
AVTSØ	Twig and Stem Girdlers	TWIG-STEM
	Disease Vector Pests	
	Bugs	
DVBG1	Bedbugs	BEDBUGS
DVBG2	Cockroaches	COCKROACH
DVBG3	Fleas	FLEAS
DVBG4	Lice	LICE
DVBG5	Mites	MITES
DVBG6	Ticks	TICKS
	Flies-Biting	
DVFB1	Black	BLACK-FLY
DVFB2	Culicoides	CULICOIDE
DVFB3	Phlebotomus	PHLEBOTOM
DVFB4	Stable	STABLEFLY
DVFB5	Tabanid	TABANID
	Flies-Nonbiting	
DVFN1	Blow	BLOW-FLY
DVFN2	House-Adult	H-ADULT
DVFN3	House-Larval	H-LARVAL
DVFN4	Midges and GNATS	MIDGEGNAT
DVFN5	Psychodid	PSYCHODID
	Mosquitoes	
DVMS1	Adult	MOSADULT
DVMS2	Larvae	MOSLARVA
DVZZØ	Other Disease Vector Pests	ODSVCPEST
	Miscellaneous Pests	
MPBDØ	Birds	BIRDS
MPNTØ	Nematodes	NEMATODES
	Rodents	
MPRD1	Mice	MICE
MPRD2	Rats	RATS
MPRD3	Other	OTHRODENT
MPSSØ	Snails and Slugs	SNAILSLUG
MPZZØ	Other	OMISCPEST
	Nuisance Pests	
NPANØ	Ants	ANTS
NPCKØ	Crickets	CRICKETS
NPEWØ	Earwigs	EARWIGS
NPFSØ	Firebrats and Silverfish	FIBRSILFH
NPZZØ	Other	
	Stored Products Insects	
SPFAØ	Pests of Food of Animal Origin	FODANIORI
SPFFØ	Pests of Fibers and Fabrics of Animal Origin	FIBFABANI
SPFVØ	Pests of Legumes, Dried Fruits, and Vegetables	LEGFRUVEG
SPGCØ	Pests of Grains and Cereal Products	GRAINCEAL
	Structural Pests	
	Marine Borers	
STMB1	Crustaceans	CRUSTACEA
STMB2	Molluscs	MOLLUSCS
STOWØ	Other Wood Destroying Insects	OWDINSECT
STPBØ	Powder Post Beetles	PDPTBEETS
STPPØ	Powder Post Borers	PDPTBORER
	Termites	
STTM1	Dampwood	DAMPWOOD
STTM2	Drywood	DRYWOOD
STTM3	Subterranean	SUBTTERRAN
STWDØ	Wood Destroying Fungi	WDESFUNGI
	Venomous Arthropods	
VACPØ	Centipedes	CENTIPEDE
VASCØ	Scorpions	SCORPIONS
VASPØ	Spiders	SPIDERS
VAUCØ	Urticating	URTICATIN
VAWBØ	Wasps and Bees	WASP/BEES
	Weed Pests	
WPATØ	Aquatic	AQUATIC
WPBLØ	Broadleaf	BROADLEAF
WPGSØ	Grassy	GRASSY
WPMXØ	Mixed	MIXED
WPWDØ	Woody	WOODY

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TABLE 2–3
PEST CONTROL OPERATION DATA CODES

Data Codes	Data Items and Explanations:	Data Item Name
	Adulticiding	
ADDS	Dust	ADULTICID-DUST
ADFG	Fog	ADULTICID-FOG
ADMS	Mist	ADULTICID-MIST
ADZZ	Other	ADULTICID-OTHER
	Insects Attacking Vegetation Operation	
AVAT	Area Treatment (Including Shrubs)	AREA-TREATMENT
AVTS	Trees Sprayed or Treated	TREES-SPRAYED
	Baiting	
BTBD	For Birds	BAITING-BIRDS
BTIN	For Insects	BAITING-INSECTS
BTRD	For Rodents	BAITING-RODENT
	Disease Vector and Nuisance Pests	
DNDT	Ditching (New and Maintenance)	DITCHING
DNLF	Land Fill	LAND-FILL
	Dip-Soak Treatments	
DSLM	Lumber	LUMBER
DSPL	Pallets	PALLETS
	Fumigation	
FMAT	Atmospheric	ATMOSPHERIC
FMVA	Vacuum	VACUUM
	Inter-Space Treatment	
ISHH	Mist, Gas, Other: Not to include household aerosol dispensers	INTER-SPACE-TRT
	In-Place Treatments	
ITPI	Pilings	PILING-IN-PLACE
ITPL	Poles	POLES-IN-PLACE
ITST	Structural	STRUCTURAL
	Larviciding	
LVDS	Dust	LARVICID-DUST
LVGR	Granules	LARVICID-GRANS
LVMS	Mist	LARVICID-MIST
LVZZ	Other	LARVICID-OTHER
	Pressure Treated (Preserved) Components Installed	
PTPI	Piling	PILING-PRS-TRTD
PTPL	Poles	POLES-PRS-TRTD
PTWL	Wood and Lumber	WOOD-LUMBER
	Residual Treatments	
RTDG	Dust or Granules	RESIDUAL-DUSTS
RTSP	Sprays	RESIDUAL-SPRAYS
	Stored Products	
SPRT	Residual Treatments	RESIDUAL-TREAT
SPST	Space Treatment	SPACE-TREATMENT
	Structural	
STFM	Fumigation	FUMIGATION
STSF	Surface	SURFACE
STST	Soil Treatment	SOIL-TREATMENT
STTR	Trench	TRENCH

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from the letter "O"; therefore, the letter "O" should never be slashed.)

The fourth data element on the AF Form 290 is the Unit of Measure. The unit of measure must be entered as SF (square feet) for all indoor treatments or AC (acres) for all outdoor treatments. "AC" has been entered in columns 18 and 19, respectively (fig. 2-28), to reflect that acres were treated in the case situation provided.

The data element appearing on the AF Form 290 as Building Terrain is used for identifying where the treatment was performed. The number "1" or "2" must be entered in column 20. Since the treatment performed in this situation occurred outdoors, the number "2" has been entered in column 20 of the form. (NOTE: When "AC" is entered in columns 18 and 19, the number "2" must be entered in column 20. If "SF" has been entered in columns 18 and 19, the number "1" must be entered in column 20.)

The data element Pesticide Name is used to identify the pesticide used in treatment. The name of the pesticide must be coded (pesticide name data code provided in table 2-4), and the data code must be entered in columns 21 through 26, as shown in figure 2-28. As you can see by the information provided in table 2-4, a data code for chlorpyrifos doesn't exist, so the code SNOP99 for other organophosphate is used. (Notice the different uses of Ø and "O" in this example).

Referring again to case situation 2–1, the pesticide form used in the treatment for adult mosquitoes was a solution. In table 2-5, you will find a solution is identified with the data code SOLU. The pesticide form data code must be entered in columns 27 through 30, as illustrated in figure 2-28, which identifies the data element Pesticide Form.

In the data element identified as Pesticide Quantity (columns 31 through 36), you must enter the total pounds of active ingredient contained in the total amount of pesticide formulation dispersed. This information must be in whole numbers (complete pounds) because the computer will not accept portions of a pound; or in other words, you cannot use ounces. Since you used ½ gallon of a concentrate containing 6 pounds active ingredient per gallon, simply divide by 2 to find the total pounds of active ingredient used; 3 pounds is entered in columns 36–38. (The Unit of

TABLE 2-4
PESTICIDE NAME DATA CODES

Data Codes	Data Items and Explanations:	Data Item Name
	Combination Herbicides	
	Growth Regulators-Contact	
CHGCØØ	Arsenicals, Organic-2, 4-D	ARSORG24D
	Growth Regulators	
CHGR1Ø	Dalapon-Silvex	DALSILVEX
CHGR2Ø	Dalapon-2, 4, 5-T	DALAP245T
CHGR3Ø	2, 4-D, 2, 4, 5-T	24D245T
	Growth Regulators-Soil	
CHGS1Ø	Amitrole-Simazine	AMISIMAZI
CHGS2Ø	Borate-2, 4-D	BORATE24D
	Soil Sterilants	
CHSS1Ø	Borate-Monuron	BORMUNURO
CHSS2Ø	Bromacil-Borate	BRMCILBOR
CHSS3Ø	Bromacil-Borate-Chlorate	BRMBORCHL
CHSS4Ø	Chlorate-Borate	CHLBORATE
CHSS5Ø	Chlorate-Borate-Monuron	CHLBORMON
CHSS6Ø	Fenuron-TCA	FUNUROTCA
CHSS7Ø	Monuron-TCA	MONUROTCA
CHZZØØ	Other Combination Herbicides	OCOMBHERB
	Fumigants	
FMAPØØ	Aluminum Phosphide	ALPHOS
FMCBØØ	Carboxide	CARBOXIDE
FMHAØØ	Hydrocyanic Acid	HYDROCYAN
FMMBØØ	Methyl Bromide	MEBROMIDE
FMPDØØ	Paradichlorobenzene	PARADICHL
FMSLØØ	Soil Fumigants	SOILFUMIG
FMSUØØ	Sulfuryl Fluoride	SULFURYFL
FMZZØØ	Other Fumigants	OFUMIGANT
	Inorganic Insecticides	
	Arsenicals	
INAR1Ø	Lead Arsenate	LDARSENAT
INAR2Ø	Paris Green	PRISGREEN
INAR3Ø	Sodium Arsenite	SODARSENT
INAR99	Other Arsenical Compounds	OARSENCMP
	Miscellaneous Inorganic Insecticides	
INMS1Ø	Copper Naphtenate	COPPERNAP
INMS2Ø	Copper Sulfate Formulations	COPERSULF
INMS3Ø	Silica Aerogels	SILICAERO
INMS99	Other Miscellaneous Inorganic Insecticides	OINORGANI
	Sulfur	
INSL1Ø	Dusting and Wettable Sulfur	DUSWETSUL
INSL2Ø	Lime Sulfur	LIMESULFU
	Miscellaneous Chemical Compounds	
MSATØØ	Attractants	ATTRACTS
MSFGØØ	Fungicides	FUNGICIDE
MSMLØØ	Mollescicides	MOLCIDES
MSZZØØ	Other Chemical Compounds	OCHEMCOMP
	Natural Organic Insecticides	
NAALØØ	Allethrin	ALLETHRIN
NACSØØ	Creosote	CREOSOTE
	Oils	
NAOL1Ø	Dormant	DORMANT
	Pre-Emergence	
UHPE1Ø	Benefin	BENEFIN
UHPE2Ø	Simazine	SIMAZINE
	Soil	
UHSL1Ø	Fenac	FENAC
UHSL2Ø	TBA	TBA
UHSL3Ø	TCA	TCA
	Soil Sterilant	
UHSS1Ø	Bromacil	BROMACIL
UHSS2Ø	Diuron	DIURON
UHSS3Ø	Fenuron	FENURON
UHSS4Ø	Monuron	MOURON
UHSS5Ø	Sodium Chlorate	SODIUMCHL
UHZZØØ	Other Uncombined Herbicides	OUNCMHERB

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TABLE 2-4 (contd)
PESTICIDE NAME DATA CODES

Data Codes	Data Items and Explanations:	Data Item Name
NAOL2Ø	Summer	SUMMER
NAPYØØ	Pyrethrum	PYRETHRYM
NAZZØØ	Other Natural Organic Insecticides	ONATORGIN
	Rodenticides	
RDACØØ	Anticoagulants	ANTICOAGU
RDCCØØ	Calcium Cyanide	CALCYANDE
RDSMØØ	Sodium Monofluoracetate	SODMONOFD
RDSNØØ	Strychnine	STRYCHIN
RDZPØØ	Zinc Prosphide	ZNPHOSPDE
RDZZØØ	Other Rodenticides	ORODENTID
	Repellants	
RPALØØ	All Types of Repellants	ALLREPELL
	Synthetic Organic	
	Carbamates	
SNCB1Ø	Baygon	BAYGON
SNCB2Ø	Sevin	SEVIN
	Chlorinated Hydrocarbons	
SNCH1Ø	Aldrin	ALDRIN
SNCH2Ø	Chlordane	CHLORDANE
SNCH3Ø	DDT	DDT
SNCH4Ø	Dieldrin	DIELDRIN
SNCH5Ø	Heptachlor	HEPTACHLO
SNCH6Ø	Kepone (include Mirex)	KEPONE
SNCH7Ø	Lindane	LINDANE
SNCH8Ø	Pentachlorophenol	PENTACHLO
SNCH99	Other Chlorinated Hydrocarbons	OCHLORHYD
	Organic Phosphates	
SNOP1Ø	DDVP	DDVP
SNOP2Ø	Diazinon	DIAZINON
SNOP3Ø	Dibrom (Naled)	DIBROM
SNOP4Ø	Fenthion	FENTHION
SNOP5Ø	Malathion	MALATHION
SNOP99	Other Organic Phosphates	OORGPHOSP
SNOSØØ	Other Sulfur Compounds	ORGSULFUR
SNOTØØ	Organic Thiocyanates	ORGTHIOCY
	Uncombined Herbicides	
	Aquatic	
UHAT1-	Copper Sulfate	COP-SULFA
UHAT2Ø	Diquat	DIQUAT
	Contact	
UHCT1Ø	Ammonium Sulfamate	AM-SULFAM
UHCT2Ø	Arsenicals, Organic	ARSEN-ORG
UHCT3Ø	Arsenite, Sodium	ARSTE-SOD
UHCT4Ø	Dinitro Compounds	DINITRO
UHCT5Ø	Oils, Herbicidal	OILSHERBI
UHCT6Ø	Paraquat	PARAQUAT
UHCT7Ø	Pentachlorophenol	PENTACHLO
	Growth Regulators	
UHGR1Ø	Amitrole	AMITROLE
UHGR2Ø	Atrazine	ATRAZINE
UHGR3Ø	Dalapon	DALAPON
UHGR4Ø	Maleic Hydrazide	MALHYDRAZ
UHGR5Ø	Silvex	SILVEX
UHGR6Ø	2, 4-D	24D
UHGR7Ø	2, 4, 5-T	245T

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TABLE 2-5
PESTICIDE FORM DATA CODES

Data Codes	Data Items and Explanations:
	Pesticide Forms
	Dry
DUST	Dusts
GRAN	Granules
SFUM	Solid Fumigant
BAIT	Bait (Ready to Use)
OTHD	Other
	Liquid
SOLU	Solution
EMUL	Emulsion
AERO	Aerosol
SUSP	Suspensions
OTHL	Other

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Measure data element for pesticide quantity must reflect "LB" in columns 37 and 38, respectively, to identify the fact that the information entered in the previous data element was recorded as pounds.)

The Supply Source data element (column 39) must reflect either an "N" if the pesticide used was a nonstandard stock item or an "S" if the pesticide was a standard stock item, as illustrated in figure 2-28.

The Man-Hours Labor data element (columns 40 through 45) is used for the purpose of reflecting only the combined man-hours actually expended while applying pesticides, including supervisory time (see figure 2-28, columns 44 and 45).

As you can see, a total of 14 hours was entered under this data element to correspond with the information provided in case situation 2–1.

NOTE: Only whole numbers will be entered under this data element, which means that no part of an hour can be shown.

The purpose for the next data element identified as Man-Hours Survey is for recording only the hours spent in conducting surveys for a specific job. Information pertaining to man-hours expended on surveys has to be keypunched onto a separate Pest detail card, which would be the Pest detail card *2/80*, as previously stated. Therefore, this information cannot appear on the same line that is used for recording pest control operations to be keypunched onto the Pest detail card 1/80. To explain this further, figure 2-29 is provided to illustrate how the survey hours are recorded on a typical AF Form 290.

Notice that the illustrated AF Form 290 in figure 2-29 has the lines numbered in the left margin. This is to allow quick reference to the comments that remain concerning the completion of this form.

In comparing figure 2-28 with figure 2-29 you will find that line 1 in figure 2-29 provides the same information that figure 2-28 does. This information pertains strictly to pest control operations and is keypunched only on the Pest detail card 1/80. Line 7 in figure 2-29 represents the information keypunched onto the Pest detail card 2/80 (Pest Survey), and line 14 represents the information pertaining to herbicide control operations that is keypunched onto the Pest detail card 3/80.

Continuing the discussion concerning data element Man-Hours Survey, 3 hours expended on surveys for the pest control operation are entered in column 51 on line 7, as illustrated in figure 2-29, which explains why it was not entered in the same column on line 1. If you will notice, entries have been made to only two data elements on line 7 prior to this one, because this is the only information that can be entered on the Pest Survey Card (2/80) up to this point.

Continuing with the remaining data elements on the AF Form 290, the Reserved data element (columns 52 through 73) requires no entry. This space is always left blank.

The Installation data element is used to identify the installation submitting the report. This code must be entered in columns 74 through 77 for each Pest detail card, as has been done in figure 2-29 . It is recommended that you obtain the proper data element code from the CE accounting section; therefore, these codes are not provided in this text.

The Month data element is used to identify the month in which the form was prepared. This data element code must be a two-digit number. If the month happens to be December, then the number 12 would be entered in columns 78 and 79. Case situation 2–1 states that this job was accomplished in May, so figures 2-28 and 2-29 reflect an Ø5, which is the proper way to enter the number that represents the month of May.

The last data element that remains on the AF Form 290 is Card Code. Column 80 is used for identifying the information entered on individual lines to the applicable Pest detail card. Notice that a "1" has been entered in column 80 on line 1 in figures 2-28 and 2-29 to identify that all the information on that line is to be keypunched onto a Pest Control Operation Card (1/80). In figure 2-29 you will note that a "2" was entered on line 7 to indicate that this information must be keypunched onto a Pest Survey Card (2/80) and a "3" entered on line 14, which means that all the information on this line must be keypunched onto a Herbicide Control Card (3/80).

Look on line 14 in figure 2-29 and observe the entries for the various data elements. This is an example of the complete information that is entered on the AF Form 290 for herbicide control. All blank data elements appearing on this illustrated form must remain blank because the computer will not accept any additional information and cannot be keypunched onto the Herbicide Control Card (3/80).

NOTE: For herbicide control operations, "AC" must be entered in columns 18 and 19, respectively, and a "2" must be entered in column 20 for the data element Building Terrain for all herbicide operations, just as it appears on line 14 in figure 2-29.

Disposition. Once the AF Form 290 is completed, it is forwarded to the Cost Accounting Section, and the information is keypunched onto the *Pest* detail cards. The AF Form 290s can be destroyed after a corrected copy of the Pest Summary Report has been prepared.

Exercises (229):

1. The AF Form 290 must be prepared __________ in accordance with _____________ .

2. What is the primary purpose of the AF Form 290?

3. The three publications that provide instructions for completing an AF Form 290 for use with the B3500 computer system are __________ , _________________ , and _______________ .

4. Data codes used in the completion of the AF Form 290 are found in _____________ .

TRANSCRIPT FOR PEST REPORT

	PEST NAME (1–5)	PEST CONTROL OPERATION (6–9)	AREA TREATED (10–17)	UNIT OF MEASURE (18–19)	BLDG TERRAIN (20)	PESTICIDE NAME (21–26)	PESTICIDE FORM (27–30)	PESTICIDE QUANTITY (31–36)	UNIT OF MEASURE (37–38)	SUPPLY SOURCE (39)	MAN-HOURS LABOR (40–45)	MAN-HOURS SURVEY (46–51)	RESERVED (52–73)	INSTALLATION (74–77)	MONTH (78–79)	CARD CODE (80)
1	DVMS1	ADZZ	3ØØ	AC	2	SNOP99	SOLU	3	LB	N	14			VNVP	Ø5	1
3																
4																
5																
6																
7	DVMS1				2							3		VNVP	Ø5	2
8																
9																
10																
11																
12																
13																
14	WPMXØ		1	AC	2	CHSS7Ø		5	LB	S				VNVP	Ø5	3

AF FORM AUG 71 290

BE-290

Figure 2-29. Sample, AF Form 290, example 2.

5. Using information in the objective pertaining to completion instructions for the AF Form 290, complete the blank AF Form 290 in figure 2-30 by entering the information below on the appropriate lines as illustrated in figure 2-28.

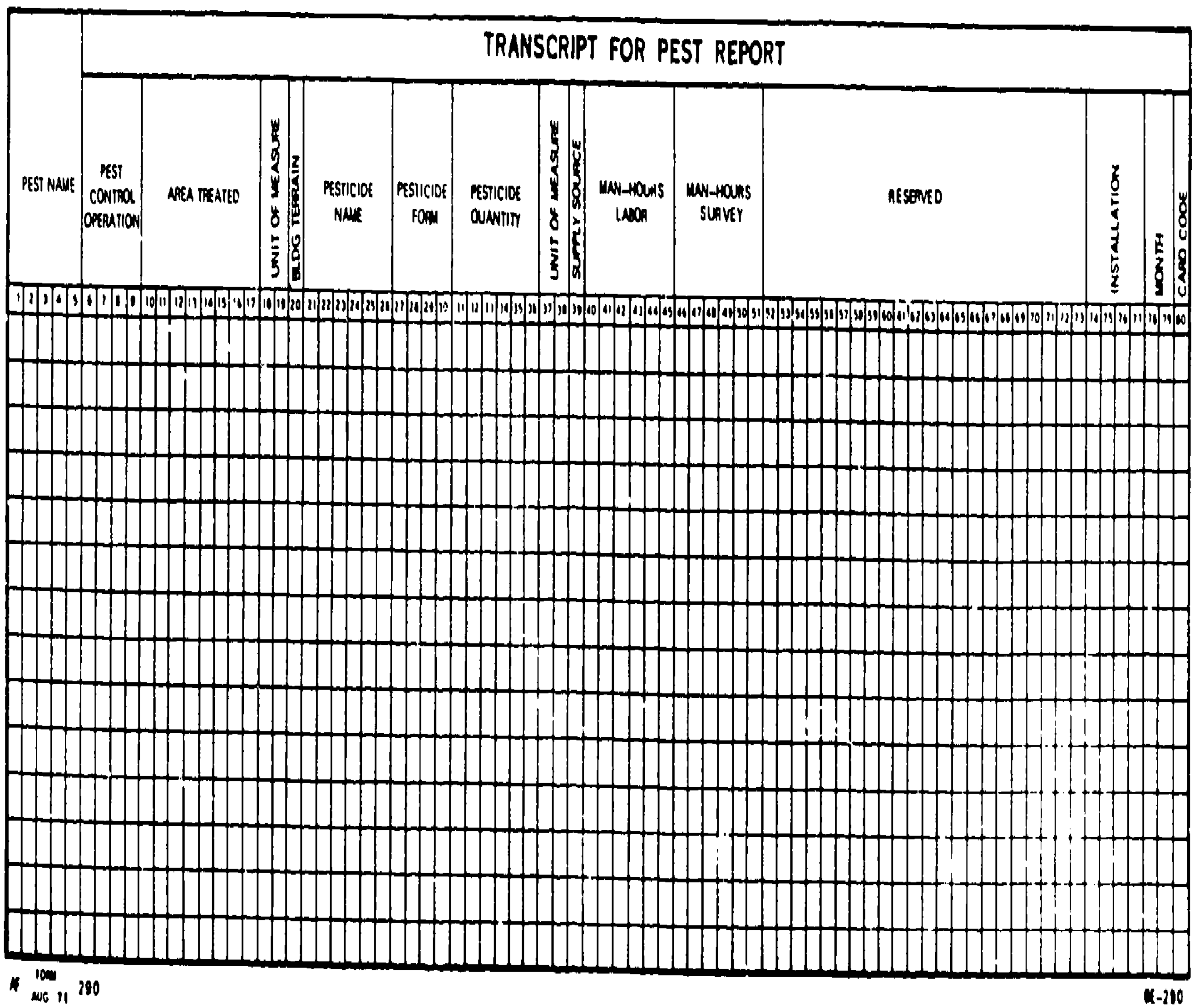

Figure 2-30. AF Form 290 (objective 229, exercise 5).

On 11 April 1984 the base parade grounds, which is 1 acre, was treated for chinch bugs. Since chinch bugs are vegetative juice-sucking pests and 1 acre is being treated, 200 gallons of a 0.5-percent emulsion finished spray is recommended. The finished spray was prepared from w gallons of a 47.5-percent diazinon emulsifiable concentrate, which contains 4 pounds of active ingredient per gallon and is a standard stock item.

Before the job was started, 1 hour (not considered man-hours of labor for this problem) was used conducting a survey. Then, it took two people 4 hours to mix and apply the pesticide. The supervisor observed the entire mixing and application operation to insure that the job was progressing smoothly and to observe the performance of the individuals.

NOTE: No entry is required for the installation data element in this exercise.

230. State the difference in use between AF Form 290 and DD Form 1532; indicate necessary entries for DD Form 1532, Pest Management Report, based on given information.

DD Form 1532, Pest Management Report. When you're keeping track of what pest management functions you conduct each day, you have more to do than complete DD Form 1532–1 and AF Form 290. You must also complete DD Form 1532, Pest Management Report (fig.2-31).

Purpose. At first, you may think this is just another pain-in-the-neck form to report pesticide use. This is true to an extent; you can see many similarities between this and AF Form 290. They're both used to identify pests controlled, types of operations you conducted, and types and amounts of pesticide used. There are, however, some important differences. Unlike AF Form 290, you can use the Pest Management Report to report both chemical and nonchemical control measures. Also, since this form is Federally mandated, if EPA officials should inspect your control operations, this is the form they would want to see.

Given its broader use than AF Form 290, this report can be an important tool in monitoring safety and effectiveness of your operations, and help you document actions you take that help protect the environment.

Completion procedures. To a degree, you can directly transcribe information from the Pest Management Maintenance Record since both of these forms use plain language. Nonetheless, we'll review DD Form 1532 in detail since there are differences in format between the two forms. Refer to figure 2-31 as you continue.

Before you enter pest management data on the form, you must put identification and address in the heading. In the top right corner, you'll see spaces for a C.D. code and UIC. Leave these spaces blank. In blocks 9 and 10, enter the last two digits of the calender year. In blocks 11 and 12, enter the numerical designation for the month. The second line of the form is self-explanatory.

Each line of DD Form 1532 can be used to report a complete pest management operation, as illustrated in figure 2-31. If only a single pesticide was used, you can easily enter the information. If two or more pesticides were used, or pesticidal forms were different, report each one as a separate operation. Then, for the work-hours spent. simply divide them equally for each pesticide.

The form is divided into specific fields and columns. We'll describe them in order as they appear on the form. Those small spaces and numbers under each column refer to data card entries sometimes used by other services and don't apply to this discussion.

Column A, pest name: Obtained from DD 1532–1.

Column B, operation name: Obtained from DD 1532–1.

Column C, total units treated: Obtained from DD 1532–1, units serviced.

Column D, unit: Use "SF" for square feet treated or "AC" for acres treated.

Column E, site: Enter "IN" for indoor treatment, or "OUT" for outdoor treatments. (NOTE: In column D, you must always use SF for indoor treatments and AC for outdoor treatments.)

Column F, pesticide name: Obtained from DD 1532–1.

NOTE 1: Use the chemical name instead of the product name as much as possible. For example, if you used "Roundup" herbicide for a job. you should record "Glyphosate" on DD 1532.

NOTE 2: You will complete Columns F through M only if you used a pesticide in the treatment.

Column G, pesticide form: Use pesticide form data codes from AFM 300-4; for example, SOLU for solutions, and SFUM for solid fumigants.

Columns H and I, pesticide amount and unit: The unit must be in whole pounds. If you entered dry ounces on DD 1532–1, convert them to pounds by dividing by 16, and round off your answer to the nearest whole pound.

Column J, final concentrate percentage: Self-explanatory. Leave this column blank if you complete the next two columns

Column K and L, rate per area unit: Use these columns only if the pesticide label directs you to apply the material in pounds per acre. In the percent column indicate the percentage of active ingredient identified on the product label, *not* the diluted percentage. These columns are particularly useful for identifying the amount of pesticide used in ultralow-volume (ULV) operations.

Column M, pesticide supply source: Indicate the supply source for the pesticide by entering one of the following codes:

- S - Standard stock pesticides or materials procured from the Defense Logistics Agency.
- N Non standard materials procured through open purchase.
- G - Pesticides obtained from the General Services Administration.
- C - Materials supplied by a contractor who also performed the work.

Column N, time: Indicate the hours devoted to all aspects of the operation, including inspections, preparation, travel time, application, clean-up, and supervision. If you conduct surveys independently of control operations, e.g., termite inspections, report them as separate operations.

REF: DODI 4150.7

PEST MANAGEMENT REPORT

C.D. CODE 1 2 | UIC 3 4 5 6 7 8 | 9 8 10 4 | 11 0 12 6 | REPORT CONTROL SYMBOL DD-M(A&R) 1080

NAME OF MAJOR OR REVIEWING COMMAND	ADDRESS	NAME OF REPORTING INSTALLATION	ADDRESS
HQ ATC/DEVP	Randolph AFB TX	Sheppard AFB TX	3750 CES/DEMYE

NO.	TARGET PEST	OPERATION				PESTICIDE								TIME
								APPLICATION			RATE (PER AREA UNIT)		SUPPLY SOURCE	
	NAME (a)	NAME (b)	TOTAL UNITS TREATED (c)	UNIT (d)	SITE (e)	NAME (f)	FORM (g)	AMOUNT (h)	UNIT (i)	FINAL CONC. % (j)	LBS. (k)	% (l)	ENTER S, N, O, C (m)	HOURS (n)
	13-16	17-19	20-24	25-27	28-30	31-33	34-36	37-41	42-43	44-47	48-53	54-64	66	65-71
1.	Mosquitoes	Granulating	17	Ac	OUT	Methoprene	Gran	2	lbs		0.25	100.0	N	6
2.	Rats	Baiting	6	Ac	OUT	Diphacinone	Bait	2	lbs	.005			S	2
3.	Roaches	Resid. Spray	5,400	SF	IN	Diazinon	Emul	1	lbs	0.5			S	1
4.	Spiders	Resid. Spray	2,000	SF	IN	Bendiocarb	Susp	1	lbs	0.5			N	1
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
16.														
17.														
18.														
19.														

DD FORM 1532 81 FEB S/N 0102-LF-001-5321 EDITION OF 1 OCT 1977 IS OBSOLETE (OVER)

Figure 2-31. Sample, DD Form 1532.

Exercises (230):

1. In what way can you use DD form 1532 that differs with how AF form 290 is used?

2. Indicate the information to be entered on DD form 1532 based on the following information:

   Two workers are assigned early morning responsibilities using a ULV generator to treat for adult mosquitoes. They use a 95.0 percent malathion solution applied at 0.5 pounds per acre, which was locally purchased. They work an 8-hour shift and treat 125 acres, using a total of 6 pounds of active ingredient.

What are the entries for each of the following columns? (Refer to figure 2-31 as needed.)

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.
m.
n.

231. Cite the purpose of AF Form 646, Pest Management Program Review; correlate various types of information entered on the form with sources for that information.

AF Form 646, Pest Management Program Review. As a pest manager, you may have to prepare this annual plan (fig. 2-32). It's purpose is to set pe . management goals and identify methods and resources you'll use in the coming year to meet those goals. As described in AFR 91–21, an AF Form 646 must be completed for each pest management project you expect to accomplish in the coming year. What is a project? It's a single chemical control method taken to control a single pest, for example:

- Diazinon for cockroach control.
- Baygon for cockroach control.
- Baygon for fly control.

Completion procedures. Fortunately, you don't have to be psychic to complete this review form, since you will largely determine future pest management activities based on past work and by considering what products you used.

Before you start preparing these reports, there are some materials you should collect to help you in this process. These items include:

- An adequate supply of AF Forms 646. You'll have to determine the amount based on the size of your installation, the number of pest species in the area, and the pesticides you use.
- Product labels for all the pesticides you plan to use in the coming year.
- DD Forms 1532–1 and 1070 on file.
- Quarterly pest management summary reports from the previous year.
- A comprehensive base map depicting lakes, ponds, ditches, etc.
- Past copies of AF Forms 1841, Maintenance Action Sheet, to identify past recurring work.
- Any correspondence where future programs are outlined.

Once you've gathered these materials, preparing the forms should be almost as easy as pushing a pencil. Refer to figure 2-32 to see how these materials benefit you as you continue this lesson.

Block 1. Refer to past quarterly reports for pest names. Also consider any plans (correspondence) to manage pests that are new to the area or didn't previously need control Consider *why* the pest should be managed; e.g., for health, morale, protection of resources, base beautification, etc.

Block 2. Refer to quarterly reports and product labels for necessary information. Don't forget the rule of completing a new form each time you use a different chemical.

Block 3. Refer to the pesticide label.

Blocks 4 and 5. Self-explanatory.

Block 6. You'll have to do some digging for this one. Look at DD Forms 1532–1 and 1070 for projects affecting future control efforts. What buildings do you expect to treat for termites, how big are they, and how many are there? How big are outside areas where the indicated pest will be managed?

Block 7. Refer to any AF Form 1841, Maintenance Action Sheet, to help determine months when controls will be used.

Block 8. Use the product label and base map to determine sensitive locations, both on and around the installation, if possible. Are you going to treat these locations with caution or avoid them completely?

Block 9. You're on your own here. Ask yourself questions such as:

- What special precautions are indicated on the label?
- What personal protective clothing and equipment will be needed?
- Does the program warrant coordination with higher base or civilian officials?

Exercises (231):

1. What is the purpose of AF form 646?

US AIR FORCE PEST MANAGEMENT PROGRAM REVIEW	INSTALLATION: Brushland AFB	COMMAND: ATC	DATE: 16 Dec 83
	PERSON TO CONTACT/AUTOVON NO.: TSgt Otto, AUTOVON 123-4567		

REFER TO AFR 91-21 BEFORE COMPLETION

Section	Item	Entry
OBJECTIVE	1. a. Project No. b. Target Pest c. Purpose *(Specify)*	a. BAFB - 25 b. Japanese Beetle c. Tree and ornamental protection
PESTICIDE	2. a. Active Ingredient(s) b. Trade Name c. Manufacturer d. EPA Registration No. e. Concentration	a. Carbaryl b. Sevin c. Union Carbide d. 10411 TN 01 e. 49%
APPLICATION	3. a. Form Applied *(dust, emulsion, gas, etc.)* b. Diluent	a. Emulsion b. Water
	4. a. Contract or In-house Application	In-house
	5. a. Method *(aerial, ground, manual, etc.)*	Ground application with mist-dust blower
	6. a. Acres or Other Units to be Treated b. Number of Applications c. Number of Sites d. Specific Identity of Sites	a. 550 acres b. 20 c. 2 d. Base area
	7. a. Month(s) of Year b. State	a. July-August b. Tennessee
SENSITIVE AREAS	8. a. Areas to be Avoided b. Areas to be Treated with Caution *(croplands, lakes, streams, food, human exposure, endangered species, etc.)*	a. None b. Bees, streams
REMARKS	9. a. Precautions to be Taken b. State and Local Coordination c. Other	a. Notify people in advance b. Coordinate with town officials c. Ensure operations don't impact local beekeepers d. Follow label instructions

AF FORM JUL 79 646

Figure 2-32. Sample, AF Form 646.

2. What constitutes a project?

3. Match the sources of information in column B with the correct block in column A. (Refer to figure 2-32 as needed). Items in column B may be used more than once or not at all.

Column A

____ (1) Block 1.
____ (2) Block 2.
____ (3) Block 3.
____ (4) Block 4.
____ (5) Block 5.
____ (6) Block 6.
____ (7) Block 7.
____ (8) Block 8.
____ (9) Block 9.

Column B

a. Pesticide labels.
b. DD Form 1532-1 or 1070.
c. Quarterly reports.
d. Base map.
e. AF Forms 1841.
f. Correspondence affecting programs.
g. Other source.
h. No source needed.

Safety, Protective Equipment, and First Aid

PESTICIDES ARE only as safe as you are, because pesticides don't cause accidents; people do! Accidents involving pesticides can be eliminated just as all other accidents can, if everyone will be aware of accident prevention and adhere to all preventive measures without deviations.

This chapter will identify the requirements and guidelines for handling pesticides safely. And, since people will make mistakes and pesticide poisonings do occur, this chapter will discuss the common causes of these poisonings and the actions to be taken when they occur.

3-1. Federal Statutes and Regulations

Without pesticides, we would not have the food, fiber, and landscape plants we need. But because pesticides can be dangerous, Congress has passed laws regarding pesticide use. These laws try to balance the need for pesticides against the need to protect people and the environment from their misuse.

The intent within this section is to identify the federal agencies that establish and enforce laws governing all phases of pesticide handling.

232. Cite the purpose and characteristics of the FIFRA.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This act was first established by Congress in 1947 and was administered by the United States Department of Agriculture (USDA), Agricultural Research Service, Pesticides Regulation Division.

Purpose. This act was established to provide laws pertaining to the certification of the usefulness of chemicals used in agriculture, specified requirements for safety precautions in handling and applying agricultural chemicals, and specified requirements for the registration of such chemicals every 5 years.

Scope. There have been five amendments to this act since the basic act was established. The first amendment occurred in 1959 to include nematodes, plant growth regulators, desiccants, and defoliants; and then in 1963, it was amended again to require labels of economic poisons to provide the statement "Keep Out of Reach of Children" and to eliminate claims such as "Safe," "Nonpoisonous," "Nontoxic," "Noninjurious," and "Harmless" from economic poison labels.

Then, on 12 May 1964, there were two amendments to the FIFRA passed by Congress. The first of these was Public Law 201, which eliminated the protest registration clause of the basic act. The second amendment enacted on 12 May 1964 was Public Law 305, which established the requirement for each pesticide label to show a registration number when the pesticide has been approved by the USDA for registration.

Exercises (232):

1. State the three purposes identified in the text for establishing the FIFRA by listing them in the order given.

   (1)

   (2)

   (3)

2. The amendment to the FIFRA that was enacted in 1963 required all economic poison labels to provide what statement?

3. The FIFRA was first amended to include ________ , ________ , ________ , and ________ .

233. Specify the relationship of the FIFRA and the FEPCA and identify the purpose and requirements outlined in the FEPCA.

Federal Environmental Pesticide Control Act (FEPCA). The FEPCA was amendment number 5 to the FIFRA passed by Congress and became Public Law 92–516, which is most often identified as "FIFRA, as amended."

Purpose. The FEPCA became law on 21 October 1972 to extend federal registration and regulation to all pesticides, including those distributed or used within a single state.

Scope. The FEPCA requires that you properly apply pesticides to insure greater protection to people and the environment. It prohibits using any registered pesticide in a manner inconsistent with labeling instructions, and it also specifies that pesticides must be classified as either general or restricted.

Under the provisions of the FEPCA, every commercial and private applicator must be certified as competent to use any of the pesticides that are classified as restricted. FEPCA also provides penalties such as fines and jail terms for people who do not obey this law.

As a pest management specialist, you are governed by this act since you're classified as a commercial applicator of pesticides. As a result of this, you will be required to be certified to apply restricted-use pesticides, and you are subject to the penalties prescribed if you do not adhere to the law.

To be certified, you must prove that you know the safe and correct way to apply restricted use pesticides. To do this, you take a written examination. Therefore, the more you study this CDC the more knowledgeable you will be when test time comes.

The civil penalties that you are subject to if you violate the FIFRA may be a fine of up to $5,000 for each offense, and the criminal penalties may be as much as $25,000 or 1 year in prison, or both.

Exercises (233):

1. The relationship of the FEPCA to the FIFRA is that the FEPCA is actually an ________ to the ________ .

2. What is the purpose of the FEPCA?

3. Identify the requirements that were outlined in the FEPCA which had not been outlined previously in the FIFRA by placing an X in the space beside each statement that applies.
   ____ a. Requiring certification of the usefulness of chemicals employed in agriculture.
   ____ b. Requiring the inclusion of nematodes, plant growth regulators, desiccants, and defoliants.
   ____ c. Included provisions for penalties in case of pesticide misuse.
   ____ d. Requiring the classification of pesticides as being restricted or general.
   ____ e. Requiring the statement "Keep Out of Reach of Children" be printed on the pesticide label.
   ____ f. Requiring each commercial and private applicator of pesticides to be certified competent.
   ____ g. Requiring the registration of each pesticide by the USDA.

234. Specify the purpose and scope of the Resources Conservation and Recovery Act (RCRA) of 1976.

Resources Conservation and Recovery Act of 1976 (RCRA). This act was previously known as the Solid Waste Disposal Act (PL 94–580).

Purpose. This law recognizes the need for careful planning and management of solid or hazardous waste to prevent endangering human health and the environment. The Act was designed to help give assistance for developing management plans and facilities. Plans developed under this act address issues such as:

- Recovering energy and other resources from solid waste.
- Guidelines for safely disposing of hazardous wastes.
- Regulating hazardous waste management.

Scope. In recent years, the media has given increasing attention to problems caused by illegal hazardous waste dumps. Problems caused by these dumps have forced the government to devote much time and money to how these areas can be cleaned up and to how people can be protected. This may suggest to you that the problems are created only on a very large scale, but this is not the case; some states estimate having virtually hundreds of unregistered, illegal toxic waste disposal sites of all sizes.

To help combat this problem, the RCRA has many environmental protection objectives. One objective, which directly affects you, regulates the treatment, storage, transportation, and disposal of hazardous wastes.

Under the RCRA, it is a criminal action to knowingly treat, store, or dispose of any hazardous waste without a permit. If you should violate this law, you may be subject to a fine of up to $25,000 for each day of the violation, imprisonment for up to 1 year, or both.

Exercises (234):

1. What was the RCRA designed to help prevent?

2. What four areas of handling hazardous wastes are covered by the RCRA?

235. State the purpose for creating the EPA and identify the scope of its functions.

Environmental Protection Agency (EPA). The EPA is the prime regulatory, research, and educational agency with the knowledge and capability to control all environmental pollutants. This agency includes organizations concerned with pesticides, or their effect on the environment, which were previously parts of the Council on Environmental Quality, the Atomic Energy Commission, and the Departments of Agriculture, Interior, and Health, Education, and Welfare.

Purpose. The EPA was created in 1970 by Congress as a result of the continuing pressure to limit the use of pesticides and to combine all activities of the Federal Government concerned with pesticides and their effects on the environment into a single agency.

Scope. This agency has responsibility for researching, developing, and enforcing standards prescribed by law for emissions and effluents; evaluating and registering pesticides and developing new pest management procedures; controlling toxic and poisonous substances; developing new methods in pollution control; and insuring that adequate technical personnel requirements are developed.

As a result of combining all the organizations identified above into a single agency, the EPA now has the responsibility for enforcing the FIFRA, as amended (FEPCA). These responsibilities include, but are not limited to, registering each and every pesticide, classifying pesticides, prosecuting individuals for misuse of pesticides, and insuring that minimum standards for certification are established and obeyed.

Exercises (235):

1. What was the purpose for creating the EPA?

2. Of the statements provided, identify the ones that pertain to the functions of the EPA by placing an X beside applicable statements.

____ a. Approves and registers all pesticides for their uses.
____ b. Enacts laws pertaining to pesticides.
____ c. Enforces the FEPCA.
____ d. Responsible for developing new pest management procedures.
____ e. Certifies all personnel as being competent to apply pesticides.

236. Identify the governing department for the OSHA and its purpose; state the scope of the OSHA pertaining to its functional responsibilities.

Occupational Safety and Health Administration (OSHA). OSHA is an organization that operates under the U.S. Department of Labor (USDL) with regional offices established throughout the United States.

Purpose. The purpose of the OSHA is to make sure all employees have safe and healthy working conditions. As you will see in section 3-2 of this chapter, there are many requirements established by the OSHA to insure safe pest management operations.

Scope. The OSHA has authority to develop and publish occupational safety standards; inspect work areas to insure that standards are met; issue citations for noncompliance with its regulations; and maintain education, training, and information programs to promote safe practices.

This administration is a very valuable source to obtain assistance in establishing safe working conditions for you and your fellow workers.

Exercises (236):

1. What is the governing department for OSHA?

2. State the purpose for OSHA.

3. List the functional responsibilities of OSHA.

   a.

   b.

   c.

   d.

237. Identify the governing department and purpose for the NIOSH and list the functions and responsibilities within its scope.

National Institute for Occupational Safety and Health (NIOSH). The NIOSH is an organization that operates under the U.S. Department of Health and Human Services (USDHHS).

Purpose. The NIOSH prepares new or improved occupational safety and health standards and provides qualified personnel to enforce these standards.

Scope. This organization develops new or improved occupational safety and health standards and conducts educational programs to provide an adequate supply of qualified personnel to carry out these standards.

The NIOSH also has responsibility for testing and approving many items of personal safety protective equipment required in pest management operations that formerly was the responsibility of the U.S. Bureau of Mines. This will be brought to your attention in section 3–2 of this chapter when respiratory protective devices are discussed.

Exercises (237):

1. The NIOSH is an activity that is controlled by what department?

2. The NIOSH was formed to (enforce occupational and health standards) or to (formulate improved occupational and health standards). Underline the correct purpose.

3. Name a responsibility of the NIOSH identified in the text that is directed toward you as a pest management specialist.

238. Describe how statutes and regulations of the EPA and OSHA relate to state and local control over Air Force pest management programs.

State and Local Statutes and Regulations. Although the EPA establishes the minimum Federal requirements for environmental protection and the OSHA establishes the minimum Federal requirements for safe working conditions, State and local governments have the perogative of establishing more stringent requirements for environmental protection and safe working conditions.

As an Air Force pest manager you must be very knowledgeable of the laws established within the State and community to which you are assigned. You must perform all pest management functions within the laws established by the State and local government, if their laws are more stringent than Federal laws.

Exercises (238):

1. When can the State and local governments override Federal statutes and regulations established by the EPA and the OSHA in regard to protecting the environment and employees?

2. Based upon the information contained in this lesson, you, as an Air Force pest manager, must adhere to which requirements?

3-2. Handling Pesticides Safely

As a pest management specialist, it is your responsibility to take every precaution available during all phases of pesticide handling to protect yourself, fellow workers, and others and to prevent accidental destruction of property through negligence.

Since all pesticides are toxic to some form of life and many are explosive and flammable, they present many hazards to the environment in one way or another or a combination of ways. These hazards can be reduced to almost nonexistent if you and everyone else will follow the basic precautionary rules for handling pesticides.

This section will identify and explain pesticide labels and will identify the facility requirements for entomology sections and the safety requirements to be adhered to during all phases of pesticide handling.

239. Specify necessary functional areas for pest management facilities and describe requirements for those areas.

Safety Requirements for Pest Management Shops. Having a proper pest management facility is often just as important as using protective equipment when you apply chemicals. But getting a safe facility isn't always easy, due to financial constraints. Luckily, in the past few years, regulations have been "beefed up" to improve opportunities for upgrading pest management facilities.

There are three basic aspects you need to consider to determine if your shop complies with Federal and Air Force standards. These are the facility location, its layout, and general requirements.

NOTE: There are several references in this lesson to requirements your shop *must* meet and items that are *essential*. More information on these requirements can be found in guidance from EPA Codes of Federal Regulations (CFRs) and Air Force Regulations.

Facility location. Pest management shops should always be isolated from congested base areas to reduce environmental hazards in the event of a fire or pesticide spill. If your base is building a new facility, this is a firm requirement. The most compelling of reasons for this is fire safety. If your shop is located in a building complex and catches fire, much more time would be needed to decontaminate nearby areas of toxic vapors, smoke, liquid, and particles. This condition is confined to the facility itself and nearby unoccupied areas when the shop is isolated.

Also, sharing a pest management building with other CE shops is strongly discouraged. In addition to increased environmental hazards, shop security is compromised. When you think about all the toxic materials you use—and must store—it's easy to see that "cohabitation" of your shop with other sections reduces security and safety, and it exposes many more people to fire, spills, and other hazards.

Facility layout and design. Your shop should be divided into clean areas and chemical-handling areas. The clean areas include office space, personnel break rooms, and utilities. Chemical-handling areas include pesticide storage and mixing rooms. There should be a dressing room to be a transitional area between the other two areas. It has room for lockers and storage for personal safety equipment. Your change room should *not* be used as an eating space at lunchtime, since some pesticide particles from clothing enter the room. If workers eat lunch at the shop, they should do it in the office, outside, or in another suitable clean area.

Office. Office space with a desk, bookcase, file cabinet, and telephone is *essential*. You should also have a table with one chair per worker for completing necessary paperwork, safety meetings, etc. There should not be any direct access between the office and chemical-mixing area. The office and other clean areas *must* be adequately sealed or separated to exclude pesticide vapors and dusts.

Change room, lavatory, and shower areas. Personnel locker space is *essential*, and each worker should have two lockers; one for street clothing, the other for work clothing and protective equipment (safety equipment must always be stored separately from pesticides).

Adequate toilet facilities (one water closet per 15 employees) are *essential* and must be located in the cleanup area. A hot-water shower *must* be provided for personal decontamination at day's end.

As you previously learned, change rooms serve as transition areas. These rooms should have direct access to the office, lavatory and shower, and the pesticide mixing area (see fig. 3-1). The change rooms should be designed to accommodate both male and female employees.

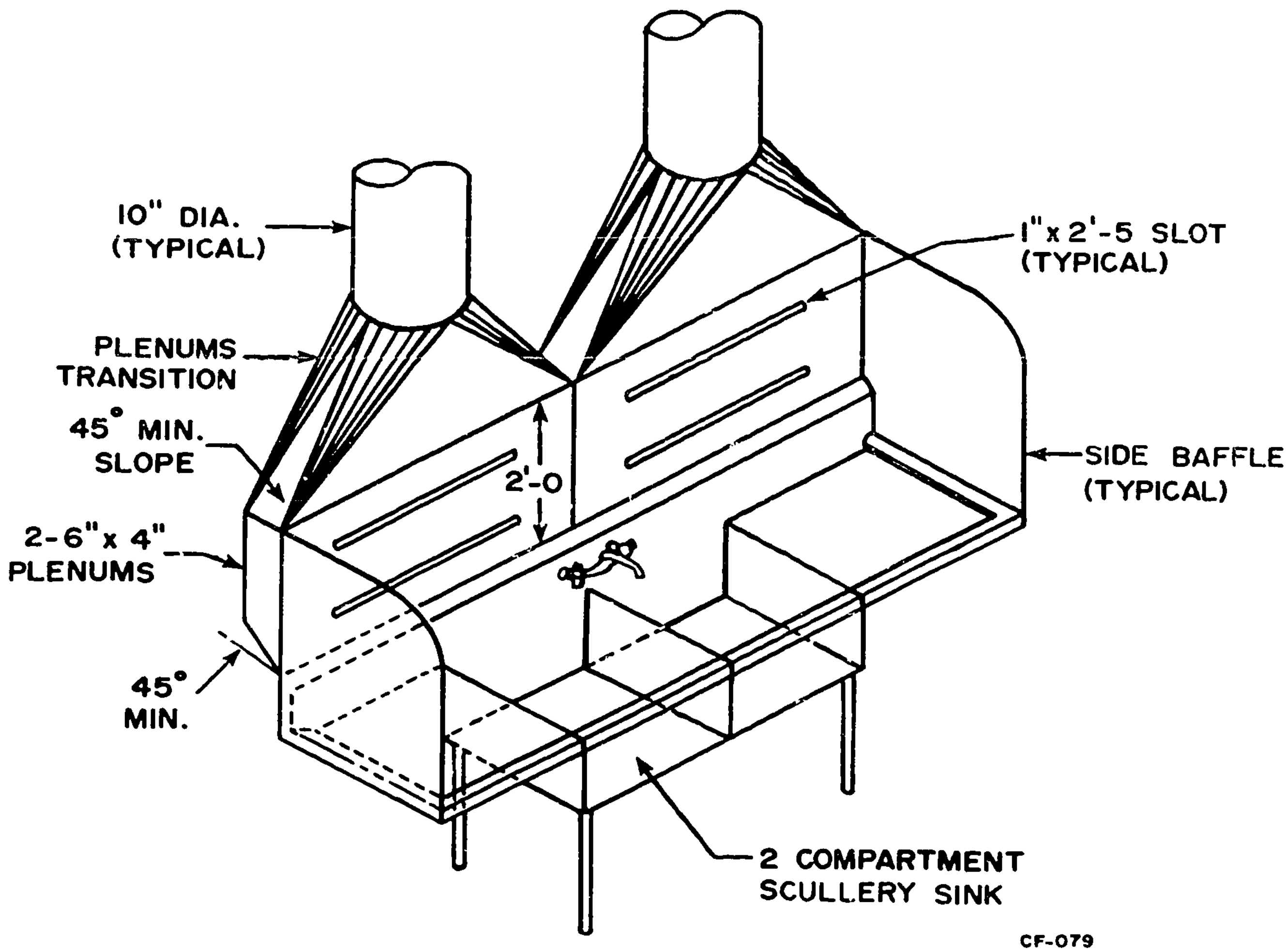

Figure 3–1. Mixing room sink and ventilation system.

Since you must wash contaminated and uncontaminated clothes in separate loads, your shop *must* have a washer and dryer. You can install them in the change or utility rooms, but *never* in chemical mixing or storing areas.

Pesticide mixing room. A work area for diluting pesticidal concentrates is *essential*. Since this is a high-hazard area where you're exposed to concentrated pesticides, there are several important requirements:

- A deep sink is *essential* to mix pesticides and wash small equipment.
- The sink area *must* have a ventilation system designed to draw air away from the worker's position at the rate of at least six air changes per hour (fig. 3-1).
- A deluge shower and eyewash lavage is *essential* in case someone is contaminated with pesticides. These items must be readily accessible to workers mixing pesticides indoors or outdoors.
- Doors leading to this and the pesticide storage room should be self-closing and self-locking.
- Walls and partitions should be coated with a nonabsorbent finish to help cleanup efforts if pesticides are spilled or splashed.

A spill kit should be available. See table 3-1 (shown later in this section).

Pesticide storage rooms. Pesticide storage facilities are *essential* if you are to safely protect and store toxic materials. The room should be versatile because pesticides come in several different sizes and types of containers. All pesticidal containers *must* be stored inside and off the floor so all labels are clearly visible, and there *must* be lanes to give workers easy access to inspect and use pesticides. If possible, keep phenoxy herbicides separate from insecticides.

The floors of pesticide storage rooms *must* be constructed of concrete or another impervious material to ease cleanup operations, and *must* have a nonslip surface. This floor should also be covered with a nonskid epoxy sealer and have a continuous curb at least 5 inches high. There should be no floor drains where y[illegible] or mix) pesticides. The pesticide storage area n[illegible] provided at least two air changes per hour.

Equipment storage and maintenance. In addition to all the aspects of storing and handling pesticides, there are also some important requirements for storing and maintaining equipment. Always keep in mind that, from the first time you use any pesticide dispersal item, parts of it will be contaminated with chemicals; handle that item with care.

Depending on your shop's arrangement or your needs, you can incorporate equipment and pesticide areas. If you do this, however, make sure that the area you use meets all necessary requirements for both areas.

Here are three requirements for the equipment storage and maintenance area:

(1) An indoor area for storing and maintaining small equipment *must* be provided.

(2) A covered or enclosed area for large equipment *must* be located next to the pesticide mixing and storage building to aid workers who handle and prepare pesticides, and to protect equipment from the weather.

(3) An area paved or lined with impervious material *must* be located next to your shop for washing pesticide dispersal equipment. This area *must* be curbed to prevent contamination from spills. Closable drains to the sanitary sewer are recommended.

General construction requirements. There are some other general requirements and considerations for your shop with which you should be familiar. These have to do with such items as security, signs, ventilation, plumbing, and electrical systems. However, since you're being trained as a pest manager and not an architect, we'll discuss only those items important in your everyday duties.

a. A climb-resistant fence *must* completely enclose the pest management facility. If your shop is located within the CE compound and the compound is sufficiently fenced, this is satisfactory.

b. Identification signs such as DANGER, POISON, and PESTICIDE STORAGE *must* be placed on appropriate rooms, buildings, and fences to advise personnel of the contents and the hazardous nature of the area.

c. A list of types of pesticides stored *must* be posted outside the chemical storage rooms(s).

d. Ventilation systems in chemical storage and mixing areas should provide 100 percent outside air.

e. Pesticide storage areas *must* contain water and other materials used to fight fires.

f. You can avoid having explosion-proof fixtures, equipment, etc., by only using pesticides that have flash points of 100° F or more.

Exercises (239):

1. What three aspects should you consider in determining if your shop meets Federal and Air Force standards?

2. Where should pest management shops be located? Why?

3. What two areas should the layout of your shop include?

4. What rooms comprise clean areas?

5. What rooms comprise chemical-handling areas?

6. What room acts as a transitional area and what should it include?

7. Briefly describe ventilation requirements for the pesticide mixing room.

8. Where should the deluge shower and eyewash be located?

9. How should pesticides be stored?

10. List three features the pesticide mixing room floor must or should have.

    (1)

    (2)

    (3)

11. Briefly state the three requirements the pesticide storage area must meet.

    (1)

    (2)

    (3)

12. How can you avoid having explosionproof fixtures and equipment in your shop?

240. State the purpose and uses of pesticide labels, identify parts of a label, and interpret signal words that may appear on labels.

Pesticide Labels. Each and every pesticide is required to be registered by the EPA, and each pesticide container must be labeled.

The EPA has established strict regulations requiring a minimum of information to be furnished by the manufacturer and printed on each pesticide container label before it can be registered.

You have probably already noticed the frequency in which the pesticide label has been referred to in the previous portions of this text, and it will be referred to over and over again in the remaining portions because the pesticide label is the most important and informative source for pesticide uses and the safe-handling precautions.

Purpose of pesticide labels. The pesticide label serves the same purpose as an Air Force regulation and you must strictly adhere to it. Any deviation that would be to a lesser degree than the information provided by the pesticide label subjects you to the same punishments as the disobeyance of an Air Force regulation would. In addition, you will be subject to a fine, imprisonment, or both under Federal laws governing the use of pesticides. However, you are encouraged to take more precautionary measures than stated on the pesticide label. In fact, more such precautionary measures are sometimes required by other regulations.

Remember that the EPA has only established minimum standards you must follow when handling pesticides, and other agencies can establish and enforce stricter standards.

Using pesticide labels. The pesticide label is used as a guideline for the safe storage, mixing, uses, application and disposal of that specific pesticide and its container. These guidelines must be recognized as the very minimum standard that must be met, but the standard can be increased. The specific recommendations for the uses and actual mixing and application rates that are provided on the pesticide label must not be deviated from under any circumstance. All other recommendations pertaining to pesticide use, formulation, and application such as the pesticide use recommendations in AFM 91–16, and in AFM 91–19, must be recognized as being only general recommendations that may be obsolete and no longer applicable.

When you find contradictory information between the recommendation provided on the pesticide label and pesticide recommendations provided in the CDC, AFM 91–16, *Military Entomology and Operational Handbook*, and AFM 91–19, *Herbicide Manual for Noncropland Weeds*, always follow the recommendations on the label.

Remember that pesticide manufacturers expend much time, effort, and money in conducting research on their products, and they are the authoritative source!

Parts of the label. As previously stated, EPA requires that certain information concerning each pesticide be provided on every pesticide container label.

To help you recognize and identify the type of information given on a typical pesticide container label, a specimen label and explanations concerning the parts of a typical pesticide label are provided below. (NOTE: figure 3-2 is provided for your reference throughout the discussion concerning the parts of a typical pesticide container label.)

a. Brand name. Each company has brand names for its products and this is the most identifiable name. This name is the one that appears in ads and is identified vividly on each pesticide label, as shown beside the number 4 in figure 3-2.

b. Common name. Many pesticides have complex chemical names. Some have been given another name to make them easier to identify. These are called common names. For instance, carbaryl is the common name of 1–napthyl N–methylcarbamate. A chemical made by more than one company will be sold under several brand names, but you may find the same common name or chemical name on all of them. There is no common name for the pesticide on the illustrated pesticide label, but the chemical name is identified directly beneath the active ingredient beside the number 7.

c. Ingredient statement. Every pesticide label must list what is in the product. The list is written so you can quickly see what the active ingredients are. The amount of each active ingredient is given as a percentage by weight or as pounds per gallon of concentrate. It can be listed by either the chemical name or the common name. The inert ingredients need not be named, but the label must show what percent of the contents they make up. This statement is identified beside the number 7 in figure 3-2.

d. Net contents. The net contents number tells you how much product is in the container. This quantity may be expressed in gallons, pints, pounds, quarts, or other units of measure. The net contents line is identified beside the number 8. If the label was actual, there would be a quantity entered on the line.

e. Name and address of manufacturer. The law requires the producer or distributor of a product to put the name and address of the company on the label. This is so you will know who made or sold the product. This information is beside the number 9.

f. Registration and establishment number. A registration number must be on every pesticide label. It shows that the product has been registered with the Federal Government. It usually is found on the front panel of the label and will be written as "EPA Registration No. 000." The establishment number tells what factory made the chemical. This number does not have to be on the label, but will be somewhere on each container. The EPA registration and establishment numbers are identified beside the numbers 10 and 11, respectively, in figure 3-2.

g. Directions for use. The instructions on how to use the pesticides are an important part of the label to you. This is the best way you can find out the right way to apply the product. The use instructions will tell you:

- The pests the product is registered to control. (Labels use common names for pests. Knowing these names will help you choose the proper pesticide and find control information.)
- The crop, animal, or other item on which the product can be used.
- Whether the product is for general or restricted use.
- In what form the product should be applied.

1 -------- DIRECTIONS FOR USE

Avitrol is a pesticide for the control of certain species of pest birds. It is composed of a choice bird food impregnated with an active bird management chemical.
2 - Birds ingesting Avitrol react with distress symptoms and calls. By limiting the amount of bait available to relatively few birds, the remainder of the flock can be frightened away from most roosts and feeding sites with a minimum of mortality. For best results the applications should be made at the proper time and place under the direction of trained personnel.

Prefeeding with untreated feed of the same composition as the Avitrol carrier is usually essential to the effective deterrence of birds with Avitrol. Careful observation of bird habits should be made to establish proper feeding locations and to determine that no desirable or protected bird species are present that may feed on Avitrol. After pest bird feeding is established, immediately replace untreated grain with Avitrol. Repeat Avitrol treatment until bird numbers have been reduced to acceptable levels on the premises.

Avitrol grain is lethal to most birds that ingest enough to cause flock-frightening symptoms. To obtain the desired minimal mortality, the distribution of Avitrol grain should be limited to scattered spot placements that will provide feeding opportunity for the necessary number of demonstrating birds. The remainder of the feeding area may be covered with untreated grain to provide desirable dilution.

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3 - AVITROL MUST NOT BE EXPOSED IN ANY MANNER THAT MAY ENDANGER DESIRABLE AND PROTECTED BIRD SPECIES. IF THERE IS A QUESTION OF SUCH HAZARD, CONSULT LOCAL, STATE, AND FEDERAL GAME AUTHORITIES BEFORE UNDERTAKING BIRD MANAGEMENT WITH AVITROL. INVESTIGATE LAWS THAT MAY PROHIBIT THE USE OF ANY TOXIC CHEMICAL IN BIRD CONTROL.

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4 ----- Avitrol®

WHEAT

5 --- For the Control of
SPARROWS, CERTAIN BLACKBIRDS
AND COWBIRDS IN, ON
OR IN THE AREA OF STRUCTURES
NESTING AND ROOSTING SITES

6 - For use by, or under the supervision of government agencies or pest control operators. Not for sale to the public.

7 ----- Active Ingredient

4-Aminopyridine			0.5%
Inert Ingredients			99.5%
	Wheat	99.31	
	Hydrogen Chloride	0.19	

8 --- Net Contents ---------------------------- lbs.

9 ---- AVITROL CORPORATION
TULSA, OKLAHOMA

10 ------ EPA Reg. No. 11649-1
U.S. Patent 3,150,041

11 ------ EPA Est. 11649-OK-1

CAUTION

12 ------

KEEP OUT OF REACH OF CHILDREN

May produce toxic symptoms if swallowed or by contact with the skin. Handle with protective gloves. Wash
13 - thoroughly with soap and water after handling, before eating or smoking. Change to clean clothing after handling. If swallowed, [illegible] vomiting [illegible] a
14 - physician. Do not feed to live[illegible] chickens. Do not mix with grain for livestock [illegible] for human con-
15 - sumption. Do not contaminate streams, lakes, or ponds with the material. Do not allow this material to remain in unprotected places after control measures are
16 - completed. Do not use where food (grain or meat) will become contaminated.

Do not reuse empty container. Destroy
17 - it by burying with waste or burning.
Stay away from smoke or fumes.

NOTICE: Buyer and/or user assumes all risks of use and/or handling of these materials contrary to label instructions.

Figure 3-2. Typical pesticide label.

* How much to use.
* Where the material should be applied.
* When the material should be applied.

This information is identified beside the numbers 1 and 5 in figure 3-2.

The misuse statement is to remind you that it is a violation of Federal law to use a product in a manner inconsistent with its labeling. Do not use a product on a crop or for a pest not listed on the label. Do not use it at more than the recommended rate. Before the product could be registered, EPA required the manufacturer to conduct many tests to be sure the label directions were correct. By following them exactly, you will:

* Get the best results the product can give.
* Avoid breaking the law.

This information is identified beside the number 3 in figure 3-2.

A reentry statement, if required for the product, will tell you how much time must pass before an area treated with the pesticide is safe for reentry by a person without protective clothing. Consult an authoritative source for special rules that may apply. The specimen label shown in figure 3-2 does not have a reentry statement because it is not applicable.

The category of applicator, if required for the product, will limit use to certain categories of commercial applicators. Although this information is not readily identifiable, it is included beside the number 6

Storage and disposal directions must be provided on each pesticide container label to tell you how to store and dispose of the product and empty containers.

This information is identified on the specimen label beside the number 17.

h. Signal words and symbols. In order to do their job, most pesticides must control the target pest. By their nature, they are toxic. Therefore, some may be hazardous to people. You can tell the toxicity of a product by reading the signal word and looking at the symbol on the label.

The signal word is one of the most important parts of the label. It tells you approximately how toxic the pesticide is to humans. The signal words, as shown in figure 3-2, are established by law, and each manufacturer is required to use the current one on each and every label. In addition to the signal word, the statement "Keep Out of Reach of Children" must be included on every label.

The signal word along with the statement is identified beside the number 12, in figure 3-2.

Note in figure 3-2 the signal word CAUTION is contained on the specimen label. This product has a low toxicity or is comparatively free from danger to humans.

The symbol is one of the best ways to catch a person's eye, and this is why a skull and crossbones symbol is used on all highly toxic pesticides along with the signal word DANGER and the word POISON.

The specimen label provided in figure 3-2 does not have a skull and crossbones because the product is not highly toxic.

i. Types of formulation. Different types of pesticide formulations (such as liquids, wettable powders, and dusts) require different methods of handling. The label will tell you what type of formulation the package contains. The same pesticide may be available in more than one formulation. Although this information is not readily identifiable on the specimen label provided, it can be seen beside the number 2.

j. Precautionary statement. The precautionary statement will provide you with information concerning the hazards to humans and domestic animals, environmental hazards, and physical and chemical hazards. This information will be included on the pesticide label if applicable to the product.

The hazards to humans and domestic animals statement will tell you the way in which the product may be poisonous to humans and animals. It also will tell you of any special steps you should take to avoid poisoning, such as the kind of protective equipment needed. If the product is highly toxic, this section will inform physicians of the proper treatment for poisoning. This type of information is identified beside the number 13 in figure 3-2.

The environmental hazards statement is included on pesticide labels to assist you in avoiding wrong or careless use of the product to prevent environmental damage. Examples of this type of information are as follows:

* "This product is highly toxic to bees exposed to direct treatment or to residues on crops."
* "Do not contaminate water when cleaning equipment or when disposing of wastes."
* "Do not apply where runoff is likely to occur."

Labels may contain broader warnings against harming birds, fish, and wildlife. This information is identified beside the number 15 on the specimen label.

The physical and chemical hazards statement will warn you of any special fire, explosion, or chemical hazards that may be presented by the product. This information has not been included on the specimen label.

k. Statement of practical treatment. If swallowing or inhaling the product or getting it in your eyes or on your skin would be harmful, the label will specify emergency first aid measures. It also will describe the types of exposure that require medical attention.

The pesticide label is the most important information you can take to the physician when you think someone has been poisoned. The statement of practical treatment is identified beside the number 14 on the sample label.

l. Statement of classification. Once EPA has finished the process of classifying all pesticides as being in either the general use or restricted use category, all manufacturers of pesticides will be required by law to identify each of their products by providing this information on each of their product labels. EPA is classifying pesticides into the categories on the basis of:

* The hazard of poisoning.
* The way the pesticide is used.
* Its effect on the environment.

The general use category is for pesticides that present very little or no hazard to the applicator or the environment when used exactly as identified by the information on the label. The label on the general use pesticides will read "General Classification."

The restricted use category is for pesticides that could cause some human injury or environmental damage even when used as directed on the label. The label on these products will state: "Restricted use pesticide for retail sale to and application only by certified applicators or persons under their direct supervision." The restricted use statement must be at the top of the front panel of the label. The specimen label that is illustrated in figure 3-2 does not contain the information pertaining to its category of use because it has not been developed.

As you have seen, the pesticide label contains much information, although some of it is not readily depicted. You must train yourself to always read the pesticide container label and follow all instructions provided on this document to protect all environmental elements as much as possible.

Exercises (240):

1. What is the purpose of pesticide labels?

2. The pesticide label is used as a guideline for what?

3. A skull and crossbones is used on what type of pesticides?

4. Matach each subject in column B with its identification in column A.

	Column A	*Column B*
____ (1)	EPA Reg. No. 1169–1.	a. Brand name.
____ (2)	99.5 percent inert.	b. Common name.
____ (3)	If swallowed induce vomiting and call a physician.	c. Ingredient statement.
____ (4)	DANGER.	d. Net content.
____ (5)	Avitrol.	e. Name, address of manufacturer.
____ (6)	Restricted use pesticide for retail sale to and application only by certified applicators.	f. Registration and establishment number.
____ (7)	Avitrol. Tulsa. Oklahoma.	g. Directions for use.
____ (8)	Handle with protective gloves.	h. Signal words and symbols.
____ (9)	Carbaryl.	i. Precautionary statement.
____ (10)	Pellet form.	j. Type of formulation.
____ (11)	3 pounds.	k. Statement of practical treatment.
____ (12)	When it should be applied.	l. Statement of classification.

241. Specify selected pesticide storage precautions and requirements.

Precautions for Storing Pesticides. To reduce or prevent explosion and fire hazards and to protect yourself and others from pesticide poisoning while pesticides and equipment are being stored, the following precautions must be taken:

(1) Pesticides must be stored in accordance with label recommendations.

(2) All pesticide and pesticide dispersal equipment storage areas must be kept locked when not in use.

(3) Pesticides must be stored out of reach of children.

(4) Exhaust ventilation must be turned on prior to entering storage areas.

(5) The "no-smoking, eating, or drinking rule" must be observed while in storage areas.

(6) Unlike pesticide substances must be stored separately.

(7) Excess, illegal, and expired shelf-life pesticides must be segregated and stored separately according to the method of disposal.

(8) Each storage area must be properly identified as to the type of substance it contains and the appropriate sign placed outside the door.

(9) Warning signs that read "Warning—Pesticide Storage" or other similar signs must be posted on each visible side of the storage area.

(10) A list of chemicals within the storage areas must be posted on the outer surface of each door.

(11) Names, addresses, and phone numbers of individuals to contact in case of emergency must be posted on the outer surface of each door.

(12) Fire protection procedures must be posted on outer wall near the door.

(13) Cleanup procedures for pesticide spills and for the disposal of contaminated items must be posted.

(14) Pesticides must be continually stored in containers that are sound.

(15) All pesticide containers must be labeled and plainly visible.

(16) Combustible materials must be labeled as such.

(17) Pesticide containers must be inspected frequently for deteriorated conditions.

(18) If pesticides are transferred from deteriorated containers to sound containers or from one container to another, utilize the same type of container and be sure to label it with the same information that was on the previous one.

(19) Pesticides must not be stored in empty food or drink containers.

(20) All pesticide containers must be kept sealed during storage.

(21) Pesticide containers must be stored in rows to permit clear visibility of labels and easy access.

(22) Containers that are 5 gallons or larger must be stored at very low levels.

(23) All glass containers must be stored at low levels in unbreakable encasements.

(24) Pesticides with the least shelf life remaining should be used first.

(25) Pesticide dispersal equipment must be labeled "Contaminated with Pesticides."

(26) Absorptive clay, hydrated lime, or detergents must be available for emergency cleanup of pesticide spills.

(27) Appropriate fire extinguishers must be readily available.

(28) The medical department must be notified, in writing, of the types of pesticides being stored and of their hazards.

(29) The fire department must be provided with a floor plan of each storage area identifying the types and location of the various pesticides.

(30) The fire chief must be provided the home and business telephone numbers of storage custodians, EPA regional administrator, and the Pesticide Safety Team Network of the National Agricultural Chemical Association.

If these general storage precautions are observed at all times, hazards presented by pesticides to the environment, yourself, and others will be reduced greatly.

Exercises (241):

1. [illegible] a list of chemicals contained within the [illegible]rage area be posted?

2. What are the requirements for storing excess, illegal, and expired shelf-life pesticides?

3. When must exhaust ventilation be turned on?

4. Pesticides must continually be stored in containers that are ______________ .

5. Pesticide containers must be stored in rows to permit __________ visibility of labels and __________ access.

6. What items of equipment must be readily available in storage areas in case of fire?

24[illegible] [illegible]ng precautions and requirements.

[illegible] phase of pesticide handling is very importan[illegible] you because it is the phase in which you are most apt to be contaminated with the most toxic form of the pesticide. To reduce or prevent possibilities of being contaminated, the following precautions must be observed:

(1) Read the pesticide label and follow the prescribed mixing instructions.

(2) Wear required safety protective equipment (discussed later in this chapter).

(3) Keep children and other unauthorized persons out of the mixing area.

(4) Mix pesticides in a well-ventilated area.

(5) Adhere to the "no-smoking, eating, or drinking rule" while mixing pesticides.

(6) Mix pesticides in a well-lighted area.

(7) Mix pesticides in an area that is capable of preventing spilled pesticides from contaminating other areas.

(8) Insure that showers and washing facilities are available within the immediate area of mixing for personal decontamination in case of pesticide spills or splashes.

(9) Know the first aid measures to be taken for the pesticide being mixed.

(10) Use the buddy system when possible.

(11) Open bagged pesticide containers with a sharp knife instead of tearing.

(12) Close all containers immediately after use and place them back in proper storage.

(13) Keep pesticide containers below eye level during mixing to prevent splashes to the face.

(14) Mix only the amount of formulation needed.

(15) Avoid electrical and fire hazards.

(16) Clean all equipment used during the mixing operation that is not required to be used during the application and hang for drying, a necessary.

These precautions that have been identified are the basic precautions to be taken in protecting yourself and others and to prevent property and environmental damage. There are others that you will probably think of, which is good, because the more precautions you take the safer the operation will be.

Exercises (242):

1. Mix pesticides in a well _______ and ________ ___________ area.

2. Know the _________ measures to be taken for the pesticide being mixed.

3. Mix only the _________ fo formulation needed.

4. Keep pesticides below _______ level during mixing to avoid splashes [illegible] the ________ .

5. Adhering to mixing precautions is very important because this phase of pesticide handling is the phase in which you are most apt to be _______ with the most _________ form of the pesticide.

243. Specify selected pesticide application precautions and requirements.

Precautions for Applying Pesticides. It is in this phase of pesticide handling that most possibilities of contaminating the environment, yourself, and others with pesticide formulations exist. This phase also presents the most possibilities of vehicular and pedestrian accidents.

As though these are not enough hazards presented during the pesticide application phase, there are others, such as fire and electrical hazards; contamination of food and beverages through direct or indirect methods; and causing damage to facilities, facility furnishing, and wearing apparel.

Because of the varied situations that are involved in this phase of pesticide handling, the precautions to be taken will be separated into general, outdoor, and indoor application precautions.

General application precautions. The general application precautions that must be taken are as follows:

(1) Select a pesticide registered for your specific problem.

(2) Read and follow all instructions provided by the pesticide label.

(3) Inspect all protective equipment you use and make necessary corrections.

(4) Wear all appropriate protective equipment while handling or applying pesticides.

(5) Adhere to the "No smoking, eating, or drinking rule" while applying pesticides.

(6) Know the hazards that may be presented to the environment.

(7) Make sure all pesticide spills are promptly cleaned up.

(8) Plan the actions to take in case of accidental poisoning or other accidents.

(9) Know first aid measures and antidotes for the pesticide selected to be used.

(10) Know emergency telephone numbers of medical and fire departments.

(11) Keep a suitable fire extinguisher readily available for the type of pesticide formulation you're using.

(12) Make sure you have a suitable decontamination kit and a change of clothing readily available.

(13) Select the safest and most effective equipment available for the job.

(14) Perform a preoperational inspection on equipment to be used to insure that it is op[illegible]ational and does not leak.

(15) Insure that equip[illegible] is [illegible]ibrated for the rate [illegible]ication req[illegible].

(16) Insure that t[illegible] equipment is properly secured with safety chains and lockpins.

(17) Insure there are no obstructions to visibility while applying pesticides. If there are, stop operations, and arrange for escort or assistance.

(18) Use the buddy system when performing operations that require towing dispersal equipment and the use of highly toxic pesticides.

(19) Apply pesticides only after all hazardous aspects have been analyzed and it has been determined that all foreseeable hazards have been eliminated.

(20) Release all pressure from pesticide dispersal equipment following application.

(21) Clean all equipment that has been used.

(22) Always wash yourself following application.

(23) Bathe and change clothes at the end of each duty day.

Outdoor application precautions. The following outdoor application precautions must be taken in addition to the general application precautions previously identified:

(1) Know the type of terrain to avoid contamination of underground water sources, streams, ponds, rivers, and lakes.

(2) Observe windspeed and direction and keep upwind from the direction of pesticide drifts to reduce drifts as much as possible.

(3) Avoid contaminating nontarget areas.

(4) Inform workers of pesticides used, poisoning signs and symptoms, and the precautions they can take when pesticides are being applied.

(5) If the program is to be conducted basewide, notify all personnel by using the official bulletin and/or base newspaper.

(6) Avoid direct application of pesticides to power lines, transformers, and transformer banks.

(7) Avoid traveling over terrain that could damage vehicles of equipment.

(8) Avoid direct application of pesticides to vehicles, pets, pedestrians, and other people outdoors.

(9) Make sure vehicle and towed equipment lights are operable and on, including emergency flashers, while applying pesticides from roadways.

(10) Don't exceed 5 mph while applying pesticides from vehicles.

If you observe these precautions, along with the general precautions, outdoor application operations will be much more safe and effective.

Indoor application precautions. The following indoor application precautions must be taken in addition to the general application precautions previously identified:

(1) Before you apply pesticides indoors, conduct a survey to determine the type and location of pests, degree of infestation, potential hazardous conditions that exist, and the actions you must take before you do the work.

(2) Make appointments with responsible building occupants as to the date and time treatment will be done. Inform them of the type [illegible] characteristics of the pesticide to [illegible] the [illegible]autions and actions that must be taken by the[illegible]ch as building preparations, safe reentry times, and cle[illegible]p instructions.

(3) Make sure all dishes, utensils, food containers, food, beverages, stored products, tobaccos, and smoking equipment are removed or covered.

(4) Don't apply liquid pesticides to electrical panel boxes, outlets, or switches.

(5) Make sure all electricity and heat sources are turned off at the building's primary source when you use fumigants or other volatile formulations.

(6) Never apply pesticides to interior portions of refrigerators and ovens, because toxic vapors of pesticides can be transferred to foods.

(7) Don't apply pesticides to closets and drawers unless all items have been removed.

(8) Don't apply residual sprays or dusts to floors and baseboards in areas where small children sleep and play.

(9) Don't use pesticidal baits in areas that are accessible to children and pets.

(10) Avoid applying pesticides directly overhead by keeping the spray nozzle extended away from and in fro · of you.

(11) Make sure fish aquariums ~ ... and covered or removed. Aquatic animals are the most sensitive forms of life to pesticides.

(12) Make sure indoor plants are removed or covered when you use volatile formulations.

These application precautions are only the basic precautions you must follow and are not intended to be a complete list of precautions you must take. It is to your benefit and others that all of these precautions—along with the ones that you think of and the special ones that are identified on each pesticide container—be observed. It is not only to your benefit but also your responsibility to follow all precautions possible when applying pesticides.

Exercises (243):

1. When applying pesticides, make sure all pesticide __________ are promptly cleaned up.

2. Make sure the equipment is properly _________ for the rate of application required.

3. In addition to presenting the most possibilities of contaminating the environment, yourself, and others, the application phase of pesticide handling presents the most possibilities of _____________ and _____________ accidents.

4. B... ore ... ...sticides indoors, you should _________ ________ to determine the _______ to be taken in case of accidental poisoning or other accidents that may be involved.

5. The most appropriate general application precaution that offers the best protection against ingestion of pesticides by the operator is also referred to as a rule. What is the rule that is being referenced?

6. If a pest management program is to be conducted basewide, all personnel should be notified. How can this notification be accomplished?

244. C ··e selected pesticide transporting precautions and requirements.

Transporting Precautions. Pesticides can present many hazards to the environment, yourself, and others if they are transported without the knowledge of how to do it safely and without adhering to the basic safety precautions.

The vehicle and the dispersal equipment used in transporting pesticides are important in this phase of handling pesticides, because if the wrong type vehicle and delapidated equipment are used, many hazards are presented.

Each vehicle used for transporting pesticides must be assigned directly to the pest management section and is not to be lent to other units, because this vehicle has become contaminated with pesticides and will present unnecessary and unwarranted hazards to others.

The vehicle must be the type that contains numerous locked storage compartments for storing various types of pesticides, supplies, equipment, and tools during transport and for conducting pest management operations throughout the base area. Such locked compartments prevent access to any of these items by children and other unauthorized people while unattended by pest managers.

To prevent undue exposure to toxic vapors and splashes to driver and passengers, the vehicle must be designed so that these storage compartments are not within the same enclosure that is occupied by the driver and passengers.

In addition to these requirements, the vehicle must have good visibility in all directions and be able to travel ... tow equipment over almost all types of terrain. Good ... is necessary to prevent vehicular and pedestrian ... ents and ... monitor the operation of powered dispersal equipment being towed.

Pesticide dispersal equipment used to transport pesticides must be in good repair to prevent dripping and splashing of pesticides during the travel, thus reducing contamination of the environment and hazards to children and others.

The following precautions must be observed during the transport phase of pesticide handling:

(1) Read the pesticide label and follow special instructions for transporting pesticides when given.

(2) Wear required safety protective equipment while loading and unloading pesticide equipment.

(3) Keep children and other authorized people away from vehicle and equipment.

(4) Label pesticide dispersal equipment as being contaminated with pesticides. Use signs that gi... easy visibility and one that can be understood by everyone.

(5) Keep all storage compartments locked at all times.

(6) Drive slowly and avoid quick, short turns to prevent pesticide spills.

(7) Know the first aid procedures to be taken for pesticides being transported and know where assistance can be obtained, if necessary.

(8) Make sure emergency procedures and telephone numbers are available in the vehicle in case of pesticide spills and traffic accidents.

(9) Make sure a CO_2 fire extinguisher is available and secure on the vehicle used to transport pesticides.

(10) Make sure vehicles and equipment are in safe operational condition.

(11) A container of water should be available on the vehicle for emergency decontamination of eyes and skin in the event of pesticide spills and splashes to the body.

(12) Transport all pesticides in unbreakable containers.

(13) Make sure all pesticide containers being transported, except for equipment, have a complete EPA-registered label.

(14) Make sure safety chains and locking pins are in place before you tow dispersal equipment.

There have been many cases of accidental poisonings that have occurred due to unsafe transporting of pesticides. Most of these poisonings occur to children while the vehicle being used is left unattended with no safe way to secure pesticides. Remember, you have the responsibility to insure that every precaution available is taken to transport pesticides safely because you are the one who is knowledgeable of the hazards that are presented by pesticides.

Exercises (244):

1. The transporting vehicle must contain numerous ____________ compartments for storing pesticides.

2. Keep ___________ and other unauthorized _________ away from transporting vehicle and equipment.

3. Pesticide dispersal equipment used in transporting pesticides must be in good __________ to prevent dripping and splashing of pesticides.

4. Vehicles used for pest management operations must be assigned directly to the ___________ ____________ section.

5. To identify pesticide dispersal equipment as being contaminated with pesticides, a __________ must be placed on the equipment.

6. Keep all _____ compartments ______ at all times.

245. State the purpose, frequency, and method for conducting pesticide inventories.

Pesticide Inventories. You should conduct a complete inventory of all pesticides that you are responsible for at least once a month. This inventory should be documented and maintained as an operational shop record. Of course, more frequent inventories are desirable, but these interval inventories don't necessarily have to be recorded. Inventories serve as a good management tool for all supplies and equipment. They provide:

(1) An additional security measure.

(2) The capability of detecting early signs of pesticide container deterioration.

(3) An additional means for insuring that pesticides are properly stored.

When pesticide inventories are not conducted regularly, a laxity in control often develops, and personnel within the section begin to give pesticides to their friends and others (who are untrained in proper pesticide use) for use within and around their homes.

Pesticides, especially those that are restricted use pesticides, should never be provided to friends or anyone else, because they do not know the proper way to apply or store them. Therefore, you are responsible for any accidents that may occur through ignorance and negligence on the part of the individuals to whom you gave the pesticide.

There are many times that deteriorated conditions of pesticide containers are detected while conducting inventories. If the inventory had not been conducted, the container could have deteriorated to the point of allowing a major spillage of the pesticide, which would have immensely increased potential hazards. However, with early detection of deterioration, you can transfer the pesticide to an approved substitute container and relabel it to reassure safe and proper storage.

In order to maintain an accurate inventory of pesticides you must record all pesticides received between each inventory and the ones that have been withdrawn from the inventory. When the inventory has been completed you should compare the withdrawals with the materials received to insure that the pesticides on hand match the total of the two transactions.

If you have less pesticide on hand than the records indicate, you should conduct another inventory immediately and recheck pesticides withdrawn and received records to determine if a mistake was made. If no mistake is found, then you should expend all efforts to determine why the pesticide cannot be accounted for, especially when the pesticide is very toxic or if the quantity is significant.

Exercises (245):

1. What are three reasons for conducting pesticide inventories?

2. When should extreme effort be expended to locate pesticides that cannot be accounted for?

3. Should you ever provide pesticides to your friends? Why?

4. When should pesticide inventories be conducted?

5. Explain how to maintain adequate pesticide inventory records.

246. Specify principles, procedures, and techniques involved in managing pesticide spills.

Handling Pesticide Spills. Regardless of how well supervisors plan shop work or train their subordinates, pesticide spills still occasionally happen. Typical spills range from a 1-gallon can of chemical falling from a truck to several 55-gallon cans being punctured by a forklift. The worst case of a spill would be exploding containers in a fire.

Spill emergency procedures. When a pesticide spill occurs, specific procedures should be followed for providing first aid, notifying proper authorities, and cleaning up and decontaminating the spill area. Personnel working with pesticides or in areas containing pesticide chemicals should be adequately trained for quick evacuation and proper spill prevention and emergency procedures as follows:

(1) Identify the chemical. If possible, determine the pesticide involved in the spill incident. Information such as formulation, percent active ingredient, and manufacturer's name and address should be obtained.

(2) Personal safety and first aid. It must be emphasized that when managing any spill the most immediate concern is for the health and well being of persons in and around the immediate spill area.

First aid kits should be maintained at pest control shops and storage areas and carried on pest control vehicles. In addition, the telephone numbers of the local medical unit and poison control center should be posted in visible locations and carried by pest control personnel at all times when on the job.

(3) Site security. Secure the spill site from entry by unauthorized personnel by roping off the area and posting warning signs. If necessary, obtain assistance from the activity's police or security unit.

Containment and control. Spilled pesticides must be contained at the original site of the spill. You must prevent the pesticide from entering storm drains, wells, water systems, and navigable waterways by following these procedures:

(1) Don appropriate protective equipment from a spill kit or the pest control shop. Refer to table 3-1 for a list of recommended spill kit contents.

(2) Prevent further leakage by repositioning the pesticide container.

(3) Prevent the spill from spreading by trenching or encircling the area with a dike of sand, absorbent material, or, as a last resort, soil or rags.

(4) Cover the spill. If the spill is liquid, use an absorbent material; if dry material, use a polyethylene or plastic tarpaulin. (*NOTE:* Use absorbent materials sparingly because they also must be disposed of as hazardous wastes.

Cleanup. Adequate cleanup of spilled pesticides is essential in order to remove any health or environmental hazards. When cleaning up pesticide spills, it is advisable NOT TO WORK ALONE and to make sure the area is properly ventilated and that appropriate protective equipment is used by all personnel.

(1) Dry spills (dusts, wettable powders, granular formulations) should be picked up in the following manner. Immediately cover powders, dusts, or granular materials to prevent them from becoming airborne. This can be done by placing a polyethylene or plastic tarpaulin over the spilled material. Weight the ends of the tarp, especially the end facing into the wind. Begin cleanup operations by systematically rolling up the tarp while simultaneously sweeping up the spilled pesticide using a broom, shovel, or dust pan. While sweeping, avoid brisk movements in order to keep the dry pesticide from becoming airborne. If indoors, a cover may not be necessary. When practical, light sprinkling with water may be used instead of a cover.

Collect the pesticide and place it in heavy-duty plastic bags. Properly secure and label the bags, identifying the pesticide and possible hazards. Set the bags aside for later disposal.

(2) Liquid spills should be cleaned up by placing an appropriate absorbent material (floor-sweeping compound, sawdust, sand, etc.) over the spilled pesticide. Work the absorbent into the spill using a broom or other tool to force the absorbent into close contact with the spilled pesticide. Collect all spent absorbent material and place into a properly labeled leakproof container.

(3) Contaminated soil should be removed to a depth of at least 3 inches below the wet surface line and placed in properly labeled leakproof drums for disposal.

Decontamination. Decontamination solutions can be used for decontaminating surfaces and materials where spills of dust, granular, wettable powder, or liquid pesticides have occurred. However, the bulk of the spilled pesticide should be cleaned up or removed before you apply any decontaminant. After cleaning up the bulk material, apply the appropriate decontamination solution and allow 1 to 6 hours of reaction time before using an absorbent material.

Depending on the location of the spill and the pesticide spilled, chlorine bleach, caustic soda (lye, sodium hydroxide) or lime can be used to effectively decontaminate most spill areas. Many pesticides, especially the organic phosphate pesticides, decompose when treated with lye or lime. Fewer pesticides are decomposed by bleach (sodium hypochlorite).

TABLE 3–1
RECOMMENDED SPILL KIT CONTENTS

Proper handling of pesticide spills requires prior preparation of a spill kit containing directions for use in case a spill incident should occur. The kits should be labeled and designated for use in handling pesticide spills only, and should be strategically placed where spills are most likely to occur. The label should list the contents, and the kit should be sealed to discourage pilferage.

Spill kits may be assembled by procuring items through the Federal Supply System, or from commercial sources. Additional suppliers may be obtained by contacting the EFD Applied Biologist or Command Entomologist.

The following is a list of equipment required for shop and vehicle spill kits:

<u>Shop Kit</u>

1 55-gallon open-head drum
1 set of instructions
4 pairs of neoprene gloves
2 pairs of unvented goggles
2 respirators and pesticide cartridges
2 aprons (chemical resistant)
2 pairs of rubber boots
2 pairs of 100% cotton coveralls
1 dustpan
1 shop brush
1 square-point "D" handle shovel
1 dozen polyethylene bags w/ties (heavy ply)
1 18" pushbroom, synthetic fibers
1 gallon liquid detergent
3 gallons household bleach
80 lbs absorbent material
1 bung wrench
1 drum spigot
1 1-3/8" open-end wrench
1 1 drum pump (manual)
30 ft. 1/2" polyethylene tubing or 1 25-ft. garden hose
1 bung 2-1/2"
1 bung 3/4"
blank labels
1 first aid kit

<u>Vehicle Kits</u>

1 instruction sheet
1 5-gallon open-head drum
2 pairs of neoprene gloves
1 pair of unvented goggles
1 respirator and cartridge
1 pair of coveralls
1 dustpan
1 shop brush
10-30 lbs absorbent material
1 pint liquid detergent
6 polyethylene bags w/ties (heavy ply)
1 portable eyewash
blank labels
1 first aid kit
1 pr rubber boots
1 apron

Most equipment and materials needed for spill emergency response and for maintaining spill kits can be obtained through the GSA Federal Supply System or local manufacturing companies.

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Dry decontaminants should be spread thinly and evenly over the spill area. Then, using a water can, lightly sprinkle the area with water to activate the decontaminant. Liquid decontaminants should be applied in amounts no greater than specified in table 3-2.

The preceding procedures must be repeated until all the spilled pesticide is removed. Clean all equipment used for spill cleanup with detergent and appropriate decontaminants. Collect all spent decontaminants and rinse water and place them in labeled leakproof containers. Clothing and gloves that cannot be decontaminated must be placed in leakproof containers for proper disposal. Depending on the particular surface, the following additional procedures may need to be done as specified.

Nonporous surfaces should be washed with detergent and water. The appropriate decontamination solution should be thoroughly worked into the surface using a long-handled broom, scrub brush, or other equipment as needed. Then the decontamination solution is soaked up using absorbent material. The spent absorbent material is then placed into a labeled leakproof container for disposal.

If pesticide containers have leaked or if pesticides have been spilled on a soil surface, all soil should be removed to at least a depth of 3 inches below the wet surface line and placed in drums for disposal.

Porous materials such as wood may not be adequately decontaminated. If contamination is great enough to warrant, they must be removed and replaced with comparable new materials.

Tools, vehicles, equipment and any contaminated metal or other nonporous objects can be readily decontaminated using detergent and the appropriate decontamination solution (table 3-2). However, smaller quantities of the decontamination solution may be required.

TABLE 3–2
PESTICIDE DECONTAMINANTS

Depending on the particular pesticide, chlorine bleach, caustic soda (lye, sodium hydroxide) or lime can be used to effectively decontaminate most spills. Many pesticides, especially the organophosphate pesticides decompose when treated with lye or lime. Fewer pesticides are decomposed by bleach (sodium hypochlorite). Other pesticides cannot be effectively decontaminated and should only be treated with detergent and water to assist in removal. Some examples of common pesticides that can be decontaminated are listed below:

Use Lye or Lime for:	Use Chlorine Bleach for:	Do not use any decontamination Chemicals for these pesticides:
Atrazine	Calcium cyanamide	Alachlor
Propoxur	Calcium Cyanide	Chloramben
Captan	Chlorpyrifos	Chlordane and other
Carbaryl	Fonophos	Chlorinated hydrocarbons
Diazinon	Merphos	Diuron
Naled	Lethane	2,4-D
2,4,5,-T		Maneb
Malathion		Methoxchlor
Acephate		Pentachlorophenol
TCA		Picloram
Rotenone		Toxaphene
Dalapon		Trifulralin
Dichlorvos		
Dimethoate		

USE

A practical guide for applying decontaminants is as follows:

Percent Active Ingredient	Amount of Decontaminant needed
1-10	Use an amount of decontaminant equal to the quantity of pesticide spilled
1-79	Use an amount of decontaminant equal to 1.5 times the quantity of pesticide spilled.
80-100	The amount of decontaminant used should be equal to twice the quantity of spilled pesticide.

WARNING: There is a slight potential for creating toxic by-products when using these procedures. In critical situations, samples of affected components (soil, sediment, water, etc.) should be taken and sent to a laboratory for analysis in order to determine if decontamination was successful.

Lye or Lime

Pesticides susceptible to lye or lime may be decontaminated when mixed with an excess quantity of either of these materials. These materials can be used in either the dry form or in solution. A 10% solution of lye or lime can be made as follows:

Mixing directions: Mix 0.75 pounds of lye or lime in 3.5 quarts of water to make 1 gallon of 10% solution.

Caution: Caustic soda (lye) can cause severe eye damage to persons not properly protected. Protect against contact by wearing unventilated goggles, long-sleeved work clothes with coveralls, neoprene gloves, and chemical-resistant apron. An approved respirator should also be worn. Do not use lye on aluminum surfaces.

Bleach Treatment. Certain pesticides can be degraded by treatment with bleach (sodium hypochlorite). In general, one gallon of household bleach, which contains approximately 5 percent sodium hypochlorite, should be used per pound or gallon of pesticide spilled. If bleaching powder is used, first mix it with water (one gallon of water per pound of bleach) and add a small amount of liquid detergent. For safety purposes, a preliminary test must be run using small amounts of bleach and the spilled pesticide. The reaction resulting from this test must be observed to make sure reaction is not too vigorous Do not store in close proximity to, or mix chlorine bleach with, amine-containing pesticides. Co-mingling of these materials can cause a violent reaction resulting in fire. Calcium hypochlorite is not recommended as a decontaminating agent because of the fire hazard.

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The decontamination solution can be applied to contaminated equipment by soaking the equipment in a pail filled with solution or by using a scrub brush. All tools and surfaces must be thoroughly rinsed with sparing amounts of clean water. All rinse water and spent decontamination solution should be collected in drip pans or other suitable containers and transferred to a properly labeled leakproof drum for disposal.

Disposal. All contaminated materials, including cloth, soil, wood, etc., that cannot be effectively decontaminated as described in this guide must be removed and placed in a sealed leakproof drum. All drums must be properly labeled as to the types of chemicals in them; all must be disposed of in a hazardous waste disposal facility (incinerator, landfill site, etc.) under current EPA or state permit.

Exercises (246):

1. What should be your immediate concern in the event of a pesticide spill?

2. What actions should be taken to secure the site of a pesticide spill?

3. List the four steps to be taken to contain a pesticide spill.

   (1)

   (2)

   (3)

   (4)

4. What actions can you take to prevent an outdoor dry spill from spreading?

5. How should contaminated soil be handled after a liquid pesticide is contained?

6. When should a decontamination solution be applied?

7. What are three decontamination solutions you can use?

8. What decontaminates work best for organophosphate pesticide spills?

9. To which class of pesticides should you *not* apply any decontaminates?

10. List the three actions you should take in disposing of materials that cannot be effectively decontaminated.

    (1)

    (2)

    (3)

247. Specify the safety methods and precautions you must take when disposing of surplus pesticides and their containers.

Disposal Methods and Precautions. Surplus pesticides must be disposed of in a manner that will not permit harm to people or animals, will not contaminate the air or the water supply, and will not harm the environment.

When cleaning pesticide application equipment, such as sprayers and dusters, do not let the cleaning solution run down the sink because this will lead to direct contamination of the sewage water. If a suitable open land area, such as a field or cinder or gravel driveway, is available, moderate amounts of wash water can be sprayed or poured on the surface so the pesticide will be broken down by the action of air and sunlight. Care must be taken to be sure there is no possibility of contamination of ground water under the disposal area, and the disposal area must be located so there is no possibility of runoff into a sewer, stream, or any other place where contamination could occur.

Federal regulations recommend these ways to dispose of organic pesticides.

(1). Burn them in a pesticide incinerator at the specified temperature/dwell time combination.

(2) If appropriate incineration facilities are not available, organic pesticides may be buried in a specifically designated landfill. Records should be kept for locating the buried pesticides in the landfill site.

The regulations also set up three categories of containers and recommend ways to dispose of each kind.

(1) Group I containers: Combustible containers that formerly contained organic or metallo-organic pesticides, except organic mercury, lead, cadmium, or arsenic compounds, should be disposed of in a pesticide incinerator, or buried in a specially designated landfill; except that small quantities of such containers may be burned in open fields by the user of the pesticide when such open burning is permitted by state and local regulations, or

buried singly by the user in open fields with due regard for protection of surface and subsurface water.

(2) Group II containers: Noncombustible containers that formerly contained organic or metallo-organic pesticides, except organic mercury, lead, cadmium, or arsenic compounds, should first be triple-rinsed. Containers in good condition may then be returned to the pesticide manufacturer or formulator. Drums may be reconditioned for reuse with the same chemical class of pesticide previously contained, providing such reuse is legal. Any other rinsed metal container should be punctured to keep others from using it before you take it to a facility for recycling or disposal. All rinsed containers may be crushed and disposed of by burial in a sanitary landfill, in conformance with State and local standards, or buried in the field by the user of the pesticide. Unrinsed containers should be disposed of in a specially designated landfill, or subjected to incineration in a pesticide incinerator.

Group III containers. Both combustible and noncombustible containers that formerly contained organic mercury, lead, cadmium, or arsenic or inorganic pesticides—that have been triple-rinsed and punctured to facilitate drainage—may be disposed of in a sanitary landfill. Such containers that are not rinsed should be buried in a specially designated landfill.

Group IV—residue disposal: Residues and rinsed liquids should be added to spray mixtures in the field. If not, they should be disposed of in the manner prescribed for each specific type of pesticide.

The general disposal precautions for extended shelf-life pesticides and deteriorated pesticide containers are as follows:

(1) Dispose of pesticides and pesticide containers in a specially designated landfill and in accordance with state and local standards.

(2) Provide a list of the pesticides and quantity of each to landfill personnel.

(3) Rinse all pesticide containers, other than paper containers, at least three times before disposal.

(4) Destroy all containers, other than aerosol cans, beyond reuse prior to disposal.

(5) Keep all pesticides and pesticide containers properly stored until you can dispose of them.

Excess stocks of pesticides will be processed in coordination with the local chief of Supply or the defense property disposal office in accordance with procedures outlined in AFRm 67-1, Volume 6, *Excess and Personal Property*.

Now that the safety precautions for storing, mixing, transporting, applying, and disposing of pesticides have been identified, you can see that you have a great responsibility. Not only must you know how to protect yourself but also how to protect the environment, property, and others.

Remember, these precautions are only general guidelines and do not cover all aspects of pesticide handling; therefore, you must follow all instructions provided on each pesticide container label pertaining to special situations.

Exercises (247):

1. In what manner must you dispose of surplus pesticides?

2. When cleaning pesticide dispersal equipment, why should you prevent waste water from going down the drain?

3. How should you get rid of moderate amounts of contaminated waste water? Why?

4. What actions must you take with noncombustible pesticide containers before you dispose of them?

5. What disposal method can be used for all types of pesticide containers?

248. Specify the types, uses, and maintenance of safety protective equipment.

All personnel who handle pesticides are definitely exposed to the hazards of contamination through inhalation, ingestion, and absorption of pesticide vapors, mists, and dusts.

As a pest management specialist, it is your responsibility to make sure you and your fellow workers wear all required safety protective equipment during all phases of pesticide handling.

Safety Gear for Handling Pesticides and it's Maintenance. There are many items of various designs which you can use to protect your body from pesticides, and the more protection you use, the less chance you will have of becoming a victim of pesticide poisoning.

Knowing what item of equipment to wear, and wearing it, is not the only important aspect of personal protection, because you may be wearing the proper required equipment and still be poisoned if the equipment has not been fitted and maintained properly. Therefore, it is essential that you know each item of protective equipment you need to wear, the purpose of the equipment, and how to maintain it.

Coveralls. When you mix and apply pesticides, you should wear coveralls that cover your entire body to protect your skin from contamination. Coveralls are authorized for pest management personnel to be worn only while on the job. You cannot use them as a replacement for the normal military or civilian dress, which means they are not to be worn to dining facilities, snack bars, base exchange facilities, commissaries, movies, or any other base facility except while performing job duties. Worn coveralls must be washed separately from other clothing in soap and water on a daily basis. To prevent contamination of other clothing, washing machines and dryers are authorized in your shop so you can maintain your own coveralls in a clean condition at all times.

Another aspect of maintaining coveralls is frequent inspections to detect holes, tears, and thinning of the material. If any of these conditions are detected, you should replace them through the supply system.

Waterproof rainsuits. If you suspect that coveralls will become wet while you're mixing or applying pesticides, you should wear a waterproof rainsuit. You can normally get rainsuits within the supply system and they are called foul weather gear. This type of protective clothing is very appropriate when handling the more dermally toxic pesticides or if you will be applying liquid pesticidal formulations for a long time.

Maintenance of these rainsuits involves washing with soap and water and hanging up to dry. The rainsuits should be inspected frequently for holes and tears and replaced if these discrepancies are noted.

Aprons. Wear a rubber apron when you're mixing pesticides, especially when large quantities of liquid pesticides are being handled. The apron serves as an additional precaution to prevent body contamination of the pubic region with pesticide. This is very important because this region of the body is the most susceptible area for pesticide absorption.

To maintain the apron, simply wash with soap and water and inspect it frequently for tears or holes. Lubricate it periodically with vegetable oil to prevent cracking.

Boots. Rubber or neoprene boots should be worn when mixing or applying liquid pesticides, especially if you're working on large-scale operations; leather or canvas boots will absorb liquid pesticides, so don't use them alone. Boots should be worn with the tops beneath the legs of the coveralls or rainsuit.

Boots can be obtained through the supply system as part of the foul weather gear and are maintained by washing with soap and water frequently, inside and out, to remove pesticide contaminant. Rubber boots should also be periodically lubricated with vegetable oil to prevent drying and cracking.

Gloves. You must wear gloves during all phases of pesticide handling and when you clean dispersal and protective equipment to prevent skin contamination. There are several types of gloves that can be worn, but leather or cotton gloves are not among these types to be worn while handling pesticides. The gloves used must be unlined and liquidproof.

Neoprene gloves are probably the most commonly used in pest management operations, but some fumigants are readily absorbed by neoprene, so be sure to read the label on the pesticide container.

Another type of glove that is popular for use with pesticides is the medical examination glove because it is extremely flexible and is disposable. This glove is not to be used when heavy work is involved because it is very thin and tears easily.

Gloves should fit the hand snugly and should be long enough to extend well above the wrist so you can wear them under the sleeves on coveralls or rainsuits.

Gloves of all types can be obtained through the normal supply system and are maintained by washing with soap and water, inside and out, and inspecting for holes and tears. To inspect for small pinholes and slits, simply fill each glove with water and gently squeeze while holding the top of the glove closed with one hand. If damage is detected, shred the gloves so no one else can use them and get rid of them.

Gloves must be periodically lubricated with vegetable oil to prevent drying and cracking.

NOTE: When you use disposable gloves, they should be shredded and disposed of also. Never dispose of gloves used with pesticides until they have been destroyed beyond the point of reuse

Hats. A wide-brimmed liquidproof hat should be worn when you apply liquid pesticides to protect your head and offer additional protection to the neck, eyes, mouth, and face. The hat should not have a cloth or leather sweatband in it because these sweatbands absorb pesticides and are very hard to clean.

The hat is used to protect the head, which is the second most susceptible external region of the body for pesticide absorption. This is due to the large amount of natural body oil that is contained in the hair, and the oil speeds the absorption rate.

The type of hat used by construction workers (plastic hardhat with plastic sweatband) is very good for protecting the head and is available through the supply system. This hat can be maintained easily by frequently washing it with soap and water, inside and out.

Goggles or faceshields. Goggles or a faceshield must be worn while mixing and applying pesticides to protect the eyes. There are times when a faceshield will be more adequate than goggles and vice versa. Just remember to offer your eyes as much protection as possible in each and every circumstance.

Goggles and faceshields are available through the normal supply system and are authorized for pest managers. There are many types of goggles that are available, but when you order them, try to get the type that completely enclose the eyes. This type has a tendency to fog over but excludes all possibility of mists and dusts from entering.

To maintain goggles and faceshields, wash them with soap and water after each operation. The elastic headbands will absorb pesticides and stretch, so they should be replaced frequently. If goggles are rubber, they should be periodically lubricated with vegetable oil to prevent drying and cracking.

Ear protectors. Ear protective devices such as earplugs or ear muffs must be worn while operating noisy equipment and while working in areas that present noise hazards.

Maintenance of earplugs amounts to nothing more than keeping them clean by washing with soap and warm water. The ear muffs should be inspected periodically to detect hardening of the rubber pads. These pads must be replaced when hardening is detected.

Respirators and gas masks. There are many types of respirators and gas masks for you to choose from, so be aware that the only ones authorized for use are those approved by either NIOSH (National Institute for Occupational Safety and Health) or MESA (Mining Enforcement and Safety Administration).

Always be sure that the cartridges and canisters you use are designed to protect you against the specific pesticide you're using. Also be sure they fit the specific respirators ar l gas masks your shop has. Otherwise, your respiratory protection will be useless, and your health may be in danger.

You should wear a chemical cartridge respirator (fig. 3-3) when you are only intermittently exposed to toxic pesticides. Air is inhaled through both a filter pad and a cartridge designed to absorb pesticide vapors, gases, and particles.

A chemical canister respirator (gas mask, fig. 3-4) should be worn when you are exposed to a continuous concentration of a toxic pesticide. The canister has longer lasting absorbing material and filters than the cartridge and protects the face better. Neither the canister nor cartridge type can be used when the oxygen supply is low.

A supplied-air respirator (gas mask, fig. 3-5) is used when you're mixing or applying pesticides:

- When the oxygen supply is low.
- When you are exposed to high concentrations of highly toxic pesticides in enclosed areas, as in fumigation.
- When your work can be done close to a supply of clean air. Clean air is pumped through a hose to the face mask.

A self-contained breathing apparatus (fig. 3-6) is worn under the same conditions as the supplied-air respirator. It does about the same thing. The difference is that you carry cylinders of oxygen with you, usually on your back. This lets you move more freely and over a wider area than you can with a supplied-air respirator.

CF-075

Figure 3–3. Cartridge respirator.

CF-076

Figure 3–4. Chemical canister respirator.

CF-077

Figure 3–5. Supplied-air respirator.

CF-078

Figure 3–6. Self-contained breathing apparatus.

The chemical cartridge and the chemical canister respirators are the two most common types of respirators used in Air Force pest management operations. Although all types are available through normal Air Force supply systems, the cartridge and canister types are more easily obtained. The supplied-air respirator and the self-contained breathing apparatus can be obtained with proper justification, but if they are only needed once in awhile, you can borrow them from the fire department or environmental support on AF Form 1297, Temporary Issue Receipt.

To maintain respiratory protection devices, wash all rubber surfaces and plastic faceshields with soap and water after use. Lubricate rubber surfaces with vegetable oil periodically to prevent the rubber from drying and cracking.

Cartridges and canisters must be discarded when odors are detected in them or once it becomes unusually difficult to breath through them. Also, keep track of the expiration date on cartridges and canisters to insure that the expiration date isn't exceeded.

Each person assigned to a pest management section should be issued coveralls, boots, gloves, goggles, respirator, and a hat to be maintained separately from uncontaminated equipment and clothing in personal lockers. These items of protective equipment are to be maintained by each individual.

Rubberized protective equipment should be stored in a cool dark area if storage is to be prolonged.

Items of safety equipment required to be worn are dependent upon the type of pesticide being handled, the phase in which it is being handled, and the method in which it is being applied. There are no safety recommendations that can cover all situations; therefore, it is your responsibility to read and follow the instructions provides on each pesticide container label and use common sense in wearing more protection as the hazards increase for handling pesticides.

Exercises (248):

1. What restrictions apply to wearing coveralls?

2. What pieces of equipment are authorized in pest management sections to maintain your coveralls in a clean condition at all times?

3. What item of protective clothing would be worn if it is suspected that coveralls will become saturated with pesticide?

4. If you are applying liquid pesticidal formulation for long periods at a time you should wear a ________ ________ .

5. When mixing large quantities of liquid pesticides you should wear an ______________ .

6. The most susceptible external region of the body for pesticide absorption is the ___ _______ region.

7. How should boots be worn?

8. When must gloves be worn?

9. A wide-brimmed liquidproof hat should be worn while applying _____________ pesticides.

10. What is worn to protect the eyes when mixing or applying pesticides?

11. When working in areas where noise may be hazardous you must wear _____________ .

12. The only gas mask or respirators authorized for use are approved by ________ or ________ .

13. Cartridges and canisters must be discarded when ________ are detected or it becomes difficult to ________ through them.

14. To maintain respiratory protective devices, wash all rubber surfaces and plastic faceshields with ___________ and _________ .

15. Rubber surfaces should be lubricated with _________ oil to prevent the rubber from __________ and ___________ .

3-3. Pesticide Poisoning Symptoms and First Aid

From the previous exercise you can readily see that pesticides are toxic and present hazards to people in many ways, either directly or indirectly, through ignorance which leads to negligence.

Negligence leads to many problems. These problems may be minor or major, but in any event, you must be knowledgeable enough to render assistance in overcoming this problem.

The problem which we are referring to is accidental pesticide poisoning. As you have already learned, a person may become poisoned through ingestion, absorption, and inhalation.

This section is devoted to the recognition of signs and symptoms of various types of pesticide poisoning and the first aid procedures you must take based upon the type of pesticide and the method of entry.

249. Identify basic facts about pesticide modes of action.

Pesticide Modes of Action. The methods in which pesticides affect living organisms are called *modes of action*. The modes of action of many pesticides in use today are either unknown or, in some instances, only partially understood. However, medical research does give sufficient information to permit certain generalizations.

Information regarding ways pesticides affect humans and other mammals are given for the following compounds.

Organophosphates. These pesticides attach themselves to cholinesterase, an enzyme in the blood, which is normally present and required for proper nerve function. Since the action of organophosphorus pesticides restrain the enzyme cholinesterase, they are referred to as cholinesterase inhibitors or anticholineasterase compounds.

Carbamates. These compounds are very similar to the organophosphorus compounds with regard to the modes of action. Carbamates also inhibit the enzyme cholinesterase; however, they differ in action in that the effect on cholinesterase is very brief because the carbamates are quickly broken down in the body. Carbamates are referred to as rapidly reversing inhibitors because the reversal is so rapid that, unless special precautions are taken, samples of blood cholinesterase of mammals that have been exposed to carbamates will commonly be inaccurate, appearing to be normal.

Organochlorines (chlorinated hydrocarbons). The exact modes of action of these compounds is not known; however, they do act on the central nervous system, and repeated doses can cause liver and kidney damage in animals.

Botanicals. The botanical compounds must be divided because the modes of action vary greatly based upon chemical structure and toxicity to humans.

a. Pyrethrum. Pyrethrum is one of the least toxic pesticides available. The extent of injury to humans usually results in minor skin allergies, sneezing, and runny or stuffy nose.

b. Strychnine. This chemical is known to affect the nervous system and in some instances causes extreme nervousness. The exact mode of action is still not completely understood.

Petroleums. Petroleums such as kerosene and No. 2 fuel oil have been used as mosquito larvicides for many years. Research indicates these oils have a toxic fraction with a low boiling point and high volatility, which penetrates the tracheae of larvae and pupae and produces an anaesthetic effect; and also have a less volatile fraction, which acts more slowly and generally does not have any direct toxic action, but suffocates by mechanical interference with breathing.

Petroleums may be absorbed orally or through the respiratory tract but are only slightly absorbed dermally. When sufficient quantities are ingested or inhaled by humans it can cause severe aspiration and occlusion of the respiratory system and may cause pneumonia or death.

Fumigants. The modes of action of fumigents are varied; therefore, the fumigants that are commonly used within the Air Force will be discussed individually.

a. Methyl bromide. This compound is among the most hazardous of the chemical compounds. It affects the protein molecules within certain cells of the body and causes severe kidney damage.

b. Hydrogen phosphide. Hydrogen phosphide is highly toxic to all forms of animal life, and the mode of action is the result of interference or inhibition of important cellular enzyme systems vital to the oxygen transport mechanisms of the body.

c. Hydrogen cyanide (calcium cyanide). Hydrogen cyanide can be inhaled or ingested and can increase excretion of thiocyanate in the urine which can result in a severe loss of oxygen in body cells.

Anticoagulants. These compounds cause capillary damage and inhibit the formation of prothrombin, which prevents the clotting of blood. This causes internal bleeding after repeated dosages have been consumed.

Exercises (249):

1. What compounds inhibit the formation of prothrombin, which prevents the blood clotting process?

2. Name the botanical compound that is considered to be one of the least toxic pesticides.

3. Two compounds that inhibit or restrain the enzyme cholinesterase are ________ and ________ .

4. What compound affects the protein molecules within certain cells of the body and causes severe kidney damage?

250. Determine what types of pesticides are indicated in various pesticide poisoning incidents.

Signs and Symptoms of Pesticide Poisoning. You should know what kinds of sickness are caused by the pesticides you use. You also should know the conditions under which each one may make you sick.

There are two kinds of clues of pesticide poisoning. Some are feelings that only the person who has been poisoned can notice—such as nausea or headache. These are symptoms. Others, like vomiting, also can be noticed by someone else. These are signs. So you should know:

- What your own feelings might mean.
- What signs of poisoning to look for in your coworkers and others who may have been exposed.

All pesticides in the same chemical group cause the same kind of sickness. This sickness may be mild or severe, depending on the pesticide and the amount absorbed. But the pattern of illness caused by one type of pesticide is always the same. Having some of the signs and symptoms does not always mean you have been poisoned. Other kinds of sickness may cause similar signs and symptoms. Headache and a feeling of being unwell, for example, may signal the start of many kinds of illness. It is the pattern of symptoms that makes it possible to tell one kind of sickness from another, which is the subject of this topic as we discuss various chemical compounds.

Organophosphates. These pesticides injure the nervous system. The signs and symptoms go through stages. They normally occur in this order:

(1) Mild poisoning.
- Fatigue.
- Headache.
- Dizziness.
- Blurred vision.
- Too much sweating and salivation.
- Nausea and vomiting.
- Stomach cramps or diarrhea.

(2) Moderate poisoning.
- Unable to walk.
- Weakness.
- Chest discomfort.
- Muscle twitches.
- Constriction of pupil of the eye.
- Earlier symptoms become more severe.

(3) Severe poisoning.
- Severe constriction of pupil of eye.
- Muscle twitches.
- Secretions from mouth and nose.
- Breathing difficulty.
- Unconsciousness.
- Death if not treated.

Illness may be delayed a few hours. But if signs or symptoms start more than 12 hours after you were exposed to the pesticide, you probably have some other illness. Check with a doctor to be sure.

Carbamates. The only carbamates likely to make you ill on the job act almost like organophosphates. They produce the same signs and symptoms if you are poisoned by them. But the injury they cause can be corrected more easily by a physician. For this reason, most carbamates are safer than organophosphates. The label will warn you of the danger.

Organochlorines. Not many organochlorines (chlorinated hydrocarbons) have poisoned applicators.

Early signs and symptoms of poisoning include:

- Headache.
- Nausea.
- Vomiting.
- General discomfort.
- Dizziness.

The person may also be unusually excited or irritable. With more severe poisoning, convulsions follow. They may even appear without the warning symptoms. Coma may follow the convulsions.

Botanicals. Botanicals are pesticides made from plants, and some are very toxic and cause different reactions depending on the type of chemical.

a. Pyrethrum. The signs and symptoms of this poison in early stages usually result in:

- Skin irritation.
- Sneezing.
- Runny nose.

More severe poisoning symptoms may include headaches, tremors, and convulsions.

b. Strychnine. Signs and symptoms of this type poisoning include:

- Nervousness.
- Stiffness of face and leg muscles.
- Cold sweat.
- Falling asleep.

A victim may undergo as many as 10 of these attacks before either recovering or dying. Usually a victim will succumb if medical aid is not obtained before five of these convulsions occur. If a victim withstands the first 5 to 6 hours, chances of recovery are good.

Petroleums. Too much exposure to these compounds may make a person seem drunk. The signs and symptoms are:

- Poor coordination.
- Slurring words.
- Confusion.
- Sleepiness.

Repeated exposure to these compounds can cause permanent internal injury.

Fumigants. The compounds may present the same signs to humans as the petroleums. The signs and symptoms for common fumigants are provided below.

a. Methyl Bromide. This compound may make a person seem drunk. The signs and symptoms are:

- Poor coordination.
- Slurring words.
- Confusion.
- Sleepiness.

Repeated exposure to the fumigant methyl bromide has caused permanent internal injury without early signs or symptoms of poisoning. You can absorb a fatal dose of it before symptoms appear.

b. Hydrogen Phosphide. The early symptoms of hydrogen phosphide poisoning are acute, obvious, and readily reversible. Overexposure of hydrogen phosphide results in:

- Tightness in the chest and diaphragm.
- Vomiting.

- Diarrhea.
- Numbness.
- Anxiety.
- Dry coughs.

In cases of severe poisoning, victims may experience cyanosis, muscular spasms, and cardiac insufficiency.

c. Hydrogen Cyanide. The signs and symptoms for this fumigant are as follows:

- Headache.
- Weakness.
- Nausea.
- Vomiting.
- Increased rate of respiration.
- Depression.
- Rapid but weak pulse.

In cases of severe poisoning, victims may experience cyanosis and convulsions, which may result in death.

Anticoagulants. Anticoagulant poisoning may be recognized by experiencing pain to the back and abdominal area. Vomiting and nosebleeding usually occur because anticoagulants are designed to induce vomiting and prevent the blood from clotting. Victims may have a skin rash appear in the form of red patches along with unexplainable bruises around the elbows and knees.

Now that you are aware of the effects of some chemical compounds, keep in mind that everyone is subject to various diseases and sicknesses. Therefore, individuals who work with pesticides may not actually be poisoned even though they may appear to have some of the signs and symptoms. However, we must be alert.

Get medical advice quickly if you or any of your fellow workers have unusual or unexplained symptoms starting at work or later the same day. If you suspect a person has been poisoned, do not leave him alone. Do not let yourself or anyone else get dangerously sick before calling your physician or going to a hospital. It is better to be cautious than too late. Take the container (or the label) of the pesticide to the physician. Do not carry the pesticide container in the passenger space of a car or truck.

Exercises (250):

For each of the following situations, determine what type(s) of pesticide is indicated as being the poisoning source.

1. After treating a small attic for wasps, Staff Sergeant Lee complains of a runny nose, sneezing, and irritated skin.

2. Airman Pyle returns from a herbiciding job acting mildly confused, sleepy, and acts as if she has been drinking on the job.

3. Sergeant Russ has been experiencing frequent nosebleeds and has difficulty working because of stomach cramps.

4. A headache, weakness, and a weak, rapid pulse characterize Senior Airman Lowry's condition after treating feral rodent burrows.

5. After spending several hours treating for flying insects, Sergeant Major is experiencing a headache, blurred vision, and his eye pupils are constricted.

251. Identify various types of accidental poisoning by matching the type with preventive measures that would help reduce poisoning dangers.

How People are Accidently Poisoned and How to Prevent It. As humans we are considered to be the most intelligent of all animal forms, so it seems that no one should be dumb enough to become poisoned by pesticides. However, there are many cases of human pesticide poisonings reported each year, and there are many more that are not reported because they have not been severe enough to cause recognition by individuals.

Most all pesticide poisonings occur accidentally through actions on the part of supposedly intelligent human beings. If we are so intelligent why and how do pesticide poisoning accidents occur? This question can be answered by two words, ignorance and negligence.

It has already been pointed out that pesticides can poison people through ingestion, absorption, and inhalation, but the methods by which these pesticides are accidentally ingested, absorbed, and inhaled have not been pointed out. The purpose of this lesson, therefore, is to identify the methods by which these poisons are accidentally taken into the body and to identify measures that can be taken to prevent these accidents.

Poisoning by ingestion. Accidental ingestion of pesticides occurs through the following ways:

(1) Sprays and dusts enter the mouth during application.

(2) Pesticides are consumed from unlabeled or contaminated containers, such as beverage and milk containers.

(3) Siphoning pesticides by the mouth in transferring from one container to another.

(4) Eating or drinking items that have been contaminated with pesticides.

Preventing accidental ingestion. You can take the following measures to prevent accidental ingestion of pesticides:

(5) Be certain the area being treated is vacated by other personnel during application.

(6) Make sure respirators or masks are worn by operators.

(7) Insure that all containers used for storing pesticides are clearly and properly labeled at all times.

(8) Store all pesticides in a secure area and out of reach of children.

(9) Make sure all consumable products and wares are removed or properly covered when you're applying pesticides in the area.

(10) Make certain that the no-smoking, eating, or drinking rule is followed during all phases of pesticide handling.

(11) Never use your mouth to siphon pesticides.

Poisoning by absorption. Accidental pesticides absorption occurs through these ways:

(12) Pesticides settle on the skin during application and are absorbed.

(13) Workers spill or splash pesticides on clothing and skin during mixing, transporting, and/or application.

(14) People enter treated areas too soon after application and come in contact with recently applied pesticides.

(14) Pesticide containers (empty or with contents) are left unsecured or aren't disposed of properly, permitting reuse or use as play objects for children.

(16) Contaminated pesticide equipment isn't cleaned properly.

Preventing accidental absorption. These measures can be taken to prevent accidental absorption of pesticides:

(1) Make sure the area being treated is vacated by other personnel during application.

(2) Store all pesticides in a secure area.

(3) Insure that coveralls, gloves, boots, goggles, and hats are worn during application and aprons are worn in addition while mixing.

(4) Mix, transport, and apply pesticides carefully to avoid spills and drips.

(5) Clean up pesticide spills immediately.

(6) Observe the no-smoking, eating, or drinking rule while handling pesticides.

(7) Allow enough time for pesticide residuals to dry before reentry is allowed.

(8) Properly discard or secure empty pesticide containers.

(9) Secure partial or full pesticide containers so unauthorized personnel can't get to them.

Poisoning through inhalation. Accidental inhalation of pesticidal vapors occurs through the following methods:

(1) During storage, mixing, and application.

(2) Unsecured or occupied areas being treated.

(3) Smoking.

Preventing accidental inhalation. The following measures can be taken to prevent inhalation of pesticides:

(1) Store pesticides in a well-ventilated area.

(2) Store all pesticides in a secure area.

(3) Inspect containers for deterioration.

(4) Mix pesticides in a well-ventilated area.

(5) Observe the no-smoking, eating, or drinking rule while handling and applying pesticides.

(6) Wear approved gas masks or respirators while mixing or applying pesticides.

(7) Temporarily vacate and secure areas that are being treated.

(8) Properly identify areas being fumigated.

(9) Discard or secure pesticide containers.

Exercises (251):

1. Match the appropriate preventive measures in column B with the method of poisoning in column A.

Column A	*Column B*
____ (1) Pesticides are drunk from beverage containers.	a. Prevent reentry into treated areas until residuals are dry.
____ (2) Pesticides are ingested while applying sprays and dusts.	b. Insure that areas where pesticides are kept are properly ventilated.
____ (3) Pesticides are absorbed by children through contact with unevaported residuals.	c. Always wear appropriate respirators for jobs being accomplished.
____ (4) Pesticides are inhaled within the storage area.	d. Adhere to the no-smoking, drinking, or eating rule.
____ (5) Pesticides are ingested by the operator during application even though all required protective equipment was being worn at the time.	e. Insure that pesticides are stored only in their proper container at all times.

2. What are the two basic causes of all accidental pesticide poisonings?

3. List the two preventive measures that appear in each of the three groups of preventive measures.

252. List the steps to follow in giving first aid to poisoning victims and specify responsibilities and basic guidelines for giving first aid.

First Aid for Poisoning Victims. As a pest management specialist, you must anticipate possibilities of accidental pesticide poisoning and establish actions to be taken in the event poisoning does occur.

If you are alone in the field with an individual who becomes sick, or if you become sick while applying pesticides, cease operations immediately and proceed to obtain the nearest professional medical assistance.

In the event you are alone with an individual who has become acutely poisoned with pesticides in the field and a vehicle is available, transport the victim immediately to a facility that has a telephone or professional medical assistance, depending upon the condition of the victim and proximity of the facilities.

Each and every individual is obligated to do whatever can be done to save a human life when called upon to render first aid. Your first responsibility in rendering first aid is to keep the victim alive; and the second is to seek professional medical assistance as soon as possible.

Being a pest manager, you must know the first aid procedures for pesticide poisoning, because it's possible that you may arrive at a scene of pesticide poisoning and will need to give first aid to the victim. Or you could even be the victim of accidental pesticide poisoning yourself. In either case, you must know what to do and how to respond to the situation. Remember that first aid is only a measure to save a victim until professional medical assistance can be obtained and is not to be substituted for professional medical assistance.

The primary purpose of first aid is to prevent further absorption of a poison, which means that aid must be given immediately. The intent of this lesson is to describe steps you can take in circumstances involving pesticide poisonings that occur through absorption, inhalation, and ingestion, if you happen to be the victim or alone with a victim.

First aid procedures if you are the victim. Prior to using any pesticide, it is important to read the directions in the "Statement of Practical Treatment" on each pesticide container label. These instructions can save your life and the lives of your fellow workers.

Self first aid for absorbed pesticides. If you get a pesticide on your skin:

(1) Remove the pesticide as quickly as possible. (NOTE: This may require you to jump immediately into a shower or waterhole, clothes and all.)

(2) Remove all contaminated clothing and wash your entire body thoroughly to include the hair, eyes, ears, and under the fingernails.

(3) Obtain medical attention for examination and to alert the staff for possible side effects.

Self first aid for inhaled pesticides. If you accidentally inhale pesticides:

(1) Vacate the area and get to fresh air immediately.

(2) Obtain medical attention for examination and to alert the staff for possible side effects.

Self first aid for ingested pesticides. If you accidentally ingest pesticides:

(1) Rinse your mouth with plenty of water.

(2) If the "statement of practical treatment" on the pesticide label recommends a general antidote, administer at once.

(3) Obtain medical attention immediately.

First aid procedures if you are alone with a victim. As a general rule, from the safety standpoint, you should never apply the more toxic pesticides alone. You should always operate under the "buddy system" just as it is suggested when hiking or swimming, because you never know when an accident may occur. If an accidental pesticide poisoning does occur to a fellow worker, you should know the first aid procedures and follow them step by step. There are many circumstances that may be involved in accidental poisonings, such as the victim being poisoned through absorption, inhalation, and/or ingestion and being conscious or *unconscious* with or without readily available medical assistance. Therefore, recognition of these circumstances and your speed and accuracy in reaction to them is your responsibility and could mean the difference in life or death to your fellow worker and a clean conscience for yourself.

When pesticide poisoning by skin absorption is suspected. If the victim is *unconscious* and medical assistance is *not* readily available by telephone, follow these steps:

(1) Don gloves and remove the victim from the contaminated area by carrying, using extreme caution to avoid self-contamination.

(2) Determine if the victim is breathing; if not, administered back pressure-armlift artificial respiration immediately; and if breathing (or once the victim's breathing has been restored), decontaminate the victim by drenching the entire body, clothes and all, with a shower, hose, or waterhole.

(3) Treat the victim for shock.

(4) Determine the type of pesticide absorbed if possible.

(5) Obtain medical assistance as rapidly as possible pertaining to the victim's condition, the first aid measures rendered, and the type of pesticide absorbed or suspected to have been absorbed.

NOTE: If the victim is *unconscious* and medical assistance *is* readily available by telephone, follow these procedures:

(1) Don gloves and remove the victim from the contaminated area by carrying, using extreme caution to avoid self-contamination.

(2) Determine if the victim is breathing; if not, administer back pressure-armlift artificial respiration immediately; and if the victim is breathing (or once breathing has been restored), decontaminate the entire body in the same manner as previously described.

(3) Treat the victim for shock.

(4) Call for medical assistance and provide all details possible at this time concerning the incident.

(5) Determine the type of pesticide responsible for the poisoning and remain by the victim to monitor conditions and to provide information to the medic.

NOTE: If the victim is *conscious* and medical assistance is *not* readily available by telephone, follow these steps:

(1) Don gloves and remove the victim from the contaminated area by carrying, using extreme caution to avoid self-contamination.

(2) Decontaminate the victim by drenching the entire body.

(3) Treat the victim for shock.

(4) Determine the type of pesticide absorbed if possible.

(5) Obtain medical assistance as rapidly as possible and provide the medic with all information possible pertaining to the victim's condition, the first aid measures rendered, and the type of pesticide absorbed or suspected to have been absorbed.

NOTE: If the victim is *conscious* and medical assistance *is* readily available by telephone, follow these steps:

(1) Don gloves and remove the victim from contaminated area by carrying, using extreme caution to avoid self-contamination.

(2) Decontaminate the victim by drenching the entire body.

(3) Treat the victim for shock.

(4) Call for medical assistance and provide all information possible at this time pertaining to the incident.

(5) Determine the type of pesticide responsible for the poisoning, if not already known, and remain by the victim to monitor conditions and to provide additional information to the medic.

When pesticide poisoning by inhalation is suspected. If the victim is *unconscious* and medical assistance is *not* readily available by telephone follow these steps:

(1) Don air-supplied respirator and remove victim to fresh air, if in an enclosed area.

(2) Loosen all tight clothing.

(3) Determine if victim is breathing; if not, administer back pressure-armlift artificial respiration immediately.

(4) If victim is breathing, or once breathing has been restored, treat for shock.

(5) Determine the type of pesticide involved in the incident if possible.

(6) Obtain medical assistance as rapidly as possible, keeping the victim quiet and warm and monitoring the victim's condition.

NOTE: If the victim is *unconscious* and medical assistance *is* readily available by telephone, follow these steps:

(1) Don air-supplied respirator and remove victim to fresh air, if in an enclosed area.

(2) Loosen all tight clothing.

(3) Determine if victim is breathing; if not, administer back pressure-armlift artificial respiration immediately.

(4) If victim is breathing, or once breathing has been restored, call for medical assistance.

(5) Treat the victim for shock.

(6) Determine the type of pesticide involved in the incident if possible.

(7) Remain with victim to monitor the victim's condition and to provide information to the medics pertaining to the incident.

NOTE: If the victim is *conscious* and medical assistance is *not* readily available by telephone, follow these steps:

(1) Don air-supplied respirator and remove victim to fresh air, if in an enclosed area.

(2) Loosen all tight clothing.

(3) Treat the victim for shock.

(4) Determine the type of pesticide involved in the incident if possible.

(5) Obtain medical assistance as rapidly as possible while monitoring the victim's condition.

NOTE: If the victim is *conscious* and medical assistance *is* readily available by telephone, follow these steps:

(1) Don air-supplied respirator and remove victim to fresh air, if in an enclosed area.

(2) Loosen all tight clothing.

(3) Call for medical assistance.

(4) Treat the victim for shock.

(5) Remain with victim to monitor the victim's condition and to provide information to the medics pertaining to the incident.

c. When pesticide poisoning by ingestion is suspected.

If the victim is *unconscious* and medical assistance is not readily available by telephone, follow these steps:

(1) Determine if the victim is breathing; if not, administer back pressure-armlift artificial respiration.

(2) Obtain medical assistance as rapidly as possible if victim is breathing or once breathing has been restored.

(3) During transport to, or while waiting for medical assistance, treat the victim for shock and monitor the victim's condition at all times.

If the victim is *unconscious* and medical assistance is readily available by telephone, follow these steps:

(1) Call for medical assistance.

(2) Determine if victim is breathing; if not, administer back pressure-armlift artificial respiration.

(3) Treat the victim for shock.

(4) Determine the type of poison ingested if possible and remain with the victim until medical assistance arrives.

(5) Once medical assistance has arrived, provide all the information possible pertaining to the type of poison ingested and first aid measures that have been administered.

NOTE: If the victim is *conscious* and medical assistance is *not* readily available by telephone, follow these steps:

(1) Obtain medical assistance as rapidly as possible by transporting to a hospital or physician.

(2) During the process of obtaining medical assistance, monitor the victim closely.

(3) If victim loses consciousness, check breathing; and if not, administer back pressure-armlift artificial respiration.

(4) Once victim's breathing has been restored, proceed for medical assistance and provide the medics with all information possible pertaining to the incident.

NOTE: If victim is *conscious* and medical assistance *is* readily available by telephone, follow these steps:

(1) Call for medical assistance.

(2) Determine the type of pesticide ingested if possible.

(3) Administer the recommended antidote if there is one and if it is available.

It is recognized that the first aid procedures outlined in this objective do not cover all pesticide poisoning situations and that they are not absolute. However, they do provide you with a basis for rendering first aid to a poisoned victim. There are many circumstances in which you may be required to react on your own common knowledge of first aid and the circumstances involved at that time.

Exercises (252):

1. A victim suspected of being poisoned with a fumigant is *unconscious* and breathing, and medical assistance is not readily available. The first aid procedures to be taken are the following.

   (1)

   (2)

   (3)

   (4)

   (5)

2. A victim suspected of being poisoned by absorbing pesticides is conscious, and medical assistance is readily available. The first aid procedures to be taken are as follows:

   (1)

   (2)

   (3)

(4)

(5)

3. A victim suspected of being poisoned by the ingestion of a pesticide is *unconscious* and not breathing; medical assistance is not readily available by telephone. The first aid procedures to be taken are as follows:

(1)

(2)

(3)

4. If you happen to spill pesticides on your body, what is the first step that you should take in rendering first aid to yourself?

5. Why should medical attention be obtained even though poisoning is not expected to be severe?

6. What is the most important source for obtaining first aid instructions for each pesticide?

7. What responsibility rests upon you as a pest management specialist prior to applying any pesticide?

8.
(a) What is your first responsibility in rendering first aid?

(b) What is your second responsibility?

9. First aid is not to be substituted for ________ ________ ________ .

10. Recognizing the fact that all pesticide poisoning situations cannot be predicted and the first aid procedures to be applied in any given situation are not absolute, how may you be required to react?

11. The first aid procedures to be taken for accidental pesticide poisoning depend upon the ________ involved at the time.

12. The type of artificial respiration to be administered to a victim of pesticide poisoning is the ________ ________ ________ type.

253. Identify the types of antidotes to be administered for specific pesticides and the precautions to be taken for pesticide poisoning situations.

Antidotes for Poisoning Victims. Many antidotes have already been discussed in previous objectives because an antidote is defined as a remedy used to counteract effects of a poison or to prevent or relieve poisoning. Therefore, the safety precautions for storing, mixing, transporting, and applying pesticides and a knowledge of first aid may be considered antidotes because they can prevent or elieve poisoning.

This objective provides special warnings in the use of antidotes for certain types of poisons and in certain situations; it also identifies antidotes that are given orally or intravenously for common pesticides.

Special warnings for oral antidotes. In situations involving certain types of poisons, oral antidotes must not be given to a victim of accidental poisoning because they probably would cause more damage to the victim. You must know when and when not to administer an antidote for specific types of poisoning. Special warnings for administering antidotes are as follows:

a. Most toxic chemical labels provide first aid instructions ("Statement of Practical Treatment" on pesticide labels) for that particular chemical. Therefore, if the container for the poison known to be responsible for the accidental poisoning is readily available, it is imperative that you read these instructions prior to administering anything orally.

b. Never give anything orally to an *unconscious* victim.

c. Never induce vomiting if the victim is *unconscious* or is in convulsions.

d. Never induce vomiting if the victim has swallowed petroleum products such as kerosene, gasoline, and diesel fuel, or has swallowed corrosive poisons such as lye, acids, and lysol.

e. Do induce vomiting when noncorrosive substances have been swallowed, if the victim is *conscious* and not convulsive.

Antidotes for common pesticide compounds. There are several household items normally found within the home that can be used as antidotes for poisons, and the item that should be used depends upon whether or not vomiting is to be induced. The antidotes given at home or on the job are only temporary measures, and their effects on the victim of accidental pesticide poisoning is dependent upon the speed in which they are given. Antidotes that have been given at home or on the job are not to be substituted for professional medical treatments.

Some household items and their uses as antidotes for poisons are as follows:

- Clean water can be used as a diluent.
- Salt water can be used as a diluent and emetic.
- Milk can be used as a diluent or neutralizer of acid or alkali poisons.
- Milk of magnesia can be used as a neutralizer of acid poisons.

NOTE: Before any of these items are used as antidotes remember the "special warnings" that were given at the beginning of this objective.

The *universal antidote* is used for a wider variety of commonly used pesticides than any other antidote. This antidote is given orally in cases of poisoning by the following pesticide compounds:

- Organochlorines (chlordane, Dieldrin, lindane, etc.).
- Phenoxy herbicide.
- Hydrogen cyanide (calcium cyanide).
- Pentachlorophenol.

The universal antidote can be prepared by a pharmacist by mixing 2 parts activated charcoal, 1 part magnesium, 1 part oxide, and 1 part tannic acid. This mixture is then administered as 1/2 ounce per 1/2 glass of warm water.

NOTE: A homemade universal antidote can be prepared by using 4 tablespoons of crumbled, burned black toast; 2 tablespoons of strong tea, and 2 tablespoons of milk of magnesia.

Atropine is the specific antidote for organophosphate pesticides such as diazinon and malathion, and the carbamate pesticides such as carbaryl and propoxur. Atropine can be administered intravenously or orally.

An antidote that is frequently used in conjunction with atropine to counteract organophate poisoning is 2–PAM. However, it must not be used for carbamate poisoning.

Vitamin K is the antidote to be used in counteracting anticoagulant poisons such as warfarin, Diaphacin and Pival. This antidote must be administered by a physician.

BAL is a specific antidote to be used for arsenical poisons. This antidote can be obtained from a pharmacist but must be injected by a physician.

Now that you are aware of the requirements for handling pesticides safely at all times and guidelines have been furnished in the prevention of pesticidal accidents, you should be capable of avoiding the unwarranted destruction of property, contamination of the environment, and human poisoning.

In the event that poisoning does occur to humans by pesticides, you now have the basic knowledge for keeping victims alive until professional medical assistance is obtained.

Exercises (253):

1. An antidote for pesticide poisoning should never be administered until the type of __________ responsible for the poisoning is known.

2. You must never administer anything orally to an __________ victim.

3. For what two circumstances can vomiting be induced?

   (1)

   (2)

4. In what two circumstances should vomiting not be induced?

   (1)

   (2)

5. Antidotes that are given in the home or on the job are only __________ measures and should never be substituted for __________ __________ treatment.

6. The degree of results in administering proper antidotes is dependent upon the __________ in which they are given.

7. List two common household items that are identified in the text that can be used as neutralizers for some pesticide poisonings.

8. The specific antidote for organophosphate poisoning is __________, and this antidote can be used as an antidote for carbamate poisoning.

9. List the ingredients and the amount of each required in preparing the homemade universal antidote.

10. The pharmaceutical universal antidote is given orally to counteract what pesticidal compounds?

11. What antidote can be used for organophosphates but not for carbamates?

12. Name the antidote that can be obtained from a pharmacist but must be administered by a physician for arsenical poisoning.

13. Vitamin K is the antidote that must be administered by a physician to counteract ____________ poisoning.

14. Based upon what you have read in previous discussions of pesticide characteristics, what is the function of Vitamin K?

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APPENDIX

ARTHROPODS OF PUBLIC HEALTH IMPORTANCE: KEY TO COMMON CLASSES AND ORDERS

1. Three or 4 pairs of walking legs (Fig. 1 A & B)..............................2

Five or more pairs of walking legs (Fig. 1 C & D)..............................33

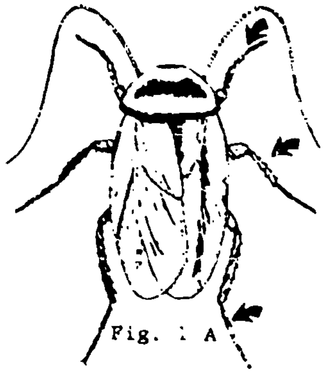


Fig. 1 A

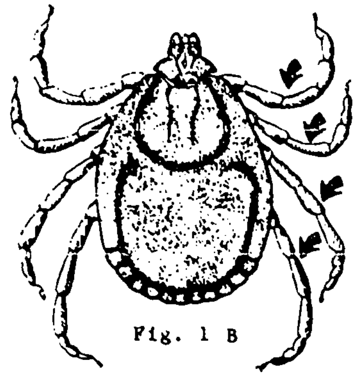


Fig. 1 B

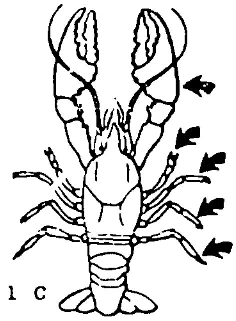


Fig. 1 C

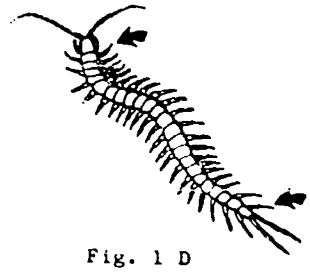


Fig. 1 D

2. Three pairs of walking legs (Fig. 2 A)..............................3

Four pairs of walking legs (Fig. 2 B)..............................25

Fig. 2 A

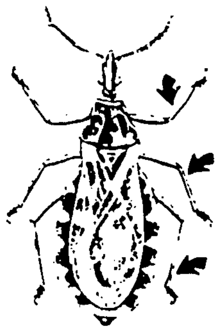
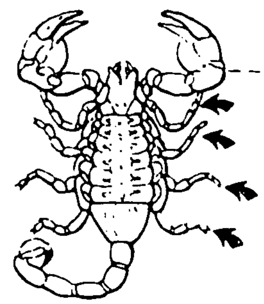


Fig. 2 B



3. Wings present, well developed (Fig. 3 A)..............................4

Wings absent or rudimentary (Fig. 3 B & C)..............................13

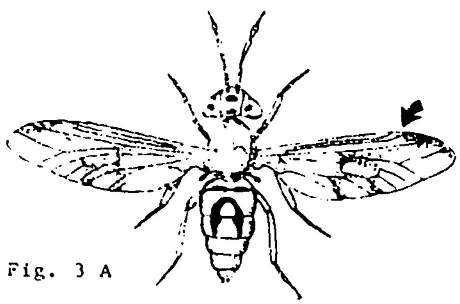


Fig. 3 A

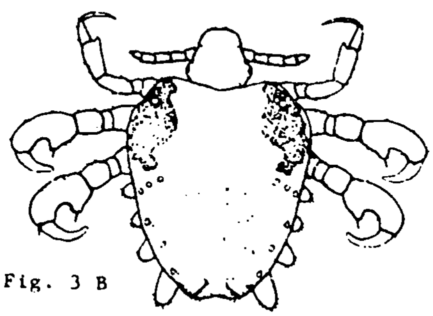


Fig. 3 B

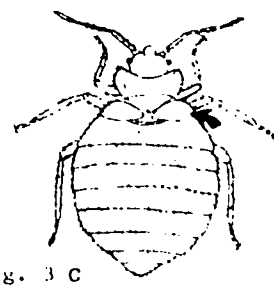


Fig. 3 C

4. With one pair of membranous wings (Fig. 4 A). ORDER DIPTERA.... 5

With two pairs of wings (Fig. 4 B & C)..............................6

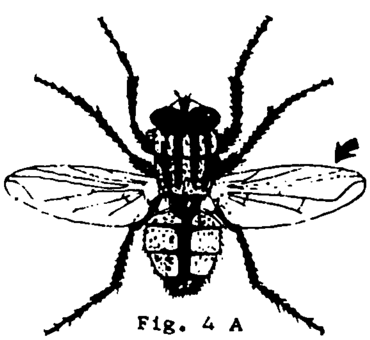


Fig. 4 A

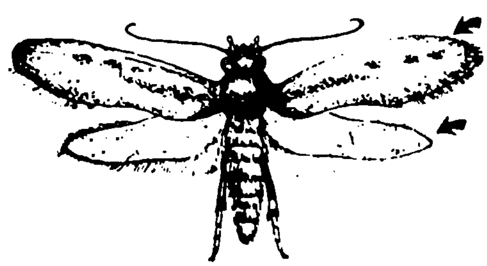


Fig. 4 B

Fig. 4 C

CFA-079

5. Wings with scales (Fig. 5 A). FAMILY CULICIDAE..MOSQUITO
Wings without scales (Fig. 5 B). DIPTERA OTHER THAN MOSQUITOES..............................FLY

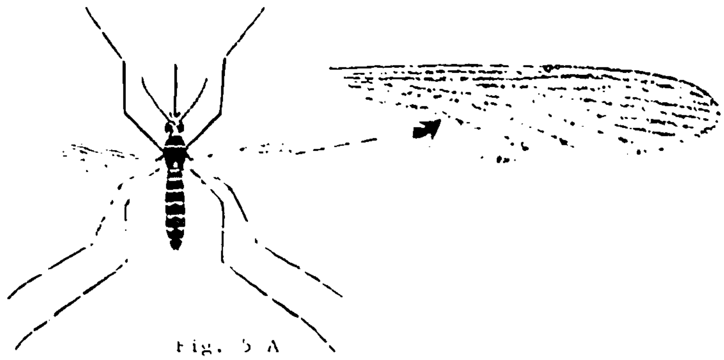


Fig. 5 A

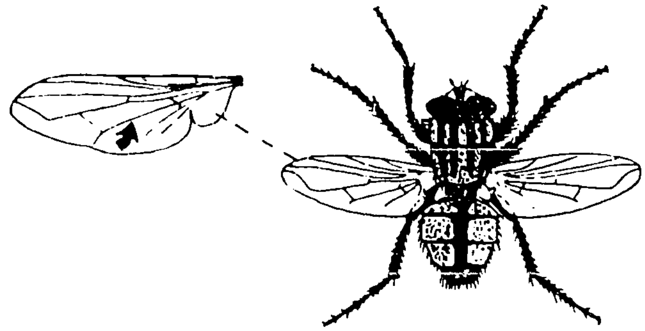


Fig. 5 B

6. Mouthparts adapted for sucking, with elongate proboscis (Fig. 6 A)...........................7
Mouthparts adapted for chewing, without elongate proboscis (Fig. 6 B).........................9

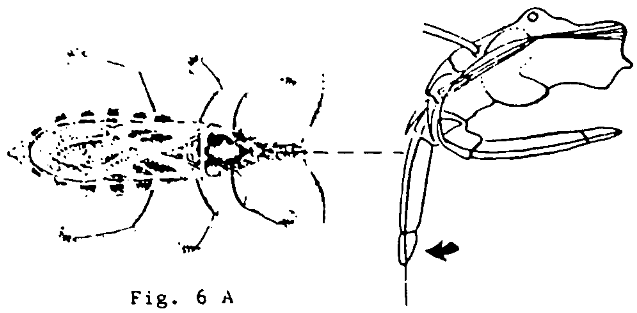


Fig. 6 A

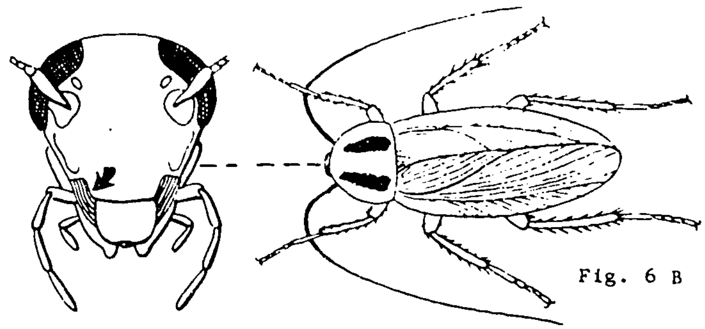


Fig. 6 B

7. Wings densely covered with scales; proboscis coiled (Fig. 7 A). ORDER LEPIDOPTERA...MOTH OR BUTTERFLY
Wings not covered with scales; proboscis not coiled (Fig. 7 B)................................8

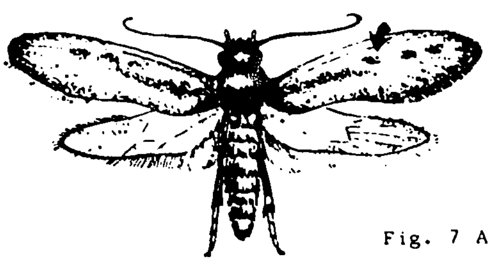


Fig. 7 A

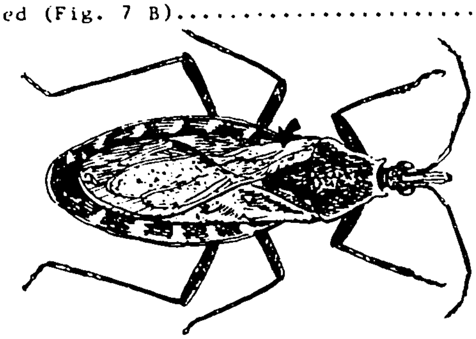


Fig. 7 B

8. Wing with fringe of long hair (Fig. 8 A). ORDER THYSANOPTERA.............................THRIPS
Wing without long hair (Fig. 8 B). ORDER HEMIPTERA................................KISSING BUG

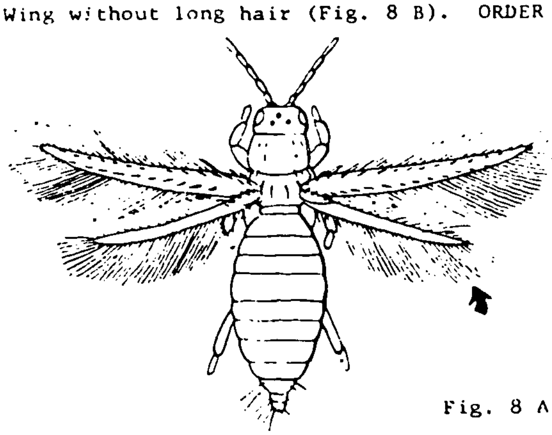


Fig. 8 A

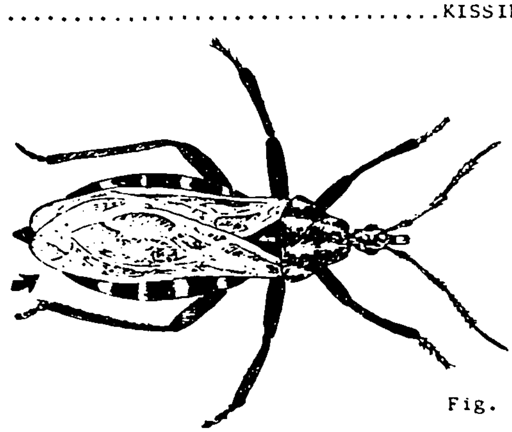


Fig. 8 B

CFA-081

9. Both pair of wings membranous and similar in structure (Fig. 9 A)..............................10
Front pair of wings shell-like or leathery serving as covers for the second pair (Fig. 9 B)......11

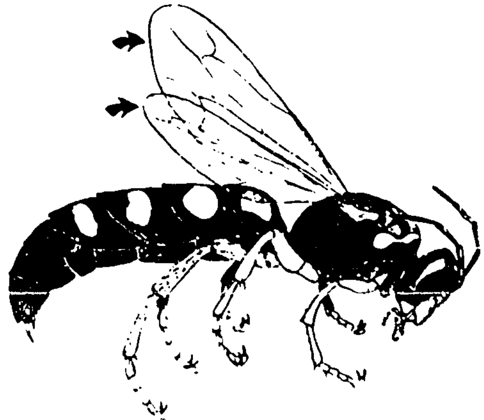


Fig. 9 A

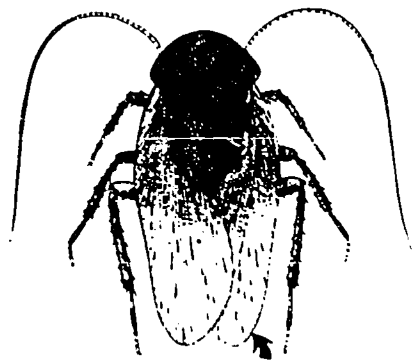


Fig. 9 B

10. Both pairs of wings similar in size (Fig. 10 A). ORDER ISOPTERA..........................TERMITE
Hind wing much smaller than front wing (Fig. 10 B). ORDER HYMENOPTERA..............................
....BEE, HORNET, WASP, YELLOW JACKET, OR ANT

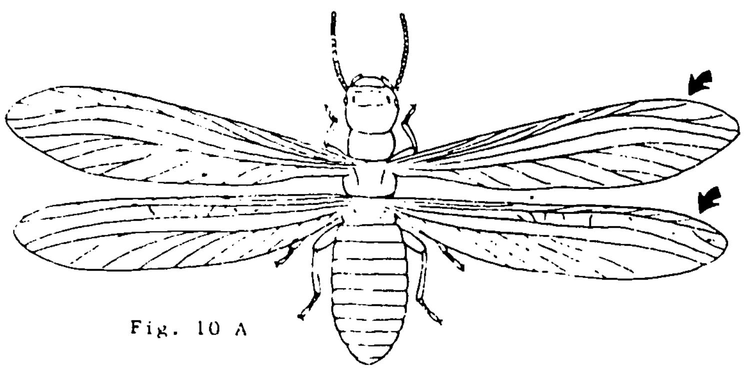


Fig. 10 A

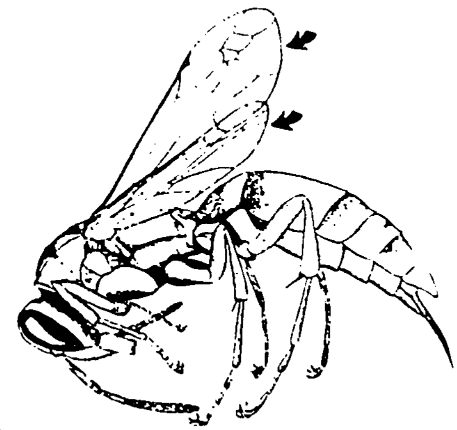


Fig. 10 B

11. Front wings horny or leathery, without distinct veins (Fig. 11 A)..............................12
Front wings leathery or paper-like, with distinct veins (Fig. 11 B). ORDER DICTYOPTERA ..COCKROACH

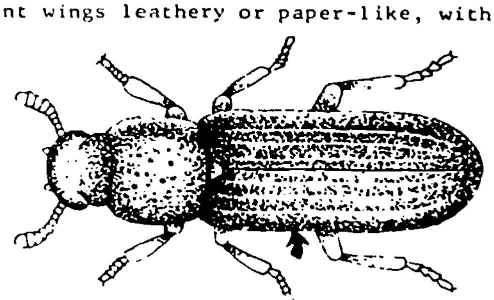


Fig. 11 A

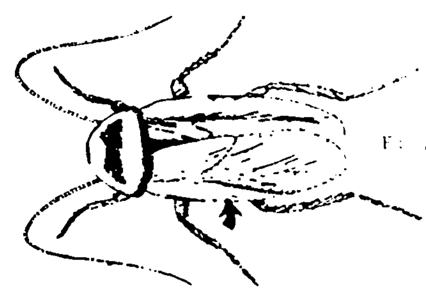


Fig. 11 B

12. Abdomen with prominent cerci; wings shorter than abdomen (Fig. 12 A). ORDER DERMAPTERA.......EARWIG
Abdomen without prominent cerci; wings covering abdomen (Fig. 12 B). ORDER COLEOPTERA.......BEETLE

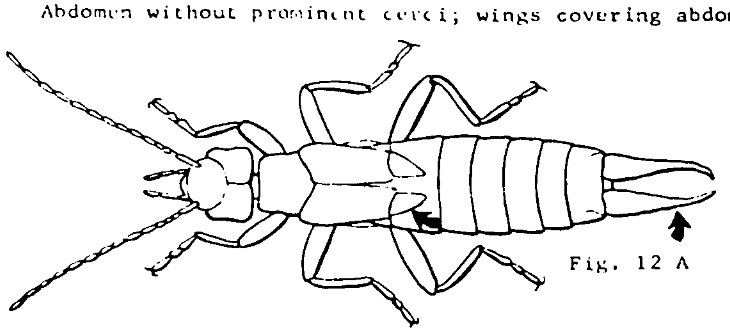


Fig. 12 A

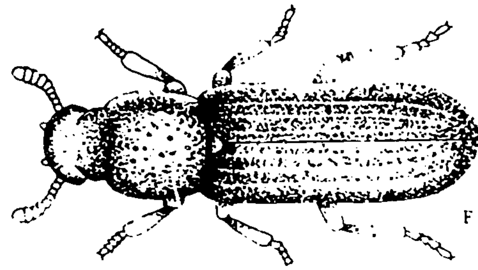


Fig. 12 B

CFA-082

13. Mouthparts with jaws for chewing (Fig. 13 A)..14

Mouthparts with a long beak or stylets for sucking up food (Fig. 13 B).........................21

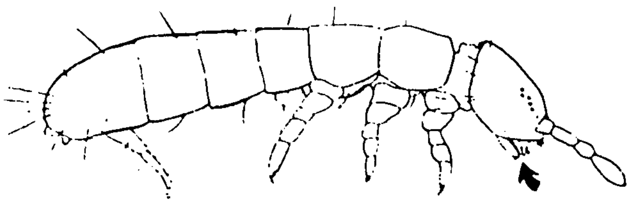


Fig. 13 A

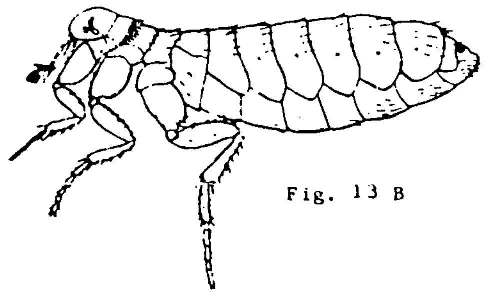


Fig. 13 B

14. With three long terminal tails (Fig. 14 A). ORDER THYSANURA..............SILVERFISH AND FIREBRAT

Without three long terminal tails (Fig. 14 B)..15

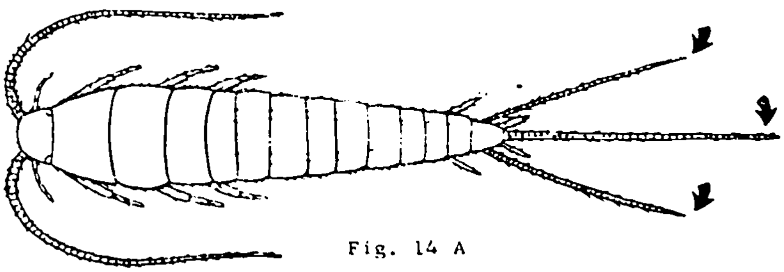


Fig. 14 A

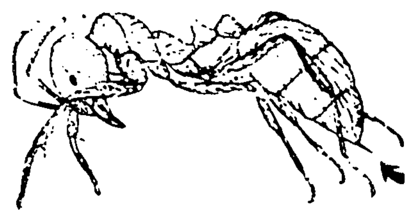


Fig. 14 B

15. Abdomen with prominent pair of cerci (Fig. 15 A). ORDER DERMAPTERA.......................EARWIG

Abdomen without prominent pair of cerci (Fig. 15 B)...16

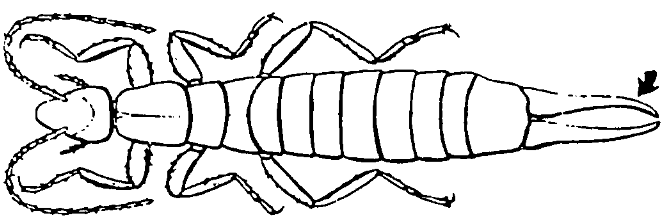


Fig. 15 A

Fig. 15 B

16. With narrow waist (Fig. 16 A). ORDER HYMENOPTERA...ANT

Without narrow waist (Fig. 16 B)...17

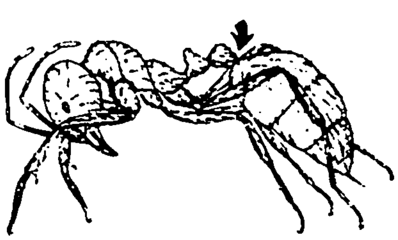


Fig. 16 A

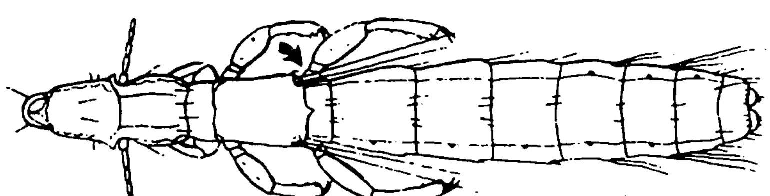


Fig. 16 B

CFA-083

17. Antenna with fewer than 8 segments (Fig. 17 A)..18

Antenna with more than 8 segments (Fig. 17 B)..19

Fig. 17 A

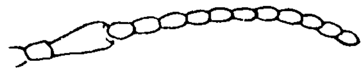


Fig. 17 B

18. Abdomen with 6 or fewer segments (Fig. 18 A). ORDER COLLEMBOLA......................SPRINGTAIL

Abdomen with more than 6 segments (Fig. 18 B). ORDER MALLOPHAGA..................CHEWING LOUSE

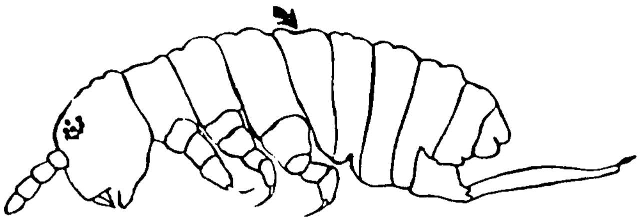


Fig. 18 A

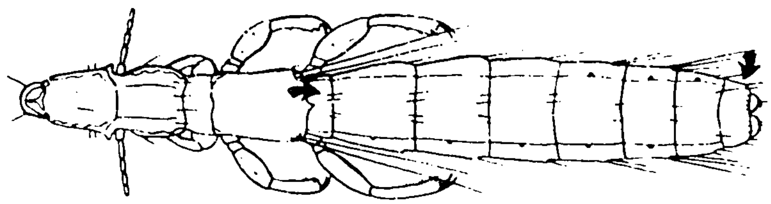


Fig. 18 B

19. Tarsus with 4-5 segments (Fig. 19 A)..20

Tarsus with 1-3 segments (fig. 19 B). ORDER PSOCOPTERA....................BOOK LOUSE OR PSOCID

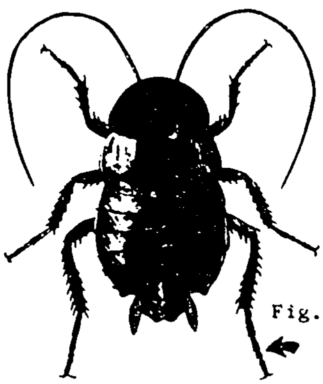


Fig. 19 A

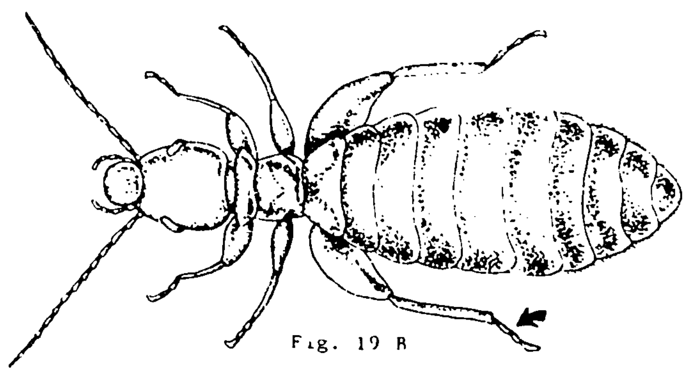


Fig. 19 B

20. Pronotum narrower than head, never covering head (Fig. 20 A). ORDER ISOPTERA..........TERMITE

Pronotum broader than head, often covering head (Fig. 20 B). ORDER ORTHOPTERA........COCKROACH

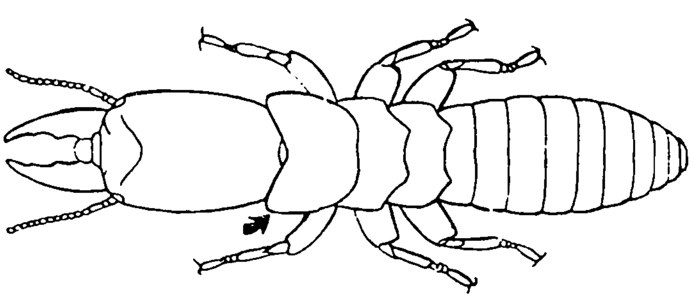


Fig. 20 A

226

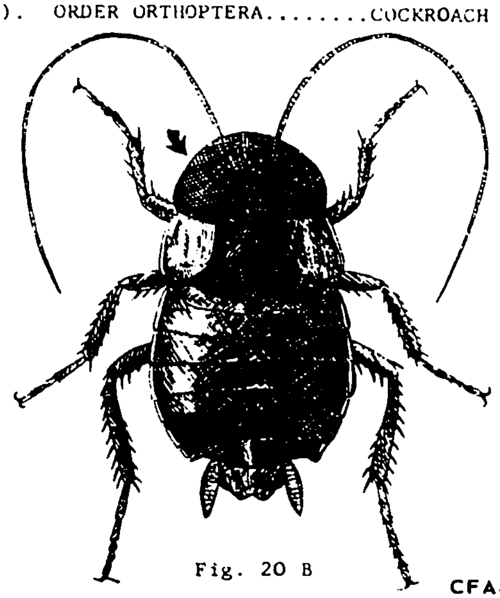


Fig. 20 B

CFA-084

21. Flattened laterally (Fig. 21 A). ORDER SIPHONATERA....................................FLEA
Flattened dorso-ventrally (Fig. 21 B)...22

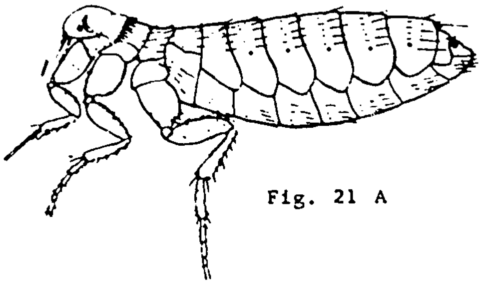


Fig. 21 A

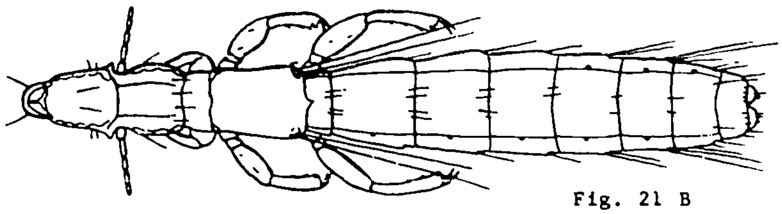


Fig. 21 B

22. Foot terminating in protrusible bladder (Fig. 22 A). ORDER THYSANOPTERA................THRIPS
Foot not terminating in protrusible bladder (Fig. 22 B)....................................23

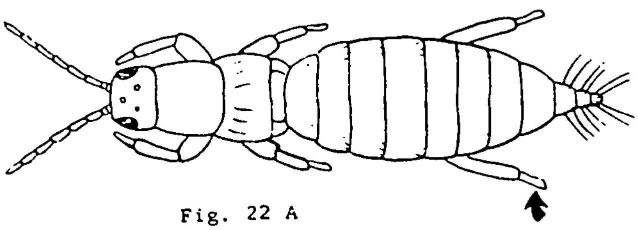


Fig. 22 A

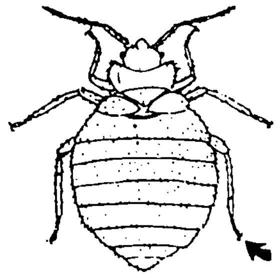


Fig. 22 B

23. Beak jointed (Fig. 23 A). ORDER HEMIPTERA...BEDBUG
Beak not jointed (Fig. 23 B)...24

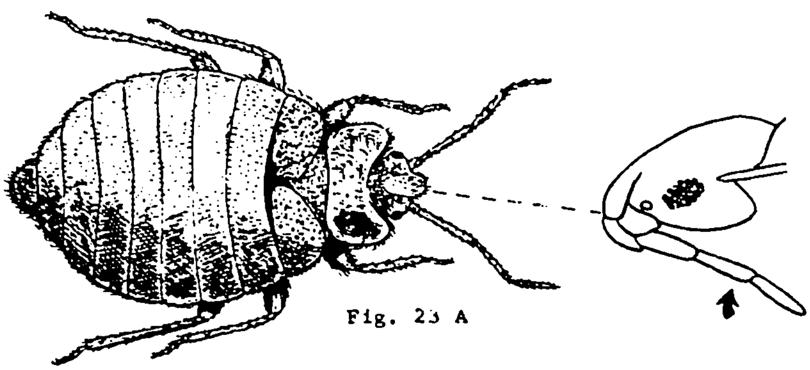


Fig. 23 A

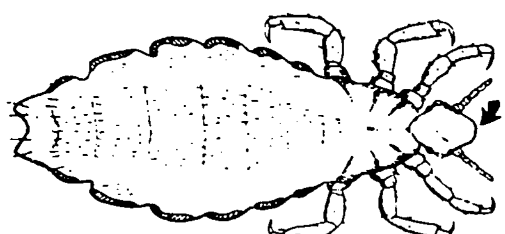


Fig. 23 B

24. Mouthparts retracted into head (Fig. 24 A). ORDER ANOPLURA......................SUCKING LOUSE
Mouthparts not retracted into head (Fig. 24 B). ORDER DIPTERA................KED OR LOUSE FLY

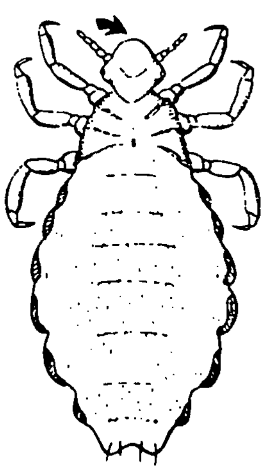


Fig. 24 A

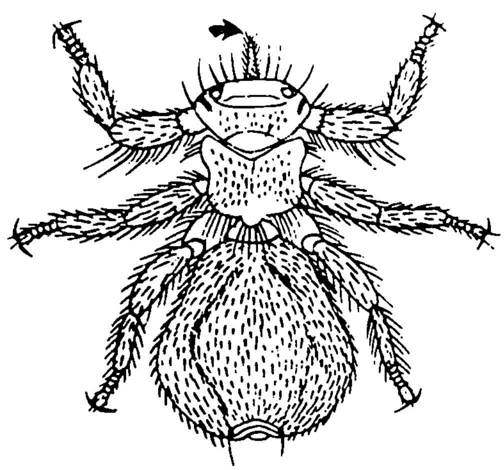


Fig. 24 B

CFA-085

25. Abdomen well-developed (Fig. 25 A). CLASS ARACHNIDA..26

Abdomen peg-like (Fig. 25 B). CLASS PYCNOGONIDA..SEA SPIDER

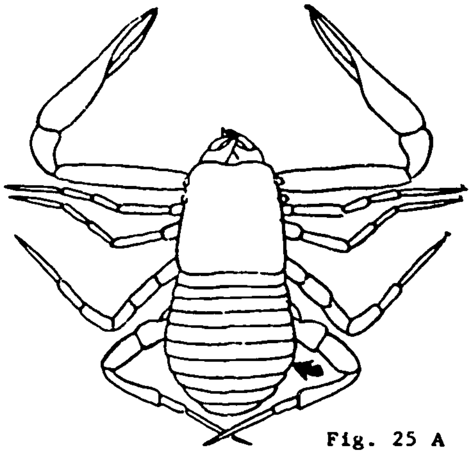


Fig. 25 A

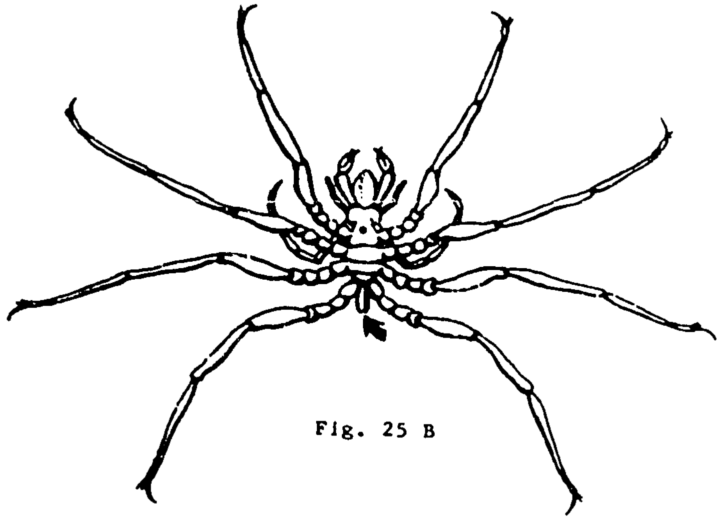


Fig. 25 B

26. Abdomen distinctly segmented (Fig. 26 A)..27

Abdomen not distinctly segmen 26 B)..31

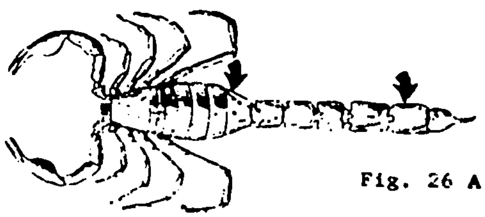


Fig. 26 A

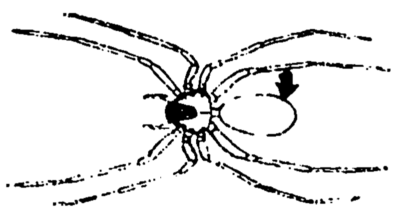


Fig. 26 B

27. Abdomen lengthened to form a long tail (Fig. 27 A)..28

Abdomen not lengthened to form a long tail (Fig. 27 B)..29

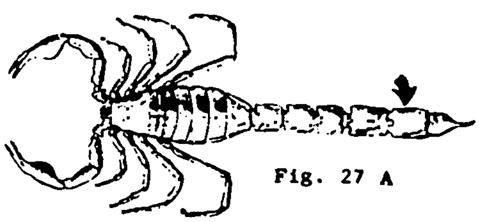


Fig. 27 A

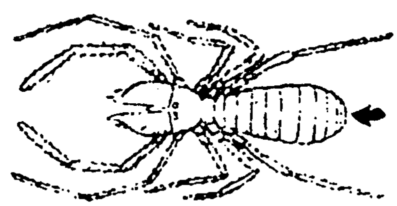


Fig. 27 B

28. Tail with stinger (Fig. 28 A). ORDER SCORPIONIDA..SCORPION

Tail without stinger (Fig. 28 B). ORDER PEDIPALPIDA..WHIP SCORPION

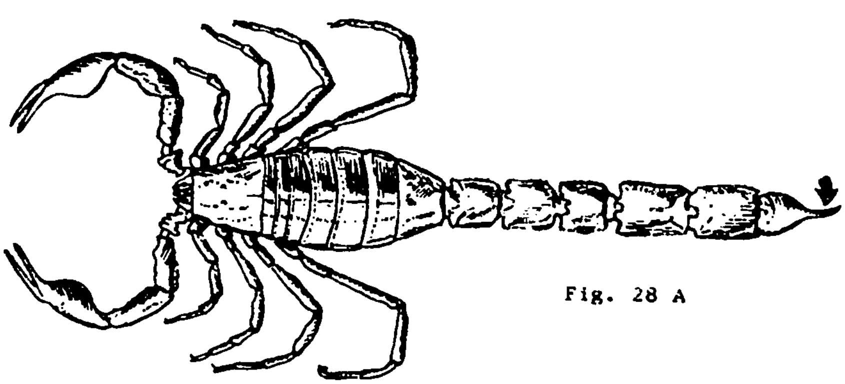


Fig. 28 A

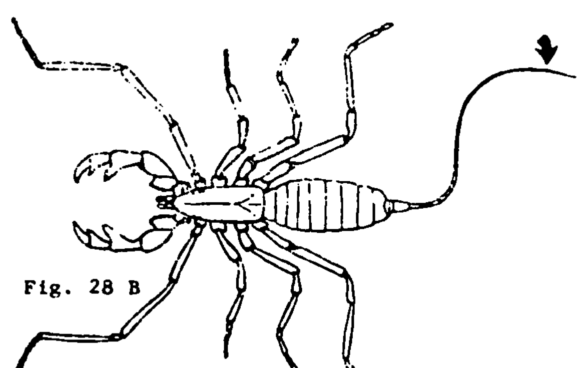


Fig. 28 B

CFA-086

29. With large pincer-like claws (Fig. 29 A). ORDER PSEUDOSCORPIONIDA..............PSEUDOSCORPION

Without large pincer-like claws (Fig. 29 B)...30

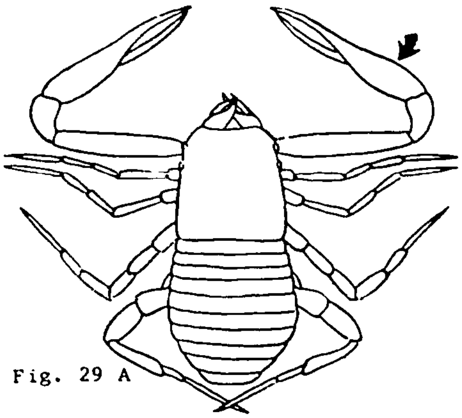


Fig. 29 A

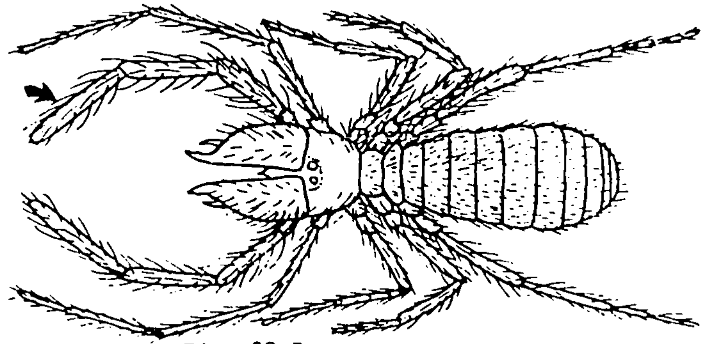


Fig. 29 B

30. Legs not longer than body (Fig. 30 A). ORDER SOLPUGIDA.............................SUN SPIDER

Legs much longer than body (Fig. 30 B). ORDER PHALANGIDA................DADDY LONG-LEG SPIDER

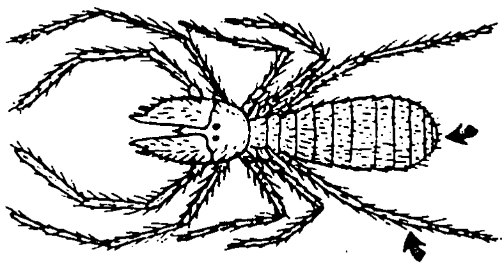


Fig. 30 A

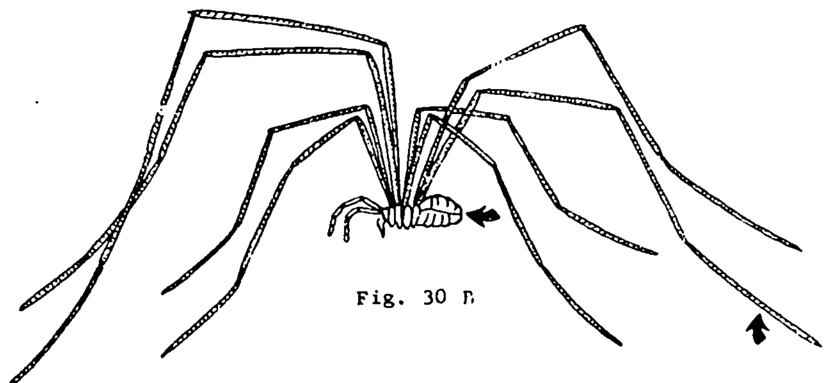


Fig. 30 B

31. Abdomen constricted to form a narrow waist (Fig. 31 A). ORDER ARANEIDA..................SPIDER

Abdomen not constricted (Fig. 31 B)...32

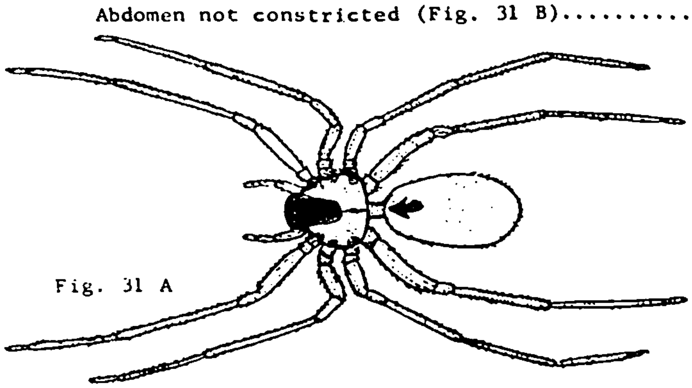


Fig. 31 A

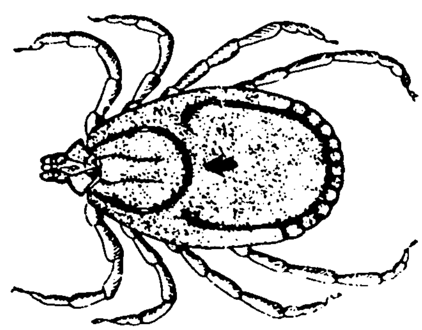


Fig. 31 B

32. Body with long hair; Haller's organ absent (Fig. 32 A). ORDER ACARINA...................MITE

Body without hair or short hair; Haller's organ present (Fig. 32 B). ORDER ACARINA........TICK

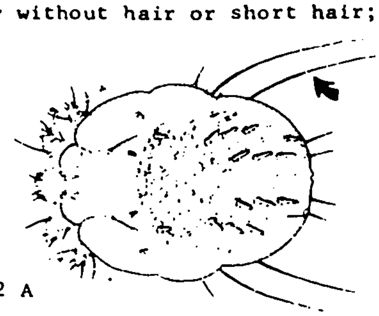


Fig. 32 A

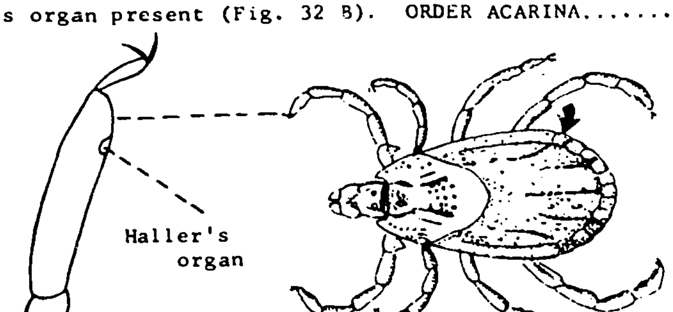


Fig. 32 B

CFA-087

33. Five to 7 pairs of walking legs (Fig. 33 A). CLASS CRUSTACEA....................................34

More than 14 pairs of walking legs (Fig. 33 B)...36

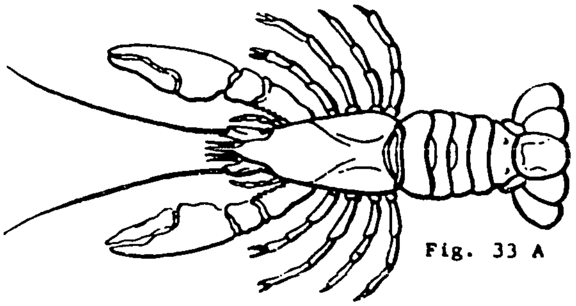


Fig. 33 A

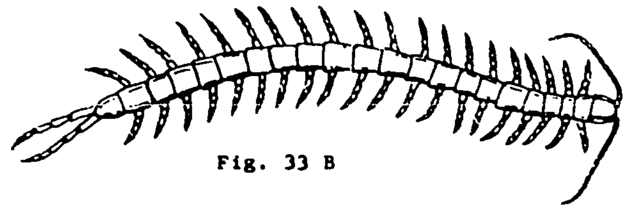


Fig. 33 B

34. Abdomen without appendages (Fig. 34 A). ORDER COPEPODA....................................COPEPOD

Abdomen with appendages (Fig. 34 B)...35

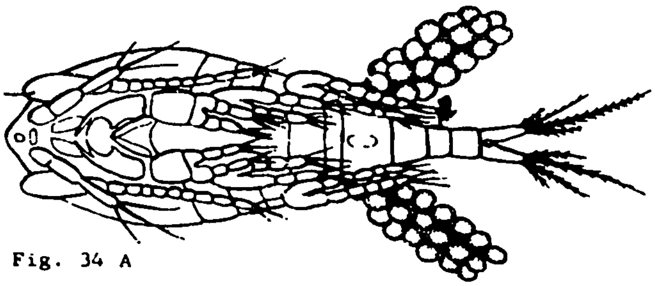


Fig. 34 A

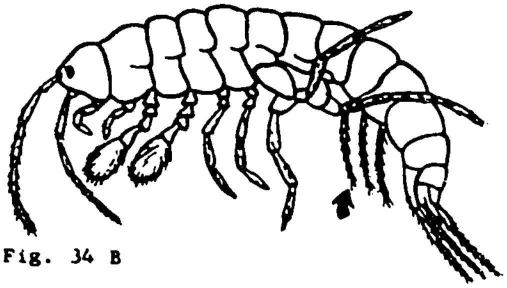


Fig. 34 B

35. Thorax covered with a fused plate; eyes, when present, on movable stalks (Fig. 35 A & B)...........
ORDER DECAPODA...LOBSTER, CRAB, CRAYFISH, SHRIMP, ETC.

Thorax not covered with a fused plate; eyes, when present, not on movable stalks (Fig. 35 C & D)...
ORDER ISOPODA...SOWBUG, PILLBUG

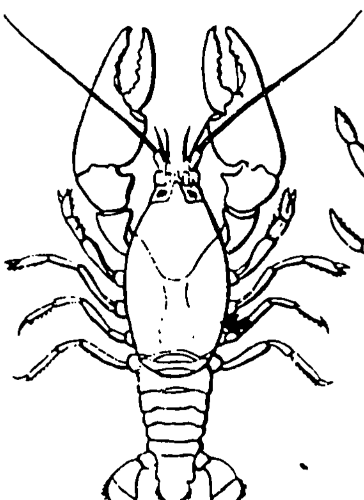


Fig. 35 A

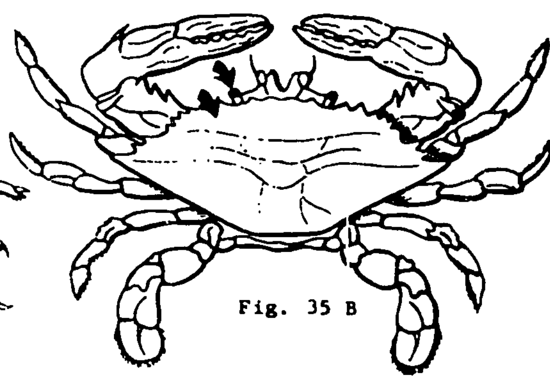


Fig. 35 B

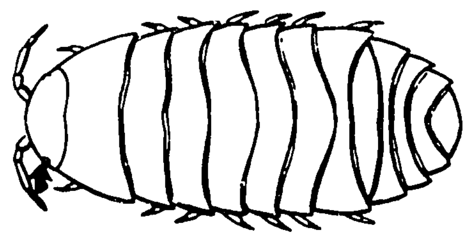


Fig. 35 C

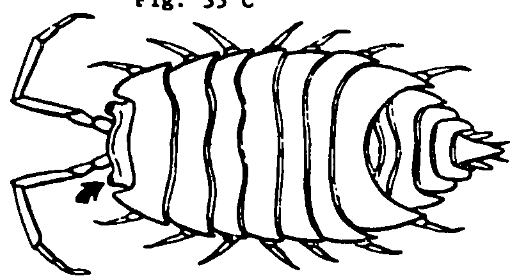


Fig. 35 D

36. One pair of legs per body segment (Fig. 36 A). CLASS CHILOPODA..........................CENTIPEDE

Two pairs of legs per body segment (Fig. 36 B). CLASS DIPLOPODA..........................MILLIPEDE

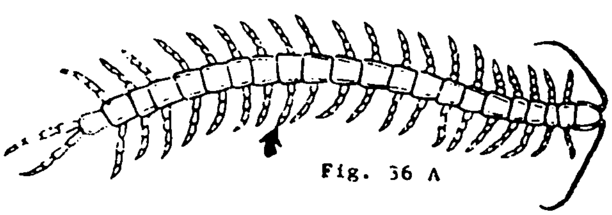


Fig. 36 A

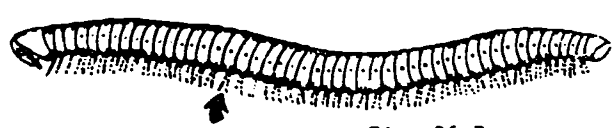


Fig. 36 B

CFA-088

Answers for Exercises

CHAPTER 1

Reference:

200 – 1. Systematic biology is the arrangement of living things into groups having similar characteristics.
200 – 2. Systematic biology.
200 – 3. The binomial system of nomenclature.

201 – 1. Applying two names to an organism.
201 – 2. *Culex.*
201 – 3. *Domestica.*
201 – 4. Scientific name.

202 – 1. Structure.
202 – 2. Kingdom.
202 – 3. Class.
202 – 4. Genus.
202 – 5. Phylum.

203 – 1. It must be capable of motion and have no chlorophyll.
203 – 2. The primary difference is the type of skeleton each phylum has. The phylum Chordata has an internal skeleton (endoskeleton), and the phylum Arthropoda has an external skeleton (exoskeleton).
203 – 3. Two wings with a second pair modified into halteres or balances, sucking mouthparts, and complete metamorphosis.

204 – 1. False.
204 – 2. Arthropoda.
204 – 3. Hexapoda and Arachnida.
204 – 4. Crustacea.
204 – 5. (1) d.
(2) a.
(3) b.
(4) e.
(5) c.

205 – 1. Head, thorax, and abdomen.
205 – 2. a. Abdomen.
b. Thorax.
c. Head.
d. Abdomen.
e. Thorax.
205 – 3. Sclerites.
205 – 4. Membraneous sutures.
205 – 5. They are as organs of touch, smell, and sometimes, hearing.
205 – 6.

Mouthparts	*Insect* (any one of the following)
(1) Chewing.	Cockroaches, termites, chewing lice.
(2) Rasping-sucking.	Trips.
(3) Piercing-sucking.	Biting mosquitoes.
(4) Sponging.	Houseflies, blow flies, fruit flies.
(5) Siphoning.	Moths and Butterflies.
(6) Chewing-lapping.	Bees and wasps.

205 – 7. Two pairs.
205 – 8. Metamorphosis.
205 – 9. Gradual or incomplete metamorphosis.
205 – 10. Complete metamorphosis.

206 – 1. (1) b.
(2) c.
(3) g.
(4) d.
(5) i.
(6) a.
(7) h.
(8) f.

207 – 1. Mallophaga; chewing lice.
207 – 2. Psocoptera; psocids.
207 – 3. Dictyoptera; cockroaches, praying mantids, walking sticks.
207 – 4. Thysanoptera; thrips.
207 – 5. Thysanura; firebrats and silverfish.
207 – 6. Mallophaga; chewing lice.
207 – 7. Lepidoptera; butterflies and moths.
208 – 1. (1) c.
(2) a.
(3) b.

209 – 1. (1) e.
(2) c.
(3) b.
(4) a.
(5) d.
209 – 2. They have an open circulatory system. The blood isn't enclosed in vessels but is circulated freely through the body.
209 – 3. The skeletal system.
209 – 4. Oviparous.
209 – 5. Parthenogenesis.

210 – 1. Smell.
210 – 2. Touch; hearing.
210 – 3. False.
210 – 4. False.
210 – 5. Smell.
210 – 6. Depositing the eggs.
210 – 7. Compound eyes.
210 – 8. Simple stimuli.

CHAPTER 2

211 – 1. Population shifts can be detected; you can concentrate control efforts in areas where they're most needed; and select control methods more effectively. Problem awareness by others is increased, as needed; consultations are made easier; and you can plan ahead logistically.
211 – 2. Basic and operational.
211 – 3. Your reasons may include:
(1) To determine the prevalence of beneficial or detrimental plants or animals.
(2) To identify beneficial or detrimental features.
(3) To determine why pests are established in the area.
(4) To see what conditions could result in future infestations.
211 – 4. Your reasons may include:
(1) To get new information for basic survey questions.
(2) To identify conditions that could prevent your taking control measures.
(3) To ensure adequate treatment.
(4) To identify undesirable side effects.
(5) To determine if the program met its objectives.
211 – 5. Probing.
211 – 6. Skimming.
211 – 7. Trapping.

212 − 1. Surveillance and identification.
212 − 2. Live collections must be conducted when specimens are to be used for research.
212 − 3. a. (1) Trapping: (a) light traps, (b) cage traps.
(2) Biting and resting: (a) aspirators.
b. (1) Cloth drags: (a) flannel cloth drag.
(2) Picking: (a) tweezers.
c. (1) Trapping: (a) cage traps.
d. (1) Dipping: (a) dipper.
(2) Skimming: (a) dipper.
e. (1) Combing: (a) comb.
(2) Brushing: (a) brush.
(3) Swirling: (a) swirling jar.
(4) Picking: (a) tweezers.

213 − 1. Pictorial; dichotomous.
213 − 2. Dichotomous.
213 − 3. Pictorial.
213 − 4. a. (1) Dictyoptera.
(2) Cockroach.
(3) 1, 2, 3, 4, 6, 9 (and) 11.
b. (1) Acarina.
(2) Tick.
(3) 1, 2, 25, 26, 31 (and) 32.

214 − 1. Adjust the width of the eyepiece adapter.
214 − 2. To adjust the magnification.
214 − 3. Properly illuminate the specimen.
214 − 4. Right eye.
214 − 5. Clean with a cotton swab that has been moistened with a soap or detergent solution and dry with a cotton swab.
214 − 6. False.

215 − 1. To allow interested persons to become familiar with pests common to the area.
215 − 2. Dry preservation.
215 − 3. 2 percent caustic potash; synthetic detergent.
215 − 4. Cut off the abdomen at the base, lay it on a flat surface, and squeeze the fluid out by rolling a small round object from abdomen tip toward the cutoff portion.
215 − 5. Camel's-hair brush.
215 − 6. Ethyl acetate, benzene, and ether.
215 − 7. Direct, staging, carding, and pointing.
215 − 8. Scientific name of specimen, the scientist who described the specimen, and the date originally described.
215 − 9. Paradichlorobenzene; naphthalene.

216 − 1. Soft-bodied.
216 − 2. Ethyl alcohol, Pampel's fluid, and chloral hydrate.
216 − 3. Spirit-preserved specimens should be stored in a cool, dark area and away from all sources of heat.
216 − 4. Smearing.

217 − 1. Remove air bubbles.
217 − 2. 4; 5.
217 − 3. Back and forth motion.
217 − 4. a. Determine the number of liquid ounces required to fill the container.
b. Convert the ounces into cubic centimeters.
c. Divide the total cubic centimeters by 3.

218 − 1. 10 percent caustic potash; 12 hours.
218 − 2. Lighten.
218 − 3. Acetic acid.
218 − 4. Acid fuchsin.
218 − 5. Water.
218 − 6. Dehydrate.
218 − 7. Caustic potash.

219 − 1. a. Involves reducing a pest's access to food, shelter, and water; or making the environment more favorable to natural enemies.
b. Using direct or indirect nonchemical methods to destroy pests, or making the environment unsuitable for their entry, dispersal, survival, or reproduction.
c. The regulation of pest organisms by their natural enemies, such as pathogens, predators, and parasites.
d. Controls that involve rearing and releasing insects which are sterile or altered genetically in order to suppress members of their own species.
e. The use of materials which kill, repel, trap, confuse, or regulate the growth of pests.
219 − 2. a. Mechanical.
b. Chemical.
c. Cultural.
d. Cultural.
e. Biological.
f. Chemical.
g. Mechanical.
h. Autocidal.
i. Biological.
j. Mechanical.

220 − 1. Your sources may include:
(1) USAF meteorological office.
(2) National Weather Service.
(3) County extention office.
(4) County health office.
(5) Past pest management program reviews.
(6) Pest summary reports.
(7) Pest management maintenance records.
(8) Basic survey.
220 − 2. a. Information on rainfall, temperatures, wind speed, and wind directions.
b. Pest population trends and movement patterns.
c. Information on managing health-related pests, local pests of medical importance, areas near your base where pests may be breeding.
d. Why pest management programs are needed; when, where, and how the work could be done.
e. What conditions are allowing the pests to become established in an area, beneficial or detrimental features of the area.

221 − 1. (1) a, g.
(2) e, h.
(3) c, f, i.
(4) b, j.
(5) b, e, h.
(6) d.

222 − 1. (1) c.
(2) e.
(3) h.
(4) f.
(5) i.
(6) g.
(7) b.
(8) d.
(9) a.
(10) j.
(11) k.

223 − 1. Misting.
223 − 2. Dusting.
223 − 3. Fumigation.
223 − 4. Aerosoling.
223 − 5. Fumigation.
223 − 6. Granulating.

224 − 1. (1) b.
(2) a.
(3) a.
(4) b.
(5) b.
(6) a.
(7) b.
(8) a.
(9) a.
(10) a.
(11) a.
(12) a.
(13) a.

(14) a.
(15) b.

225 – 1. (1) e.
(2) c.
(3) f.
(4) d.
(5) b.
(6) g.
(7) a.

226 – 1. All personnel engaged in direct field supervision of pest management operations, or those who operate independently of direct supervision.
226 – 2. Every 3 years.
226 – 3. To identify individuals who have proved they are competent in handling pesticides and to insure they are aware and knowledgeable of current policies related to all phases of pest management.
226 – 4. A letter requesting certification or recertification is forwarded through proper channels to the designated certifying official.
226 – 5. a. Category of certification requested.
b. Individual's name, rank, and social security number.
c. Training accomplishments within the career field.

227 – 1. To maintain a complete record of all pest problems and the procedures used to deal with those problems.
227 – 2. Each time control measures are taken.
227 – 3. Two years after a treated building is destroyed.
227 – 4. Date: 23 March 1984.
Units Serviced: Bottom floor, admin. section.
Work Origin: WR.
Unit of Measure: .2 MSF.
Pest: cockroaches.
Operation: Residual Spray.
Name: Diazinon EC.
Percent Concentrate: .5 percent.
Amount: 3 oz.
Labor Time: 1 hr.
(Your initials.)

228 – 1. Facilities that are constructed completely or partially of wood.
228 – 2. They must be inspected annually, but should be inspected semiannually.
228 – 3. To record inspection, provide information pertaining to building condition, and to record action taken.
228 – 4. After building has been disposed of or if the installation is inactivated or dropped from real property accounts.
228 – 5. Date Inspected - 17 January 1984.
Building Number - 302.
Installation - Bryan AFB.
Type Building - "Permanent" block should show an "X."
Inspector: SSgt Thomas Tony.
Block I: Other (Specify) - "Deteriorated attic vent screens."
Block II: Other (Specify) - "Termites in rafters."
Block III: An X should appear in block beside "Nonsubterranean."
Block IV: No entry made.
Block V: An X should appear in block beside "Superficial."
Block VI: Other (Specify) - "Replace screens over attic vents; inject rafter with pentachlorophenol."
Block VII: The Yes block should have a X in the Wood Injection for Dry-wood Termite space. To the right of that in Chemical Used space the word "pentachlorophenol" should appear.
Block VIII: Labor - $227.00
Material - $73.00
Other - $30.00
Total - $330.00
Block IX: Date - 20 Janaury 1984.
Title of individual - Section Supervisor.
Signature - Name of SSgt Thomas T. Tony.

229 – 1. Daily; AFR 91–21.
229 – 2. It's used to record daily pest management activities and is the source document for creating a pest file.
229 – 3. AFR 91–21, AFM 300–4 (and) AFM 171–200.
229 – 4. AFM 300–4.
229 – 5. Data element code AVDJO should be entered in columns 1 through 5 on lines 1 and 7.
Data element code AVAT should be entered in columns 6 through 9 on line 1 only.
A "1" should be entered in column 17 on line 1 for Area Treated.
An "A" and a "C" should be entered in columns 18 and 19, respectively, on line 1 for Unit of Measures.
A "2" should be entered in column 20 on lines 1 and 7 for Building Terrain.
Data element code SNOP20 should be entered in columns 21 through 26 on line 1 only.
The abbreviation on EMUL should be entered in columns 27 through 30 on line 1 for Pesticide Form.
An "8" should be entered in column 36 on line 1 for Pesticide Quantity (2 gallons of concentrate × 4 pounds per gallon.)
An "L" and a "B" should be entered in columns 37 and 38, respectively, on line 1 for Unit of Measure.
An "S" should be entered in column 39 on line 1 for Supply Source.
A "1" and a "2" should be entered in columns 44 and 45, respectively, on line 1 for Man-Hours Labor (8 hours mixing and applying the pesticide and 4 hours supervision).
A "1" should be entered in column 51 on line 7 for Man-Hours Survey.
A "1" and a "0" should be entered in columns 78 and 79, respectively, on lines 1 and 7 for Month.
A "1" should be entered in column 80 on line 1, a "2" should be entered in column 80 on line 7 for Card Code.

230 – 1. Unlike AF Form 290, you can use DD Form 1532 to report both chemical and nonchemical controls.
230 – 2.

a. Ad. Mosquitoes.	h. 6.
b. ULV Spraying.	i. lbs.
c. 125.	j. (leave blank).
d. AC.	k. 0.5.
e. OUT.	l. 95.0.
f. Malathion.	m. N.
g. Solu.	n. 16.

231 – 1. To set pest management goals and identify methods and resources you'll use in the coming year to meet those goals.
231 – 2. A single chemical control measure taken to control a single pest.
231 – 3. (1) c. f.
(2) a, c.
(3) a.
(4) g.
(5) g.
(6) b, g.
(7) e.
(8) a, d.
(9) g.

CHAPTER 3

232 – 1. (1) To provide laws pertaining to the certification of the usefulness of chemicals used in agriculture.
(2) To provide specified requirements for safety precautions in handling and applying agricultural chemicals.
(3) To provide specified requirements for registering agricultural chemicals every 5 years.
232 – 2. Keep out of Reach of Children.
232 – 3. Nemoticides, plant growth regulators, desiccants and defoliants.

233 – 1. Amendment; FIFRA.
233 – 2. To extend Federal registration and regulation to all pesticides.
233 – 3. You should have placed an X beside c, d, and f.

234 – 1. It was designed to help prevent endangering human health and the environment.
234 – 2. Treatment, storage, transportation, and disposal.

235 – 1. It was created because of continuing pressure to limit the use of pesticides. It combines all activities of the Federal Government concerned with pesticides and their effects on the environment into a single agency.
235 – 2. You should have placed an X beside a, c, and d.

236 – 1. U.S. Department of Labor.
236 – 2. To insure that all employees have safe and healthy working conditions.
236 – 3. a. Develop and publish occupational safety standards.
b. Inspect work areas to insure that standards are met.
c. Issue citations for noncompliance with its regulations.
d. Maintain education, training, and information programs to promote safe practices.

237 – 1. U.S. Department of Health and Human Services.
237 – 2. Formulate improved occupational and health standards.
237 – 3. Testing and approving many items of personal safety protective equipment.

238 – 1. When the State and local requirements are more stringent.
238 – 2. The more stringent requirements, whether they be Federal, State, or local requirements.

239 – 1. Facility location, its layout, and general requirements.
239 – 2. Shops should always be isolated from congested base areas. This reduces environmental hazards in the event of a fire or pesticide spill.
239 – 3. Clean areas and chemical-handling areas.
239 – 4. Office space, personnel break rooms, and utilities.
239 – 5. Pesticide storage and mixing rooms.
239 – 6. The dressing room, which includes lockers and storage for personal safety equipment.
239 – 7. There must be a sink area ventilation system which pulls air away from the worker's position at the rate of at least six air changes per hour.
239 – 8. They must be readily accessible to workers mixing pesticides indoors or outdoors.
239 – 9. They must be stored inside and off the floor so labels are clearly visible and access by workers is convenient.
239 – 10. Any three of these should be on your list:
(1) Must be constructed of concrete or another impervious material.
(2) Must have a nonskid surface.
(3) Should be covered with an epoxy sealer.
(4) Should have a continuous curb at least five inches high.
(5) Should have no floor drains.
239 – 11. (1) Indoor area for small equipment.
(2) Covered or enclosed area for large equipment.
(3) Paved, curbed area for washing equipment.
239 – 12. By using only pesticides that have flash points of 100° F or more.

240 – 1. The pesticide label serves the same purpose as an Air Force regulation.
240 – 2. The safe storage, mixing, uses, and application of that specific pesticide.
240 – 3. Highly toxic pesticides.
240 – 4. 1. f.
2. c.
3. k.
4. h.
5. a.
6. l.
7. e.
8. i.
9. b.
10. j.
11. d.
12. g.

241 – 1. On the outer surface of each door.
241 – 2. They must be segregated and stored separately according to the method of disposal.
241 – 3. Prior to entering the room.
241 – 4. Sound.
241 – 5. Clear; easy.
241 – 6. Appropriate fire extinguishers.

242 – 1. Ventilated; lighted.
242 – 2. First aid.
242 – 3. Amount.
242 – 4. Eye; face.
242 – 5. Contaminated; toxic.

243 – 1. Spills.
243 – 2. Calibrated.
243 – 3. Vehicular; pedestrian.
243 – 4. Plan ahead; action.
243 – 5. No smoking, eating, or drinking while handling pesticides.
243 – 6. Official bulletin and/or base newspaper.

244 – 1. Locked.
244 – 2. Children; people.
244 – 3. Repair.
244 – 4. Pest Management.
244 – 5. Label.
244 – 6. Storage; locked.

245 – 1. (1) As an additional security measure.
(2) To help detect early signs of container deterioration.
(3) To help insure proper pesticide storage.
245 – 2. When the pesticide is very toxic or when the quantity is significant.
245 – 3. No. They do not know how to apply pesticides or the proper way to store them.
245 – 4. At least once a month, but more often if desired.
245 – 5. You must record all pesticides that have been received and withdrawn from the time of the last inventory until the present inventory.

246 – 1. Minimize contamination of personnel.
246 – 2. Rope off the area and post warning signs. If necessary, post guards.
246 – 3. (1) Don appropriate protective equipment.
(2) Prevent further pesticide leakage.
(3) Prevent the spill from spreading.
(4) Cover the spill.
246 – 4. Cover it with a tarpulin, or if appropriate, sprinkle the area lightly with water.
246 – 5. Remove a layer of soil at least 3 inches below the wet surface line.
246 – 6. After most of the pesticide has been cleaned up or removed.
246 – 7. Chlorine bleach, caustic soda, or lime.
246 – 8. Caustic soda or lime.
246 – 9. Chlorinated hydrocarbons.
246 – 10. (1) Remove the materials and place in a sealed leakproof drum.
(2) Properly label the drum as to the types of chemicals and materials in it.
(3) Dispose of the drum in a hazardous waste disposal facility under current EPA or State permit.

247 – 1. Dispose of surplus pesticides in a manner that will not permit harm to people or animals, will not contaminate the air or water, and will not harm the environment.
247 – 2. Because this will cause direct contamination of the sewage water.
247 – 3. By spreading it over a suitable land area such as a gravel driveway or a field. Sunlight and air will help break down the pesticide as a result.
247 – 4. They must be triple-rinsed and rendered unusable.
247 – 5. They can be buried in an approved sanitary landfill.

248 – 1. They are not to be worn to dining facilities, snack bars, and base exchange facilities except while performing actual pest management duties.
248 – 2. A washing machine and dryer.
248 – 3. A rainsuit.
248 – 4. Waterproof rainsuit.
248 – 5. Apron.
248 – 6. Pubic.
248 – 7. With the tops beneath the legs of the coveralls or rainsuit.
248 – 8. During all phases of pesticide handling.
248 – 9. Liquid.

248 – 10. Goggles or a faceshield.
248 – 11. Earplugs.
248 – 12. NIOSH; MESA.
248 – 13. Odors; breathe.
248 – 14. Soap; water.
248 – 15. Vegetable; drying; cracking.

249 – 1. Anticoagulants.
249 – 2. Pyrethrum.
249 – 3. Organophosphates; carbamates.
249 – 4. Methyl bromide.

250 – 1. Pyrethrum.
250 – 2. Methyl bromide or petroleums.
250 – 3. Anticoagulants.
250 – 4. Hydrogen cyanide.
250 – 5. Organophosphates or carbamates.
251 – 1. (1) c.
(2) c.
(3) a.
(4) b.
(5) [illegible]
251 – 2. Ignorance and negligence.
251 – 3. Store all pesticides in a secure area; observe the no-smoking, eating, or drinking rule.

252 – 1. (1) Don air-supplied respirator and move victim to fresh air.
(2) Loosen tight clothing.
(3) Treat the victim for shock.
(4) Determine type of pesticide involved, if possible.
(5) Obtain medical assistance as rapidly as possible.
252 – 2. (1) Don gloves and remove the victim from contaminated area.
(2) Decontaminate the victim by drenching the entire body.
(3) Treat the victim for shock.
(4) Call for medical assistance and provide all information possible at the time.
(5) Try to determine the type of pesticide responsible for the poisoning and remain by the victim.
252 – 3. (1) Administer back pressure-armlift artificial respiration.
(2) Obtain medical assistance as rapidly as possible.
(3) Treat the victim for shock and monitor the victim's condition at all times.
252 – 4. Remove the pesticide as quickly as possible.
252 – 5. Because the severity is not actually known and to alert medical staff for possible side effects.
252 – 6. The statement of practical treatment found on the pesticide label.
252 – 7. To anticipate possibilities of pesticide poisoning and to establish actions to be taken in the event of pesticide poisoning.
252 – 8. (a) To keep the victim alive.
(b) To obtain medical assistance.
252 – 9. Professional medical assistance.
252 – 10. On your own common knowledge of first aid and the circumstances involved at the time.
252 – 11. Circumstances.
252 – 12. Back pressure-armlift.

253 – 1. Pesticide.
253 – 2. Unconscious.
253 – 3. If it has been determined that the victim has swallowed a noncorrossive substance and if the victim is conscious and not convulsive.
253 – 4. a. If the victim has swallowed petroleum products.
b. If the victim is unconscious or convulsive.
253 – 5. Temporary; professional medical.
253 – 6. Speed.
253 – 7. Milk and milk of magnesia.
253 – 8. Atropine.
253 – 9. Four tablespoons of crumbled, burned black toast, 2 tablespoons of strong tea, and 2 tablespoons of milk of magnesia.
253 – 10. Organochlorines, phenoxys, hydrogen cyanide, and pentachlorophenol.
253 – 11. 2–PAM.
253 – 12. BAL.
253 – 13. Anticoagulant.
253 – 14. To clot the blood in humans.

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STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 02 22

INTRODUCTION TO PEST MANAGEMENT

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the *best* answer to each question.

1. (200) Systematic biology classifies living things into

   a. groups having similar characteristics.
   b. animal or vegetable groups.
   c. land or water groups.
   d. airborne or land groups.

2. (200) Why was systematic biology developed?

   a. To pay tribute to Aristotle.
   b. To provide a foundation for further description.
   c. To identify generalized body structures and habits.
   d. To provide a standardized and universally accepted method of classification of liv ng animals.

3. (201) What is meant by the "binomial system of nomenclature"?

   a. Using two cla ification systems.
   b. Applying two names to an organism.
   c. Classifying plants and animals separately.
   d. Classifying plants and animals by a name and a number.

4. (201) Which of these scientific names is properly written?

   a. *Cimex Lectularius.*
   b. *musca domestica.*
   c. *Sturnus vulgaris.*
   d. *anopheles Quadrimaculatus.*

5. (202) Which of the following correctly depicts the major divisions of the animal kingdom in descending order?

   a. Class, phylum, family, order.
   b. Order, phylum, class, family.
   c. Phylum, class, order, family.
   d. Phylum, order, class, genus.

6. (202) Which of these terms represents the greatest degree of nomenclature breakdown in the animal kingdom?

   a. Order.
   b. Family.
   c. Genus.
   d. Species.

7. (203) Humans and insects are in the same

   a. order.
   b. class.
   c. family.
   d. kingdom.

8. (203) Arthropods are distinguished from humans in that the arthropods have

   a. jointed appendages, three pairs of legs, and two wings.
   b. one pair of antennae, a dorsal heart, and three pairs of legs.
   c. cold blood, dorsal heart, and an exoskeleton.
   d. one pair of antennae, a ventral nerve cord, and complete metamorphosis.

9. (204) Which of these classes are of *primary* concern to us?

a. Hexapoda and Diplopoda.
b. Hexapoda and Arachnida.
c. Arachnida and Chilopoda.
d. Arachnida and Diplopoda.

10. (204) Which of the following characteristics does *not* apply to the class Hexapoda?

a. One pair of antennae.
b. Four pairs of legs.
c. Reproductive organs at the posterior end of the abdomen.
d. Three body regions.

11. (205) An insect's antennae may serve as sense organs for all of the following *except*

a. seeing.
b. hearing.
c. smelling.
d. touching.

12. (205) In complete metamorphosis, what stages does an insect go through:

a. Egg, nit, pupa, adult.
b. Egg, larva, nymph, adult.
c. Egg, nymph, larva, adult.
d. Egg, larva, pupa, adult.

13. (206) Which of these insect orders is considered the most beneficial to humans?

a. Hymenoptera.
b. Homoptera.
c. Dermaptera.
d. Anoplura.

14. (206) To which order do mosquitos belong?

a. Anoplura.
b. Coleoptera.
c. Dermaptera.
d. Diptera.

15. (207) Caterpillars are the larval stage of which order?

a. Thysanoptera.
b. Thysanura.
c. Dictyoptera.
d. Lepidoptera.

16. (207) Cockroaches develop through what type of metamorphosis?

a. No metamorphosis.
b. Gradual metamorphosis.
c. Complete metamorphosis.
d. Any of these, depending on the species.

17. (208) To which class do spiders and scorpions belong?

a. Arthropoda.
b. Arachnida.
c. Hexapoda.
d. Chilopoda.

18. (208) Which of the following is characteristic of arthropods within the order Araneida (spiders)?

a. The abdomen has a stinger and is broadly joined to the cephalothorax.
b. The head, thorax, and abdomen are fused into a single body region.
c. The cephalothorax is joined to the abdomen by a slender waist.
d. The mouthparts have a hypostome for piercing the skin to obtain blood.

19. (209) One of the *main* functions of blood in an insect's system is to

a. remove waste products from body cells.
b. carry oxygen to other body systems.
c. transport carbon dioxide out of body cells.
d. maintain an adequate level of moisture within the insect.

20. (209) Organs which transfer air through an insect's body are

a. ganglia.
b. trachea.
c. ostia.
d. malpighean tubules.

21. (210) Which organs provide the sense of touch in insects?

a. Cuticle and antennae.
b. Cuticle and feet.
c. Hairs and antennae.
d. Hairs and feet.

22. (210) Insect behavior is influenced by all of the following stimuli *except*

a. heat.
b. gravity.
c. light.
d. memory.

23. (211) Which of the following is *not* a reason for conducting a basic survey?

a. To determine why pests are established in an area.
b. To determine if a prevalence of beneficial or detrimental species exists.
c. To determine if a control program met its goals.
d. To determine what conditions could cause future pest problems.

24. (211) A probing survey is used to determine the

a. presence of pests in hard-to-reach places.
b. damage from past treatments for pests.
c. presence of potential pest breeding places.
d. damage from termites, fungi, and wood borers.

25. (212) What pests are usually collected with a cloth drag?

a. Ticks.
b. Mites.
c. Mosquitos.
d. Lice.

26. (212) What prevents ectoparasites from being lost when they are brushed from an anesthetized animal?

a. They can't crawl up the sides of the collection pan.
b. They are also anesthetized.
c. They are stunned by the brushing.
d. They are killed by the brushing.

27. (213) What process do you use with a key to identify pests?

a. Ordering.
b. Elimination.
c. Structuring.
d. Reduction.

28. (213) When working to identify an insect, you should first determine its

a. order.
b. family.
c. genus.
d. species.

29. (214) If you wear glasses, what should you do when using a microscope?

a. Take your glasses off while viewing.
b. Take your glasses off while adjusting the focus.
c. Make adjustments with glasses on; view with glasses off.
d. Do all adjusting and viewing with glasses on.

30. (214) How do you determine the proper width of a microscope eyepiece?

a. View with one eye at a time until the field is visible without moving your head.
b. Measure between the centers of your eyes; adjust the same distance to the center of the eyepieces.
c. Move the eyepieces while viewing; adjust until you see two distinct images.
d. Move the eyepieces while viewing; adjust until you see a single image.

31. (215) How should you clean specimens that are very fragile or dry and rigid?

a. With a small camels hair brush.
b. By immersing in water and detergent.
c. By immersing in alcohol or formaldehyde.
d. With a moistened cotton swab.

32. (215) Which method of pinning is best to use for mounting small, dry-preserved specimens?

a. Carding.
b. Staging.
c. Pointing.
d. Direct pinning.

33. (216) What type of specimens are best preserved in spirits?

a. Soft-bodied specimens.
b. Very small specimens.
c. Very large specimens.
d. Hard, crusty specimens.

34. (216) How should spirit-preserved specimens be stored?

a. In a ventilated jar or other container.
b. In a well-lighted, warm area.
c. In a cool dark area away from heat sources.
d. Anywhere as long as they are in an airtight container.

35. (217) How should you prepare a mold before filling it with plastic resin?

a. Coat the interior of the mold with uncatalyzed resin.
b. Apply a mold release compound inside the mold.
c. Wash the mold and dry it in a light bulb oven.
d. Wash the mold in synthetic detergent and leave it wet?

36. (217) What precautions should you take when stirring a resin and catalyst mixture?

a. Do not create any bubbles in the mixture.
b. Use a plastic stirring rod.
c. Allow bubbles to float to the top and skim off.
d. Stir until the mixture begins to thicken.

37. (218) What type of specimens are best suited for slide preservation?

a. Any specimen which can be made transparent.
b. Very small, soft specimens.
c. Specimens no larger than the slide.
d. Parts of large specimens.

38. (218) How are specimens cleared of internal body tissues prior to slide mounting?

a. By soaking in alcohol and squeezing the abdomen.
b. By drawing body fluids out with a hypodermic needle.
c. By soaking in caustic potash solution for 12 hours.
d. By placing in a vacuum chamber for 12 hours.

39. (219) The introduction of pathogens, predators, or parasites to control a pest species is what type of control?

a. Autocidal control.
b. Biological control.
c. Chemical control.
d. Disease control.

40. (219) Which of the following is an example of cultural control?

a. Placing sticky traps in rodent burrows.
b. Releasing parasitic wasps to prey on caterpillars.
c. Using basic good housekeeping practices.
d. Applying polyethelene to prevent growth of vegetation.

41. (219) Which of the following is *not* an example of chemical control?

a. Using sex attractants to confuse stored products pests.
b. Using tracking patches to monitor rodent movements.
c. Using repellents on your skin to prevent insect bites.
d. Using growth regulators on turf to reduce grass cutting requirements.

42. (220) Which information source would you use to find out about areas near your base where disease vectors are breeding?

a. County health office.
b. County extension office.
c. Animal damage control department.
d. Pest management maintenance record.

43. (220) Which information source would you use to learn about pest population trends and movement patterns?

a. Pest summary report.
b. USAF meteorological office.
c. County extension office.
d. County health office.

44. (221) What is the *first* step you should take when selecting pest management procedures?

a. Determine equipment and material availability.
b. Determine the personnel available.
c. Identify pest locations.
d. Identify the pest.

45. (221) All phases of pest management planning should be based *primarily* on

a. economy and safety.
b. effectiveness and economy.
c. safety and effectiveness.
d. responsibility and authority.

46. (222) Which of the following sections can be of help to you in repairing two-cylinder engines?

a. Power production.
b. Equipment section.
c. Pavements and grounds.
d. Environmental support.

47. (222) Who would you contact if you needed a special vehicle to do a special type of pest management work?

a. Construction maintenance.
b. Information office.
c. Exterior electric.
d. Traffic management.

48. (223) Which pesticide dispersal method gives you maximum control over where liquid pesticide particles go?

a. Aerosoling.
b. Brushing.
c. Spraying.
d. Baiting.

49. (223) When you use an ultra-low volume generator, what pesticide dispersal method are you using?

a. Aerosoling.
b. Misting.
c. Spraying.
d. Dusting.

50. (223) Which pesticide dispersal method would you use to treat a large outdoor area to control crawling insects without harming vegetation?

a. Spraying.
b. Misting.
c. Dusting.
d. Brushing.

51. (224) Which residual gives the best control with a reduction in the amount of pesticide applied?

a. Crack and crevice treatment.
b. Baseboard treatment.
c. Spot treatment.
d. Vaporization.

52. (224) How are space treatments normally dispersed?

a. With nonwettable dusts.
b. With granular pesticide.
c. As mists or sprays.
d. As aerosols.

53. (225) How does foliage treatment affect plants?

a. Decreases nitrogen food supply.
b. Cuts off oxygen supply to the plant.
c. Burns tissue or affects plant growth.
d. Stimulates desirable plants which choke out undesirable plants.

54. (225) Which type of soil treatment stops vegetation growth by preventing seed germination?

a. Postemergence.
b. Preemergence.
c. Nonselective.
d. Selective.

55. (226) How is DD Form 1826 used?

a. To identify certifiable personnel.
b. To explain the purpose of certification.
c. To explain how to obtain certification.
d. To certify competence in pest management.

56. (226) How often must certified personnel be recertified?

a. Every year.
b. Every two years.
c. Every three years.
d. Every four years.

57. (227) How is DD Form 1532-1 used?

a. As a pest management maintenance record maintained for each facility and area where pest management is conducted.
b. As a pest management historical record indicating only chemical applications made in base structures and areas.
c. As a quality control form used to review the performance of the pest management section on a monthly basis.
d. As a request for pest management services.

58. (227) When can you destroy a DD Form 1532-1?

a. When the last entry on the form is at least 1 year ago.
b. When the last entry on the form is at least 3 years ago.
c. Not until two years after the building involved has been destroyed.
d. Not until two years after the base is closed.

59. (228) What type of facilities require a DD Form 1070, Termite and Wood Decay Inspection?

a. All wood facilities.
b. All wood or partial wood facilities.
c. All wood facilities which had no preventive measures taken during construction.
d. All wood or partial wood facilities which had no preventive measures taken during construction.

60. (328) Base facilities requiring wood pest inspections should be inspected at least

a. semiannually; preferably monthly.
b. quarterly; preferably monthly.
c. annually; preferably semiannually.
d. biannually; preferably annually.

61. (229) How often is the AF Form 290, Transcript for Pest Report, prepared?

a. Daily.
b. Weekly.
c. Monthly.
d. Quarterly.

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62. (229) In completing the AF Form 290, the first coded data element entered on the form is the

a. pest name.
b. pest control operation.
c. pest survey.
d. herbicide.

63. (230) How is DD Form 1532 used in a way different from AF Form 290?

a. DD Form 1532 is used to report only nonchemical controls.
b. AF Form 290 is used to report only nonchemical control.
c. DD Form 1532 can be used to report both chemical and nonchemical controls.
d. AF Form 290 can be used to report both chemical and nonchemical controls.

64. (230) When you enter the pesticide amount and unit on DD Form 1532, be sure to list the units in

a. dry ounces.
b. pounds.
c. gallons.
d. liquid ounces.

65. (231) What is the purpose of AF Form 646, Pest Management Program Review?

a. Eliminate wasteful programs.
b. Set pest management goals.
c. Determine pest management financial needs.
d. Identify procedural improvement requirements.

66. (231) In identifying areas to be avoided in a control program to what information should you refer?

a. The product label and a base map.
b. The product label and DD Form 1532-1.
c. Quarterly reports and a base map.
d. Quarterly reports and other correspondence.

67. (232) What important amendment was made to the Federal Insecticide, Fungicide, and Rodenticide Act in 1963?

a. Prohibition for agricultural use.
b. Prohibition for commercial sale.
c. Requirement for labels to state the certification of use.
d. Requirement for labels to state "Keep out of reach of children."

68. (233) How are you as a pest management specialist affected by the Federal Environmental Pesticide Control Act (FEPCA)?

a. You are prohibited from using restricted pesticides.
b. You must have pest management certification before using restricted pesticides.
c. You must have formal training in the use of restricted pesticides.
d. As an Air Force pest management specialist you are not subject to FEPCA restrictions.

69. (234) What areas of hazardous waste handling are covered by the Resources Conservation and Recovery Act?

a. Treatment, detoxification and disposal.
b. Detoxification, transportation, and disposal.
c. Storage, treatment, transportation, and disposal.
d. Transportation, detoxification, storage, and disposal.

70. (235) The Environmental Protection Agency (EPA) was created in 1970 with what responsibilities in the field of environmental pollutants?

a. Regulation, research, and education.
b. Research and development.
c. Governing certification of commercial pesticide applicators.
d. Identification of toxic dump sites and prosecute offenders.

71. (236) What is the purpose of the Occupational Safety and Health Administration (OSHA)?

a. To ensure all employees have a safe and healthy work environment.
b. To plan and manage the disposal of hazardous waste.
c. To enforce the safety codes established by the Federal Environmental Pesticide Control Act.
d. To ensure and enforce safety standards for the use and storage of hazardous chemicals.

72. (236) Which of the following is *not* a functional responsibility of OSHA?

a. To develop and publish occupational and health standards.
b. To inspect work areas to ensure that standards are met.
c. To test and approve personal safety protective equipment.
d. To issue citations for noncompliance with its regulations.

73. (237) What agency is responsible for developing new or improved occupational safety and health standards?

a. Office of Occupational Safety and Health Administration.
b. U.S. Bureau of Mines.
c. National Institute for Occupational Safety and Health.
d. Bureau of Labor Statistics.

74. (238) Under what conditions may state and local government rules override those developed by the EPA and OSHA?

a. When there is not sufficient funding to comply with federal guidelines.
b. When a state or locale disagrees with federal guidelines.
c. When the state or local laws are more stringent than federal laws.
d. When the state or local laws are less stringent than federal laws.

75. (239) What two areas should the layout of your shop include?

a. Clean areas and contaminated areas.
b. Clean areas and chemical-handling areas.
c. Pesticide areas and equipment areas.
d. Free-access areas and limited-access area.

76. (239) How many air changes per hour must be provided by the ventilation system in the pesticide mixing room?

a. 2.
b. 4.
c. 6.
d. 8.

77. (240) When you find a conflict in information in a publication or directive and information on a pesticide label, what should you do?

a. Follow the label.
b. Follow the regulation.
c. Get a clarification from EPA.
d. Get a clarification from OSHA.

245

78. (240) What is the purpose of the reentry statement on the pesticide label?

a. Specifies the requirements for re-registration.
b. Indicates the strength of time the pesticide will remain toxic.
c. Indicates the approximate time of pesticide effectiveness.
d. Specifies the amount of time that must elapse before a person without protective clothes can safely enter an area.

79. (240) Which part of a pesticide label is considered one of the *most important*?

a. Signal Word.
b. Misuse Statement.
c. Storage and Disposal Instruction.
d. Registration and establishment Number.

80. (241) Which of the following precautions must you take before you enter a pesticide storage area?

A. Turn on the exhaust ventilation fan.
B. Put on protective clothing.
C. Notify the fire department.
D. Notify the medical service.

81. (241) What is the purpose of having absorptive clay, hydrated lime, or detergents, available in a pesticide storage area?

a. To absorb pesticide vapors.
b. To clean up pesticide spills.
c. To neutralize pesticide on the skin.
d. To neutralize different vapor to prevent explosions.

82. (242) Which statement *best* describes the reason the mixing phase of pesticide handling is so very important?

a. You must work alone.
b. Pesticides are unpredictable.
c. Unmixed pesticides are flammable.
d. You are working with the most toxic form of the pesticide.

83. (243) After pesticide application, what should you do before transporting the equipment?

a. Install warning signs on the equipment.
b. Request an escort.
c. Drain the equipment.
d. Release all pressure.

84. (243) When you apply pesticides in homes or work areas, you should inform the occupants about all of the following *except*

a. pesticides to be used.
b. advance precautions to be taken.
c. when the area will need retreatment.
d. when the area will be safe for reentry.

85. (244) In vehicles, how are pest management personnel protected from exposure to pesticide vapors and splashes?

a. Personnel wear protective clothing and equipment.
b. Pesticides are hauled in trailers.
c. All pesticides and equipment are sealed before transporting.
d. The passenger compartment is separate from the storage compartment.

86. (244) Why is a container of water carried on pest management vehicles?

a. For emergency fire protection.
b. For use in mixing pesticides.
c. For vehicle decontamination.
d. For decontamination of skin and eyes in the event of a spill.

87. (245) How often should you inventory pesticides?

a. Daily.
b. Weekly.
c. Monthly.
d. Quarterly.

88. (245) Pesticide inventories are taken to determine all of the following conditions *except*

a. proper use.
b. security.
c. container deterioration.
d. proper storage.

89. (246) In the event of a pesticide spill you should identify the chemical and then

a. put on protective equipment.
b. contain the spill with rags or a tarp.
c. prevent further pesticide leakage.
d. minimize contamination of personnel.

90. (246) Which of the following is *not* used as a pesticide decontamination agent?

a. Absorptive clay.
b. Caustic soda.
c. Chlorine bleach.
d. Lime.

91. (247) What is the *most* convenient source of instructions for pesticide disposal?

a. The pesticide label.
b. The base medical service.
c. Your shop chief.
d. Sanitation engineering.

92. (247) How may you dispose of moderate amounts of contaminated waste water?

a. By pouring it down the drain.
b. By spraying it over a suitable open area.
c. By pouring it in an evaporation tank.
d. By turning it in to the base disposal office.

93. (248) When are pest management personnel authorized to wear coveralls?

a. Anytime.
b. When applying pesticides.
c. When mixing pesticides.
d. When mixing or applying pesticides.

94. (248) What maintenance is required on rubber boots?

a. Washing and sealing.
b. Sealing and lubricating.
c. Lubricating and patching.
d. Washing and lubricating.

95. (248) Which type of gloves is recommended for pesticide handling?

a. Lined leather.
b. Unlined neoprene.
c. Unlined cotton.
d. Line neoprene.

96. (249) Which of these compounds affects the protein molecules within certain cells of the body and causes kidney damage?

a. Methyl bromide.
b. Hydrogen phosphide.
c. Hydrogen cyanide.
d. Carbamate.

97. (249) Which pesticide compounds cause capillary damage and inhibit the blood's ability to clot?

a. Petroleums.
b. Anticoagulants.
c. Botanicals.
d. Carbamates.

98. (250) What type of pesticide poisoning would you suspect if a worker had a runny nose, irritated skin, and was sneezing?

a. Pyrethrum.
b. Strychnine.
c. Carbamates.
d. Petroleums.

99. (250) What type of poisoning would cause a worker to experience back and abdominal pain, a skin rash, and nosebleeding?

a. Carbamate.
b. Fumigant.
c. Anticoagulant.
d. Organochlorine.

100. (251) Which of the following measures helps to prevent accidental ingestion of pesticides?

a. Remove or cover food and utensils.
b. Insure adequate ventilation.
c. Wear protective clothing.
d. Avoid smoking while applying pesticides.

101. (252) What is the *first* thing you should do if you get an absorbed pesticide on your skin?

a. Remove the pesticide as quickly as possible.
b. Remove all your clothing.
c. Seek medical aid.
d. Alert staff of possible side effects.

102. (252) When you are alone with a conscious victim of pesticide poisoning, what is the *first* thing you must determine?

a. Method of treatment.
b. Distance to the hospital.
c. Severity of the poisoning.
d. Method of poisoning: ingestion, absorption or inhalation.

103. (253) Which of the following drugs is the specific antidote for organophosphate pesticide poisoning?

a. Amyl nitrate.
b. Atropine.
c. Barbituates.
d. Vitamin K.

104. (252) Which of the following antidotes is normally used for arsenical poisons?

a. Vitamin K.
b. BAL.
c. Atropine.
d. 2-PAM.

END OF FILE

MAIL TO: ECI, GUNTER AFS AL 36118-5643

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012. PRINCIPAL PURPOSE: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package, and used by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's inquiry. Failure to provide all information would result in slower action or inability to provide assistance to the student.

I. CORRECTED OR LATEST ENROLLMENT A

1. THIS REQUEST CONCERNS COURSE (1-6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7-15)	6. GRADE/RANK	7. NAME *(First initial, second initial, last name)* (17) – (18) – (19-32)
_ _ _ – _ _ – _ _ _ _		

8. ADDRESS	
OJT ENROLLEES Address of unit training office with zip code.	(33-53)
ALL OTHERS Current mailing address with zip code.	(54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33-39)

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FOR ECI USE ONLY

X	*Place an 'X' through number in box to left of service requested.*		
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2	Request Test Control Office change as indicated in Section I, Block 10.		
3	Request name change/correction. *(Provide Old or Incorrect data here)*		
4	Request Grade/Rank change/correction.		
5	Correct SSAN. *(List incorrect SSAN here.)* *(Correct SSAN should be shown in Section I.)*		
6	Extend course completion date. *(Justify in "Remarks")*		
7	Request enrollment cancellation. *(Justify in "Remarks")*	16 G	33
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 10 Originals were: [ ] Not received [ ] Lost [ ] Misused	K	VOL 33-35 GR 36-38
9	Send course materials. *(Specify in "Remarks")* [ ] Not received [ ] Lost [ ] Damaged	M	33-34 35-40
10	Course exam not yet received. Final VRE submitted for grading on __________(date).	N	33-35
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 10 not yet received. Answer sheet(s) submitted __________(date).	P	VOL 33-35
12	Results for CE not yet received. Answer sheet submitted to ECI on __________(date).		TC 36-37 38
13	Previous inquiry ([ ] ECI Fm 17, [ ] ltr, [ ] msg) sent to ECI on __________(date).		DOE 39-45
14	Give instructional assistance as requested on reverse.	Q	33-34 ØØ 38 1
15	Other *(Explain fully in "Remarks")*		MC 39-42

REMARKS *(Continue on reverse)*

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ALL OTHER STUDENTS may certify their own requests.	SIGNATURE

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NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

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☐ Yes ☐ No

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In ☐ left ☐ right column

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REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

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CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 3

Pest Management Chemicals and Equipment

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Preface

THIS THIRD VOLUME of CDC 56650, *Pest Management Specialist*, contains information on pesticides in the environment; pesticide classification, characteristics, and diluting; and pest management equipment.

In Chapter 1, Pesticides in the Environment, you'll learn about the impact pesticides have on our environment, how you can work to reduce this impact, and pest resistance and tolerance to pesticides.

Chapter 2, Pesticide Classification, Characteristics, and Diluting, discusses a wide variety of pesticides. The list includes insecticides, rodenticides, herbicides, and fungicides for plant diseases.

In Chapter 3, Pesticide Dispersal Equipment, we'll discuss types and uses of equipment, its operation, and maintenance and calibration.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in the publication is for information purposes only and does not imply indorsement by the Air Force.

This volume is rated at 33 hours (11 points).

Material in this volume is technically accurate, adequate, and current as of April 1984.

Acknowledgement

PREPARATION of this volume was aided through the cooperation and courtesy of Harcourt Brace Jovanovich Publications, publishers of the *Scientific Guide to Pest Control Operations*, 3rd edition. Information from this publication helped in developing text regarding several types of pest management chemicals and equipment.

Course development was further enhanced through the cooperation and courtesy of Gie, Inc. Publishers, publishers of *Pest Control Technology* magazine. Articles in past issues helped in the development of text regarding modern rodenticides. Permission to use materials by these publishers is gratefully acknowledged.

Contents

Pesticides in the Environment

IN YOUR WORK AS a pest management specialist you must always be careful to avoid environmental contamination. Remember, the environment includes all of our surroundings and its many forms of life. Soil, air, and water are all parts of the environment as well as plants and animals. Pesticides put in the wrong place, on the wrong plant, or where the wrong animal can eat them are pollutants and can cause serious harm.

In this chapter, you will learn about the impact pesticides have on the environment, and ways we can reduce pesticide hazards in our environment.

1-1. Impact of Pesticides in the Environment

Our surroundings, and its many living and nonliving components, make up our environment. Every plant and animal is affected by other plants and animals in the environment. Rain, temperature, and wind are other parts of our surroundings, but we can't control them. We can, however, control the use of pesticides we put in the environment.

400. Define ecology and cite the role and importance of identified environmental elements and the ways they interact.

Ecology. Ecology is the study of the relationship between living things and their environment. The environment may be called a household or a place to live, so a pond would be the environment for fish, aquatic vegetation, and other living elements that live in or on the water. Likewise, you live on—and are supported by—the land, and you interact with other people around you. The land, air, water, and other animals you come in contact with are parts of your environment.

Given human primacy among living creatures, you can readily see that we play a significant role in the ecology of other animals around us. As a pest manager, your role is even more pronounced. Because your actions can increase or decrease environmental hazards, you must understand the importance of each element within the environment. Manage pests as safely, effectively, and economically as possible so you don't adversely affect the environment, and choose pest management methods that will minimize environmental hazards.

Life on our planet is limited to a very thin layer of the atmosphere. We call this layer the *biosphere*. It is made up of *biotic* (living) and *abiotic* (nonliving) elements. As these two groups of elements interact and recycle in the biosphere, we call this an *ecosystem*.

Abiotic elements. Abiotic elements are required for the growth and development of the biotic elements. The abiotic elements in ecosystems are grouped into cycles we call *natural cycles*. There are several natural cycles, but we will limit this discussion to only three: (1) the carbon cycle, (2) the nitrogen cycle, and (3) the oxygen cycle.

The carbon cycle. The most basic cycle in the ecosystem is the carbon cycle. Most of the carbon in biotic elements occurs in the form of carbon dioxide (CO_2). Photosynthetic plants (those essential for producing oxygen) use carbon dioxide along with other elements to produce food. In the next part of the cycle, these plants are eaten by herbivores, which transform, or synthesize, the carbon compounds into other compound forms. In turn, the herbivores are consumed by carnivores that redigest and synthesize the carbon into yet more compounds. Some of the carbon is released back into the atmosphere as carbon dioxide, while most of it is returned to the soil as excretory waste and carrion. Bacteria and fungi feed on this organic matter and reduce it to simple elements again. At this point, most of the organic carbon is released back into the air as carbon dioxide and the rest is drawn into the earth and eventually transformed into coal.

The nitrogen cycle. This cycle also aids plant growth. Plants get nitrogen directly from the soil with the help of nitrogen-fixing bacteria, which convert the gaseous nitrogen into a form usable by the plant. Nitrogen is returned to the soil as the result of plant death and decay, denitrifying bacteria, erosion, and lightning. This cycle is continuous, as is the carbon cycle.

The oxygen cycle. This is the last cycle we will consider. Keep in mind, oxygen is a by-product of photosynthesis. Oxygen is found in air and water, and it is vital in the respiration process of both plants and animals. Animals take in oxygen from the atmosphere and water, and transform it into carbon dioxide. The carbon dioxide is expelled and then taken in by green plants that transform it back into oxygen, continuing the cycle.

Biotic elements. Green plants are the prime living elements in each ecosystem because they alone can make food from sunlight and inorganic matter. As a result, they provide an essential link in the natural food chain by storing the sun's energy and passing it through the ecosystem by the processes of eating and being eaten. Finally, they are vital in the respiration process as you learned in the discussion on the oxygen cycle.

Just like green plants, their consumers are also vital in the respiration process. Again this is explained in the oxygen cycle. Consumers of green plants include (but are not limited to) animals, insects, bacteria, and fungi; and they too provide another important link in the food chain.

Up to this point, you have studied the importance of abiotic and biotic elements within the ecosystem and have realized their relationship in the respiration process, but more discussion should be devoted to their relationship and dependency within the food chain. This relationship and dependency can be better understood by using the following example.

The abiotic elements are required to provide food for green plants, which are considered to be the basic food element within the ecosystem. Green plants then provide food for the herbivores (plant-eaters, such as rabbits) and omnivores (plant and meat-eaters, such as man). Herbivores such as rabbits are then eaten by the carnivores (meat-eaters, for example coyotes) and again the omnivores. Other carnivores such as bears, hawks, and vultures kill and eat the coyotes and each other. Then comes man, who kills various carnivores for food and sport, and in turn, man dies. With the death of plants, herbivores, carnivores, and omnivores comes the food source for the decomposers (bacteria, fungi, and protozoa). As the decomposers feed, they return essential organic matter to the soil to support plant growth, thus completing the food chain.

Discussion about phytoplanktons has been reserved for last because they consist of both green plants and consumers of green plant matter. Phytoplanktons are very minute organisms that float about in various bodies of water and are the principal producers of photosynthesis. It is estimated that they produce 70 percent of the Earth's photosynthesis required for oxygen renewal in the atmosphere.

Based upon this information, it is understandable that each cycle and element is dependent upon the others, and the interaction between them is required to support each ecosystem. The biosphere is constantly undergoing changes and each change affects an ecosystem; thus, it is your responsibility to insure that you do not present hazards that could adversely affect the environment.

Exercises (400):

1. Define ecology.

2. What is the biosphere?

3. Describe the role played by the abiotic elements in the biosphere.

4. Describe the interdependence of green plants and animals in the respiration process.

5. What is considered to be the primary biotic element? Why?

6. Describe phytoplanktons.

7. State the role of importance played by bacteria, fungi, and protozoa within the food chain.

401. Specify beneficial and detrimental effects of pesticides as a result of pest management operations.

Beneficial and Detrimental Effects of Pesticides. For you to understand the impact pesticides have on our environment, you must consider both their beneficial and detrimental aspects.

Our pesticides may be helpful or harmful, sometime simultaneously, depending on how we use them. Although this may sound contradictory, you will understand it better as we continue.

Beneficial aspects of pesticides. We need pesticides to manage pests that are important both medically and economically. If farmers couldn't use insecticides and herbicides, they would be unable to grow enough food to feed the world's population; these crops would be badly damaged by the spread of unwanted plants and crop-eating insects. Many buildings would be much more vulnerable to many fungi and insects that attack wood. As a result, these buildings could be rendered unsafe and unusable because we couldn't chemically protect them from these pests. Diseases that were greatly feared a few decades ago would still have a considerable impact on our health if we didn't have the chemicals to control the pests that transmit them.

Because of pesticides, however, American farmers produce far more food than this nation needs, buildings—both old and new—are still useful and structurally sound, and diseases that used to be universally feared are known only in name to many of us.

There are many vertebrate and invertebrate animals that are disease transmitters, venomous, or simply nuisances that interfere with our activities. For these and other reasons, you can readily see how pesticides help us maintain a healthy, prosperous nation; as a result, pesticides are genuinely beneficial to our environment.

Detrimental aspects of pesticides. Pesticides present many hazards to our environment because they can affect many biotic elements. If we used pesticides constantly, without the proper concern for their hazards, the damaging effects could become severe and permanent. You may think that your singular activities would never cause such an impact, but when your work is combined with the work of others around you or you're working on large-scale operations, the results could be significant.

The major problem with pesticides is the impact they may have on nontarget organisms (plants and animals we don't want to affect). Regardless of how carefully you apply pesticides, there is always this possibility, either as a direct or indirect result of your actions. Directly destroying nontarget organisms usually results when you apply pesticides to kill target pests, and nontarget plants or animals are in the same area. This is a good example of how pesticides can be beneficial and detrimental at the same time. Indirectly destroying nontarget organisms usually happens when our pesticides are moved off target because of natural environmental activities like wind, rain, and soil erosion. Indirect poisoning can also result when animals (such as birds) feed on insects killed by pesticides (secondary poisoning).

When you apply pesticides outdoors, chemical particles (dusts or liquids) are carried off target by the wind and moved to areas up to several miles away. As they drift, some particles are caught on trees, others may settle to the ground, and the rest are left suspended in the air. Using aircraft to apply pesticides presents the greatest drift hazard, followed by fogging for mosquito control and applying residual pesticides to trees and ornamentals.

The soil is contaminated with pesticides in many ways other than drifting chemical particles settling to the ground. Suspended particles in the air may be released to the ground as rains cleanse the air of many suspended particles. The rain will also wash pesticide particles from buildings, trees, shrubs, and grasses, thus contaminating the soil. Once pesticides are in the soil, they may move about by leaching or erosion.

Almost all pesticide particles eventually end up in the water regardless of how carefully you apply them. As the particles drift through the air, they fall on plants, the soil, and water. Rain increases the amount of pesticides in water by washing chemical particles off of other surfaces and out of the soil by leaching. From here, the chemicals may wash into surface waters either directly or indirectly through circulating ground waters (fig. 1-1).

Persistent pesticides probably cause more environmental hazards than any other product because they don't break down very easily or quickly. They can stay stable for several months or even years in the air, soil, and water. Furthermore, some can be transformed into more toxic substances than they were originally in a process called *potentiation*.

Our largest concern with using persistent pesticides is the effect they can have on the food chain. This chain can be severely jeopardized under a variety of conditions. Consider this possibility: you treat an area with a persistent pesticide to control grubs that are destroying the grass. From a nearby area, moles come in to feed on the grubs. Some may die, others may live, but now they have the pesticide stored in their bodies. The toxicity level can increase within their bodies, so if they get eaten by other animals, these predators may be killed. This process can continue throughout the food chain and eventually affect us. Traces of many pesticides can be found in almost any product from eggs to breast milk, and the worst part of it is that these persistent chemicals can be stored and transferred through a continuous cycle.

Exercises (401):

1. List the beneficial aspects of pesticides from the economic standpoint.

2. What are the beneficial aspects of pesticides from the medical standpoint?

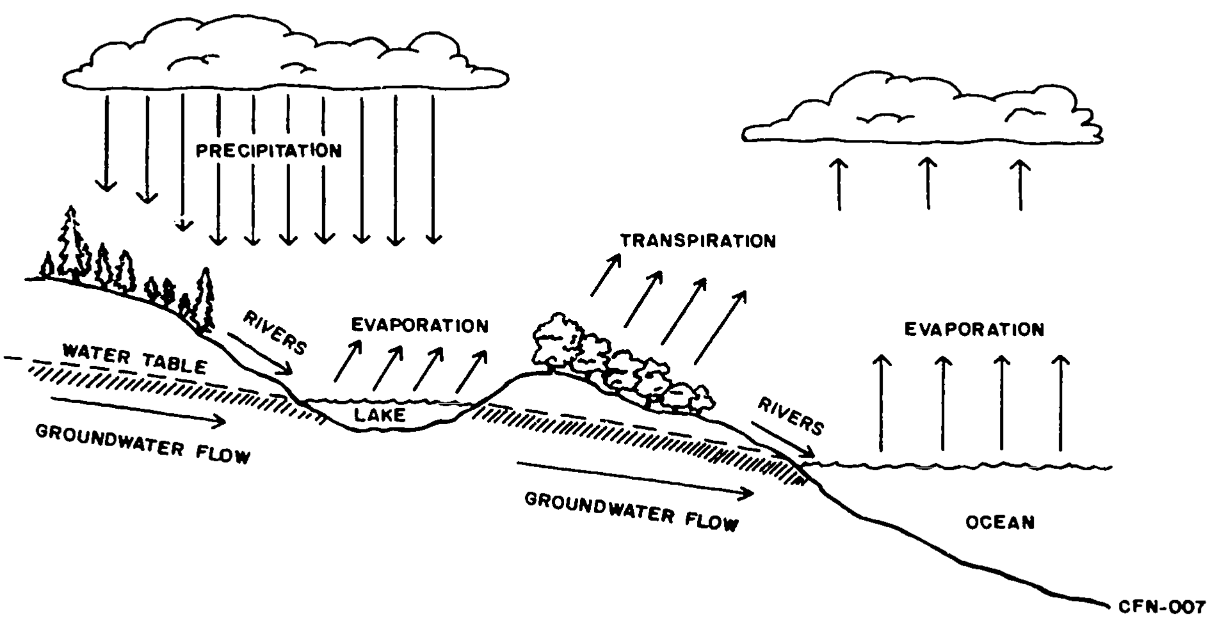

Figure 1-1. The Hydrologic Cycle: Pesticide can enter the water at any point in this cycle.

3. What is the major problem with pesticides?

4. When could the detrimental effects of pesticides become severe and permanent?

5. Describe how the rain can contaminate the soil with pesticides?

6. Wha' is potentiation?

1-2. Pesticide Resistance and Tolerance

We can carry the thought of how pesticides impact our environment one step further by considering how insects react to pesticides. Two terms are of key importance to pest managers: pesticide resistance and pesticide tolerance. These terms are frequently used in discussion about pests and how they affect our control measures. Understandably, they generate much concern about how we can most effectively manage pests.

For example, in some New England states, German cockroaches have developed a degree of resistance that renders ineffective both previously experienced pesticides and even totally new ones. During your career as a pest management specialist or technician, you'll undoubtedly hear about or become involved in issues like this, so your understanding of pesticide resistance and tolerance is very important.

402. Define and cite facts regarding pesticide resistance.

Pesticide Resistance. Pesticide resistance can be defined as the ability of a pest population to withstand pesticide treatments that were generally lethal to earlier populations. It is often stated that insects develop resistance, but this statement is inaccurate. Resistance is a trait that is inherited through a complicated genetic process by a few individuals within a reasonably large population. There is a tendency for this hereditary trait to be passed from parent to offspring. However, where a very few resistant specimens exist in a large population, probability dictates that only a very few resistant-breeding combinations will occur, thus insuring that the trait will not develop throughout the population. Population alterations begin to occur, however, when the natural process of checks and balances is interrupted by the introduction of pesticides into the population. In the initial stages of the use of a particular pesticide to control a pest population, it can generally be said that a majority of the individuals are not resistant. The susceptible individuals, upon exposure to the pesticide, die, while any resistant individuals survive (the weak perish; the strong survive). This process progresses to the point where the resistant strain, through its ability to survive, achieves a position of dominance in population reproduction. Continued use of the pesticide involved simply reinforces this dominance by the resistant individuals until finally, virtually all reproduction is being done by resistant individuals, thereby producing a resistant population. Once this occurs, further use of the pesticide will not produce satisfactory result . The matter can be further complicated by cross-resistance—a process whereby exposure to one pesticide can produce populations that are also resistant to one or more other pesticides. This resistance to pesticides occurs in two forms, physiological and behavioristic.

Physiological resistance. Physiological resistance is the ability of an organism to physically negate the effects of the pesticide. Many facets of physiological resistance are not clearly understood. However, the following types of physiological resistan have been determined to exist:

a. Slow absorption rate. Some members of a population absorb the poison too slowly to receive a lethal dose from a normal exposure.

b. Storage. Some members of a population have the ability to store the poison in nonsensitive body tissues before it can kill.

c. Excretion. Some members of a population ble to excrete the poison before it can kill.

d. Detoxification. Some members of a popu' n are able to detoxify the poison before it can kill. This de.oxification is known to be the result of enzyme action. The harmless detoxification products are stored, excreted, or metabolized.

e. Substituting biochemical systems. Death by pesticide poisoning, as from any other means, occurs as a result of blockage of vital life functions. This blockage is usually done by the destruction or paralysis of vital organs. Some members of a population are able to substitute a blocked function with other body systems until normal biophysical balance is restored.

Behavioristic resistance. Behavioristic resistance occurs in the following forms:

a. Habitat. A few members of a population may occupy a habitat different from that of the normal population. As a result, they are not exposed to routine pesticide applications.

b. Avoidance. Some members of a population may be particularly sensitive to the pesticide. As a consequence, they will avoid contact with it.

Resistant members of a population, regardless of the type of resistance, tend to survive the pesticide application and rebuild a resistant population.

As the foregoing discussion illustrates, insects do not truly develop resistance to pesticides. The emergence of resistant populations occurs as a result of manmade alterations of the breeding population that allows resistant strains to become dominant, thus permitting massive reproduction of the resistant strains.

Exercises (402):

1. Define pesticide resistance.

2. Compare physiological and behavioristic resistance.

3. Describe the types of physiological resistance listed below.
   a. Slow absorption rate.

   b. Substituting biochemical systems.

403. Define pesticide tolerance, compare it with resistance, and cite ways of reducing both.

Pesticide Tolerance. Pesticide tolerance can be defined as the ability of one or more pests within a pest population to withstand pesticide treatments that are lethal to others within the population.

Tolerance is another means by which certain members of a pest population may survive pesticide applications. Tolerance is acquired, whereas resistance is inherited. When an individual is exposed to one or more sublethal doses of pesticide, the body tends to develop a tolerance to that particular pesticide, making it possible for the individual to survive a future lethal dose. This tolerance, however, is not passed on to the offspring. Tolerance usually occurs in two different forms, physiological and behavioristic.

Physiological tolerance. Physiological tolerance is the result of adjustments by body systems that prevent the normal harmful action of the pesticide.

Behavioristic tolerance. Behavioristic tolerance is the behavioral adjustment the pest makes as a result of having undergone an unpleasant experience due to contact with a sublethal dose of the pesticide. This unpleasant experience causes the pest to recognize and tend to avoid the pesticide.

Reducing chances of resistance and tolerance. Now that the problems of resistance and tolerance have been discussed, the question arises, "How can these problems be prevented or minimized?" One of the most effective solutions is to apply integrated pest management (IPM) to the fullest possible extent. Don't depend on just one control technique for a given problem. This approach can be as simple as using both traps and baits to control rodents or as detailed as using water management, predatory fish, insect growth regulators, and adulticides in a wide-scale mosquito management problem.

In many situations, however, by the time a pest problem is reported to your shop, chemical control is the only practical method available. You'll see this happen frequently in military family housing and in dormitories; when it does, there are still several practical ways you can help prevent resistance or tolerance.

(1) Make sure residents have applied all the standard nonchemical measures; in a word, insure proper sanitation.

(2) Use the pesticides only as directed on the label.

(3) Place the pesticides where pests will be forced to come in contact with them, such as in cracks and crevices for cockroach control.

Exercises (403):

1. Define pesticide tolerance.

2. What is the primary difference between pesticide resistance and tolerance?

3. What are four ways you can help prevent pesticide resistance and tolerance?

1-3. Reducing Pesticide Hazards in the Environment

As you can easily appreciate, chemical pesticides are—and will continue to be—of considerable importance economically in forest management, food production, and public health. However, with the resulting possible adverse effect on some fish and wildlife populations, it's essential that you take every possible precaution to protect the environment as you carry out your pest management programs. In this lesson, therefore, we'll review some of the more basic aspects of reducing environmental hazards caused by pesticides.

404. Specify methods for reducing pesticide hazards in the environment.

Methods of Reducing Pesticide Hazards in the Environment. Environmental damage by pesticides virtually can be eliminated by simply adhering to some fundamental pest management principles. Foremost of these principles is the accurate assessment of the pest problem to determine if a pest management operation is really necessary. Then, if a valid requirement actually exists, select and execute measures that will provide maximum pest management results while causing minimal environmental damage (using pesticides as a last resort).

Carefully determine pest management program requirements. You can accurately determine pest management needs only after you've surveyed the area concerned to confirm the existence of pest populations and you've identified environmental conditions conducive to the existence and propagation of these pest populations. An ongoing pest surveillance program is very effective not only in helping you detect existing problems, but is also an invaluable tool in identifying potential pest problems so timely preventive measures can preclude the need for drastic eradication measures in the future. As a general rule, environmental sanitation techniques, such as eliminating harborage and breeding areas, will prevent buildups of pest populations without causing significant damage to populations of desirable species. Occasionally, use of biological methods, such as the introduction of predacious minnows to impounded water to feed on mosquito larvae, will provide very satisfactory control of some mosquito populations. In other instances, mechanical devices or structural modifications to buildings may give good results. In any case, only use pesticides when there is a substantial need to immediately reduce a pest population and no other feasible technique will do the job.

The following hypothetical situation is an example of problems requiring a certain amount of value judgment as well as expertise in maintaining a high degree of target specificity in applying pesticides. The problem involves a close association between wasps and honeybees in a housing area. The wasps have established several large nests under the eaves of a number of houses in the housing area. This is a matter of considerable consternation among the housing occupants since the wasps, if disturbed, will readily attack and sting people. It is a well-established fact that wasp stings are painful in all cases, and in the case of hypersensitive people, will usually cause dangerous (sometimes fatal) allergic reactions.

In selecting a means of eradicating the wasps, you must consider the fate of a large number of honeybees that work in the flowerbeds around the houses. Honeybees produce food (honey) and are extremely important crop pollinators (some crops can reasonably be expected to fail in the absence of honeybees); hence, they are considered to be highly beneficial insects. Also, honeybees, when away from the hive, are not prone to attack and sting people. The matter of whether or not to apply pesticides for control of the wasps at the risk of killing a number of honeybees requires a value judgment on your part. In this instance, the human health factor outweighs the beneficial factor associated with the honeybees, and the operator will be justified in using pesticides to kill wasps. However, you're a skilled operator and are reasonably concerned with the preservation of beneficial life forms, you'll minimize damage to the honeybees by selecting a nonpersistent insecticide and apply it with equipment that can direct the chemical directly at the wasp nests. This will confine most of the pesticide to the target area. Any pesticide that drifts to the flowers will quickly degrade and pose little or no threat to the honeybees (and to yourself). Also, you could apply the pesticide at night or in the early morning when both the honeybees and the wasps are inactive. Evening applications of pesticides to wasp nests are especially desirable because all the wasps are on the nests at night and the entire colony can be killed with one application. Also, since wasps are not active at night, this technique will virtually eliminate the possibility of your getting stung by irate wasps.

As discussed in Volume 2, there are two fundamental types of pest control, natural and applied. Two examples of natural controls are unfavorable weather conditions and predation. Natural controls occur without help from people. Applied controls are those in which human effort is directed toward the control of pests and includes a wide variety of IPM techniques. In the foregoing problem, natural controls could not be relied upon since wasps are not severely affected by predation and since unfavorable weather conditions do not normally occur until the arrival of winter. In a situation like this, it is necessary to resort to applied controls, such as the use of a pesticide to kill the adult wasps and mechanical destruction of the nests to prevent new populations of wasps from hatching.

Implement nonchemical controls when possible. Pest management programs should only be started if nature cannot manage the pests adequately and quickly enough for the situation. If applied controls are required, either preventive or corrective, your controls should be conducted whenever and wherever possible.

Preventive measures are normally preferred because they are designed to forestall the buildup of pest populations. Also, they are almost always more effective and more economical in the long run. Preventive controls consist of good sanitation, construction design and maintenance to exclude pests, and drainage or management of impounded water. Legal controls, such as quarantine measures, are effective in preventing the introduction of alien pests into an uninfested area. Occasionally, preventive controls may also serve as corrective measures.

Routine programming of corrective controls is the least desirable technique because the control measures are intended to cope with pest populations after they have grown to intolerable levels. Such controls do not provide for elimination of pest problems. They simply reduce the problem, temporarily, to tolerable levels. Since these measures seldom produce permanent results, they must be repeated frequently and, as a consequence, are very expensive in the long run. Also, since corrective measures usually require frequent repeated applications of pesticides, they pose a significantly greater threat to the environment. As a rule, use corrective controls, particularly pesticides, only when there is a need to effect an immediate reduction of a pest population to avert an impending medical problem or economic loss. In the previously discussed wasp problem, the use of chemical corrective measures was justified because of a need to immediately eliminate a human health hazard. The mechanical destruction of the nests was a preventive measure of sorts in that it was designed to prevent reestablishment of the colonies.

Use chemical controls as a last resort. Timely and sustained use of nonchemical techniques will significantly reduce the need to resort to the use of pesticides. When, however, as a result of inadequate or improper nonchemical measures or as a result of natural (or manmade) disasters and migrating pest invasions, it becomes necessary to effect an immediate reduction of pest populations by chemical means, you should select the chemical and method of application that will give maximum results in terms of both pest eradication and environmental protection.

In order for pesticides to be used safely and effectively, they must be selected on the basis of the type of pests and their location. You must be knowledgeable of their development, habitats, and feeding habits. In many situations, it is more effective and safe to control pests in the larval stage because they are more susceptible to chemicals, which requires less chemical to control them. If you know the habitats of pests, you can direct control efforts to specific areas instead of having to treat an entire area just to insure the pests are affected, therefore, reducing hazards to nontarget organisms.

How pests feed is important in the selection of pesticides to be used in management programs. For chewing pests, stomach poisons applied to their food source would probably be more effective and less hazardous to other organisms in the area, especially those that are not chewing organisms; thus, you reduce the hazards to nontarget organisms. Contact poisons are very useful, and in many cases, are required, but they do present more hazard to nontarget organisms than the stomach poisons.

Now that the common bases for pesticide selection have been established, further environmental protection steps must be considered. These steps are diluting and applying pesticides. Manufacturers conduct extensive research at an enormous expense to determine the proper formulation strength application rates for pesticides. This data, along with a great deal of other important information, as a matter of law, must be registered by the Environmental Protection Agency (EPA) before the product can be marketed. The diluting and applying procedures, as well as all use restrictions, are binding on all users of the product (including Government agencies). It is most important, therefore, that you strictly follow label instructions. This practice will insure maximum effectiveness of pesticide applications and minimum damage to the environment. Overdoses of pesticides rarely provide an increased kill of pests. They do tend to needlessly contaminate the environment, waste materials, and cause development of pest populations that are resistant to the chemical involved.

Exercises (404):

1. List steps you can take to reduce pesticide hazards in the environment.

2. What is one way to accurately determine pest management requirements?

3. When should you start applied pest management programs?

4. If pest management programs are needed, what controls should you consider first?

5. Can preventive controls also serve as corrective measures?

6. Why are preventive controls normally preferred over corrective controls?

7. Why may you have to begin chemical control programs?

8. How can you achieve maximum effectiveness with minimum environmental hazards when you use pesticides?

Pesticide Classification, Characteristics, and Diluting

THE WORD "pesticide" has been the subject of many discussions for many years and has really been brought to the attention of the public in recent years through almost all categories of news media. This concern for pesticides is justifiable because most are very toxic, and if not handled properly, they can cause severe damage to the environment; however, if they are handled responsibly, they are a great asset to the environment.

In this chapter, commonly used pesticides will be thoroughly described and you will become knowledgeable of how pesticides are classified and diluted.

2-1. Classifying Pesticides

For you to select the most suitable pesticide for the pest you're managing, and to do it properly and safely, a knowledge of pesticides is required. This section will present information regarding how pesticides are classified and will discuss the characteristics of commonly used pesticides.

405. Classify pesticides in terms of pests to be managed, how they enter the body, and the stage of the pest affected.

Pesticide Classification Methods. Pesticides are generally classified according to the type of pest to be managed, the mode in which it enters the body (or the mode of action of pesticides used to manage plants), and the stage of the pest to be acted upon.

Pest to be managed. The first step taken in classifying a pesticide is to determine what pests it controls. Until now, almost all discussion pertaining to chemicals has been devoted to the term "pesticide," but beginning here, we will be more technical by classifying a pesticide according to the pest to be controlled.

As you already know, a pesticide is a chemical designed to kill pests; but if the pests happen to be insects, then the pesticide is classified as an insecticide. *Arachnicides* are used to manage Arachnids such as spiders, scorpions, ticks, and mites. Pesticides used to control plants are classified as *herbicides*, and those used to control fungi are *fungicides*. Notice the manner in which most of the pesticides used for managing each type of pest begins with the pest type and ends with "cide," which means "kill," as in *rodenticide*, a pesticide used to kill rodents.

Stage of pest acted upon. The second step in classifying a pesticide involves the pest stage to be controlled. The stages are the developmental process of certain insects and are referred to as egg, larva, pupa, and adult. Controls are seldom directed toward the egg stage because it's very hard to locate; furthermore, eggs are hard to penetrate. The pupal stage is also not normally controlled because it's dormant in most cases. The larvae and adult stages are the ones most often controlled because these are the most damaging and they are easier to control.

Using this information, you can understand that insecticides are identified as ovicides, larvicides, or adulticides, depending upon the intended use. For example, if the insecticide is to be used for controlling the larval stage, the insecticide would be further classified as a larvicide.

Along this same order, herbicides can be further classified as being preemergence or postemergence herbicides. Preemergence herbicides are those designed to kill seeds and immature stages of plants before they break the soil. The postemergence herbicides are designed to kill ground after the plant has broken the surface.

Mode of entry or action. The final step in classifying pesticides is traditionally done according to the method in which it kills.

Pesticides that are designed to kill pests when taken into the digestive system are classified as stomach poisons. Stomach poisons are applied directly to the natural food of pests, mixed into bail material, or sprinkled over runways. These poisons are very effective against certain pests that chew, suck, and have protective shields; they are generally very toxic to humans and other vertebrate animals.

Contact poisons are pesticides that are designed to kill pests through absorption. These poisons are applied directly to the pests or to surfaces the pests will crawl over. Contact poisons are probably used more than any other type of pesticide.

Respiratory poisons are most often referred to as fumigants. These poisons are volatile chemicals that kill an organism by entering through its respiratory system and are very useful in controlling pests that are difficult to manage by other methods.

Exercises (405):

1. A pesticide that is used to manage vegetation is classified as a ________.

2. A pesticide that is used to control the eggs of an insect is classified as an ________.
3. A pesticide that kills an organism when it is applied directly to the organism or when the organism crawls into it is classified as a ________ ________.
4. A pesticide designed to control rats and mice is a ________.
5. The complete classification of a pesticide that is designed to kill adult mosquitoes when they fly into it is as follows: ________ ________ and ________ poison.
6. A pesticide designed to kill a plant before it breaks the ground surface is a ________ ________.
7. A pesticide that kills by ingestion would be classified as a ________ poison.

406. Distinguish between pesticide toxicity and hazard, state how LD50 is expressed, and define acute oral and dermal LD50.

Pesticide Toxicity and Hazard. Federal law requires that all manufacturers of pesticides place accurate and complete dilution and application instructions on their container labels. This and other information on the labels must be based upon very extensive research, which in turn must be reviewed and approved by the Environmental Protection Agency before the label is registered for use. During this research, the manufacturer must also establish toxicity levels for the pesticide being tested. This is the main topic of our discussion.

Comparing toxicity and hazard. A number of people tend to use the terms "toxicity" and "hazards" synonymously when discussing pesticides. This practice is erroneous since toxicity implies the ability of a compound to cause death or injury, whereas hazard implies the likelihood that the compound will cause death or injury in a given situation. "Toxicity," therefore, represents a fixed quantity, and "hazard" represents a variable quantity. For example, consider sodium monofluoroacetate (Compound 1080). This is an extremely deadly rodenticide that is capable of causing death in warm-blooded mammals when ingested in rather minute quantities. It is an extremely toxic compound whether locked in a steel vault or placed on a kitchen table where small children are present. The toxicity of the compound does not vary, regardless of its location. However, when the compound is left on a kitchen table in the presence of small children, it presents an infinitely greater hazard than when locked in a steel vault. In addition to the hazard to human beings, the hazard to other desirable animal and plant forms must be considered when selecting and applying pesticides. This can be a complicated process because many pesticides with a low-mammalian toxicity are extremely toxic to cold-blooded animals and vice versa. All these hazards can be minimized or eliminated by adhering to label instructions and practicing safety when handling or applying pesticides.

Determining and expressing LD50 values. Toxicity of pesticides is based principally upon the results of laboratory tests wherein rats, mice, and rabbits are exposed to carefully measured doses of pesticides. These animals are used because their bodies function much in the same way as human bodies. Test animals in the laboratory environment are carefully examined before the test to insure that all body functions are normal and that they are healthy animals. The ultimate objective of these tests is to determine the amount of pesticide that is lethal to 50 percent of the test group of animals. The figure is expressed as milligrams of toxicant necessary to kill 1 kilogram of body weight (mg/kg/).

Relationship of LD50 values and pesticide classification. LD50 values are useful in classifying pesticides into groups according to their relative toxicities as follows: Highly toxic = 0 to 50 mg/kg, moderately toxic = 50 to 500 mg/kg, slightly toxic = 500 to 5,000 mg/kg and relatively nontoxic = 5,000 + mg/kg.

As you can see, the lower the numbers, the more toxic a pesticide is. This is because a lower number indicates that a smaller amount of toxicant is required to cause death.

Toxicity is usually expressed in terms of exposure routes. The two common terms are "oral toxicity," which relates to ingestion of the toxicant by mouth and "dermal toxicity," which relates to absorption of the toxicant through the skin. Dermal toxicity values are based upon the quantity of toxicant that will kill 50 percent of the test animals when absorbed through the unabraded skin. Oral and dermal toxicities of a given toxicant are rarely identical. Usually, dermal exposure is less hazardous than oral exposure. However, some chemicals are almost as dangerous when left in contact with the skin as they are when ingested, and in no case should any toxicant be left in contact with the skin, especially if the toxicant is in its concentrated form.

It is apparent that the traditional practice of environmental exploitation must now be modified. From the beginning of time until very recently, humans have pursued socioeconomic endeavors on the premise that the Earth's natural resources were inexhaustible and that the earthy environment was indestructible and, in fact, inalterable at their hands. Now, largely due to the burgeoning world population and rapidly advancing industrialization, we have been compelled to face the stark reality of natural resource depletion and increasingly harmful environmental pollution.

This text has discussed the interdependence of all elements, living and nonliving, in our environment. Human beings are an integral part of this environment and are just as dependent on the other elements of the environment as any other organism. Therefore, in order to insure our own continued existence and state of well-being, we must not commit acts that could ultimately result in the destruction of any essential element of our environment.

We, as pest managers, have a great responsibility resting on our shoulders. As you have seen, pesticides are an essential tool in the control of medically and economically important pests, and will remain so for the foreseeable future. We also demonstrated, on the other hand, that the improper and indiscriminate use of pesticides can exert a very destructive influence on our environment. It is our responsibility to use pesticides only to the extent necessary and to insure that we use them in such a way as to prevent unnecessary deleterious effects on the environment. We must make the greatest possible use of nonchemical methods to manage pest populations.

Exercises (406):

1. Define hazard.

2. Define toxicity.

3. Explain what the term "LD50" means.

4. How is LD50 expressed?

5. What is the main difference between oral and dermal toxicity? Which is more toxic?

2-2. Pesticides for Controlling Arthropods

This is the first of several lessons you'll study to learn about classes of pesticides and how they are used. In later sections, you'll read about rodenticides, avicides (pesticides for controlling birds), herbicides, and turf fungicides.

In this section, you'll learn about many of the classes of pesticides used to control arthropods. These classes include organophosphates, organic sulfers (carbamates), organochlorines (chlorinated hydrocarbons), insecticidal fumigants, biological pesticides, and various other insecticides.

407. Specify characteristics of organophosphate compounds, and identify various organophosphate compounds with their appropriate uses.

Organophosphates. These compounds are synthetically produced, basically derived from phosphoric acid, and are characterized by their similar structure and mode of action. All of them work as inhibitors of the enzyme cholinesterase.

In the early 1970s, the organophosphate insecticides played much the same role in controlling arthropods of medical importance as did the chlorinated hydrocarbons (organochlorines) from the middle 1940s to the middle 1960s. The organophosphates have almost completely replaced the chlorinated hydrocarbons as the pesticides of choice, because they are effective against insect resistant to the organochlorine compounds and they are biodegradable; therefore, they do not contaminate the environment for very long and have less long-lasting effects on nontarget organisms.

The greatest disadvantage of organochlorine compounds from the medical standpoint is that they are accumulative in the body of humans. These compounds will not dissipate through the functions of the normal body system after a short time as compared to other pesticide groups.

Malathion. Malathion is one of the safest and most useful of insecticides, being a far less active cholinesterase inhibitor than most other common organic phosphates. It has less adverse effect upon the natural habitat than more persistent insecticides and, in general, has replaced DDT as the most commonly used chemical for killing adult mosquitoes, bedbugs, and human lice.

Technical grade malathion is a clear amber fluid that can be incorporated into solutions, emulsifiable concentrates, dusts, and wettable powders. The odor-causing impurities have largely been removed in present-day, premium grade materials. Malathion is registered for the control of more than 100 species of insects and is a standard stock item within the Air Force inventory.

Residual application of malathion to surfaces at a rate of 100 to 200 milligrams per square foot (standard applications of 1 to 2 gallons of 2.5 to 5 percent sprays are 1,000 square feet) has effectively killed mosquitoes for 3 to 5 months. When used as a mist in space spraying, excellent mosquito kills have been obtained. Ultralow volume space application of malathion with ground or aerial equipment has resulted in spectacular control of mosquitoes in many areas.

Dichlorvos. Dichlorvos (DDVP or Vapona) was synthesized and tested by research workers at the Center for Disease Control. It differs from most other insecticides in that it can be incorporated into resin strips or pellets, to give off toxic vapors for up to 4 months, and be used as a residual fumigant. DDVP resin strips, a standard stock item, are sold commercially and used by the general public to control cockroaches, ants, spiders, clothes moths, silverfish, and many other household insects. The Air Force uses these strips for inclusion into retrograde cargo.

Dichlorvos emulsions can be used as residual sprays or as space sprays for controlling pests such as bedbugs, biting midges, mosquitoes, and stored products pests.

Dimethoate. Dimethoate (Cygon) has been proven effective as a space spray and larvicide in controlling flies. As a residual spray, it is effective in controlling most common fly species except the housefly, although it is recommended for controlling housefly larvae. Other uses of Dimethoate allowed by the Air Force are for controlling spider mites and scale insects. This compound is a nonstandard stock item and must be obtained through local purchase.

Naled. This chemical (Dibrom) is closely related to DDVP in terms of its molecular structure. It is a contact and stomach poison. This material is generally used in space sprays for control of adult mosquitoes and flies at application rates of from 0.02 to 0.1 pound per acre, significantly lower dosages than are used with malathion for mosquito control. Naled aerial applications are reported to provide better adult fly control than malathion, a factor of some importance in vector control in disaster or flooded areas. Naled is approved for aerial ultralow volume (ULV) application and has provided excellent control of flies and mosquitoes in many areas. It is also used as a bait or spot treatment for houseflies out-of-doors. It is sometimes irritating to people, causing them to cough and sneeze, thus limiting its usefulness in populated areas. Naled can cause corrosion of insecticidal equipment, and requires special cleaning precautions or the use of special materials such as stainless steel, plastic, or fiberglass.

Naled must be used with care to avoid hazards to fish and wildlife, although it breaks down chemically within a few days after application. It has moderate toxicity to humans. You can obtain naled as a standard stock item.

Trichlorfon. Trichlorfon (Dipterex) is approved for use by the Air Force only in the treatment for white grubs on golf courses, parks, ornamental turf, and cemeteries; however, it is a nonstandard stock item and must be ordered through local purchase.

When used with normal precautions, trichlorfon creates a very low toxic hazard to insect controllers and the public. It should not be mixed with malathion, because the resultant mixture is more toxic to mammals than either of the chemicals used separately.

Abate. Abate is very effective as a mosquito larvicide but not as an adulticide. Its extremely low toxicity to mammals, birds, and fish, plus its high toxicity to mosquito larvae make it very effective for mosquito control. Abate may be applied by ground or aerial equipment.

The 1-percent Abate sand formulation has been used in *Aedes aegypti* eradication programs at the rate of one-tenth teaspoonful per gallon of water, or approximately one part per million of actual toxicant. Look at this rate for the treatment of birdbaths, animal drinking containers, and drums of rainwater. Because rainwater is often used for drinking or cooking in Puerto Rico and the Virgin Islands, a careful evaluation of Abate was made for 4 weeks without clinical symptoms or side effects attributable to Abate and without detectable effect on red blood cell or plasma cholinesterase.

Diazinon. Diazinon is authorized and widely used by Air Force personnel in controlling cockroaches, silverfish, fleas, spiders, and many other household pests. It is more toxic to humans than malathion; therefore, only the 0.5-percent spray and 1-percent dust are used. Pyrethrins or dichlorvos may be added to diazinon sprays to provide a rapid knockdown or a flushing of cockroaches, thus producing a more effective kill.

Dilute spray solutions not more than 24 hours before use. The solvent used in formulations may stain certain plastic, rubber, and asphalt materials such as tiles and floor coverings. Use dust applications to supplement spray applications for more complete coverage.

Chlorpyrifos. Chlorpyrifos (Dursban) acts as a contact insecticide and stomach poison with some fumigant action in field formulations. It has proved effective in controlling a wide variety of arthropod pests. The 0.5-percent spray of chlorpyrifos has given longer periods of control of cockroaches in some experiments than either diazinon or propoxur.

In mosquito control, it has shown promise as a larvicide and adulticide. It is highly toxic to mosquito larvae, with an LD95 value of 4.5 parts per billion against *Aedes aegypti*. Dursban is effective against culex larvae in polluted waters. It has also been used as a prehatch treatment to control temporary pool mosquito larvae. For example, Aedes vexans larvae were controlled in Minnesota where it was effective for periods of more than 60 days. Although Dursban was not labeled for ULV application with ground or aerial equipment as of February 1973, experimental work with backpack ULV sprayers in Minnesota gave a good reduction of aedes mosquitoes.

Since Dursban is slow acting against many insects, dichlorvos or pyrethrins may be added to sprays to give a rapid knockdown. Mixtures of 0.5 percent Dursban with 0.5 percent pyrethrins or 0.5 percent DDVP produced rapid knockdown of cockroaches and 100 percent mortality in laboratory tests. It is less expensive to use 0.5 percent dichlorvos than the higher concentration of Dursban.

Dursban is moderately toxic to warm-blooded animals. Heavy application of 0.5 percent emulsions and suspensions in *Aedes aegypti* larviciding has decreased the plasma cholinesterase level in applicators.

Propetamphos. Propetamphos (Safrotin) is a moderately toxic contact insecticide with some stomach activity. You can use it to control several insect pests such as cockroaches, ants, crickets, firebrats, silverfish, carpet beetles, pantry pests, and others. Permitted application areas include homes, stores, warehouses, schools, hospitals, industrial buildings, trucks, and other areas. You can't, however, apply it in restaurants, dining halls, and other areas where food is processed or prepared. In household kitchens, apply propetamphos only as a crack and crevice or spot treatment. Don't use it as a space spray.

In recommended dilutions, propetamphos is a low-odor insecticide, is nonstaining, and won't harm or cause damage to fabrics, plastics, paints, or other surfaces that can't be damaged by the carrier (water or oil). It's available as an emulsifiable concentrate or wettable powder.

Exercises (407):

1. From what material are organophosphates derived, and how do they work?

2. What two advantages do organophosphate compounds have over chlorinated hydrocarbons?

3. Match the organophosphate compounds in column B with their described uses in column A.

Column A	*Column B*
____(1) Very effective as a mosquito larvicide, but not as an adulticide.	a. Malathion.
____(2) Widely used by AF personnel to manage cockroaches.	b. Dichlorvos.
____(3) Authorized for AF use to control spider mites and scale insects, if the label so states.	c. Dimethoate.
____(4) Widely used to control mosquitoes using ultralow volume equipment.	d. Naled.
____(5) A moderately toxic contact and stomach pesticide labeled for use in many areas except food-handling areas for cockroach and other pest control.	e. Trichlorfon.
____(6) AF approved for controlling white grubs on airfields; it should not be mixed with malathion because of increased mammalion toxicity.	f. Abate.
____(7) Acts as a contact and stomach poison with some fumigant action in field formulations.	g. Diazinon.
	h. Chlorpyrifos.
	i. Propetamphos.

Column A

____(8) Can be used as a residual fumigant in resin strips or pellets to control flying insects for up to 4 months.

____(9) A contact and stomach poison offering better adult fly control than malathion, and requiring lower application rates.

408. Specify characteristics of and safety precautions for various carbamate compounds, and identify them with their appropriate uses.

Organic Sulfurs (Carbamates). Partly because of increased environmental awareness, organic sulfur compounds are being used more often due to their rapid breakdown within the environment. Common organic sulfur compounds used on Air Force installations are carbaryl, propoxur, SMDC and bendiocarb.

The carbamates are derivatives of carbamic acid. Typical carbamates contain nitrogen, but differ from the chlorinated hydrocarbons and organophosphate insecticides in their lack of chlorine and phosphorus. Most carbamates are contact insecticides, lowering the cholinesterase level and acting as nerve poisons in much the same manner as organophosphate insecticides. A number of carbamates, such as carbaryl, produce a rapid knockdown of insects similar to the action of pyrethrum.

Carbaryl. Carbaryl (Sevin) is widely used in Air Force pest management programs to control a variety of pests. It has a low-mammalian toxicity but is highly toxic to honey bees. Carbaryl dusts are used at 2 to 5 percent concentrations to kill fleas on dogs, cats (except kittens, and puppies under 4 weeks of age). Since the restrictions on the use of DDT in the United States, carbaryl dust has been one of the insecticides of choice to kill the Oriental rat flea in murine typhus control programs and wild rodent fleas in rural plague control programs. Carbaryl sprays and dusts have been used to control adult mosquitoes. Very finely powdered carbaryl combined with other insecticidal dusts have been used effectively in aircraft disinsection. This compound is probably most often used in controlling ornamental and turf pests and can be mixed with a variety of non-alkaline turf, fungicides, such as maneb, thiram, ziram, zineb, and mancozeb.

Propoxur. Propoxur (Baygon) acts both as a stomach poison and contact insecticide. In cockroach control, the 2-percent bait acts as a stomach poison, while the 1-percent spray acts as a long-lasting residual contact insecticide. Propoxur differs from many other insecticides in having a "flushing action," or irritating quality that forces insects out from hiding places to make greater contact with sprayed surfaces. It also has a rapid knockdown action. In some areas, staining and odor problems have been noted following applications. Propoxur is also used in controlling mosquitoes, flies, sand flies, ants, earwigs, and many other arthropods. In residual applications, it is effective in controlling the brown dog tick, but propoxur should not be used in treating animals themselves. Propoxur is a cholinesterase inhibitor and must be used with care despite its moderate toxicity to mammals.

Bendiocarb. Bendiocarb (Ficam) is a ready-to-use insecticidal product that gives effective control of several indoor and outdoor pests. The lists of pests controlled includes cockroaches, wood-destroying pests, venomous pests, stored-product pests, fleas, ticks, and fire ants. It's formulated as a 76 percent wettable powder for dilution in water to give a .25-percent or .50-percent suspension, as a 1-percent ready-to-use dust, as a wettable powder including synergized pyrethrins, and as a 25-percent oil suspension for ULV application.

Bendiocarb shares some characteristics with propetamphos in that it is low in odor and doesn't harm surfaces that aren't damaged by water.

Store this product in a cool, dry location away from pesticides with strong odors that may be absorbed. Keep it away from heat sources, since bendiocarb gives off methyl isocyanate fumes when heated.

The acute oral toxicity of carbamates is high, but the acute dermal toxicity is low; however, as in all cases, when handling any pesticide, you must wear protective clothing and equipment and observe the rule of no smoking, eating, or drinking while handling these compounds.

NOTE: SMDC is a carbamate used as a fumigant; therefore, it will be discussed later within this section along with other fumigant compounds.

Exercises (408):

1. Why are carbamates being used more extensively?

2. In what ways are carbamate insecticides similar to the organophosphates?

3. What are the oral and dermal toxicity characteristics of carbamates?

4. What safety precautions must you take when handling carbamates?

5. Match the carbamate compounds in column B with their appropriate descriptions in column A. Items in column B may be used more than once.

Column A	*Column B*
____(1) May cause staining and odor problems in some areas.	a. Carbaryl.
____(2) Compatable with several fungicides.	b. Propoxur.
____(3) Should never be stored near pesticides with strong odors.	c. Bendiocarb.
____(4) Has replaced DDT in control programs for fleas that transmit diseases.	
____(5) Diluted in water, it's applied as a .25-percent or .50-percent suspension.	
____(6) Has a flushing action and rapid knockdown action.	

409. Cite characteristics, uses, and safety precautions for various organochlorine compounds.

Organochlorines (Chlorinated Hydrocarbons). Organochlorines are organic synthetically produced compounds that contain chlorine, hydrogen, and carbon elements, with some containing other elements such as oxygen and sulfur. These compounds are very persistent and contributed immensely to the concern over pesticide use you learned about earlier. Because of this, most organochlorine formulations have been classified as *restricted use* pesticides, which means that they can only be used in specific situations and by certified personnel or personnel under their direct supervision.

There are three organochlorine compounds commonly used by Air Force personnel: chlordane, chlordecone, and pentachlorophenol.

Chlordane. Chlordane is a pale amber, oily fluid that can be dissolved in many solvents—but not in water—to produce oil solutions or emulsifiable concentrates. Chlordane acts as a stomach poison, contact insecticide, and fumigant. Because of its volatility, and other potentially hazardous characteristics, chlordane can be used only under buildings for treatment of termites.

Chlordecone. Chlordecone (Kepone) is a chlorinated polycyclic ketone compound. It is used as a stomach poison to control ants and cockroaches and is prepared in bait material such as peanut butter.

This poison bait must not be used in places that are accessible to children and pets, since it is very toxic to mammals. Always handle with rubber gloves or equivalent type and avoid contamination of other food and water sources. Adhere to the no smoking, eating, and drinking pesticide rule while handling chlordecone.

Pentachlorophenol. Pentachlorophenol is a highly toxic chemical used to protect wood from attack by termites, fungi, and lyctus beetles. It's highly irritating to the skin and eyes and must be handled with care. It's available as an oil solution and as creamy emulsion paste that releases the preservative into the wood slowly, thus providing good penetration. It's also available as a water soluble salt, sodium pentachlorophenate.

Exercises (409):

1. Why are most organochlorine pesticides for restricted use only?

2. For what purpose may you use chlordane?

3. What modes of action does chlordane have?

4. What personal safety precautions must you observe when using chlordecone?

5. How is chlordecone used?

6. How is pentachlorophenol used?

7. In what formulations is pentachlorophenol available?

410. Identify various insecticidal fumigants with their described characteristics and uses.

Insecticidal Fumigants. Fumigants are gases designed to kill cells and tissues of plant and animal matter by penetrating the dermal wall and respiratory process. These gases are dispersed in molecular form, which provides thorough and rapid penetration. Fumigants may be obtained in solid, liquid, and gaseous forms. Regardless of what form the fumigant is obtained in, the end result will be in gaseous form once it is released.

All modern fumigants that produce effective control of pests are also toxic to man. Therefore, every fumigator must receive thorough training, must be provided with proper equipment, and must understand the hazards associated with the fumigants he or she uses.

Naphthalene. This common household fumigant is obtained by the distilling of coal tar. The product is marketed as mothballs or flakes and is used by the Air Force in controlling bats. Naphthalene has proven to be an excellent repellent for squirrels, skunks, and rats in inclosed spaces. It's also effective in small spaces for repelling clothes moths, but odors last a long time. It has therefore been replaced, to a large extent, by paradichlorobenzene, a fumigant that has a more pleasant odor.

Paradichlorobenzene (PDB). This is a crystalline solid commonly used in deodorant cakes and mothballs, and is used primarily for protecting woolens, furs, and insect collections from insect attack, and as a masking deodorant in such places as public restrooms. The odor of PDB is not as persistent as that of napthalene, so it is more suitable for use when storing clothing.

Methyl bromide. This is a heavy (heavier than air), odorless, and nonflammable gas fumigant. It is used for fumigating structures in treating for dry-wood termites. Other methyl bromide uses include fumigating for clothes moths and carpet beetles and also as a herbicidal fumigant.

As a herbicidal fumigant, it is used as a preplant herbicide to kill seeds and can be used to control nematodes and soil fungi. It is especially good as a herbicidal fumigant because of its heavy properties that allow it to remain on the ground instead of rising.

Since methyl bromide is odorless, chloropicrin is added to provide a warning agent.

Dichlorvos. This compound was previously discussed in this section under the subject of organophosphates. It does serve as a fumigant and is authorized for use by the Air Force when placed within retrograde cargo.

Sulfuryl fluoride. This fumigant (vikane) is used in fumigating structures for dry-wood termites. This is a liquid compound that is stable, odorless, nonflammable, nonexplosive, noncorrosive, and shows rapid penetration and may eventually replace methyl bromide since it is more toxic to dry-wood termites.

Aluminum phosphide. This is one of the newest compounds used as a fumigant. The fumigant is actually hydrogen phosphide, which is a gas released by aluminum phosphide. It is used primarily for intransit freight car fumigation to rid processed nonperishable subsistence items of stored-products pests. This compound can be obtained in pellet, tablet, and powdered forms and is authorized for use by military personnel in fumigating for stored-products pests, which is done by the inplace atmosphere fumigation method.

Aluminum phosphide has a very rapid molecular action, is corrosive to gold, and, in its pure state, is highly explosive when exposed to the atmosphere; but commercial forms have been developed with a cooling agent and protective layer to retard rapid decomposition caused by exposure to air.

Although this compound is considered to be the safest fumigant available, protective clothing and equipment still must be worn when entering or cleaning a freight car of stack that is under fumigation. The advantages of this fumigant is the intransit fumigation ability and the fact that stocks can be fumigated under cover within a building that is occupied by other personnel.

All fumigants are toxic to all forms of life, and you must use them with extreme caution. Always wear protective clothing and equipment. Gas masks with appropriate cannisters for the type of fumigant being used must be worn and precautions must be taken to avoid explosions and fires. The area being fumigated must be adequately and readily identified by posting warning signs, and in most cases the areas must be sealed off to keep individuals away.

Exercise (410):

1. Match the fumigant in column B with the appropriate characteristic or use in column A.

Column A	*Column B*
____(1) Crystalline solid commonly used in deodorant cakes and mothballs.	a. Napthalene.
____(2) Very safe fumigant usable in occupied buildings for stack fumigation of stored foods.	b. PDB.
____(3) Effective in small spaces for repelling clothes moths, but odor lasts a long time.	c. Methyl bromide.
____(4) Used for fumigating buildings for dry-wood termites, is more toxic to them than methyl bromide.	d. Dichlorvos.
____(5) This nonflammable gas may be used as a herbicidal fumigant.	e. Sulfuryl fluoride.
____(6) This chemical is approved for Air Force use in fumigating retrograde cargo.	f. Aluminum phosphide.

411. Differentiate between various miscellaneous pesticides and their characteristics.

Miscellaneous Pesticides. In addition to the classes of pesticides you've learned about, there are other important chemicals of which you should be aware. These pesticides, in a variety of chemical classes, are the subject of this lesson.

Pyrethrum. Pyrethrum is a pyrethroid derivative of a flower that is one of the chrysanthemums. As an extract, it is a dark syrupy liquid that must be purified and standardized for insecticidal use. It is available in a variety of concentrations: as a concentrate in both oil solutions and emulsifiable concentrates and also as a dust. It is actually a mixture of four toxic chemicals. On insecticide labels, these are grouped and referred to collectively as pyrethrins. The pyrethrins comprise a chemically unstable group that accounts for their short residual effectiveness. Pyrethrum is frequently combined with other chemicals that act as synergists to increase its effectiveness. Pyrethrum is quick acting and thus an excellent knockdown insecticide, but it does not always kill all of the insects it knocks down. Its action is very irritating to insects and it is frequently used by the pest control specialist to flush out insects in hidden cracks and crevices. The acute oral LD50 of pyrethrins is 1,800 mg/kg, a relatively safe group of compounds.

Resmethrin. Resmethrin (SBP-1382) is a synthetic pyrethroid. The knockdown action of resmethrin is slightly slower than pyrethrum, but all insects knocked down usually die. In dark areas such as cracks and crevices it has some residual action. Commercial preparations are available that contain an ultraviolet-light-screening agent, which prevents the resmethrin from breaking down rapidly and thus provides some residual action. These preparations cannot be used in food processing areas. The toxicity of resmethrin is less than that of pyrethrum, having an acute oral DL50 of more than 4,000 mg/kg.

Boric acid. This chemical is a slightly toxic, white, free-flowing powder used for cockroach control. It is slow acting, requiring 7 to 10 days to control roach populations, but offers long-lasting control when it's properly applied in walls, voids, and other small spaces. As with other pesticides, you can only use it in cracks and crevices of food-handling facilities, and you should always take care to avoid depositing the powder onto exposed surfaces or in the air.

Methoprene (Altosid, Precor). This insecticide is an insect growth regulator (IGR) that is used in commercial products for controlling culex mosquitoes, and dog and cat fleas in buildings. This amber liquid is formulated as 4 percent briquettes, a 10-percent slow release formulation, and as a 5-percent active ingredient fogger for indoor use. Unlike ordinary insecticides, methoprene prevents larval and pupal insect stages from maturing to the adult stage instead of having a direct toxic impact on the pest. As a result, it is highly selective to a few insect species and extremely low in toxicity to fish and mammals.

Amdro. Like methoprene, amdro is a biodegradable insect growth regulator used to obtain long-term control of imported fire ants. It's available as a soybean oil and corn grit bait and works by sterilizing the queen, the colony's only egg layer. Since the workers have a short life span and provide for the queen, when they die off, the queen also soon dies. As a result, amdro works slowly, requiring several applications over 4 to 6 months to eliminate large colonies. This chemical is toxic to fish, so it must be kept out of lakes, ponds, and streams.

Silica aerogel. This is a very finely ground dust composed of precipitated silicic acid. This material is thought to kill insects by inducing excessive water loss through physical disruption of the waxy layer of the epicuticle. Regular silica gels are very light and fluffy and are very difficult to keep confined to the treatment areas. For this reason, commercial formulations are usually impregnated with another insecticide, such as pyrethrins, in order to increase the weight of the powder and keep it from drifting away from the area being treated. Silica gels are not poisonous to humans, but they should not be breathed into the lungs.

Bacillus thuringiensis, var. israelensis (BTi). This is a biological pesticide containing bacterial spores and crystalline endotoxin. It's a specific insecticide for controlling several genera of mosquito larvae, including Psorophora, Aedes, Anopheles, Culex, Culiseta, and others as well as lepidoptera larvae. It's environmentally safe, being harmless to humans, animals, and useful insects. BTi is available as a water dispersible concentrate (Teknar) or as a high-potency wettable powder, granular and briquette product (Bactimos).

Exercise (411):

1. Match each pesticide in column B with its appropriate description in column A.

Column A	*Column B*
____(1) An insect growth regulator for selective control of culex mosquitoes, and dog and cat fleas.	a. Pyrethrum.
____(2) A botanical insecticide frequently used as a flushing agent.	b. Resmethrim.
____(3) A synthetic pyrethroid used for flying insect control, but with lower toxicity and slower knockdown action than pyrethrum.	c. Boric acid.
____(4) An environmentally safe biological pesticide for selective control of mosquito larvae.	d. Methoprene.
____(5) An extremely light, nontoxic dust usually mixed with pyrethrum powder; it possibly kills insects through abrasion of the body wall and loss of body fluids.	e. Amdro.
____(6) This slightly toxic pesticidal dust gives slow but long-lasting control of cockroaches when properly applied in walls, voids, and other small spaces.	f. Silica aerogel.
____(7) A biodegradable insecticide for controlling imported fire ants; it works slowly to eliminate a colony.	g. BTi.

2-3. Rodenticides

Rodenticides have evolved into a variety of products over the years. Until about 30 years ago, most were "one shot" poisons, those generally requiring only one feeding. Then in the 1950's, anticoagulants made their debut. These multiple-dose chemicals controlled rodents over a number of days and required more than one feeding. Today, in the face of growing rodent resistance to some of these products, we're seeing the emergency of a new class of rodenticides—single-dose anticoagulants—which combine the best features of the earlier two, plus some other advantages.

In this section, you'll learn about many of the most commonly used rodenticides. Also, you'll learn about some fumigants that can be used in rodent control programs.

412. Cite general characteristics of anticoagulants and identify descriptive statements with various multiple-dose rodenticides.

Multiple-Dose Rodenticides. All of the multiple-dose rodenticides are anticoagulants. These synthetic organic compounds are used mostly as rodenticides, although at least one of these compounds is used in the medical treatment of humans in the prevention of blood clots.

Anticoagulant rodenticides act to reduce the clotting ability of the blood, resulting in internal and external hemorrhage and eventual death. An important characteristic is that relatively low dosages of anticoagulants ingested daily for about 7 days are fatal to rodents when the same total amount of a single-dose chemical may produce no significant damage or symptoms. The low concentrations at which the anticoagulant rodenticides are effective almost eliminates the hazard of acute toxicity to humans and greatly reduces this hazard to domestic animals. Also, the meal baits in which they are used are not generally attractive to children and pets.

The anticoagulants kill in a radically different manner from the older single-dose poisons. Most single-dose poisons kill rats within hours (½ hour to 48 hours) after ingestion. Anticoagulants must be ingested in small amounts for several days before they become effective. Even when weakened, rats apparently do not associate their loss of strength with their food supply. They return to feed on anticoagulant treated baits again and again. Thus, the problem of bait shyness commonly associated with "one shot" poisons is largely overcome. Nonfatal doses of single-dose poisons are painful; whereas, anticoagulants apparently cause no pain.

Warfarin. Warfarin is an anticoagulant with an acute oral LD50 of 50 to 232 mg/kg. It is a cumulative poison usually requiring several repeated feedings over a period of several days for best results. It is effective against all kinds of rats and mice, and bait shyness does not develop on repeated feedings, but in some areas, rats are developing resistance to it. Warfarin is used as a dry powder with solid baits, but is also available under the name Warfacide to be used as a liquid bait.

Pival. Pival is a fluffy, yellow powder with a slightly moldy, acrid odor suggestive of marigolds or tobacco. It is essentially insoluble in water but soluble in organic solvents. The sodium salt derivative, though soluble in water up to 0.1 percent, nevertheless settles out sufficiently from water to be observed grossly by rodents and to cause concern with diminished efficiency. To eliminate this drawback, a stabilizing agent, versene (regular), can be added to the water to make a 0.1-percent solution from which the product will not precipitate.

Pival is available as a 0.5 percent concentrate in cornstarch. The manufacturer recommends a 1:19 dilution by weight in bait. The sodium salt (Pivalyn) is available as packaged units sufficient to poison 1 quart of water. Each packet has versene added to the Pivalyn.

You can use Pival in most situations for controlling both rats and mice. It appears to be about equal to warfarin in its rodenticidal effectiveness. Pival has been found to inhibit mold formation and the development of insects infesting grain.

Diphacinone. Diphacinone is one of the newer anticoagulant chemicals made available in the fall of 1957 and is widely used to control both rats and mice. This product is available as a 0.1 percent concentrate, which is mixed with 1 to 19 pounds of bait, and in a ready-to-use dry bait formulation containing a 0.005-percent concentration of the active ingredient. It generally requires fewer successive feedings to kill than older anticoagulants and resists insects and mold. Methods of application for rodent control are similar to those used for other anticoagulants in food baits.

Chlorophacinone. This product (RoZol) is an anticoagulant soluble in oil and thus suitable for use in oily baits. It is effective against Norway rats and house mice. It is a cumulative poison usually requiring repeated feedings over a period of several days for best results. Rats and mice do not develop bait shyness on repeated feedings of this material. Chlorophacinone can be absorbed through the unbroken skin, so it should be handled with rubber gloves.

Exercises (412):

1. How do anticoagulants kill rodents?

2. What advantages do anticoagulants have for people and nontarget animals as compared to single-dose poisons?

3. Match the rodenticide in column B with the appropriate descriptive statement in column A.

Column A	*Column B*
____(1) A stabilizing agent such as versene should be added when using this product in water.	a. Warfarin.
____(2) This rodenticide is widely used in the Air Force for both rat and mouse control.	b. Pival.
____(3) In some areas, rats are developing resistance to this rodenticide.	c. Diphacinone.
____(4) This rodenticide is soluble in oil, making it suitable for use in oily baits.	d. Chlorophacinone.

413. Specify characteristics and safety precautions for various single-dose rodenticides.

Single-Dose Rodenticides. In this lesson, you'll learn about some older rodenticides still in use as single-dose rodenticides. Additionally, you'll learn about some of the newest rodenticides referred to as single-dose anticoagulants.

Zinc phosphide. Zinc phosphide, a synthetic inorganic compound, is a heavy, dark-gray powder that is chemically stable and insoluble in water. It has a faint odor of phosphorus due to the slow release of phosphine (PH_3). Both the powder and gas are very toxic. You should weigh and mix zinc phosphide out-of-doors, or in a well-ventilated room, to avoid inhalation of gas or dust. Wear gloves when mixing or distributing baits.

This rodenticide has been used for many years and is effective against all species of rats and mice. Though highly toxic to all animal life, some animals will not eat baits prepared with it because of its objectionable odor and taste. Most species of rats and mice will accept attractive zinc phosphide baits. Zinc phosphide is used at a strength of about 1 percent by weight in blended or mixed baits. The baits must be thoroughly mixed because of the small amount of toxicant required.

Zinc phosphide reacts with dilute acids to release phosphine; therefore, bait materials containing organic acids may be unsuitable because they cause this poison to deteriorate too rapidly. However, bait materials that cause slow deterioration may be desirable as a safety factor.

As a safety factor, add tartar emetic (antimony potassium tartrate) to the poison before mixing with bait in the proportion by weight: zinc phosphide—8 parts, tartar emetic—3 parts, even though acceptability of such baits is thereby reduced. Oils and fats used as a binder also increase absorption of poison into a rat's body.

Strychnine. This is the only botanical compound used by the Air Force as a rodenticide at the present time. Strychnine is a white powder, practically insoluble in water, but is readily soluble in chloroform and certain other organic solvents. It can be obtained as a premixed bait and tracking powder. Some products are approved for controlling moles and prairie dogs.

Strychnine is highly toxic if ingested; therefore, you must take every precaution available to avoid contamination of all food and water sources and to prevent children and animals from coming into contact with it.

Brodifacoum and bromadiolone. These chemicals are among the "third generation" rodenticides used to control rats that are resistant to other products. They act as single-dose anticoagulants for controlling Norway rats, roof rats, and house mice in industrial and residential buildings and in urban outdoor areas.

Brodifacoum (Talon) has an acute oral LD50 of 0.26 mg/kg for rats, and Bromadiolone (control, Maki) has an acute oral LD50 of 1.125 mg/kg.

As with other rodenticides, keep these products away from children, domestic animals and wildlife, and wash after handling baits. After treatment, remove and bury uneaten bait and rodent bodies.

Exercises (413):

1. Why should zinc phosphide be mixed outdoors when possible?

2. At what concentration are food baits made with zinc phosphide?

3. Describe the safety precautions you should take when placing strychnine poisons.

4. In what form is strychnine available?

5. What characteristics set bromadiolone and brodifacoum apart from other anticoagulants?

6. What precautions should you take following a treatment program with rodenticides?

414. State characteristics and safety precautions for rodenticidal fumigants.

Rodenticidal Fumigants. There are two products you can use as fumigants in rodent burrows. These are calcium cyanide and aluminum phosphide.

Calcium cyanide. This compound is for gassing rodent burrows outdoors. It should never be used near a building occupied by people. It is a grayish-white compound available in either granular or powdered form that produces hydrocyanic acid gas upon exposure to moist air. Both the dust and the gas liberated will kill any animal, including insects and man. In rat control it is used to treat burrows and under certain circumstances, small inclosed spaces or harborages. An advantage of this gas over poisons is that it kills the flea and mite parasites as well, a factor of considerable importance in controlling the spread of diseases such as plague and murine typhus.

Calcium cyanide is extremely hazardous to humans and should be used only by well-trained personnel. Personnel should stand upwind while applying this fumigant and must have appropriate gas masks and canisters available for use.

Aluminum phosphide. You have already learned about using this product as an insecticidal fumigant. With proper labeling you can also use it outdoors to control these rodents in their burrows:

- Woodchucks.
- Marmots.
- Prairie dogs.
- Norway and roof rats.
- House mice.
- Ground squirrels.
- Moles, voles, gophers, and chipmunks.

As with other fumigants; there are some important environmental hazards and use limitations for aluminum phosphide. You can't use it within 15 feet of inhabited structures or place it in burrows that may open into or under occupied buildings. Also, some important considerations regarding endangered species are listed on the label, along with special local restrictions in some states. Assuming you follow these and other label directions properly, aluminum phosphide can be a very safe, effective treatment for rodents in burrows.

Exercises (414):

1. How can you use calcium cyanide as a rodent fumigant?

2. What advantages does calcium cyanide have in a disease vector control program?

3. List the safety precautions you should always observe when using calcium cyanide.

4. Under what conditions should you *not* use aluminum phosphide to control rodents in burrows?

2-4. Avicides

Avicides are pesticides used to control birds (class Aves). In this section, you'll learn about three chemicals that may be used in a bird management program, although one of them isn't an avicide in the true sense of the word, but a type of sterilant for pigeon birth control.

If you have a bird problem at your installation, you're strongly encouraged to study bird management in Volume 7 before you resort to any type of chemical control. This is because you have many more options using IPM in bird management than in some other areas of your job. Also, chemical control of birds is more likely to create a public relations problem than are nonchemical controls.

415. Relate given avicides to specific characteristics about each.

Avitrol (R). Avitrol is a highly toxic bird control chemical used to treat bait. When treated bait is mixed with untreated bait in low concentrations, it can be used as a psychological repellent. In higher concentrations, it is used as a poison.

This product is EPA labeled for controlling crows, pigeons, grackles, starlings, sparrows, cowbirds, gulls, and blackbirds in and around structures and agricultural areas.

Avitrol can be used as a poison for Domestic Pigeons and House Sparrows in situations where rapid results are required, nontarget species are not present, and the occurrence of dead birds in the surrounding area is not likely to cause an adverse public reaction.

Ornitrol (R). Ornitrol is not a toxicant in the true sense of the word, but is a chemosterilant registered for pigeon control. Instead of poisoning birds, Ornitrol inhibits the embryo from developing within pithin pigeon eggs and sterilizing results with no direct harm to the birds. This effect lasts for about 6 months.

Ornitrol is available as a 0.1-percent whole kernel corn bait in 30-pound bags. It's very safe since a toxic dose is practically impossible, and it has a very bitter taste for people.

DRC-1339. This chemical was tested as a bird poison by the Denver Wildlife Research Center of the U.S. Fish and Wildlife Service. The commercially available product, sold only to professionals, consists of feed pellets treated with the poison. "Starlicide" is the registered trademark of this product, and the 0.1-percent mixture is called "Starlicide Complete."

This poison is registered for use only on Starlings and blackbirds at livestock and poultry feedlots. If feedlots near an air base are attracting birds that are creating a strike hazard or if a large proportion of a roosting flock is feeding at a particular feedlot, this control method may be appropriate.

Starlicide is less toxic to mammals than Avitrol. It is less toxic to light-colored birds than to dark birds (such as Starlings), so the danger to many protected species is reduced.

There is always some danger that protected species may be affected. Poisoning birds is unpopular and may cause an adverse public reaction, especially since the slow-acting poison will not take effect until birds have moved to another, perhaps more populated, location.

Be sure to wear gloves when handling treated bait and destroy excess bait and dead birds by incineration. Place the bait where it is inaccessible to poultry or livestock, and follow label instructions carefully.

Restrictions on Use. Consult U.S. Fish and Wildlife Service personnel before starting a management program using any toxicant. Permits are required in some localities. Never use toxicants where protected species may be affected.

Exercise (415):

1. Match the avicide listed in column B to the appropriate description in column A. Items in column B may be used more than once.

Column A	*Column B*
____(1) Works as a chemosterilant instead of a toxicant in pigeon control programs.	a. Avitrol.
____(2) Available as feed pellets for starling and blackbird control.	b. Ornitrol.
____(3) Less toxic to light-colored birds than to dark-colored birds.	c. DRC-1339.
____(4) May be used to control a variety of pest birds in and around structures.	
____(5) A toxic dose is almost impossible and it has a very bitter taste.	
____(6) May be used in low concentrations as a repellent.	

2-5. Herbicides

In this section, you'll study several different classes and specific types of herbicides. These classes include arsenicals, phenoxys, phenylureas, triazines, dinitros, benzoic acids, and alaphatic acids. There is also a final lesson on some other herbicides that are not in any of these classes, but have various uses.

Frequently, herbicides in the same class will have the same general use. As you continue, think about the weed problems you have on your base and look for classes or specific types of herbicides you could use. If you already have a weed control program, think about the herbicide(s) you're using and ask yourself what characteristics make your chemical suitable for your needs. Then compare your mental notes with what you learn in this section and see if you can come up with a better alternative.

416. Specify characteristics, uses, and safety precautions for arsenical compounds.

Arsenical compounds used as pesticides are divided into two groups—inorganic and organic.

Inorganic Arsenicals. These compounds are derived from mineral elements, and due to their persistence (ability to remain stable for long periods of time) they are commercially unavailable.

Organic Arsenicals. These compounds are derived from plant and animal matter and are much less persistent than inorganic arsenicals. The more common compounds used within the Air Force as herbicides are DSMA, MSMA, and AMA.

DSMA. DSMA (disodium monomethylarsonate) is a postemergence herbicide that is soluble in water, nonvolatile, and nonflammable. It is formulated as water-soluble powders containing 50 to 100 percent hexahydrate, and as dry mixtures with vermiculite containing 2.5 to 4 percent hexahydrate. Total water-soluble arsenic in the 50- and 100-percent powders is 12.8 and 25.86 percent, respectively. DSMA is compatible with the salts and esters of 2,4-D.

MSMA. MSMA (monosodium methanearsonate) is used as a selective, contact, postemergence herbicide. It is formulated as a water-soluble powder and is very similar to DSMA in action, although it is more phytotoxic and more effective in high temperatures.

AMA. AMA (ammonium methanearsonate) is a selective postemergence herbicide formulated as a water-soluble liquid. This compound is often added to silvex in controlling certain vegetation.

These organic arsenical compounds are considered to be moderately toxic upon ingestion and moderately to relatively nontoxic through absorption; however, protective clothing and equipment must be worn, and there must not be any smoking, eating, or drinking during the handling of these compounds. Always insure that these compounds do not contaminate any water source during or after application.

Exercises (416):

1. Comparing the characteristics of organic arsenicals and inorganic arsenicals, you will find that organic arsenicals are derived from ________ and ________ matter; whereas inorganic arsenicals are derived from ________ elements.

2. Which arsenical compound is used as a herbicide?

3. A common use characteristic of DSMA, MSMA, and AMA is that all three are used as ________ herbicides.

4. What safety precaution applies to environmental protection when using arsenical herbicides?

417. Specify characteristics and uses of phenoxy compounds.

Phenoxys. The phenoxy compounds we'll discuss are 2,4-D and MCPA. In the acid form, these herbicides are only slightly soluble in water. For commercial use, they are formulated as esters, which form milky emulsions with water and also dissolve in light oils, or as water-soluble salts. The amines are the most widely used salts. They are easily soluble in water and are commonly sold in liquid form. There are also sodium and ammonium salt formulations that are sold as water-soluble powders, but they are not so effective as are the amine salts on hard-to-kill species or on weeds that are in bud stage and beyond. All of the salts are practically nonvolatile. Two general kinds of esters are commercially available: relatively high-volatile esters and relatively low-volatile esters. Although the low-volatile esters vaporize less rapidly, both types are volatile at high temperatures. Drift can occur with any of the formulations if the spray is in very fine droplets or mist and there is a wind.

The phenoxy formulations are moderately toxic. The hazard to livestock and wildlife is negligible on treated vegetation, but toxic amounts could be eaten if animals had access to undiluted concentrates or large amounts of spray mixtures. As ordinarily handled, these materials are not likely to cause irritation to skin or eyes. They are not absorbed through the skin to any appreciable extent and, in the amounts likely to be inhaled, are not hazardous. Neither is the ingestion of harmful amounts likely. As dosages used for weed control, they may harm fish in still, shallow water. They are noncorrosive and nonflammable.

2,4-D. 2,4-D is formulated as water-soluble sodium, ammonium, or amine salts and volatile or low-volatile esters. A new formulation is the diamine salt. It is an oil-soluble amine that has the weed-killing properties of an ester and the nonvolatile features of amine salts. It is formulated in a concentrate containing 2 pounds acid equivalent per gallon.

2,4-D is used for the control of herbaceous broadleaf weeds. It can be applied at extremely low concentrations compared with the inorganic herbicides, such as borates and chlorates. It is absorbed through leaves and is readily translocated in the plant, but it is also absorbed by plant roots. It is commonly used as a selective herbicide rather than soil sterilant. Its effect, when applied to the soil, is temporary except under very dry conditions or cool weather. 2,4-D is used on many perennial broad-leaved weeds, since it is translocated to the roots and underground storage organs. It is carried with the sugars as they move out of the leaves. It is, therefore, most effective on warm sunny days when photosynthesis is active. It is a very useful herbicide to kill annual nongrass weeds that frequently reinfest an area treated with a soil sterilant after it has leached below the surface layer. It is also an inexpensive and convenient chemical to kill certain weeds that are tolerant to a soil sterilant. On roadsides and similar areas where grasses are desirable for erosion control and in turf, 2,4-D can be used selectively to kill broad-leaved plants in sod. 2,4-D is also effective on certain broad-leaved aquatic plants. It is also used for control of woody plants. The salt formulations are practically nonvolatile, but, with the possible exception of the diamine salt, are less effective than the esters on hard-to-kill species. The low-volatile esters are equally as effective as the volatile esters and in some instances are better. Some woody species are tolerant to 2,4-D.

MCPA. MCPA contains several isomers, but the 2-methyl-4-chloro isomer is the most effective for killing weeds. Therefore, the better formulations contain a high proportion of this isomer. The most widely used formulations are the sodium and amine salts. MCPA is very similar in use to 2,4-D because it, too, is used in controlling broad-leaved weeds; however it is more expensive than 2,4-D. Depending on the weeds being controlled, it may be more or less effective than 2,4-D.

Exercises (417):

1. Into what toxicity range do the phenoxy compounds fall?

2. List the personal safety advantages phenoxy compounds offer when you apply them at the recommended rate and strength?

3. How is 2,4-D used?

4. Under what conditions is 2,4-D most effective?

5. In terms of control results, how does MCPA compare with 2,4-D?

418. Cite general characteristics for phenylurea compounds and identify uses of specific compounds with the herbicide they describe.

Phenylureas. These compounds are used for soil sterilants and include monuron, duron, siduron and tebuthiuron. They are only slightly soluble in water, have a low volatility, are noncorrosive, and nonflammable. They are formulated as water-dispersible powders and granular products. With the exception of the granular materials, all forms are applied as suspensions in relatively large volumes of water and require agitation in the spray tank.

Although these chemicals do not move far laterally in the soil, they may be washed down the surface slopes to kill vegetation below and they leach deeply enough to reach the roots of trees, shrubs, and the deep-rooted plants growing under the treated area. All these chemicals can irritate your eyes, nose, throat, and skin.

Monuron. Monuron is formulated as a water-dispersible powder containing 80 percent active ingredient. It is also formulated as a granular material.

The effects of monuron on all weeds are slow to appear. Monuron is more effective in light, sandy soils than in heavy types at equivalent rates and is more active in mineral soils than those high in organic-matter content. It is much more soluble in water than diuron, so it is better adapted to areas of less than 25 inches of rainfall a year, except along irrigation and drainage ditches. It is also preferred to diuron for soils containing considerable amounts of clay, especially bentonite, or of organic matter. At high rates, it leaches readily from sandy soils and moves downward twice as fast as diuron in both clay and sandy soils. It is somewhat more effective on grasses than nongrasses. Heavy rainfall and standing or running water; condition favoring microbial activity such as warm soils of high organic-matter content and moisture; and soil cultivation shorten its persistence in the soil. Sterility of the soil may last 1 to 3 years; this depends on rates applied, soil type, and rainfall.

Diuron. Diuron is even less soluble in water than monuron. It is formulated as a water-dispersible powder containing 80 percent active ingredient. There is also a liquid suspension, containing 2.8 pounds per gallon, active ingredient.

The effects of diuron on all weeds are slow to appear. Diuron is more effective than monuron where rainfall is over 25 inches a year and especially on sandy soils. It is not recommended for areas of low rainfall, especially to control deep-rooted plants. Larger amounts of diuron than monuron are absorbed by all soils; consequently, it is more persistent.

Siduron. Siduron is a slightly toxic herbicide used for preemergence control of a variety of annual grasses in established cool-season turf. Controlled grasses include crabgrass, foxtail, and barnyard grass. You can apply siduron in newly seeded or established plantings of bluegrass, fescue, redtop, and other cool-season turfs. It's available as a 50-percent wettable powder under the trade name "Tupersan."

Tebuthiuron. This is a highly active preemergence and postemergence herbicide for total vegetation control in noncropland areas, including trees and shrubs. It's formulated as an 80-percent wettable powder. Depending on the vegetation you want to control, it can be applied at rates of 2.5 to 20 pounds per acre. In areas where rainfall is at least 25 inches per year, an application rate of 3.0 lbs/acre should generally be used. If the average annual rainfall is less than 15 inches per year, apply it just before rainfall reaches its seasonal peak. At least 1 to 1.5 inches of rainfall is needed to activate tebuthiuron.

Given the broad spectrum characteristics of tebuthiuron, it's very important that you don't contaminate bodies of water, because aquatic vegetation could be injured or killed. Also, never contaminate water when you clean application equipment or dispose of wastes.

Exercises (418):

1. How are phenylurea compounds used?

2. What are the basic chemical characteristics of phenylureas?

3. In what forms are phenylureas commonly available?

4. Describe how phenylurea compounds are moved through the soil.

5. Match the statements in column A with the herbicide each describes in column B.

	Column A	*Column B*
____(1)	Highly active against all types of vegetation, including trees and shrubs.	a. Monuron.
____(2)	Most effective as a soil sterilant where rainfall is over 25 inches per year, especially in sandy soils.	b. Diuron.
____(3)	Used for preemergence control of annual grasses in established cool-season turf.	c. Siduron.
____(4)	Most effective as a soil sterilant where rainfall is less than 25 inches per year.	d. Tebuthiuron.

419. Specify characteristics, uses, and safety precautions for triazine compounds.

Triazines. Triazine compounds include simazine and atrazine. These are soil sterilants when applied at high rates. They are noncorrosive, nonflammable, and present no electrical or conductivity problem around utilities, powerplants, transformers, signal blocks, or other electrical installations.

Simazine. Simazine is practically insoluble in water. It is formulated as an 80-percent water-dispersible powder and as a 4-percent granular product. Both formulations are used for the nonselective control of vegetation on areas where any plant growth is undesirable. The granular product is also effective against rooted aquatic plants such as coontail, fanwort, horned pond-weed, and water milfoil.

Simazine is absorbed by soil colloids. High cation-exchange capacity, high organic-matter content and, to a less extent, high clay content of soils reduce its toxicity to plants. It is probably also deactivated by soil micro-organisms. Simazine has little or no contact action on foliage, so there is

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no drift hazard. It cannot penetrate an unbroken leaf cuticle and is absorbed only through the roots. Simazine is ineffective until water carries it to the root zone, and its action is slow. It is easily removed from equipment by washing. It forms a suspension in water that requires agitation to keep the chemical from separating out.

Atrazine. This product is formulated as an 80 percent water-dispersible powder and a 4-percent granular product. It is more soluble than simazine, so it is more effective in dry areas. Weeds that are better controlled with atrazine than simazine are horsetail, Indian hemp, prickly lettuce, yellow nutgrass, rush, sedge, and Canada thistle.

Atrazine, unlike simazine, is absorbed through plant leaves; hence, there is a drift hazard. It is slightly more toxic than simazine to mammals and remains toxic in the soil for a slightly shorter time.

Exercises (419):

1. When applied at high rates, triazine compounds are used as ________ ________.
2. The triazine compound that has little or no contact action on foliage and does not penetrate unbroken leaf cuticles but is absorbed only through the roots is ________.
3. The triazine compound that presents a drift hazard is ________.
4. Based upon the text, ________ would be the safest compound to use.

420. Cite characteristics of dinitro compounds and the hazards they present humans.

Dinitros. These are contact herbicides used alone and to fortify oils. The parent compounds do not dissolve in water but are soluble in oil. Sodium, ammonium, or amine salt formulations are water soluble.

The three parent compounds are designated by the Weed Society of America (WSA) as DNAP, DNBP, and DNC.

All three compounds are yellow dyes that stain skin, hair, and clothing. They are highly poisonous if swallowed, if absorbed through the skin, or if any appreciable amount of spray mist is inhaled. Although they are not irritating, they are readily absorbed through the skin. They should be kept away from heat and open flame.

The parent compounds are used nonselectively for top-kills of vegetation. The sodium, ammonium, and amine salts are used selectively. The parent compounds are very effective contact herbicides that control a wide range of herbaceous plants, including many oil-resistant plants. They require large amounts of water, and their effectiveness as weed killers varies widely with the temperature.

The dinitros are not economical to use on perennial grasses and on coarse, vigorous, annual grasses. Repeated applications are required for control in areas of long seasons and high rainfall.

DNBP is the most effective form, DNC the least effective, and DNAP intermediate.

DNBP. DNBP commercial formulations contain 5 pounds DNBP per gallon plus 87.9 percent oil or an alkanolamine salt containing 3 pounds DNBP per gallon. Ammonium salts of DNBP contain 1 pound per gallon.

DNC. Commercial formulations contain 30 percent sodium salt of DNC. The effectiveness of DNC can be increased by adding ammonium sulfate, aluminum sulfate, or sodium bisulfate.

Exercises (420):

1. Name the parent compounds of the dinitros and their physical characteristics.
2. What hazards do the compounds present to humans?
3. How are dinitro parent compounds used?
4. What plants do the compounds effectively control?

421. State characteristics, uses, and safety precautions of benzoic acid compounds.

Benzoic Acids. These compounds are readily translocated in the plant. They kill through both root and foliage absorption. They are good temporary soil sterilants for both perennial and annual weeds.

2,3,6-TBA. This product is formulated as the dimethylamine salt of trichlorobenzoic acid, containing 2 pounds per gallon acid equivalent. It is nonvolatile, noncorrosive, and nonflammable. It is a mild skin irritant and is compatible with 2,4-D amine, dalapon, diuron, and monuron.

PBA. This is a mixture of a small amount of 2,3,6-Trichlorobenzoic acid and a higher proportion of several other polychlorobenzoic acid derivatives. It is formulated as the dimethylamine salts of polychlorobenzoic acids, containing 4 pounds per gallon, acid equivalent. It is nonvolatile, noncorrosive, and nonflammable. It is a mild skin irritant and is also compatible with 2,4-D amine, dalapon, diuron, and monuron.

Dicamba. Dicamba is formulated as the dimethylamine salt of 2-methoxy-3, 6-dichlorobenzoic acid in water, containing 4 pounds acid equivalent per gallon.

It is very effective on several hard-to-kill broad-leaved weeds such as buckwheat, tartary, garlic wild, prostate knotweed, Russian thistle, green smart-weed, sowthistle, Canada thistle, and wild buckwheat.

When handling these compounds, wear protective equipment and clothing. Avoid drifts so that desired vegetation will not be affected and water sources will not be contaminated.

Exercises (421):

1. How do benzoic acids act on affected vegetation?

2. Which benzoic acid compound is very effective against hard-to-kill weeds such as buckwheat and knotweed?

3. What should you do to avoid personal contamination?

422. Cite characteristics and uses of aliphatic acids, and list the safety precautions to be observed with them.

Aliphatic Acids. These compounds are relatively strong acids and are primarily used as herbicides. They are derived from sodium salt and are usually obtained in powder or pellet forms. They are water soluble and are used principally as selective, translocative, preemergence, and postemergence herbicides. The two most common aliphatic acids used in the Air Force are Dalapon and TCA.

Dalapon. Dalapon (2,2-Dichloropropionic acid) is formulated as the sodium salt of dichloropropionic acid. It is a water-soluble powder applied as a solution for foliage spray. A typical commercial product contains 85 percent of the salt or 74 percent of the acid equivalent. The acute oral toxicity is low. It is not absorbed through unbroken skin. Undiluted, it may cause skin irritation after prolonged contact, but spray concentrations are not irritating. The powder or concentrate solutions can cause painful irritation of the eyes. Dalapon is used principally to control grasses, but it is also effective against cattails, jack pine, phragmites, rushes, and white-cedar. It is a growth-regulator type of herbicide that is translocated from leaves to roots and rhizomes of perennial grasses. It is more effective in foliar applications than TCA, but it is also absorbed by the roots. For general weed control, it is mixed with a broad-leaved weedkiller such as 2,4-D amitrole, or silvex. Dalapon disappears from the soil most rapidly in warm and humid regions. It persists longer in dry, cool soils where microbial activity is low.

TCA. TCA (Trichloroacetate acid) is very similar to Dalapon, but a typical commercial product contains a higher percentage of sodium salt; therefore, it is basically used as a temporary soil sterilant.

Do not apply these compounds near desired vegetation or irrigation water or when heavy rains are expected, because these compounds have a tendency to leach out of top soil.

Wear protective clothing and equipment, avoid drift, and wash spray equipment immediately following use because these compounds are very corrosive.

Exercises (422):

1. Aliphatic acids are derived from what source?

2. How are aliphatic acids used?

3. What aliphatic acid compound is used basically as a temporary soil sterilant?

4. Dalapon is primarily used to control ________.

5. List the environmental safety precautions that must be observed when using aliphatic acids.

6. Equipment that has been used to apply aliphatic acid compounds should be ________ immediately because these compounds are ________.

423. Identify miscellaneous herbicides with their descriptions.

Miscellaneous Herbicides. There are many other classes of herbicides in addition to the ones you've studied up to now, but it's easier for you to study them as individual chemicals than to describe them by group. In this lesson, you'll learn about some herbicides in various classes and having several different uses. These products include glyphosate, bromacil, trifluraline, diquat, endothall, and paraquat.

Glyphosate. Glyphosate (Roundup) is a moderately toxic nonselective, postemergence herbicide. You can use it to control many annual and perennial grasses, broadleaf weeds and woody brush species in the spring, summer, or fall using a wide variety of equipment. Glyphosate is a foliar-applied, translocated herbicide and is available as a 41-percent water-soluble concentrate.

Bromacil. Bromacil (Hyvar X; XL) is slightly toxic as a dry formulation and moderately toxic as a water-soluble liquid. You can use it as a preemergence and postemergence herbicide or as a nonselective soil sterilant. It is slow-acting, noncorrosive and nonvolatile. A small amount of rainfall, about one-half inch is enough to activate it.

Applied at a rate of 2 to 8 pounds per acre, it controls a wide variety of grasses, including:

- Crabgrass.
- Cheatgrass.
- Ragweed.
- Pigweed.
- Quackgrass.
- Dandelion.
- Bermuda grass.

Use higher rates for soil high in organic matter.

Bromacil works best when you apply it just before or during the weed's most active growing period. If you use it, do not use the same equipment to apply other pesticides, and don't use equipment that uses air agitation.

Trifluraline. Trifluraline (Treflan) is a toluidine compound used as a selective, preemergence herbicide. It's available as an emulsifiable concentrate with 4 pounds active ingredient per gallon or as 5 percent granuals. This slightly toxic product can be used to control many different grasses plus some broadleafs such as lambsquarters, pigweed, Russian thistle, sanbur, and others. It's applied at .5 to 1.5 lbs active ingredient per acre; lower rates are used on sandy soils.

Trifluraline works best when it's incorporated 2 to 4 inches into the soil. Rainfall isn't needed to activate it. It's very resistant to leaching, with little, if any, lateral movement in the soil.

Diquat. This is a nonvolatile, nonflammable contact compound you can use as an aquatic or general use herbicide. It controls practically all types of annual plants, but annual grasses are less susceptible than broadleaf plants. It generally acts by local absorption but may be translocated. Diquat is rapidly and completely inactivated by contact with the soil, so it doesn't cause residual buildup.

Paraquat. Paraquat is a foliage spray with rapid absorption, thus it is not affected by rain. Also, action on the plant is very rapid, since wilting may start within 30 minutes. Use of an appropriate surfactant is essential. It will control young grass, broadleaf weeds, and will kill the tops of some perennial grasses, including Kentucky bluegrass. It may be used to kill small weeds a day or two before seeding grass, and may be used in nurseries and under shade trees. It is also used to kill weeds in noncrop areas, along fence lines, railroads, and tank areas. There is some evidence that it may be used on aquatic weeds such as alligator weed and southern water grass. It is completely soluble in water, nonflammable, and virtually noncorrosive.

Paraquat has a high-oral toxicity, and you should take care to avoid contact with skin, eyes, and nose. It is toxic to wildlife, so birds and other wildlife may be harmed in treated areas. Avoid drift to valuable plants. Like Diquat, it is inactivated upon contact with the soil.

Endothall. Endothall consists of three isomers, of which the exo-cis isomer shows the greatest biological activity. Its acute oral toxicity to mammals is high; therefore, endothall must be handled with care.

Endothall is selective; but, combined with 2,4-D, it provides control of many grasses and broadleaf weeds. It breaks down rapidly in the soil so that residual toxicity is short, especially in the humid areas. It is absorbed by plant roots, but it may be translocated in some plants.

Both liquid and granular formulations are used for aquatic-weed control. A typical liquid formulation is a water solution containing 19.2 percent disodium endothall. A granular formulation contains 5 percent disodium endothall on an inert clay carrier. Potassium and amine formulations are also used for aquatic weeds. In most cases, the concentration of amine salt needed to kill the weeds is fatal to fish (amine salt is toxic to fish at 0.3 parts per million (ppm) or higher). Concentrations of 10 ppm of sodium and potassium salts are harmless to fish. Either may be fatal if swallowed, and both are irritating to skin, nose, and throat.

Both formulations are contact herbicides effective on burreed, coontail, horned pondweed, watermilfoil, and pondweeds (Potamogeton spp.). In northern areas, Pithophora, Cladophora, and Spirogyra algae appear susceptible at the 2 to 5 ppm rate. Because of endothall's short residual life, treated areas that have conditions favorable for algae development may be subject to regrowth within the season. At rates of 1 to 2 ppm of the sodium or potassium salt, there is a wide margin of safety for fish.

Exercise (423):

1. Match each herbicide in column B with the statement that best describes it in column A.

Column A

____(1) A moderately toxic, postemergence herbicide for nonselective control of vegetation. May be applied in the spring, summer, or fall.
____(2) An aquatic and general use herbicide that's nonvolatile, nonflammable, and nonselective.
____(3) This selective aquatic herbicide can be used to control many grasses and broadleafs when it's combined with 2,4-D.
____(4) A selective, preemergence herbicide for controlling several different grasses and some broadleaf plants. Works best when incorporated 2 to 4 inches into the soil.
____(5) A compound used as a preemergence and postemergence herbicide or as a nonselective soil sterilant. Applied just before or during the weed's most active growth period.
____(6) A foliage spray with rapid absorption; plant wilting may start within 30 minutes.

Column B

a. Glyphosate.
b. Bromacil.
c. Trifluraline.
d. Diquat.
e. Paraquat.
f. Endothall.

2-6. Fungicides

As the role of pest managers expands in the area of turf management, you may get involved in controlling turf diseases. This section has been added to familiarize you with some of the turf fungicides you may use for this purpose. Some of these products are carbamates; some are chlorinated hydrocarbons. Most are slightly toxic and systemic in action. All of them should be used *only* in conjunction with proper turf management practices. (You'll learn about these in detail in Volume 5, along with various diseases mentioned in this section.)

424. Outline various characteristics and uses for turf fungicides.

Benomyl. Benomyl (Benlate, Tersan 1991) is a slightly toxic carbamate compound used as a systemic foliar and soil fungicide. It is available as a dust or a 50-percent wettable powder. You can use it on a wide variety of plant diseases, including:

- Powdery mildew.
- Black rot.

- Fusarium patch.
- Brown patch.
- Dollar spot.
- Anthracnose and others.

Benomyl is not phytotoxic (toxic to higher plants) when used as directed. It has excellent residual characteristics both as a preventive and eradicant fungicide.

Chloroneb. Chloroneb (Ansi, Tersan SP) is a slightly toxic fungicide formulated as a 65-percent wettable powder. It is used as a supplemental seed treatment and preemergence fungicide for various crops. In turfgrass, it controls snow mold and pythium blight.

Chloroneb is a chlorinated hydrocarbon and you should avoid contact with skin and clothing.

Maneb. Maneb (Manzeb, Tersan LSA) is a carbamate compound used as a foliar fungicide. It's used to control leaf spots, rust, and brown rot. It is formulated as an 80-percent wettable powder and is labeled as a slightly toxic pesticide.

Thiabendazole. Thiabendazole (Arbotect S) is a systemic fungicide that provides preventive and therapeutic control of Dutch elm disease and sycamore anthracnose. It's a slightly toxic fungicide, but may irritate skin and eyes. It comes as a liquid concentrate containing 1.3 percent active ingredient and mixed with a 1:1 ratio (one part water to one part thiabendazole concentrate). This diluted mixture is then injected into the tree in various amounts, depending on the type of treatment and the size of the tree.

Bayleton. This systemic fungicide is formulated as a 25-percent wettable powder and is moderately toxic. It controls several diseases on flowers, turf, trees, and other foliage. On turf, you can use it as a preventive control of a variety of diseases. For corrective control, it is used to treat dollar spot, brown patch, copper spot, powdery mildew, red thread, and rusts.

Thiram. This chemical (Tersan 75) is an organic systemic fungicide. It can also be used as a seed treatment and as a repellent to protect shrubs and ornamentals from rabbit and deer depredation. As a turf fungicide, it gives preventive and corrective control of damping off, seedling blights, brown patch, dollar spot, snow mold, and others.

Thiram is a slightly toxic fungicide and is available as a dust, wettable powder, and a water suspension.

Exercise (424):

1. For each of the fungicides listed here, identify the characteristics specified. As an example, number one has been done for you.

(1) Benomyl

a. Type of fungicide—Systemic foliar fungicide and soil fungicide.

b. Toxicity characteristics—Slightly toxic, not toxic to higher plants.

c. Residual characteristics—Excellent, both as a preventive and eradicant fungicide.

d. Diseases controlled (list 4)—Any four of the following: powdery mildew, black rot, fusarium patch, brown patch, dollar spot, and anthracnose.

(2) Chloroneb

a. Chemical classification.

b. Turf diseases controlled.

c. Toxicity characteristic.

(3) Maneb

a. Chemical classification.

b. Turf diseases controlled.

c. Toxicity characteristic.

(4) Thiabendazole

a. Type of fungicide.

b. Diseases controlled.

c. Toxicity characteristic.

(5) Bayleton

a. Type of fungicide.

b. Recommended uses

c. Toxicity characterisuc.

(6) Thiram
  a. Recommended uses.

  b. Diseases controlled (list 3).

  c. Toxicity characteristic.

  d. Repellent uses.

2-7. Diluting Pesticides

In most cases, pesticides are received in concentrated form to reduce shipping expenses. Therefore, you as a pest manager will be required to prepare safe and effective pesticidal formulations. To do this, you must know what type of materials you can use to prepare certain products. In addition to this, you must be able to dilute pesticidal concentrates according to label instruction and calculate the correct amount of finished product to do the job according to recommendations provided on the pesticide label.

In this section we discuss identifying supplementary materials used in conjunction with pesticides, the components of common pesticide formulations, and a method for diluting pesticidal concentrates.

425. Differentiate between supplementary materials and their uses.

Supplementary Materials and Their Uses. The materials discussed in this section are those that help pesticides work more efficiently and economically by acting as solvents, emulsifiers, spreading and wetting agents, adhesives or stickers, perfumes and masking agents, synergists, and carriers or diluents. It is generally not economical to apply pesticides as technical grade material or in concentrated form. A wide variety of chemicals have been found useful in formulating sprays and dusts.

Repellents. These are substances that keep pests away from plants or animals by emitting odors that are offensive or by presenting an appearance or taste that is undesirable. Diethyl toluamide, a repellent, is applied to exposed skin surfaces and clothing to prevent attack by mosquitoes and other arthropods. Moths are repelled by clothing treated with naphthalene. Repellents do not necessarily kill arthropods, but they do protect people and materials from arthropod attack.

Attractants. These are substances that attract arthropods by sensory stimulation. They are used to lure arthropods into traps or away from certain areas. They are also used to enhance poison baits so that an arthropod will eat it. An example of attraction is the response of insects to odors from foods, opposite sex, prey, or from sites suitable for the deposit of eggs. A few attempts have been made to use the principle of attraction to induce pests to eat poison baits or to lure them into various types of traps.

Dessicants. Very finely powdered silica gels and silica aerogels have been tested for the control of cockroaches, fleas, kissing bugs, dry-wood termites, and such ectoparasites of domestic animals as ticks, lice, and mites. Silica aerogels and diatomaceous earths are also used to protect stored grains from the attacks of beetles and moths in many countries. These compounds kill arthropods by damaging the outer, waterproof layer of the arthropod exoskeleton, the epicuticle, either by absorbing the fatty or waxy material, or by abrasion. The arthropods lose liquid rapidly, sometimes becoming incapacitated in an hour's time, and die by dessication. These materials are reported to be nontoxic to human and to warm-blooded animals. Sorptive dusts are uncrystallized and it is possible that arthropods will not become resistant to them. The real problem in using this type of control is to keep the fine powder in areas where arthropods will come in contact with it.

Solvents. A solvent dissolves a pesticide so that the molecules of a pesticide are evenly dispersed throughout the resultant solution. The solvent acts both as a carrier for the pesticide and as a diluent, reducing the concentration of the insecticide to the most economical percentage. Some solvents, such as petroleum products, also add to the insect-killing powers of the formulation. Many pesticides are dissolved in solvents such as fuel oil, kerosene, or xylene in the preparation of field spray solutions or emulsifiable concentrates. The selection of a solvent depends on its ability to hold the pesticide in solution, its toxicity to animal and plant life, its odor and staining characteristics, and its fire hazard.

Two general types of solvents are commonly used: (1) volatile liquids, such as xylene, which evaporate after spraying and leave only a residual deposit of the pesticide, and (2) nonvolatile or semivolatile liquids, such as petroleum oil, which leave the surface coated with a solution of the toxicant. Fuel oil and kerosene do not dissolve the high concentrations of pesticides needed to make emulsifiable concentrates, so other compounds are often used as auxiliary solvents. The flashpoint must be considered when selecting a pesticidal solvent for fogging operations. Materials with a low flashpoint increase the fire hazard of an insecticide; therefore, solvents with flashpoints over 200° F are preferred.

Emulsifiers. An emulsifier is a surface active agent (detergent) that stabilizes a mixture of a liquid within a liquid. Milk, for example, is an emulsion with tiny globules of butterfat and other ingredients suspended in water. A technical grade insecticide may be dissolved in xylene and an emulsifier added to produce an emulsifiable concentrate of low bulk that may be stored and moved with ease, rather than storing or shipping large amounts of more dilute materials. At the time of use, the concentrate is diluted with water, the most universal and economical carrier, to produce an inexpensive and effective emulsion.

The emulsifier forms a thin film around each minute droplet of oil, resisting the tendency of the droplets to coalesce and separate into continuous layers of oil and water.

In the familiar oil-in-water insecticidal emulsions, the many finely divided oil droplets form the dispersed phase and the water comprises the continuous phase.

The early emulsifiers were soaps, but modern usage requires more effective synthetic detergents such as the Tritons, Spans, and Tweens. Substances that lower the surface tension of water tend to stabilize a water emulsion.

Spreading and wetting agents. Many of the synthetic emulsifiers and detergents are also used as wetting and spreading agents. These agents are rather difficult to define, except according to the manner in which they are used. Detergents are developed primarily for their cleaning ability. Spreading agents, such as Hercules Triton B-1956, may be added to oil larvicides to decrease the surface in which the larvae live. Wetting agents promote the formation of a continuous film of pesticide on water-repellent surfaces or increase the rate with which the pesticide soaks into or wets other materials. Sulfonated oils, the higher sodium alkyl sulfates, and other surface-active dispersants may be added to pesticidal dusts to produce wettable pesticide powders (also known as water-dispersible powders) that form suspensions when added to water.

Adhesives or stickers. Adhesives are substances added to liquid sprays to improve the adhesive quality of the insecticidal deposit, especially to avoid leaching by the rain. Protective materials such as gelatin, glue, rosin, and other gums are valuable adhesives.

Masking agents. Perfumes or masking agents are agreeable scents, like oil of wintergreen, that are added to household insecticides to mask unpleasant odors (such as those of kerosene, pyrethrum, or cyclohexanone). There are many proprietary perfumes and masking agents now available.

Synergists. Synergism (from the Greek, meaning "working together") is said to occur when two materials give greater physiological action when applied together than separately. Certain compounds added to pesticidal mixtures do increase their toxicity; therefore, the amount of the basic pesticide in the formulation may be greatly reduced. For example, the addition of the relatively inexpensive synergist piperonyl butoxide to fly and mosquito sprays makes it possible to reduce the amount of the more expensive pyrethrum insecticide and still obtain effective control with substantial savings in the final formulation. These synergists may also be used to counteract the resistance of insects to certain chemicals. A synergist apparently brings about an alteration in the insect's physiological reaction to an insecticide, making the poison more effective. A synergist applied as much as a day before the pesticide may still produce an activating effect. However, a synergist applied after the pesticide is of no value. The most practicable procedure is to mix the synergist with the insecticide; then, only one application is required.

Some of the activators, or synergists, are piperonyl butoxide, sesamex, sulfoxide, propylisome, and MGK-264.

Carriers and diluents. Most pesticidal dusts are purchased "ready for use," but may be diluted for special purposes. Some of the generally available carriers include attapulgite, bentonite, calcite, diatomite, gypsum, hydrated lime, kaolin clay, pyrophyllite, and talc. Dust carriers should be relatively low in cost, and must have greater absorptive capacity when they are used to absorb liquid pesticides such as malathion. These carriers must not produce any breakdown of the pesticidal chemical. Dusts are usually mixed in a ballmill or other type of blending machine. They must be extremely fine particles and of low density in order that they may be airborne for a considerable distance when applied.

Exercise (425):

1. Match each of the supplementary materials in column B with its purpose of use in column A. Some column B items may be used more than once.

	Column A	*Column B*
____(1)	Adhesives/stickers.	a. Peanut butter, apples, and sugar.
____(2)	Attractants.	b. Xylene, fuel oil, and kerosene.
____(3)	Carriers/diluents.	c. Oil of wintergreen and shaving lotion.
____(4)	Dessicants.	d. Bentonite, verniculite, and talc.
____(5)	Emulsifiers.	e. Gelatin and resin.
____(6)	Masking agents.	f. Silica gels.
____(7)	Repellents.	g. Naphthalene and para-dichlorobenzene.
____(8)	Solvents.	h. Synthetic detergents.
____(9)	Spreading and wetting agents.	i. Piperonyl butoxide and sesamex.
____(10)	Synergists.	

426. Identify pesticide formulations with their components.

Pesticide Formulations and Their Components. icides are produced from natural or synthetic chemicals that kill insects readily, but will not cause undue hazards to man, animals, and plants when formulated and applied correctly. Precise formulation and application are essential in all pesticidal programs. Some toxicants are applied as technical grade pesticides, such as malathion in ultralow volume (ULV) applications. Most pesticides, however, are made into proper strength dusts, granules, suspensions, solutions, or emulsions before application. Dusts are often diluted to lower concentrations with talc or pyrophyllite. Wettable powders are mixed with water to form suspensions of desired concentration. Liquid sprays are often purchased as concentrated solutions or emulsifiable concentrates. Concentrated solutions may be diluted with oils, and emulsifiable concentrates with water, to prepare field strength solutions or emulsions.

Technical grade pesticide. This is the basic toxic agent in its purest commercial form. It is rarely chemically pure. Some technical grade pesticides are liquids; others occur in solid form. Technical grade malathion is a clear, amber liquid, whereas chlorpyrifos (Dursban) is a white, granular, crystalline material. Some undiluted technical grade pesticides are used in ultralow volume space applications. However, in most cases, technical grade pesticides are mixed with a carrier before use, forming a dust, granule, suspension, solution, or emulsion, as shown in figures 2-1

TECHNICAL GRADE PESTICIDE	+ INERT CARRIER	= INSECTICIDAL DUST or GRANULAR PESTICIDE		
	+ INERT CARRIER	+ WETTING AGENT	= WETTABLE (Dispersible) POWER	
	· INERT CARRIER	+ WETTING AGENT	+ WATER	SUSPENSION

CFN-006

Figure 2-1. Components of basically dry formulations.

and 2-2. Refer to these figures as we discuss the following liquid and dry formulation.

Pesticidal dust. A pesticidal dust in its simplest form is merely finely pulverized insecticide (such as sulfur dust used to repel chiggers). Most pesticidal dusts, however, consist of the technical grade pesticide and an inert carrier such as talc or pyrophyllite with each minute particle of the carrier coated with the chemical toxic to insects. Dusts may be applied by hand, by simple dust guns, by large power dusters, or by airplanes. These materials are usually low in cost, easy to apply, nonstaining, and nontoxic to vegetation.

Pesticides in dust form are generally absorbed through the skin, but may be dangerous if inhaled into the respiratory tract. Dusts do not adhere well to vertical surfaces and are easily removed by rain and wind. They are unsightly in the home and have been replaced, by the most part, by sprays and aerosols.

Pesticidal granule. These are basically the same as the dust formulation shown in figure 2-1, except the carrier particles are larger. Vermiculite is used as the inert carrier instead of talc or pyrophyllite in most granular formulations. Since granules are heavier than dusts, they do not adhere to leaves; therefore, they will penetrate dense foliage, which are real advantages when you want the pesticide to reach the water surface for mosquito control in vegetated swamps, or to get to the ground surface through trees and shrubs for chigger or fire ant control. Other advantages of using granules are that they provide longer lasting effects and they are not as apt to drift away from the target areas.

Wettable powder. This formulation consists of the technical grade pesticide, an inert carrier, and a wetting agent (usually a synthetic detergent) that helps mix it with water. You can see this in figure 2-1. Many wettable powders have an anticaking agent that prevents lumping while in storage, and a dispersant that helps keep the particles in suspensions from settling out too quickly. Wettable powders may have a technical grade chemical content ranging from 15 to 90 percent. The insecticide is coated (absorbed) onto a fine inert dust, such as talc or pyrophyllite. Wettable powders have advantages over other concentrates. They do not require the addition of solvents, which can cause injury to plants; they lack a solvent odor; and they do not have a tendency to irritate the skin of the operators or to be absorbed through the skin.

Suspension. This formulation is obtained when wettable powders are added to water. A great advantage of a suspension is the tendency of the pesticide to be deposited on the porous surface of the structure sprayed. When porous materials such as concrete, plaster, adobe, or unpainted wood are sprayed with a suspension, the water penetrates, leaving the carrier and the maximum amount of the pesticide on the surface available to kill pests. By contrast, when solutions or emulsions are sprayed, they penetrate porous materials so that less of the pesticide remains on the surface. When using suspensions, be sure to agitate them continuously to prevent settling of the solid pesticide particles.

Suspensions tend to clog the strainers and nozzles of

TECHNICAL GRADE PESTICIDE	+ SOLVENT	= SOLUTION		
	+ SOLVENT	+ EMULSIFIER	= EMULSIFIABLE CONCENTRATE	
	+ SOLVENT	+ EMULSIFIER	+ WATER	= EMULSION

Figure 2-2. Components of liquid formulations.

sprayers, especially when the wettable powder is stored for long periods in humid areas, which causes a clumping of particles, or when it is applied in high concentration. Trouble is experienced when using some municipal water supplies. Some waters produce foaming while others require the addition of more wetting agent.

Solution. This formulation consists of the technical grade pesticide dissolved in a solvent such as kerosene, diesel oil, or xylene. Solutions are available as ready-to-use formulations (e.g., ordinary household fly and mosquito sprays with a low percentage of pesticide) and as solution concentrates. Solution concentrates contain a high percentage of insecticide and must ordinarily be diluted in oil, water, or other suitable solvent and diluent indicated on the label before use. Some concentrates are used without dilution in ultralow volume (ULV) applications. In residual spraying, the solvent evaporates from the treated surfaces, leaving a deposit of the pesticide. DDT and some other insecticides cause a "blooming" of fine crystals that are readily picked up by the feet and bodies of insects. Some other pesticides, such as chlordane and malathion, do not crystallize, but form a thin film of insecticide on treated surfaces.

Solution concentrates have the advantage of low volume, which reduces bulk, weight, and shipment costs. They are diluted at the destination, often in the field, making their portability a real advantage. The diluted mixture is called a *field strength solution.* Oil solutions are used outdoors extensively in fog applicators, but aren't used for most dilute spray applications because of their toxicity to plants (you're using them for vegetation control).

Emulsifiable concentrate. Emulsifiable concentrates consist of the technical grade pesticide, a solvent, and an emulsifying agent, usually a synthetic detergent. Emulsifiable concentrates have the same advantages as the solution concentrates, plus the benefits of a low cost and a readily available diluent water.

Emulsion. When the emulsifiable concentrate is added to water and agitated, an emulsion is formed, and the concentration of pesticide is reduced to the desired field strength. Pesticidal solutions and emulsifiable concentrates usually are clear, whereas emulsions have an appearance similar to milk, the most common natural emulsion. Unlike solutions, most emulsions require periodic agitation to prevent the concentrate from separating out of the water. Emulsions or solutions, diluted to field strength, are called finished sprays.

Emulsions are widely used for the residual treatment of solid surfaces. Pests that rest on these treated surfaces are killed by the residue of pesticide. Some emulsions remain effective for a longer time on masonite and bare or painted wood than on glazed tile or shiny metal. This is an important consideration in determining the time interval between residual applications. Emulsions with a high percentage of the pesticide (and solvent) may burn plants. Therefore, any emulsions sprayed on plants should have a low percentage of pesticide and solvent and a high percentage of water. Mosquito larvicidal treatments with emulsions are usually confined to shallow bodies of water and to treatment of water containers, where excessive dilution will not take place. Oil solutions are more suitable for deep bodies of water. Mosquito larvicidal treatments with emulsions are usually in a thin film that kills the larvae when they come to the sprayed surface to breathe atmospheric air. Emulsions may damage aluminum, varnish, and painted surfaces, due to the action of solvents such as xylene. Emulsions are often corrosive to metal sprayers and their fittings. Sprayers used to dispense emulsions should be made of stainless steel, aluminum, fiberglass, or other noncorrosive materials. After use, the sprayers are easily cleaned by a water rinse.

Invert emulsion. These formulations are water-in-oil mixtures in which every droplet is surrounded by oil instead of water. This results in a viscous material that is difficult to apply but is less likely to drift. This type of formulation is rarely used in the Air Force, but it does have certain merits in herbicidal applications.

Exercise (426):

1. Match the formulation components in column A with the appropriate pesticidal formulation in column B.

Column A	*Column B*
____(1) Technical grade pesticide and vermiculite.	a. Emulsifiable concentrates.
____(2) Technical grade pesticide, talc, and synthetic detergent.	b. Invert emulsions.
____(3) Technical grade pesticide, xylene, synthetic detergent, and water.	c. Pesticidal dusts.
____(4) Purest commercial toxicant.	d. Emulsions.
____(5) Technical grade pesticide, pyrophyllite, synthetic detergent, and water.	e. Granules.
____(6) Technical grade pesticide and kerosene.	f. Solutions.
____(7) Technical grade insecticide, kerosene, and water.	g. Suspensions.
____(8) Technical grade pesticide and pyrophyllite.	h. Technical grade pesticide.
____(9) Technical grade pesticide, xylene, and synthetic detergent.	i. Wettable powders.

427. Solve given pesticide dilution problems based on area size.

Determining Pesticide Amounts by Area. In recent years, EPA label requirements have made it much easier for you to quickly and accurately dilute and apply pesticides. Specific instructions for preparing diluted products are a part of every label. If you have some chemicals that are so old that they don't have these instructions, or the label is unreadable, you can't legally use them. Hence, the purpose of this lesson is to show you—in one quick, easy operation—how to determine how much pesticide you need to complete a given area. It doesn't matter if you're using liquids, solids, or both; the formula is the same, and it has only four steps.

Step 1. Find the product rate on the label. An example of this is "20 pounds per acre." When you've found this, you're done with step 1.

Step 2. Find out the size of the area you have to treat. The industrial engineering section in CE can tell you this for large outdoor areas or individual buildings. If you want to figure this out for yourself, refer to table 2-1. For example, if you have to treat an area that measures 400 by 750 feet, then 400 $\times$ 750 = 300,000 square feet you must treat.

TABLE 2-1

CALCULATIONS

1. Conversions of units of measures:
   a. To convert square yards to square feet multiply by "9".
   b. To convert square feet to square yards divide by "9".
   c. To convert the area to be treated to match the application units on the product label, divide the application units (5a) into the total area (5b). This gives the area in BLOCK units.
   d. To convert acres to square feet multiply by 43,560.
   e. To convert square feet to acres multiply by .000023, or multiply by 23 and move the decimal to the left six places in your answer.
   f. Common conversion equivalents:
      1 oz. = 30 grams
      1 fl. oz. = 30 milliliters
      1 lb. = 16 ounces
      1 gal = 128 fluid ounces
      1 qt. = 32 fluid ounces
      1 Kgr. = 2.2 pounds = 1000 grams
      1 mi. = 5,380 linear feet = 1,760 linear yards
      1 Ac. = 43,560 square feet
      1 cup = 8 fluid ounces = 16 Tablespoons
      1 dry cup = 4 ounces
2. Area calculations:
   a. Length X Width = Rectangle
   b. (3.14) X Radius ^{2} = Circle
   c. 1/2 Base X Point Height = Triangle
3. Perimeter measurement:
   a. (Length + Width) X 2 = Rectangle
   b. (3.14) X Radius X 2 = Circle
   c. Sum of all the sides = Triangle
4. Volume calculations:
   a. Length X Width X Depth = Volume
   b. Surface Acres (L X W) X Average Depth in Feet = Acre/Ft.
5. Computing total product:
   a. Find product rate on the label
   b. Find area
   c. Convert area units in "b" to match area units on product label (follow "1c").
   d. Multiply "C" times "A" = Total product
6. Computing total active ingredient (A.I.) for AF Form 290:
   a. Compute total product
   b. Use formula #1 when computing pounds A.I. for dry chemicals; use formula #2 when computing pounds A.I. for liquid chemicals.

      Formula #1 - Dry

      $$\text{Total produce} \times \frac{\%\text{A.I.}}{100} = \text{Pounds A.I.}$$

      Formula #2 - Liquid

      Total produce X lbs. A.I. or A.E. per gal. = Pounds A.I.

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Step 3. Convert the area units in step 2 to match the area unit in step 1. Look back and you'll see that in step 2, the unit was square feet—in step 1, acres. Now refer to table 2-1 and use the formula for converting square feet to acres. This is how the above problem would work out:

300,000 sq. ft. × 23 = 6,900,000.

Move the decimal point over 6 places to get 6.9 acres.

There is one more step sometimes involved here. If, for example, you must apply 1 gallon of a product to each 10 acres and you have 50 acres to treat, you'd have to figure out how many "groups of 10 acres" you have. To do this, simply divide the unit area into the total size of the area to be treated:

50 ÷ 10 = 5 "groups of 10 acres."

Step 4. Multiply the answers in steps 1 and 3. For the above problem, it would work out like this:

20 lbs/acre × 6.9 acres = *138 pounds of concentrate.*

Refer to the following case situations to see how this formula works for other problems.

Case Situation #1: You're going to apply Tebuthiuron herbicide to a field at the rate of 2 pounds per acre. The area is 500 by 3,500 feet.

- Step 1. The product rate is 2 pounds per acre.
- Step 2. The area size is 500 by 3,500 feet.
- Step 3. Convert the area units in step 2 to match the area unit in step 1.

Since the product refers to acres, you must first determine the total number of *square feet* and then convert it to acres:

500′ × 3,500′ = 1,750,000 square feet.

Then:

1,750,000 × 23 = 40,250,000. After moving the decimal point six places to the left, you get 40.25 acres you'll treat.

Step 4. Multiply the answers in steps 1 and 3. Since you have 40.25 acres and will apply 2 pounds per acre, then:

40.25 × 2 = *80.5 pounds of product needed.*

Case Situation #2. You must apply Maneb fungicide to a yard measuring 110′ by 40′ in the front and back and 30′ by 20′ on each side. Label instructions say to apply the concentrate at 3 ounces per 1,000 square feet.

- Step 1. The product rate is 3 ounces per 1,000 square feet.
- Step 2. You must figure the size in square feet for 4 yard sections, the front, back, and 2 sides:

a.	110′ × 40′ × 2 sections =	8,800 square feet
b.	30′ × 20′ × 2 sections =	1,200 square feet
	Total:	10,000 square feet

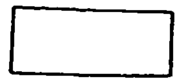
- Step 3. Both units in steps 1 and 2 are in square feet, but you must find out how many "groups of 1,000" you have:

10,000 ÷ 1,000 = 10 "groups of 1,000"

- Step 4. Multiply the answers in steps 1 and 3:

302 × 10 = 30 ounces of concentrate needed.

By now you should understand the formula. The following exercises give you a chance to test your skills.



RECTANGLE:

Area - L X W Perimeter = (L + W) X 2

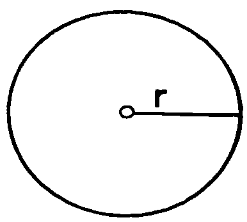
Example: Find area of rectangle with length of 18 ft and width of 12 ft

Area = L X W
= 18 X 12
= 216 sq ft

Example: Find the perimeter of the same rectangle.

Perimeter = (L + W) X 2
= (18 + 12) X 2
= (30) X 2
= 60 ft

Remember, a square is a rectangle where the length and width are the same.



CIRCLE:

Area = π X r^2 (r x r) where
= 3.14

Example: Find area of circle with radius of 10 feet.

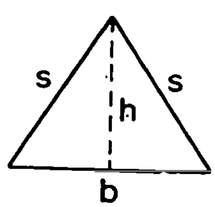
Area = π X 10 X 10
= 3.14 X 10 X 10
= 3.14 X 100
= 314 square feet

Circumference = π X r X 2

Example: Find circumference of the above circle.

Circumference = π X r X 2
= 3.14 X 10 X 2
= 3.14 X 20
= 62.8 feet

Remember, the diameter of a circle is twice the length of the radius.



TRIANGLE:

Area = 1/2 X b X h
Perimeter = b + s + s

Example: Find area of a triangle with base of 46 feet and height of 20 feet.

Area = 1/2 X 46 X 20
= 1/2 X 920
= 460 sq ft.

Example: Find perimeter of triangle with base of 46 feet and sides of 42 feet.

Perimeter = b + s + s
= 46 + 42 + 42
= 130 feet

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Exercises (427):

1. How many gallons of a concentrate containing 6 pounds per gallon would you use to treat 20 acres of land if the rate of application on the label is 1 gallon concentrate per 100 gallons of water applied to 5 acres?

2. A glyphosate label says to apply 1 quart of concentrate per acre to control annual weeds. You'll apply this along a perimeter fence that is 2.5 miles long, spraying 1 foot out from each side of the fence. How many quarts of concentrate will you need?

Pesticide Dispersal Equipment

SINCE 1940, insect control has been revolutionized by two outstanding developments; first, the production of phenomenally effective pesticides such as the chlorinated hydrocarbons, organophosphates, and carbamates; and second, the parallel development of new types of pesticide application equipment. Ultralow volume insecticide generators, for example, became available only a few years ago and have a considerable impact on the efficiency and effectiveness of many pest management programs.

Hundreds of different kinds of sprayers, dusters, aerosol generators, and other devices have been designed, manufactured, and marketed. Your selection of the best equipment for a pest management program is of great importance since pesticide application problems may seriously affect a program. Safely and efficiently applying pesticides to control insects and other arthropods requires a knowledge of pesticide application equipment and training in the method of applying these pesticides.

This chapter identifies and describes the uses of equipment commonly used by Air Force pest managers; outlines operational and maintenance responsibilities and procedures; and describes the methods used for regulating dispersal rates and calibrating pesticide dispersal equipment.

3-1. Types and Uses of Equipment

You can use some equipment items in several different types of pest management programs. However, there is usually one piece of equipment that is safer and more efficient for a particular program than other types of equipment. The purpose of this section is to give you a basis for selecting pesticide dispersal equipment and help you identify some of the types and uses of pesticide dispersal equipment commonly used in Air Force pest management programs.

428. Identify factors involved in selecting pest management equipment.

Basis for Selecting Equipment. Before the actual selection of pest management equipment, you must consider all the factors outlined in Volume 2 and Chapter 2 of this volume.

After reviewing these lessons, you can see that there are many factors to consider in selecting equipment; and yet, there are more.

The remaining factors that are used as basis for selecting equipment are dependent upon:

- Availability.
- Effectiveness.
- Safeness.
- Cost.
- Durability of the equipment.

Availability. When selecting equipment to be used for a particular pest management situation, base your selection on the equipment that is presently available, providing it will do the job effectively and safely. However, there may be some pest management situations that will require special equipment. In this case, check the table of allowance (TA 489, Part C) to see if the equipment you want is listed and authorized for your section. Whether the equipment is authorized or not, you must prepare and submit sufficient justification as to why this equipment is required.

Effectiveness. This is one of the primary factors you must consider when you select equipment. The equipment you choose must be the most effective for doing the job.

In the following lesson, you'll learn more about equipment effectiveness in regards to the pesticide particle size it creates.

Safety. This the most important factor for you to consider when selecting shop equipment. Regardless of how effective the equipment might be for a pest management situation, if it is unsafe, you can't use it.

Cost. With today's austere operational budget, it is essential that you strongly consider equipment costs. Ideally the equipment you select should be low in initial cost and inexpensive to maintain.

Durability. Consider durability when you contemplate the total cost of the equipment. The item may have a low purchase price, which would be low in cost initially, but if it isn't durable, the overall cost may be great due to maintenance and, possibly, replacement costs.

Remember, the effective use of pesticides depends upon your having efficient and durable equipment. When you select equipment, do it on the basis of its being the safest and most effective for the work you do.

Exercises (428):

1. Why is the identification of the type of pest important in selecting control equipment?

2. The equipment you select must be the most ________ for doing the job.

3. Your selection should be based on that which is presently ________ and provided that it will do the job ________ and ________.

4. The most important factor to consider in selecting equipment is that the equipment must be ________.

5. The equipment you select should be low in ________ initially and ________ to maintain.

6. If the equipment is not ________, the overall cost may be great.

429. Identify pesticide particle sizes with the type of application each describes, and specify facts about how pesticide particle size affects performance.

Pesticide Application and Particle Size. The effectiveness of an equipment item and the pesticide it disperses is greatly influenced by the size of the droplets of pesticide generated. For example, in residual applications, a spray is desirable in order to wet the surface and leave a long-lasting deposit. In space spraying, where you want to kill mosquitoes and flies on the wing, use a mist or fog so the pesticide will remain suspended in the air for a long time to kill the insects exposed to the droplets. Pesticides may be applied as liquid or dusts.

Liquid sprays. Liquid sprays range from rainlike drops delivered by orchard sprayers to mists and fogs produced by mist, fog, or aerosol generators. It is impossible to break up a liquid into entirely uniform droplets, although the range of droplet size may be considerably restricted. There are always some fine droplets among the others, even when the spray is rather coarse. The usual practice is to refer to the mass median diameter (MMD) of the spray, which is the droplet diameter that divides the volume or mass of the spray into two equal portions, respectively, more finely and more coarsely atomized. The unit of measurement is the micron, 1/1,000 of a millimeter or about 1/25,000 of an inch. The average diameter of a human hair is about 100 microns.

Coarse sprays contain droplets 400 microns or more in diameter, which are produced with coarse disc nozzles or solid-stream gun nozzles.

Fine sprays have droplets ranging from 100 to 400 microns, produced with high pressure through hollowcone and fan-spray nozzles.

Mists range in droplet size from 50 to 100 microns in diameter. They are produced by high-pressure pumps, high-speed mechanical rotors, and atomizers.

Aerosols, smokes, and fogs. Aerosols, smokes, and fogs may be defined as assemblages of solid particles or liquid droplets suspended in air and ranging in size from 0.1 to 50 microns. Pesticidal aerosols and fogs may be produced by spraying insecticides into a blast of hot air as with a thermal aerosol generator, or by mixing them with a liquified gas, which is then released through small orifices, as with the household "bug bomb." They can also be produced by atomization from very fine nozzles, or by being thrown off the rim of high-speed rotors.

Fumigants. This includes fumes, vapors, and gases and consists of particles in the range of 0.001 to 0.1 microns in diameter. These are common in the release of fumigant compounds within the atmosphere.

Dusts and granules. Pesticidal dusts occur in three sizes:
- Coarse dusts have a particle size about 175 microns or larger, which include granules.
- Medium dusts range from 45 to 175 microns.
- Fine dusts have a particle size of 44 microns or less.

Fine dust particles will pass through a 325-mesh screen; i.e., one with 325 wires to the inch. A coarse dust is used where excessive drift must be avoided, as in aerial application.

During the past few years, increasing concern has been expressed about the effects of pesticides on nontarget organisms, particularly from the buildup of pesticides in the environment following repeated applications. Therefore, there has been great interest in recent research indicating that very effective control of insects could be obtained by dispensing very small amounts of pesticide (such as 0.5 ounce of naled or 3 ounces of malathion per acre) in the form of millions of tiny droplets evenly dispersed over large areas.

Today we know that the effectiveness of a pesticide increases with an increase of its exposed surface. For droplets of different diameters, the volumes are to each other as the cubes of the diameters, while the surfaces are to each other as the squares of the diameters. Thus, for equal volumes of one aerosol dispersed as droplets of 50 microns in diameter and another as droplets of 5 microns in diameter, there would be $10 \times 10 \times 10$, or 1,000 times, as many of the smaller droplets, while the surface area of the smaller droplets would be 10×10, or 100 times, as great as the total surface area of the larger droplets.

Exercises (429):

1. Match each pesticide particle size range in column B with the type of application in column A.

Column A	*Column B*
____(1.) Aerosols and fogs.	a. 0.001 to 0.1.
____(2.) Fine sprays.	b. 0.1 to 50.
____(3.) Fumigants.	c. 50 to 100.
____(4.) Medium dusts.	d. 45 to 75.
____(5.) Mists.	e. 100 to 400.

2. The average diameter of a human hair is about ________ microns.
3. The effectiveness of a pesticide is greatly influenced by the ________ of the particles when applied.
4. If you were applying pesticide particles that range in size from 0.1 to 50 microns as opposed to particles that range in size from 50 to 100 microns, the effectiveness of the pesticide would ________.

430. Differentiate between listed items of manual spray applicators and their described uses.

Types and Uses of Manual Sprayers. Now that you know the factors you must consider when selecting equipment, you must know the types and uses of manual sprayers that you can use to carry out safe and effective pest management programs.

Generally speaking, there are three manually operated sprayers that are commonly used in Air Force pest management programs: compressed air sprayers, aerosol dispensers, and pressurized cylinders.

Compressed air sprayers. This item of equipment (fig. 3-1) is the mainstay of most pest management programs. It is used particularly to apply residual sprays for mosquito, fly, and flea control; larvicides for mosquito and fly control; spot treatments and crack crevice treatments for cockroaches, ants, ticks, and many other types of househould insects; and small area treatments outside to control fleas, ticks, and other pest species. (NOTE: Be cautious in selecting high-quality equipment.)

Aerosol dispensers. The aerosol dispenser "bug bomb" is more widely used by the general public than any other type of pesticide applicator.

This is a small low-pressure, disposable dispenser (fig. 3-2) that is used in the average household for flying insect control. Depending on the insecticidal formulation, it may also be used to control crawling insects. You will probably frequently hear of people who use the wrong type of product for their purposes as a result of this fact.

For pest managers, aerosol dispensers are often used as inspection tools to flush indoor pests from cracks, crevices, and other harborage areas.

One of the most common types of aerosol dispensers for flies and mosquitoes contains pyrethrum, allethrin, or synthetic pyrethrum for quick knockdown, a synergist such as piperonyl butoxide, and a synthetic insecticide such as methoxychlor for the kill. Other aerosol dispensers contain different chemicals to kill cockroaches, ants, and other household insects. One bomb, manufactured to throw a fine stream for 10 to 20 feet, is used to spray nests of stinging insects such as wasps and hornets from a safe distance.

Pressurized cylinders. Another type of spray system you can use is the pressurized cylinder (fig. 3-3). Tnis is especially designed for ULV application of liquid pesticides The cylinder, typically having a 15-pound capacity, is pressurized as is the more typical aerosol dispenser; however, it differs in that the only solvent in the tank is the propellent gas (which together with the pesticide) is the entire contents of the tank. The cylinder is equipped with an extension hose and tube you can use to inject the fine pesticide particles into cracks and wall voids.

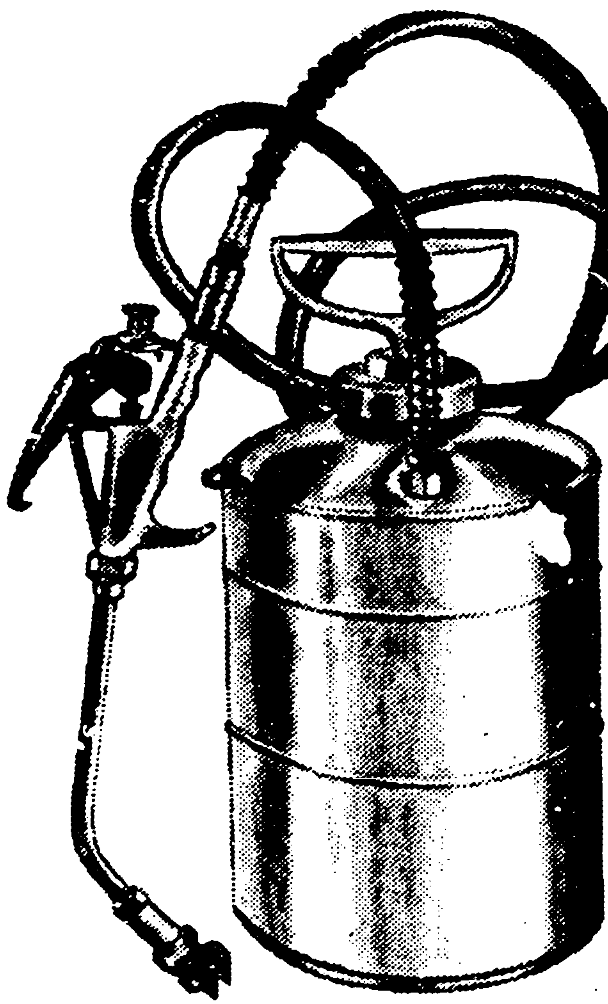

Figure 3-1. Compressed air sprayer.

Figure 3-2. Aerosol dispenser.

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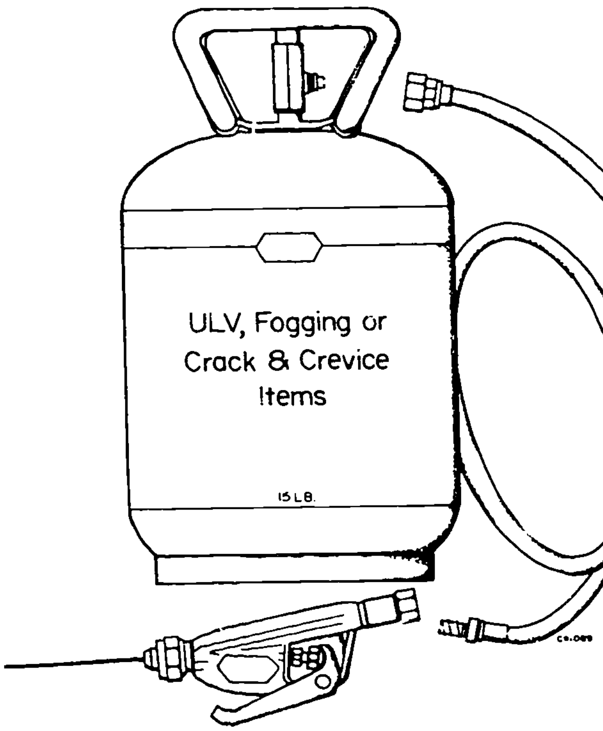


Figure 3-3. Pressurized cylinder.

Exercise (430):

1. Match the equipment uses in column A with the applicator you should use in column B. Some column B items may be used more than once.

Column A	*Column B*
____ (1) Most frequently used for space applications in homes and offices.	a. Compressed air sprayer.
____ (2) Used to inject pesticide particles into cracks and wall voids.	b. Aerosol dispenser.
____ (3) Used to apply residual sprays in buildings and to small outside areas to control crawling insects.	c. Pressurized cylinder.
____ (4) Used as an inspection tool for flushing insects from cracks and crevices.	

431. Identify types of manual dusters with their described uses.

Types and Uses of Manual Dusters. There are several types and variations of manual dusters; eight will be described in this lesson. You must be able to recognize these items of equipment and know their uses since they are frequently discussed in day-to-day Air Force pest management programs and literature.

Hand shaker. The hand shaker (fig. 3-4) is ideal for placing pesticides on high or hard-to-reach areas. You can use a large shaker which holds 9 pounds of insecticidal dust to dust exposed rat runs along the base of walls and foundations to kill rat ectoparasites like oriental rat fleas which transmits several disease organism. Small 1- or 2-pound shakers may be used for dusting rat runs you can't get with the large shaker.

Hand bellows. This duster (fig. 3-5) is used where careful placement and neatness are essential, dusting crevices where cockroaches and silverfish hide, or placing a small amount of anticoagulant dust in voids for mouse control.

Bulb duster. The bulb duster (fig. 3-6) is also designed for careful indoor dusting operations. Its uses are basically the same as the hand bellows, but some operators prefer the bulb duster over the hand bellows.

Plunger duster. The plunger duster (fig. 3-7) is suitable for applying patches of malathion and carbaryl dust outdoors or in outbuildings for rodent ectoparasite control. You may also use this duster to apply pesticides to control many other types of pests such as chiggers, mites and ticks.

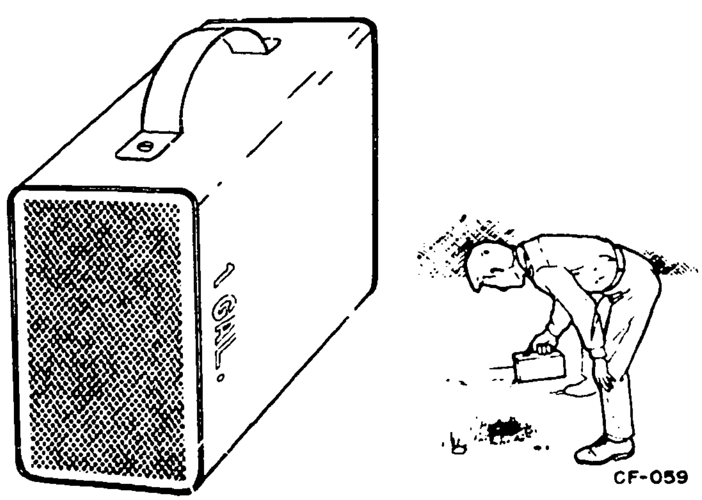


Figure 3-4. Hand shaker.

Figure 3-5. Hand bellows.

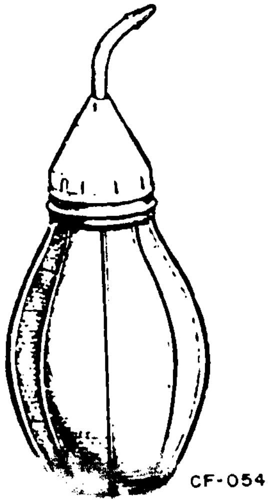


Figure 3-6. Bulb duster.

Figure 3-7. Plunger duster.

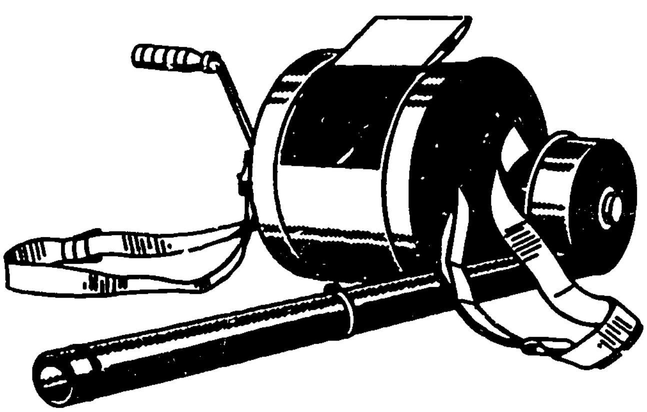


Figure 3-8. Rotary duster.

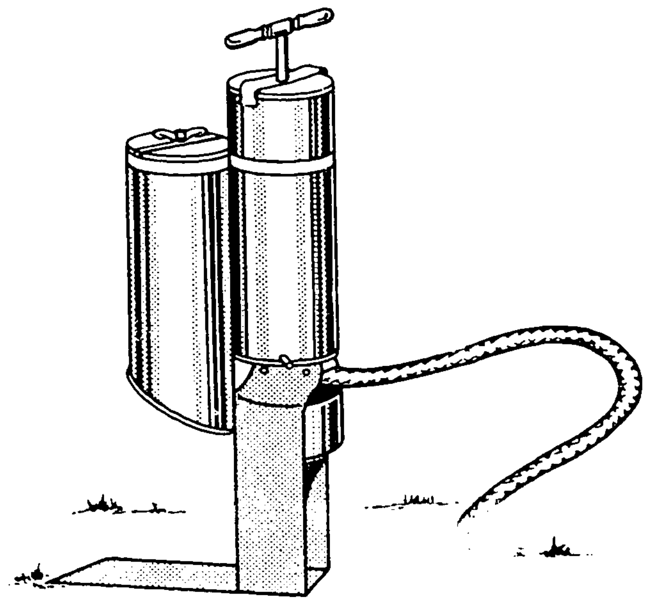


Figure 3-9. Foot pump duster.

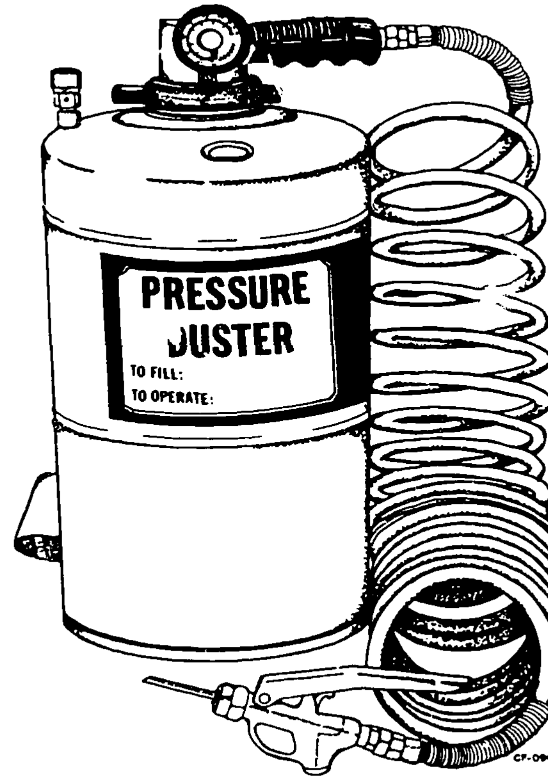


Figure 3-10. Compressed air duster.

Rotary duster. The rotary duster (fig. 3-8) is used effectively for applying pesticides for controlling fleas, ticks, and other ectoparasites around buildings, and for applying dusts as mosquito larvicides. Most rotary hand dusters are sold with a fan-shaped tip to give a broad band of dust for mosquito larviciding or for area treatment in flea, tick, or chigger control.

Foot pump duster. The foot pump duster (fig. 3-9) is designed to apply calcium cyanide to rat burrows to kill rats and their ectoparasites. It is also useful for applying dust to rodent burrows and other inclosed harborages.

Compressed-air duster. The compressed-air duster (fig. 3-10) is similar to the compressed-air sprayer, except it is adapted for applying dusts. However, instead of having a hand pump attached, you must charge the tank at a source of compressed air after you've put dust in the tank. You can then apply dust by compressing a lever mounted over the tank. This duster discharges large amounts of dust very rapidly and is mainly used to dust large confined areas such as crawl spaces under buildings.

Granular spreader. There are two basic types of spreaders commonly used in Air Force pest management programs; one is known as the granular spreader (fig. 3-11), and the other is a push-type fertilizer spreader. Both types can be used effectively in applying pesticide granules over small outdoor areas to control many insect larvae and pests of vegetation.

Figure 3-11. Granular spreader.

Exercise (431):

1. Match the use of dusters in column A with the type of manual dusters in column B.

Column A	*Column B*
____(1) Used effectively in controlling fleas and ticks around buildings and applying larvicides.	a. Hand shakers.
____(2) Ideal for placing pesticides on high or hard-to-reach areas.	b. Hand bellows.
____(3) Used outdoors to distribute pesticides to control insect larvae and pest vegetation.	c. Bulb dusters.
____(4) Used where careful placement and neatness are essential.	d. Plunger dusters.
____(5) Discharges large amounts of dust very rapidly.	e. Rotary dusters.
____(6) Used to apply calcium cyanide to rat burrows.	f. Foot pump dusters.
____(7) Suitable for applying patches of malathion and carbaryl dust outdoors or in outbuildings.	g. Compressed-air duster.
____(8) Designed for careful indoor dusting operation.	h. Granular spreaders.

432. Identify items of portable powered equipment with their recommended uses and characteristics.

Types and Uses of Portable Powered Equipment. Portable powered equipment has improved pest management programs tremendously. It gives you access to areas you couldn't otherwise reach with larger equipment items and at the same time, reduces time requirements for treatment. You'll learn about these items of equipment, along with their common uses, in this lesson. For text purposes, the term "portable" applies to items of equipment that can be carried easily from one place to another by one or two people.

Backpack mist-dust blower. The backpack mist-dust blower (fig. 3-12) is very light in weight and one person can carry it. You can use most models to apply liquids, dusts, or granules. This item of equipment is very useful in applying pesticides to small outdoor areas and areas you can't reach with a larger mist-dust blower. This equipment can be used to apply residuals to trees, shrubs, and grasses for controlling pests of vegetation, ants, earwigs, and ectoparasites such as fleas, lice, ticks, and mites. The backpack mist-dust blower is also used in larviciding programs for mosquitoes, flies, and beetles. It can also be used to treat exterior surfaces of buildings to control flying insects and spiders.

Hand-carried ultralow volume (ULV) generator. The hand-carried ultralow volume generator (fig. 3-13) is primarily designed to disperse technical grade or very highly concentrated pesticide formulations. You can also use it for space and residual treatments of indoor and small outdoor areas. Its principal use outdoors is for mosquito adulticiding programs and its principal use indoors is for controlling household pests.

High-pressure pesticide sprayer. This portable unit (fig. 3-14) is designed to precisely mix a pesticide concentrate with water as you work. This eliminates the need for a large, cumbersome spray tank, and also insures that you use only what you need for any given job. It also saves you the time and trouble of mixing liquid pesticides with water before you go on a job. A typical unit weighs 54 pounds, has a ½-

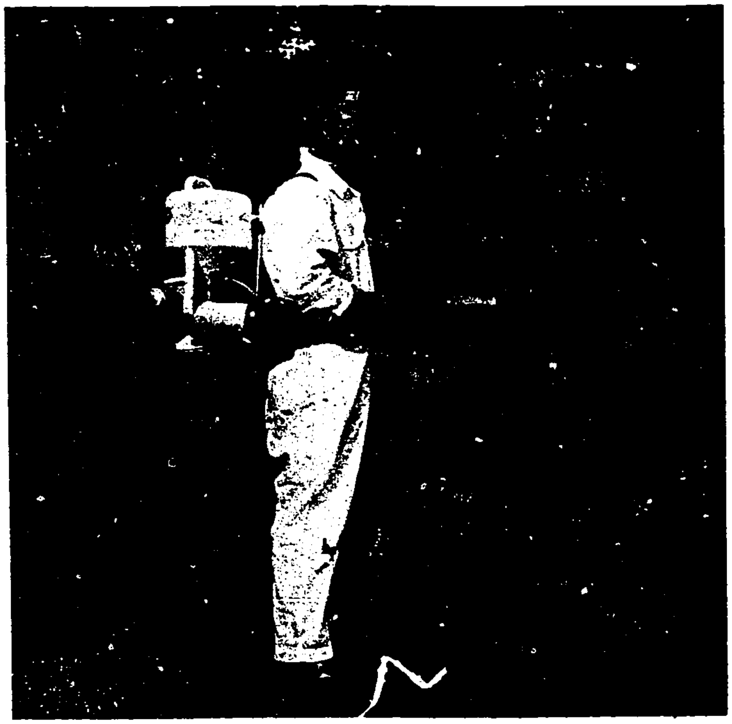


Figure 3-12. Backpack mist-dust blower.

horsepower electric motor, which operates a 3-gallon-per-minute capacity pump, connectors for a garden hose and pesticide tank, and various dials and gauges for adjusting the sprayer. To use it, you need a separate grounded power source, and a water source. Around buildings, this can be a standard water spigot since the sprayer has built-in backflow preventors to keep pesticide from entering a main water source.

This sprayer injects emulsifiable concentrate pesticide directly into a high-pressure waterflow. This lets you switch quickly from one pesticide to another and still comply with EPA regulations regarding professional pesticide applications. It also makes it easy for you to keep accurate records of how much chemical you use for each job. The injection rate is adjustable from OFF to 6.76 ounces of concentrate per gallon

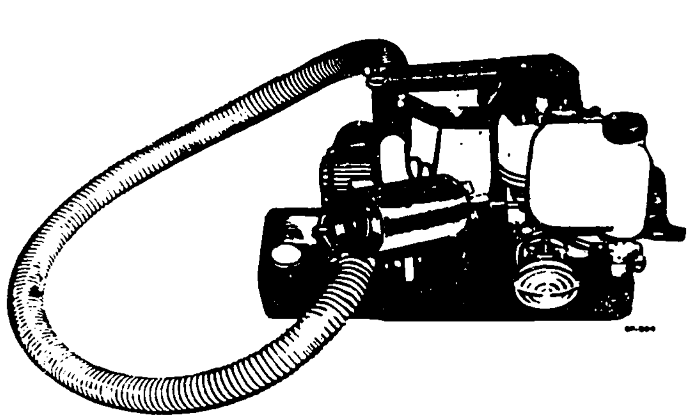


Figure 3-13. Hand-carried ULV generator.

of water. As a result, you must use pesticides which, when properly diluted for the job you're doing, do not exceed the 6.76-oz/gallon limit. For example, if you wanted to control lawn pests with an insecticide that called for dilution at 8 oz/gal, you'd have to use a different type of sprayer. However, if the insecticide is diluted at 6 oz/gallon, then you could use this sprayer.

You can use the sprayer in any outdoor situation where you have access to a water and electricity source. Attachments are available that make it useful for lawn applications and all types of termite treatment work.

Frame-mounted hydraulic sprayer. This unit (fig. 3-15) is designed to disperse emulsion and solution formulations as sprays, but it isn't efficient for dispersing suspension formulations since it doesn't have an adequate agitator for suspensions. Since this sprayer is operated by a gasoline engine, it's suitable for doing the same jobs as the high-pressure pesticide sprayer, but in areas where there is no electrical source. Use it for soil-poisoning operations to control termites; to apply residuals to trees, shrubs, and grasses to control pests of vegetation and ectoparasites; to apply residuals to exterior surfaces of buildings and beneath them to control disease vectors and venomous arthropods; and to apply herbicides and larvicides to soil and water areas to control beetle, fly, and mosquito larvae.

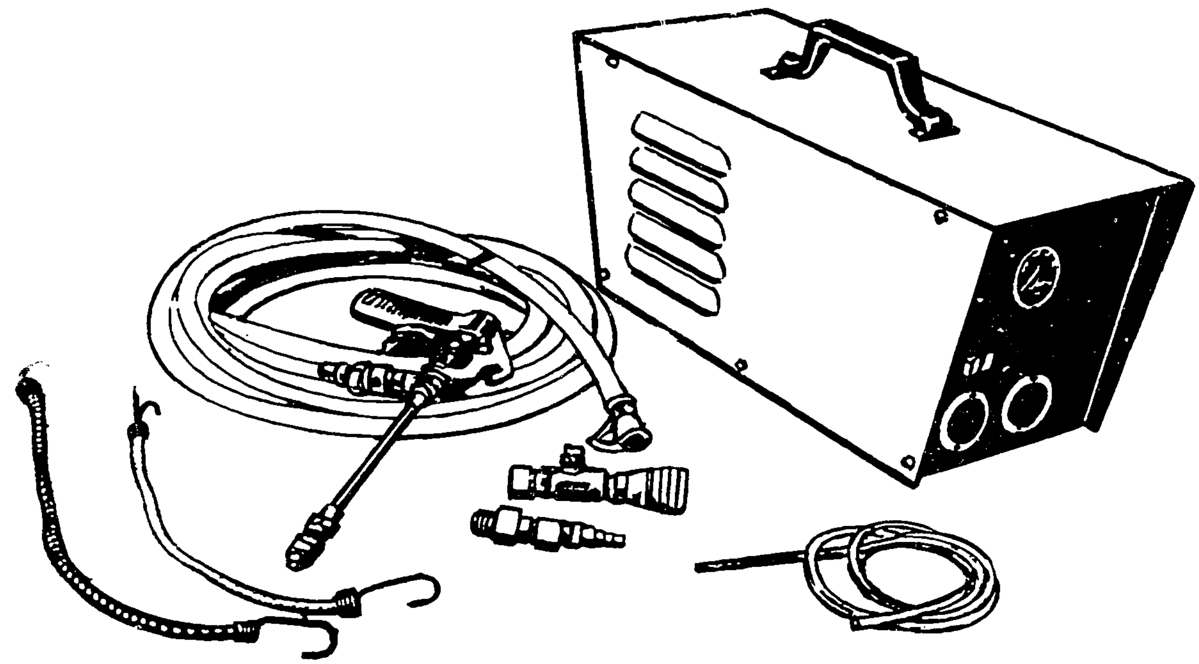
Exercises (432):

1. Match the types of equipment in column B with their appropriate uses and characteristics in column A. Colum B items may be used more than once.

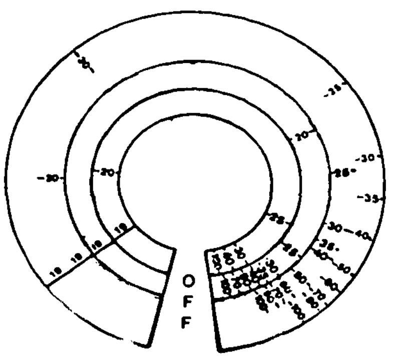
Column A	*Column B*
____(1) Electrically powered unit used to apply liquid pesticides outdoors.	a. Backpack mist-dust blower.
____(2) Useful for applying mists, dust, and granules.	b. Hand-carried ULV generator.
____(3) Designed to disperse technical grade or highly concentrated pesticides.	c. High-pressure pesticide sprayer.
____(4) Lightweight unit for dispersing larvicidal dusts.	d. Frame-mounted hydraulic sprayer.
____(5) Suitable for outdoor spraying jobs where no electrical source is available.	
____(6) Used for space and residual treatments in small indoor or outdoor areas.	
____(7) Designed to disperse emulsions and suspensions.	
____(8) Doesn't require prior mixing of liquid concentrates with water.	

433. Identify items of nonportable powered equipment with their recommended uses.

Types and Uses of Nonportable Powered Equipment. Nonportable powered equipment as described in this text is equipment that you must transport with a vehicle due to its weight or awkwardness. The types of nonportable powered equipment are as varied as the portable powered equipment. Although the designed uses for each type are

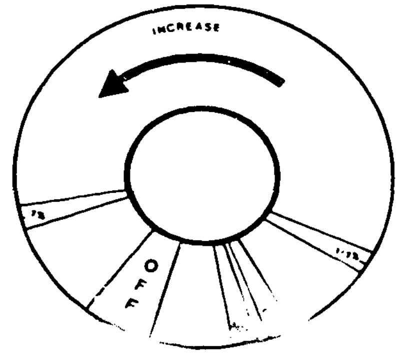


RED POINTER HANDLE DIAL



PERCENTAGE OF PESTICIDE
IN CONCENTRATE

BLUE POINTER HANDLE DIAL



PERCENTAGE OF PESTICIDE
IN FINISHED SPRAY

Figure 3-14. High-pressure pesticide sprayer.

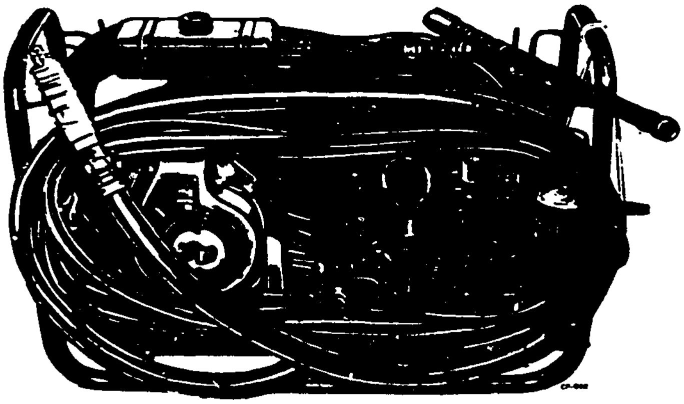


Figure 3-15. Frame-mounted hydraulic sprayer.

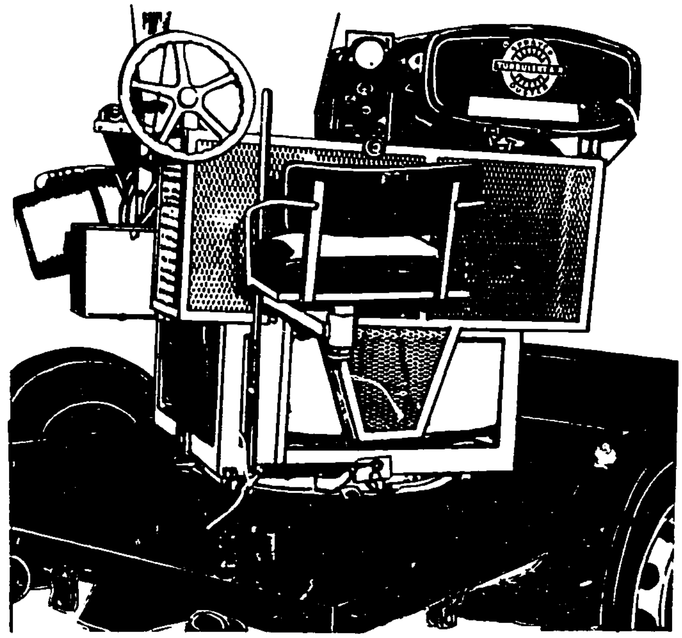


Figure 3-16. Nonportable mist-dust blower.

basically the same, the nonportable equipment is designed for treating larger areas in a much shorter time.

Nonportable mist-dust blower. This equipment item is manufactured in many forms for different pest management programs. Some are designed to be mounted on trailers and others for trucks of various sizes; some are designed to rotate on a rail base, and others are mounted on a fixed base.

It can disperse liquid, dust, and granule formulations and you can use it to treat large outdoor areas by applying pesticidal mists and dusts to trees, shrubs, and grasses to control pests that attack vegetation and the ones that harbor in vegetation. The nonportable mist-dust blower (fig. 3-16) is also used for applying residual mist to exterior surfaces of buildings for controlling adult flying insects, and venomous arthropods, and for applying larvicides to turf and water for controlling beetle, fly, and mosquito larvae.

Trailer-mounted hydraulic sprayer. The trailer mounted hydraulic sprayer is used to apply all types of liquid formulations as sprays. There are two basic types of this sprayer. One is the boomless sprayer and the other is the boom sprayer; however, some are designed to be used either way, as illustrated in figure 3-17.

Boomless hydraulic sprayer. The boomless hydraulic sprayer is designed to disperse pesticides through a single nozzle and is used to apply residual sprays to trees, shrubs, vegetation, and buildings. You may also use the boomless hydraulic sprayer to apply herbicides in ditchbank, irrigation

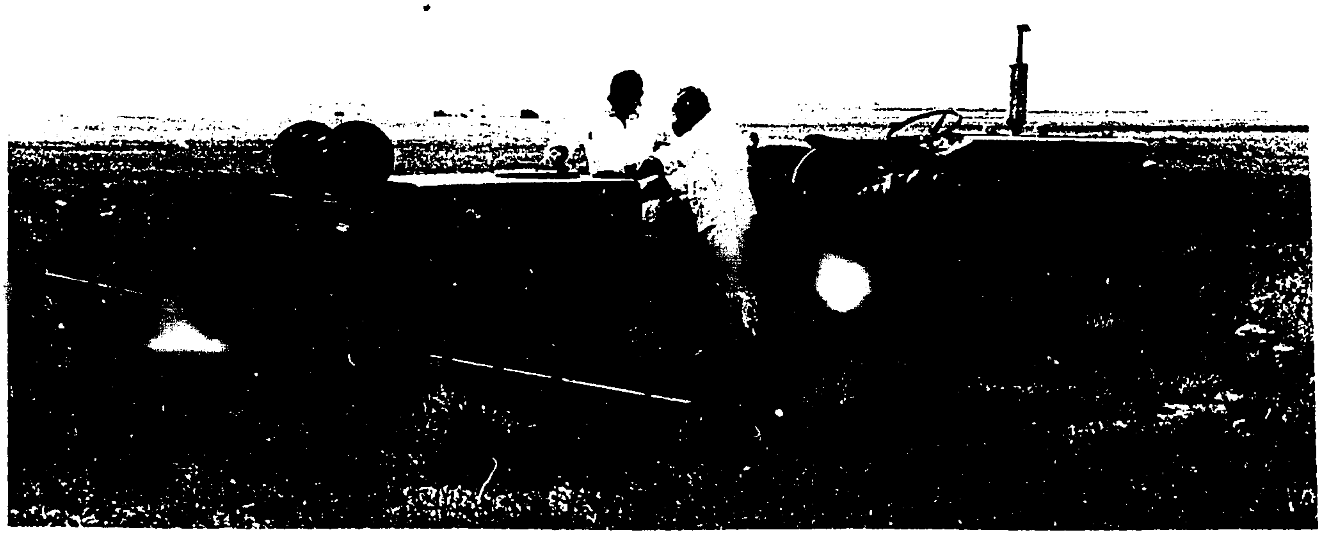


Figure 3-17. Trailer-mounted hydraulic sprayer.

and drainage systems; and in basal-bark, stump, and fence-row treatments.

Boom hydraulic sprayer. The boom hydraulic sprayer is designed to disperse pesticides through several nozzles that are contained in the boom. This way you can apply the pesticide at an even rate over a wide area of soil and turf in a single swath. This type of hydraulic sprayer is used in soil applications to prevent termite infestations and seed germination. It is also used to apply pesticides over turf ar grass areas to control larval and adult ... ...tion, ... larvae, weeds, and to control turf ...

Nonportable ULV generator. In recent years, there has been a rapid increase in the use of undiluted insecticides applied at extremely low dosage to control insects of medical and economical importance using a nonportable ULV generator.

The nonportable ultralow volume generator (fig. 3-18) has almost completely replaced the thermal and cold fog generators since it is much more efficient, cost effective, and safe. This is because they do not produce dense fogs—as do thermal fogs—that constitute a traffic hazard, which might result in deaths of children running or bicycling in the fog or cars driving in it. The nonportable ULV generator is relatively small. Its insecticide tank is usually of the 5- to 10-gallon size, and it is usually mounted on a small vehicle such as a ½-ton pickup truck.

In some areas, car spotting, or damage to automobile finishes, has occurred because of the corrosive properties of some of the insecticides, but generally only when large droplets (greater than 100 microns, the diameter of a human hair) are present in the spray. As a result, you must take great care in handling the concentrated or technical insecticides used in the ULV method because of increased degree of exposure to toxic concentrations of the chemical, particularly by spillage during loading operations.

Another type of ULV dispersal equipment, similar to the one illustrated in figure 3-19, cart-mounted generator, is authorized for use in large warehouses and storage areas to control stored-products pests.

Exercise (433):

1. Match the types of equipment in column B to their characteristics and uses in column A.

Column A	*Column B*
____(1) Used to apply liquid pesticide over a wide area at an even rate.	a. Nonportable mist-dust blower.
____(2) Used to apply undiluted insecticides at extremely low rates.	b. Boomless hydraulic sprayer.
____(3) Used to apply mists and dusts to trees, shrubs, and plants.	c. Boom hydraulic sprayer.
____(4) Used to apply liquid formulations through a single nozzle.	d. Nonportable ULV generator.

434. Specify the types of fumigation equipment and supplies and their uses and requirements.

Types and Uses of Fumigation Equipment and Supplies. There are many items of equipment and supplies you need for fumigation programs. However, the items that are required will depend upon the type of fumigation operation that is to be implemented.

In this lesson, you'll learn about the types and uses of equipment and supplies that are commonly required for inplace fumigating.

Fumigant. As you learned in objective 410, there are many fumigant compounds you may use in your pest management programs. The uses of these compounds were also discussed within the same objective. Therefore, they

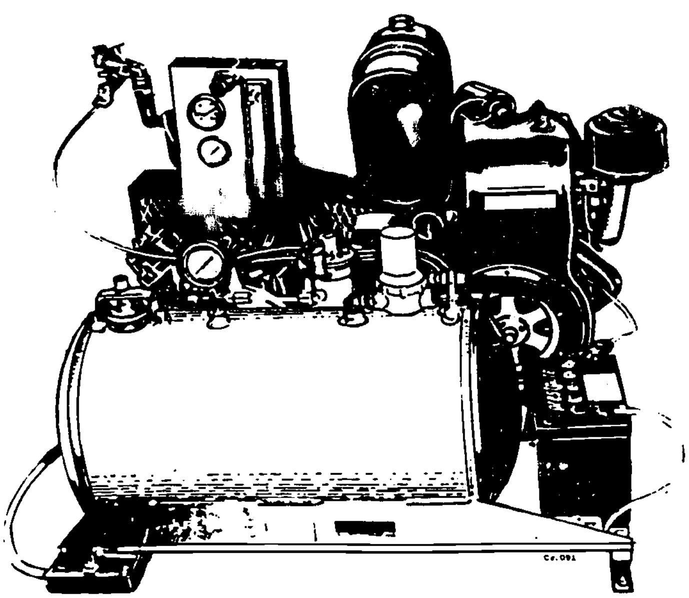


Figure 3-18. Nonportable ULV generator.

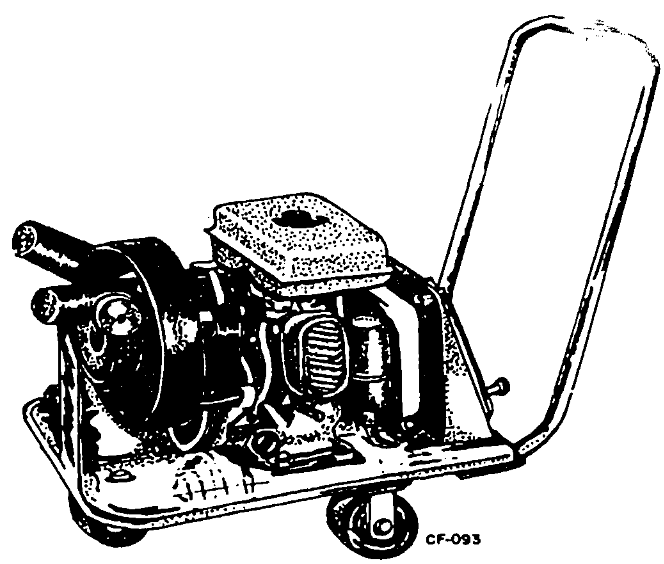


Figure 3-19. Cart-mounted ULV.

will not be discussed in this section so you may want to review them before you continue this objective.

Covering material. For all inplace stack and structural fumigation operations, you need an airtight cover to place over the stack or building to contain the fumigant. Use a thick heavy material such as a 10-mil polyethylene or canvas cover for all fumigation operations except when you use hydrogen phosphide. To perform inplace stack fumigation using aluminum phosphide, use a light, thin (2 to 6 mil) polyethylene sheet.

Tape. Use wide masking tape to reinforce the covering material at corners and wherever there are protrusions in the stacks or buildings. The wide cloth or cellophane tape can also be used to make temporary repairs to the covering in the event it becomes torn.

Sand snakes. This term applies to the plastic, sand-filled tubing you use to seal the bottom edges of the cover on an inplace stack, structural, and soil fumigation operations to the floor or ground. You prepare sand snakes by filling tubes (6 feet long and 5 inches wide) formed from 10 mil polyethyene, nylon, or canvas material with sand.

You must apply fumigants at a certain rate wihin a specific amount of space based on label instructions; therefore, you need a tape measure to determine how much space you'll treat before the operation.

Fans. Sparkproof electric fans are required when you conduct inplace stack and structural fumigation operations with methyl bromide to keep the fumigant circulating. Without the fans, methyl bromide would settle to the floor or ground, causing a very hazardous situation.

Fumigant trays. To conduct aluminum phosphide inplace stack fumigation, loosely scatter the pellets and tablets in a single layer in an aluminum tray and place it under the stack covering. This keeps the tablets or pellets from coming in contact with foods and materials that could create fire and explosion hazards. Disposal of the residue of the tablets or pellets is also easier when you're done.

Gas detection and metering devices. To perform fumigation operations effectively and safely, you need detection and metering devices. Fumigants must be applied at a certain rate per cubic foot of space being treated, which means that there must be so many parts per million of fumigant concentrate contained within the space over a specified amount of time. For this to be done, you must monitor these concentrates by taking air samples from the area being fumigated with the detection and metering devices as frequently as is specified on the fumigant label. If the concentrate level is higher or lower than the level that is recommended to be maintained, you must make the proper adjustments. Remember, if the concentrate is lower than recommended, your operation may fail, and if the concentrate is higher, this presents a potentially hazardous situation.

There are many types of gas detection and metering devices available for use with fumigants. The Drager bellows pump, (fig. 3-20) and the Auer bulb detection apparatus and detection tubes (fig. 3-21) are available for use with hydrogen phosphide. These or other similar detection and metering devices are available for use with other types of fumigants and will give you the ppm of fumigants contained within a treated area.

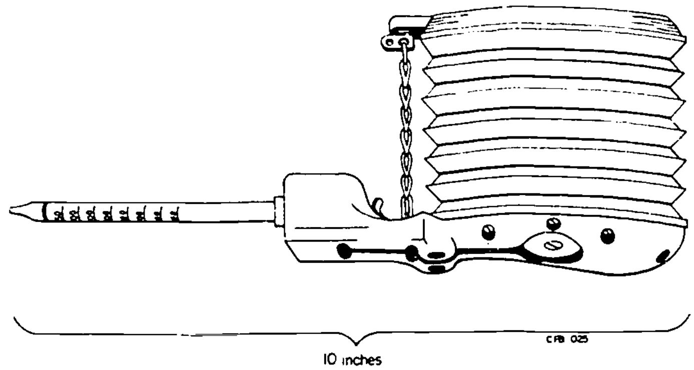


Figure 3-20. Drager bellows pump.

NOTE: To obtain an accurate reading of the amount of fumigant contained in an area, you must have the right detection apparatus for the fumigant you're using, and the detection tube must be specifically designed to match the apparatus being used.

Other available devices for detecting the presence of gases other than oxygen and carbon dioxide within the air are Halide gas detectors, fumiscopes, and explosimeters. These devices are only designed to detect contaminant and explosive properties within the atmosphere and will not identify the type of fumigant exposed.

Thermometers. Atmospheric and commodity temperatures are very important contributing factors in the effectiveness and safety of most fumigation programs. For instance methyl bromide can be used effectively in areas where temperatures may be 39° F or lower, whereas hydrogen phosphide is not to be used in areas where the temperature is below 40° F.

In almost all cases, each fumigant will have an optimum temperature at which it works best, and the optimum temperature will vary with each fumigant; thus, the gas concentration and time of required exposure will vary as the temperatures vary. For this reason you need a thermometer in fumigation operations.

Moisture permeable envelopes. For railcar fumigation with aluminum phosphide pellets or tablets, special moisture permeable envelopes are required for containing the pellets or tablets.

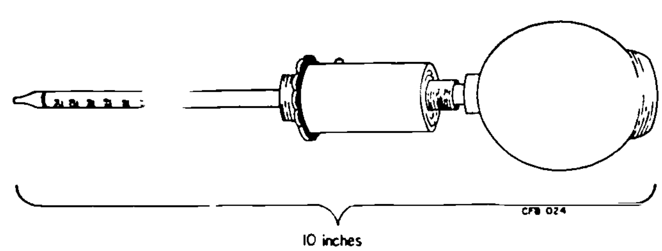


Figure 3-21 Auer bulb.

Warning signs. Regardless of the type of fumigation operation that is to be conducted, warning signs that specify the type of fumigant being used, precautions to be taken, and emergency phone numbers of responsible individuals must be conspicuously posted at every visible approach to the area where fumigation is to occur.

Safety protective equipment. As previously discussed in Volume 2, coveralls, gloves, and a hat must be worn during all phases of fumigant handling and monitoring. An approved full-face respiratory device designed to protect against the fumigant compound must be worn during all phases of handling and monitoring all types of fumigants except for paradichlorobenzene, naphthalene, and aluminum phosphide.

You don't need to wear a respiratory protective device while applying aluminum phosphide tablets, pellets, or bags as long as the application can be completed within 20 minutes; however, an approved respiratory protective device and canister must be nearby if you need it.

Exercises (434):

1. When performing inplace stack fumigation with hydrogen phosphide, a light, thin ________ sheet is used.

2. To prevent tears in the covering materials, projections or sharp edges are padded with ________ ________.

3. What is the tubing used to seal the bottom edges of covering material called?

4. To keep the fumigant circulating, sparkproof electric ________ are used.

5. Aluminum phosphide pellets and tablets are loosely scattered in a single layer in ________ ________.

6. To perform fumigation operations effectively and safely, gas detection and ________ devices are required.

7. Where are aluminum phosphide pellets or tablets placed when used to fumigate railcars?

8. An approved ________ protective device and canister must be readily available when applying fumigants.

435. Identify trapping devices with the animals they are mainly used to trap.

Trapping Devices. Some of the trapping devices used in managing pests were identified and discussed in Volume 2. The trapping devices previously identified are used not only for collecting pests in surveys, but they are also very beneficial and often the most practical for controlling pests in many situations.

Light trap. The types of light traps illustrated in Volume 2 kill many nocturnal flying insects that would not be killed otherwise. You can use these traps near patio or camping areas to attract mosquitoes and nuisance pests away from the areas you want to enjoy. There are other types of light traps specially designed with an electrical grid used to attract and kill flying insects around outdoor entertainment areas.

Baited jar trap. These traps are very useful for controlling many types of crawling pests. This type of trap is often the safest to use in controlling cockroaches in child care centers where pesticides would be unsafe. You can also use them to some degree as a personal protective measure by placing the legs of beds in jars to prevent scorpions, centipedes, and millipedes from crawling into bed with you. Jar traps are also effective in attracting certain flying insects such as flies, bees, and wasps.

Rodent cage trap. Cage traps of the types previously identified in Volume 2 are very effective in controlling almost all domestic and field rodents. Cage traps are useful in cold storage areas to trap rodents where glue traps and snap traps are unsuitable.

Snap traps. Snap traps such as the one illustrated in figure 3-22 are used for controlling vertebrate animal pests when injury or death to the animal is not of concern. These types of traps are most often used within the Air Force for controlling domestic and field rodents. The small wood-base snap traps are used primarily for controlling mice indoors, although they are sometimes used to control field mice outdoors. The larger wood-base snap traps are most often used to control

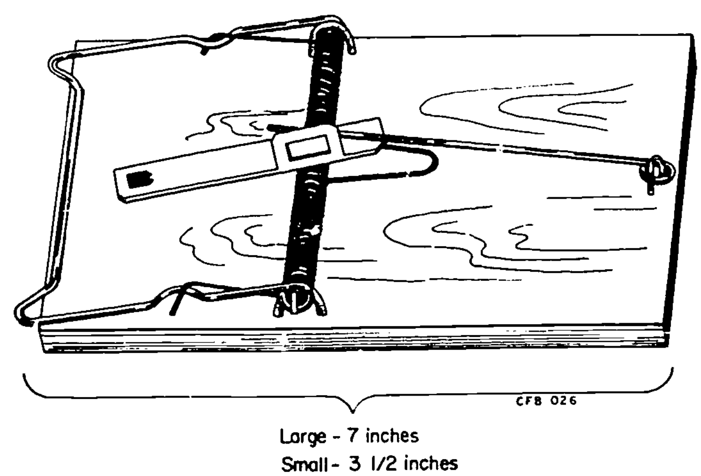


Figure 3-22. Wooden snap traps.

rats indoors and outdoors and to control field rodents and other pest mammals. Steel and wood-base snap traps may be used baited or unbaited, depending upon where they are to be used and for what they are to be used.

Glue boards. Another effective means of mouse and rat control particularly important in situations in which toxic materials should not be used is the glue board (fig. 3-23). Rat and mouse glues are very sticky materials available commercially from a number of sources. These adhesive materials are spread over cardboard or wooden squares and then placed on floors across rodent runways. As the animals attempt to cross the boards their feet become entangled and they are unable to free themselves. This technique is also effective against rats but, being larger and more powerful animals, they are more likely to pull themselves free from the glue than are mice. If a rat gets more than two of its feet entangled, it is rather unlikely to escape. Glue boards should be at least 12 inches by 12 inches, although smaller boards can be useful for mice. Since a very tacky glue is involved, they can be very messy to handle, install and service. However, where baits and traps cannot be used because of children, pets or food, glue boards may be useful.

Pigeon trap. A pigeon trap consists of a screened enclosure with an entrance through which birds are lured by bait and live decoys. The entrance door is made of lightweight rods that only swing inward, thus preventing the birds from leaving the enclosure.

Trapping reduces the numbers of pigeons feeding, roosting, or nesting around buildings. You can construct pigeon traps with wood or meshed wire, with entrance bobs made of aluminum or steel wire or wooden dowels. Figure 3-24 illustrates a low-profile trap. Preconstructed individual bobs or bobs in a frame can be obtained from commercial sources, as can completely assembled traps of various styles.

Modified Australian crow trap. This type of trap also is known as the center-drop trap. The modified Australian crow trap captures birds unharmed by luring them with bait and live decoys. The principle is that birds drop through an opening at the bottom on the V-shaped top of the trap to take the bait as shown in figure 3-25. When attempting to leave, they go up into the ends of the "V" instead of back through the entrance slots.

This trap is an effective means of capturing starlings, house sparrows, blackbirds, and other problem birds in an area of limited size. The design illustrated in figure 3-25 was developed for starling control in orchards, but it has many other applications. It's very successful when used around buildings and other structures and gives you a good way to capture protected songbirds.

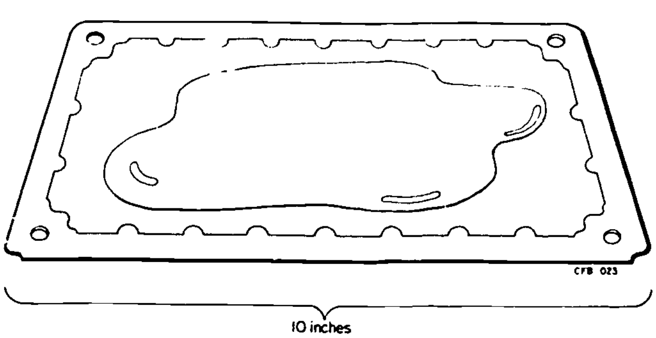


Figure 3-23. Glue board.

The modified Australian crow trap is probably the best live trap yet devised, simple and effective. Protected species usually can be released unharmed, while nonprotected species can be killed or transported and released. Trapping large populations of starlings or other birds is impractical. It may be necessary to capture decoy birds by other means. The traps are large and may require disassembly before moving or storage.

Nest-box trap. This trap looks like a bird house. When a bird enters the box to investigate, its weight tips a device that drops it into a bag attached to the bottom of the trap. The trap is then automatically reset for another capture.

You may use nest-box traps to reduce local numbers of starlings or house sparrows during their breeding season. Nest-box traps come in several different designs. Plans for a trap designed to capture house sparrows are shown in figure 3-26. For starlings, make the opening 2 inches instead of the 1½ inches used for house sparrows. When constructing the trap, put the front wall on last and fasten it by screws instead of nails to make repair easier. Glue pieces of hay and feathers to the back of the chamber. Use a tightly woven sack to receive the birds as they are captured. Place the trap on the side of a building or on a pole where the sack can hang freely and be easily reached with the use of a ladder. The elimination of existing nesting sites by means of exclusion may increase the effectiveness of the traps.

Raptor traps. A number of trap designs are available to capture raptors (hawks or owls). Two of the common designs are the Verbail pole trap and the Bal-Chatri. The Verbail snares birds of prey by the feet when they perch atop a pole. The Bal-Chatri uses nooses to entangle the feet of raptors that are attracted by live bait in a cage.

Exercise (435):

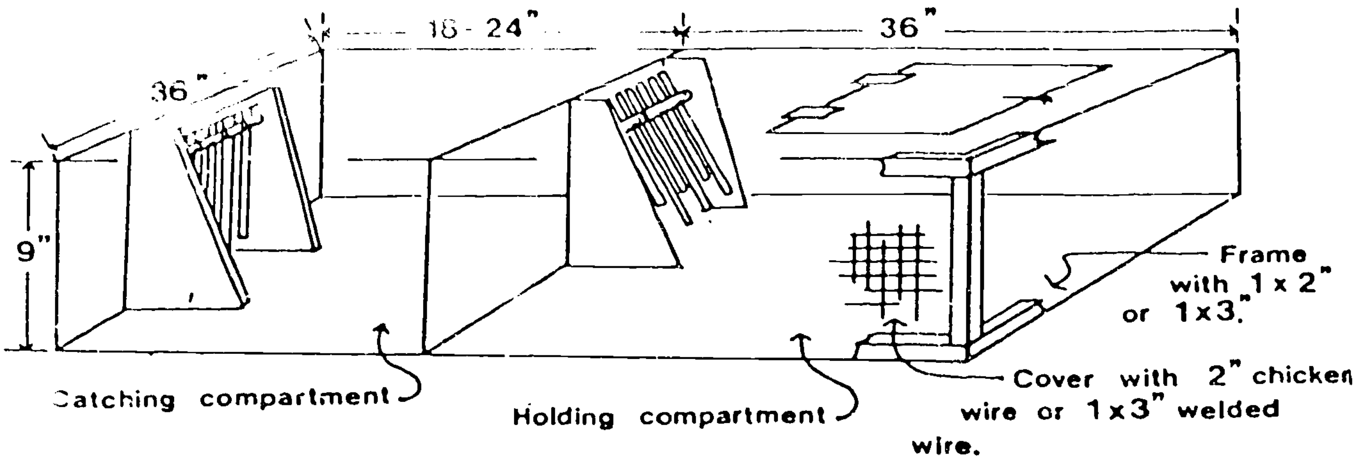
1. Match each trap listed in column B with its recommended uses in column A. Some uses may apply to more than one trap.

Column A

____(1) Consists of a screened enclosure with an entrance through which birds are lured by bait and live decoys.
____(2) Snares birds of prey by their feet when they perch atop a pole.
____(3) Used to control crawling insects where it is unsafe to use pesticides.
____(4) Controls vertebrate pests where injury or death to the pest is not of concern.
____(5) Effective for controlling starlings, house sparrows, and others in an area of limited size.
____(6) Used to kill nocturnal flying insects.
____(7) Used to trap rodents in areas where baits and snap traps may be hazardous.
____(8) Useful in cold storage areas to trap rodents where glue traps and snap traps are unsuitable.

Column B

a. Light trap.
b. Baited jar trap.
c. Rodent cage trap.
d. Snap trap.
e. Glue boards.
f. Pigeon trap.
g. Modified Australian crow trap.
h. Verbail pole trap.
i. Bal-Chatri trap.
j. Nest-box trap.



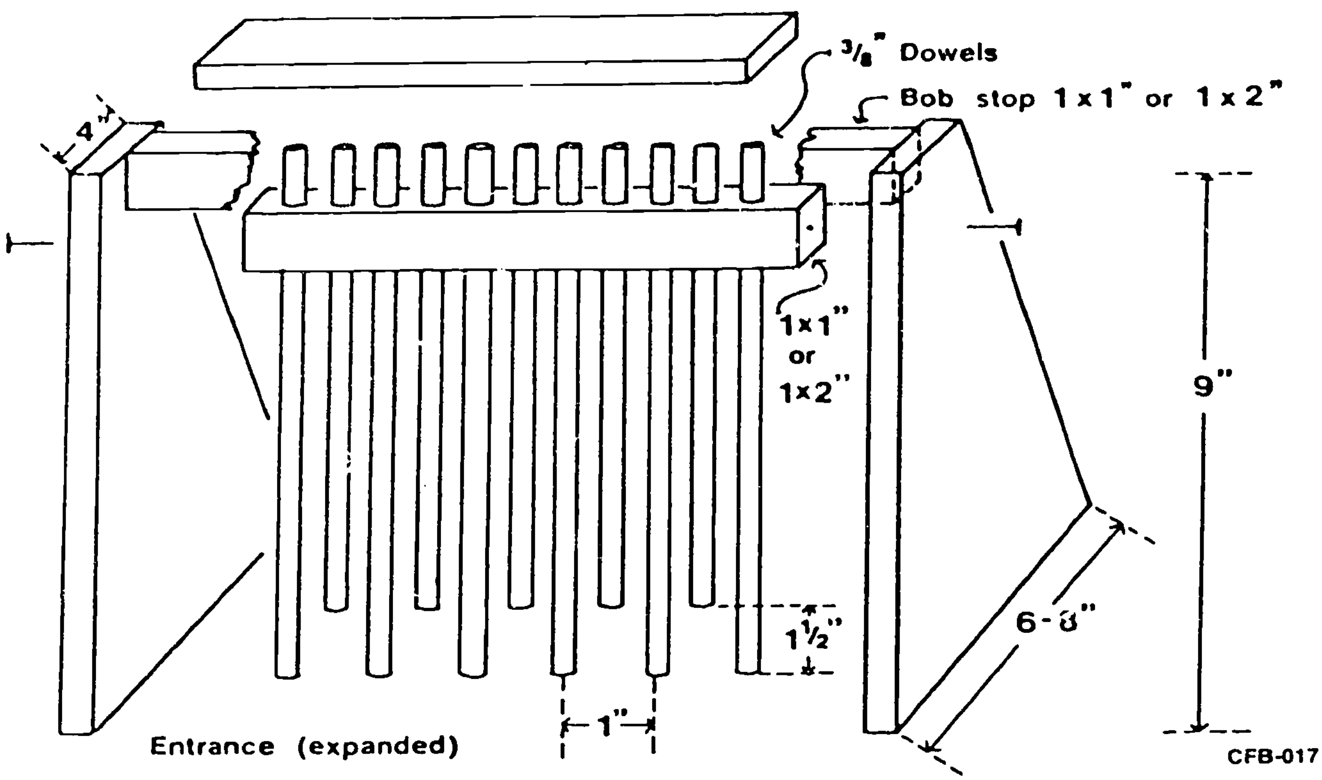


Figure 3-24. Low-profile pigeon trap.

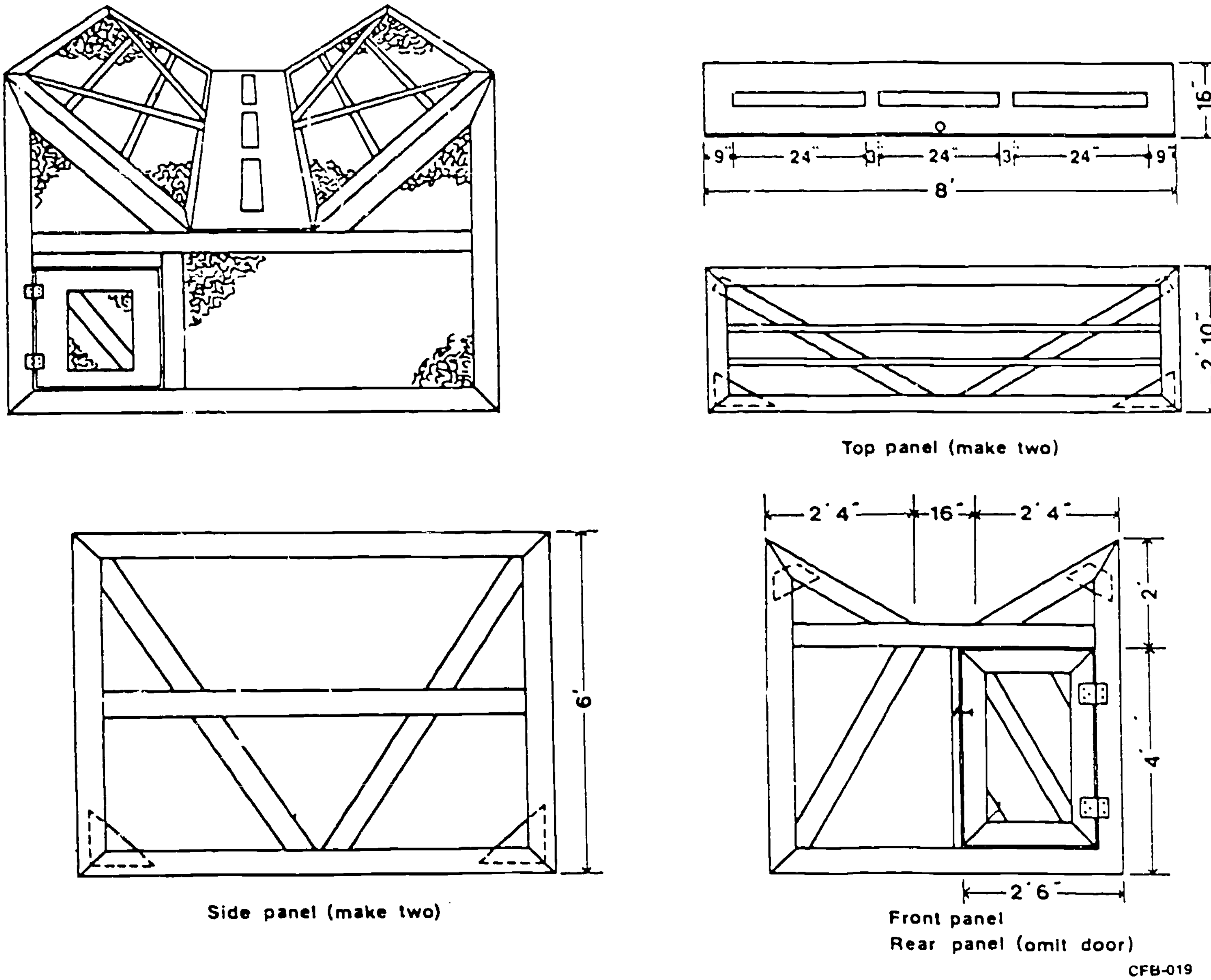


Figure 3-25. Modified Australian crow trap.

Column A

____(9) Uses nooses to entangle a raptor's feet when the bird is attracted by live bait in a cage.

436. Identify specific characteristics of pesticidal pumps.

Types and Uses of Pesticidal Pumps. There are several types of pumps you can use to apply pesticides, and each type has its own characteristics. When ordering equipment, also specify the type of pump you want, because in most cases, a sprayer can be equipped with several types of pumps. Therefore, if the type of pump desired is not specified, you are apt to receive an equipment item you can't use or one that you will have very little use for.

When selecting pumps, you must consider the type of pesticide, the pesticide formulation you'll use most often, and how much pressure and volume you'll need to disperse the pesticide formulation.

The pump you choose must be adequate for all spraying pressures you're going to use, and it must give enough flow to:

- Supply all nozzles.
- Allow for hydraulic agitation when needed.
- Leave a reserve to allow for loss of flow due to wear.

Pumps should resist corrosion and abrasion. The capacity of the pump should be at least twice the nozzle delivery rate to provide for an overflow that is bypassed back to the tank for spray agitation. The most commonly used pumps are discussed in the following paragraphs.

Centrifugal pump. A centrifugal pump (fig. 3-27) is a

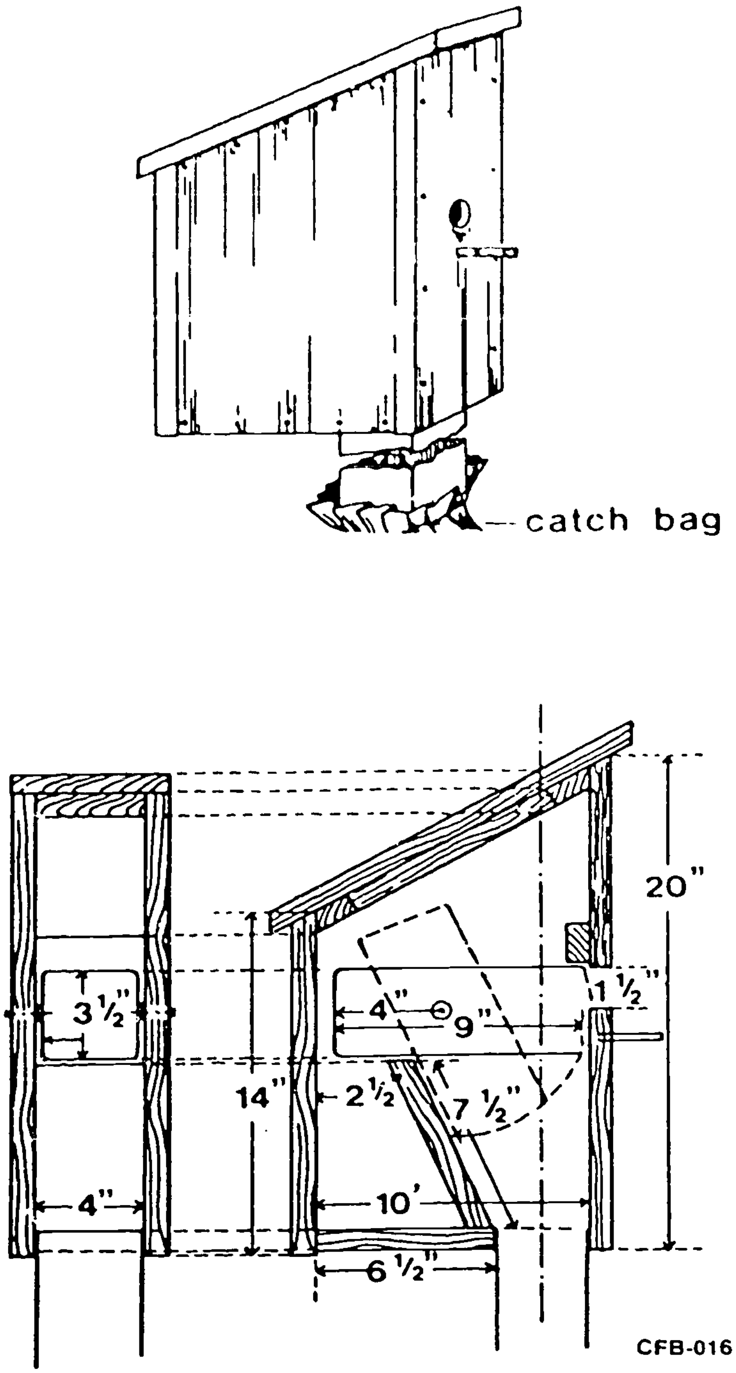


Figure 3-26. Nest-box trap.

single-rotating impeller type. It pumps a large volume of spray but does not develop a high pressure—40 to 70 psi. It can handle all spray materials with minimum wear. It is not self-priming, so you must mount it lower than the tank. Unlike most pumps, it pushes the liquid in one direction only.

Piston pump. A piston pump (fig. 3-28) is designed for large quantities of spray and moderate to high pressures—up to 1,000 psi. It has one or more plungers connected to a crankshaft. The piston pump can be used for any type of sprayer, stand rough treatment, and is long lasting but expensive.

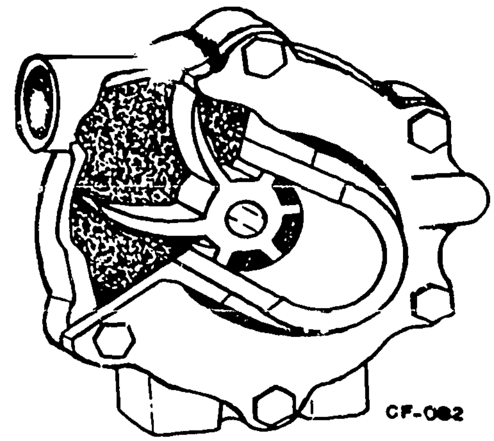


Figure 3-27. Centrifugal pump.

Diaphragm pump. A diaphragm pump is similar to a piston pump, except that one side of the chamber is made of a flexible fabric that creates a vacuum. This pump handles abrasives well, but the fabric does not always last long under the pressure normally required for spraying. The diaphragm, however, can be replaced easily and economically.

Remember, centrifugal pumps provide high volume at low pressure. They are not self-priming. Piston and diaphragm pumps provide moderate to high volumes at high pressure. They are self-priming. If you need pressures about 75 psi, piston pumps are more likely to provide them over a longer period of time.

You will damage a pump if you operate it dry or with a restricted inlet. Follow the manufacturer's recommendations for pump operation. Keep all shields in place.

Exercises (436):

1. a. When ordering equipment you must specify the ________ ________ ________ desired.
   b. When selecting pumps, you must consider the type of pesticide and ________ ________.

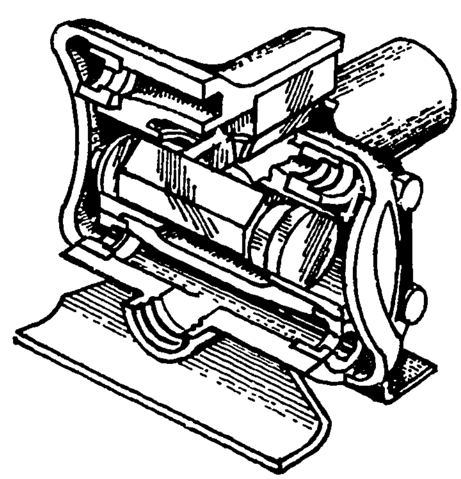


Figure 3-28. Piston pump.

c. The pump selected must be adequate for all spraying ________ you are going to use.
d. Pumps should resist ________ and ________.
e. You will damage a pump if you operate it ________ or with a ________ inlet.

2. Match the pump types in column B with their appropriate description in column A. Some descriptions may apply to more than one pump.

Column A	*Column B*
____(1) Used for pressures over 75 psi.	a. Centrifugal.
____(2) Not self-priming.	b. Piston.
____(3) Self-priming.	c. Diaphragm.
____(4) Provide high volume at low pressure.	
____(5) Provide moderate to high volumes at high pressure.	

437. Specify uses and characteristics of various sprayer accessories.

Types and Uses of Sprayer Accessories. If you're a "computer buff," you know that you can't do much with just a computer terminal. Depending on your needs, you must also have a variety of accessories and software programs to make that computer perform the way you want.

The same is true of our spray equipment; a tank and pump just isn't enough. Depending on the work you do, a sprayer needs several accessories such as agitators, pressure regulators, a suitable type of tank, strainers, pressure gauges, nozzles, valves and hoses.

The purpose of this lesson, therefore, is to familiarize you with the uses and characteristics of these sprayer components. As you study this section, refer to figure 3-29.

Agitators. When using power-driven equipment, it is frequently necessary to maintain an active agitation of the liquid in the tank in order to keep it thoroughly and evenly mixed. If emulsion-type materials are being used, a simple return bypass as found on most power sprayers is sufficient to keep the emulsion in suspension. However, where wettable powders are used, it is necessary to have a more positive and violent method of agitating the solution. In using a power rig that places compressed air over the surface of the chemical in the tank, the air jet itself becomes the agitator. This agitation is adequate for emulsions, but is not sufficiently violent for wettable powders.

Wettable powder suspensions must be agitated by a mechanical agitator operated by the power source on the spray rig. Mechanical agitators provide excellent mixing of the chemical. They must, however, have a liquid-tight bearing where they pass through the tank, and this bearing must be maintained in this liquid-tight condition to avoid leakage of the spray chemical from the tank.

All bypass agitators divert spray material from the spray line, thus reducing the amount of material available at the spray nozzle. Be sure your pump has adequate capacity to supply both the agitator and the nozzle.

Pressure regulators. In all power pump-operated equipment, it is necessary to have a pressure regulator located in the line between the pump and the discharge valve to the nozzle. The pressure regulator is set at the desired pressure for spraying and, when the pressure in the line exceeds this pressure, the regulator opens. This permits some of the chemical to return to the tank through a bypass line, thus lowering the pressure at this point. With the usual pressure regulator, the pump and its power source are operating against this set pressure at all times whether the spray nozzle is in use or not.

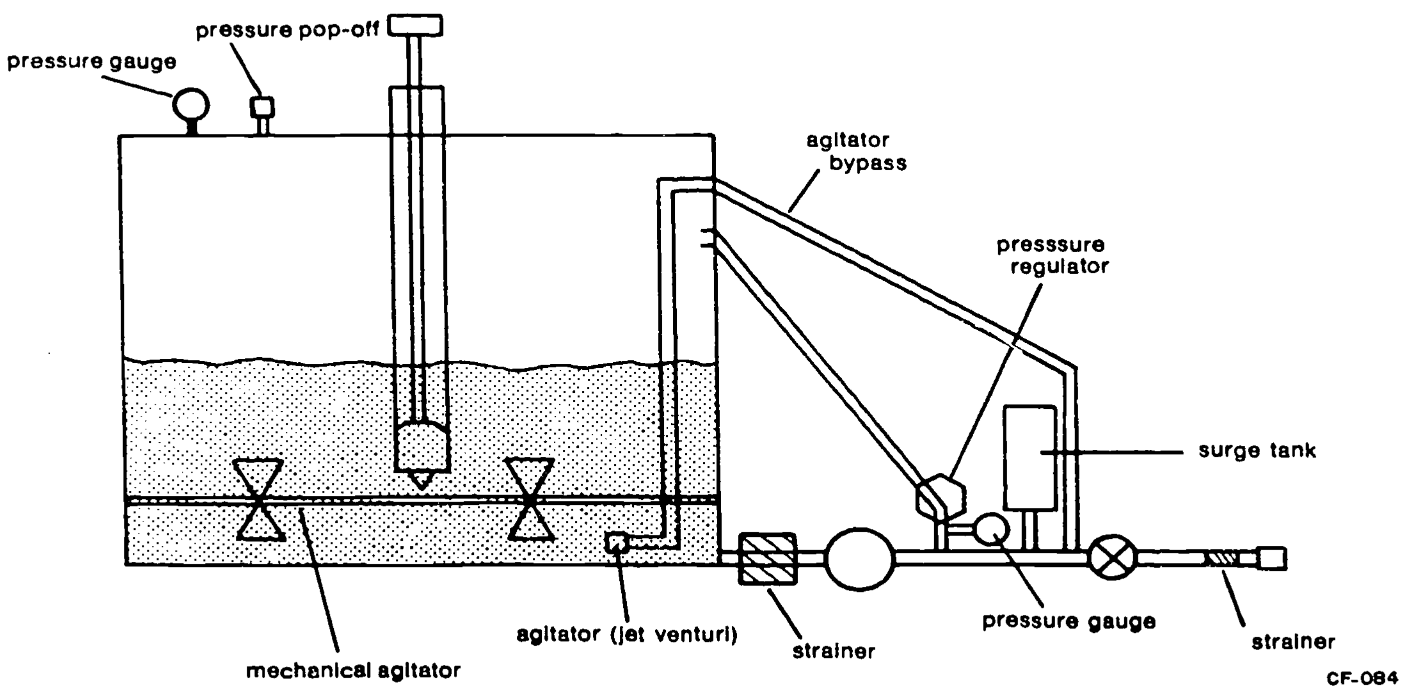


Figure 3-29. Sprayer accessories.

The power unloader is a modification of the regular pressure regulator. With this device, no spray liquid is returned to the tank as long as the spray nozzle is in operation. When the spray nozzle is closed, however, the full pressure from the pump is thrown on the unloader, which then builds up to a pressure of 150 to 200 pounds and then opens completely so all material being put through the pump is returned to the tank through an open line. This relieves the workload on the pump and its power source and results in less wear on both the pump and the power source. If you use a power unloader, make sure you use a hose with a breaking strength in excess of the maximum pressure necessary to operate the unloader, and be sure the hose is attached to its couplings tightly enough to withstand this same pressure. Otherwise, the hose will burst or will come loose from the couplings with the sudden surge of pressure before the unloader opens.

Spray tanks. Sprayer tanks may be made of many different materials. It is advisable for you to use the strongest and most durable of these materials you can get. However, where weight is a factor it may be necessary to use lighter materials.

Tanks are made of steel, stainless steel, glass, fiberglass, and plastic. Glass tanks are suitable only for use in small sprayers in which pressure is not put into the tank. Plastic tanks have good chemical resistance, are light in weight, but are usually not strong enough for much pressure in the tank itself, thus limiting them to use in small hand sprayers. Ordinary iron tanks are suitable for use in pest control operations; however, they rust quite readily and thus create a problem of dirt in the spray lines and cause nozzle clogging.

The most suitable tanks for use in pest control operations are stainless steel and fiberglass. Stainless steel of course is quite durable and will last for a long time, will not rust, and is easily cleaned. Such tanks are, however, somewhat heavier than some specialists like to use and they are expensive. Fiberglass tanks are light in weight and have most of the other advantages of stainless steel tanks. They do not break or crack easily, but if struck with a small object, they can be easily punctured. Still, their light weight, and comparatively low cost make them very suitable for large tank operations in pest control.

Strainers. A strainer is necessary in all sprayers to prevent damage to pumps and to prevent clogged nozzles. In large power equipment, a strainer is placed between the tank and the pump to prevent coarse particles from reaching the pump and damaging it. This strainer is usually a coarse one with openings large enough to permit materials such as wettable powders to pass through, but small enough to hold back pebbles, twigs, and other such debris. A strainer is also frequently placed either ahead of the shutoff valve to the nozzle or in the nozzle itself. This strainer must be fine enough to hold back any particles large enough to block the nozzle tip.

Pressure gauges. Every pressurized spray tank should have a pressure gauge on it to give an accurate representation of the amount of pressure in it. In high-pressure tanks, a pressure gauge is absolutely necessary to prevent putting too much pressure into the tank as well as to help you set the pressure regulator or power unloader properly. In small tanks, it is necessary in order to maintain the proper spray pressure so the nozzle performs properly.

On some pressurized tanks it is also necessary to install a popoff valve. This device is preset to the maximum pressure that is to be put into the tank and will open and release the pressure automatically if this pressure is exceeded. Test the popoff valve regularly to see that it is in proper operating condition.

Nozzles. The nozzle is the most important part of the sprayer, it determines how the pesticide will be sprayed—as a solid stream, flat fan, hollow cone, solid cone, or broadcast. It also determines the rate of spray output at a given pressure. Nozzles are available in many types and styles, each designed with a particular purpose in mind. They may be mounted in many ways. If two or more nozzles are placed at the end of a wand, the spray gun is referred to as a spray boom. The orchard spray gun has a single nozzle that can be adjusted to produce spray patterns varying from a solid stream to a fine mist by reducing the size of the whorl chamber. Many compressed-air sprayers have adjustable nozzles that are very beneficial for indoor work, where you need a variety of spray patterns.

The pesticide distribution rate and pattern of nozzles is dependent upon:

- The nozzle design or type.
- Its operating pressure.
- The size of the opening.
- Its discharge angle.
- Its distance from the target.

Nozzles are designed so the stream of pesticide can be in the pattern the specialist desires. The primary function of a nozzle is to obtain uniform distribution and particle size of pesticides, whether the material is placed on a surface or is dispersed into the air. Common patterns used in the pest control industry are the fan, pin stream, solid cone, hollow cone, flooding, and broadcast.

Flat fan nozzles put out a flat spray that strikes the surface being sprayed in a straight line (fig. 3-30). It is particularly good in situations where it is necessary to apply an even coating of pesticide to a flat surface such as a wall, and may also be used to apply pesticide into a crack wherever there is room enough for such application. Liquid dispersed in the flat fan pattern usually will not penetrate as deeply into a crack as it will when applied as a pin stream.

A pin stream nozzle (fig. 3-31) projects pesticide in a straight stream. Pest managers most often use a relatively fine pin stream for spraying into small cracks. This type nozzle, when used properly, will force pesticide farther into cracks and crevices than will any other. When using the pin stream nozzle keep the pressure quite low, not over 20 pounds. If your sprayer does not have a pressure gauge, judge the pressure that you have by the distance the pin stream of pesticide projects from the nozzle. It should project not more than 12 to 18 inches. This low pressure causes a great deal less splash and contamination of surfaces you don't want to treat. It requires you to keep the nozzle closer to the crack while making the application so you will inject your pesticide into the crack more uniformly. This task is simplified if you use a nozzle with an extended plastic tip designed for crack and crevice injection.

Solid cone nozzles spray a round pattern more or less

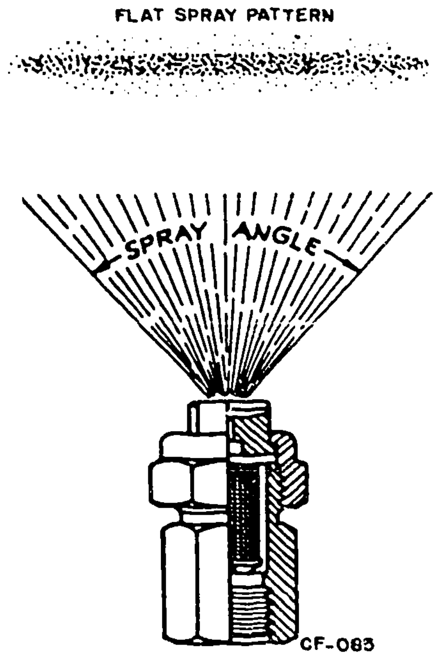


Figure 3-30. Flat fan nozzle.

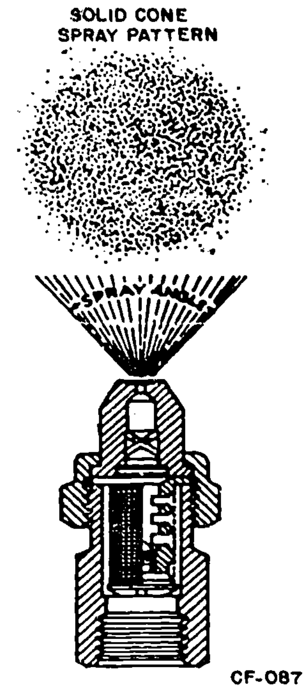


Figure 3-32. Solid cone nozzle.

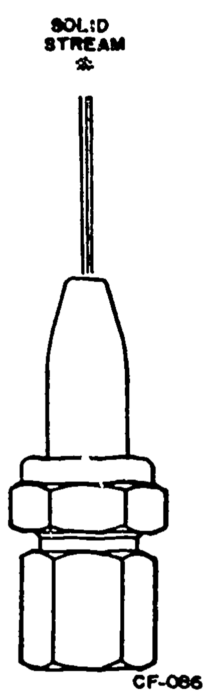


Figure 3-31. Pin stream nozzle.

evenly over the entire pattern (fig. 3-32). They're mostly used for spraying low foliage or turf areas.

Hollow cone nozzles spray a circular pattern with very little spray striking the center (fig. 3-33). These are also used for spraying foliage and turf.

A flooding nozzle makes a wide-angle flat spray pattern, (fig. 3-34). It works better at low pressures than other flat fan nozzles. Its pattern is fairly uniform across its width. It's used for broadcast spraying.

The broadcast nozzle is used like a flooding nozzle (fig. 3-35). It's advantage is that it gives a boomless sprayer a swath width similar to boom sprayers when you have to spray a large outdoor area.

When using a fan, solid cone, or a hollow cone nozzle it is necessary to use a higher pressure than when using the pin stream nozzle. The pressure required is usually between 35 to 45 pounds per square inch (psi). It is only at these higher pressures that the nozzles spray evenly and exhibit the characteristics for which they were designed.

Adjustable nozzles that let you change the form of the spray pattern to suit the conditions under which you're spraying are available. Some adjustable nozzles can be changed from a pin stream to a hollow cone merely by rotating the tip. Others have several different tips on one plate and these tips can be rotated to the one desired.

Atomizing nozzles such as those used on paint sprayers are not suitable for use in pest control work because they produce a wet spray together with a fine mist, which drifts extensively and could easily cause damage.

The large majority of spray nozzle tips are made of brass, which is a quite satisfactory material for general use when using clear oil or emulsion sprays. If, however, it is desired to use wettable powders, brass tips are not at all satisfactory as the abrasive in the wettable powders will wear them out too

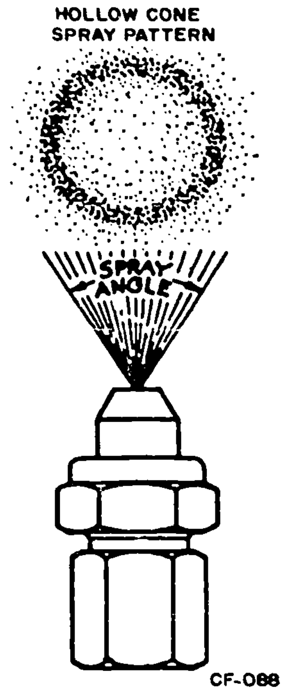


Figure 3-33. Hollow cone nozzle.

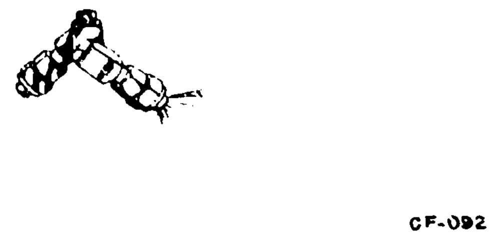


Figure 3-35. Broadcast nozzle.

rapidly. In pest management operations, the longest use will be obtained from nozzles made of stainless steel or carbide because these nozzles will retain the desired spray characteristics for which they have been designed for a much longer period of time than will brass.

Valves. Every continuous flow sprayer must have a method of turning on and shutting off the flow of material to the nozzle. This is done by a valve of some type placed in the line. There are many different kinds of valves; some are turned, some are squeezed, and some are bent to cause them to operate. A quick-acting valve is usually preferred because it shuts off immediately when the handle is released, and thus prevents leakage from the nozzle, especially when the valve is located close to the nozzle. It also gives you optimum control over where a pesticide is applied.

Slow-acting valves are ordinarily closed by rotating the valve stem, resulting in a slow but positive shutoff. This type valve is frequently used in the lines of heavy-duty power sprayers, although a quick-acting valve should be used at the nozzle end of the line. Spray guns usually have a quick-acting valve in them, although some orchard spray guns use a rotating handle for a shutoff.

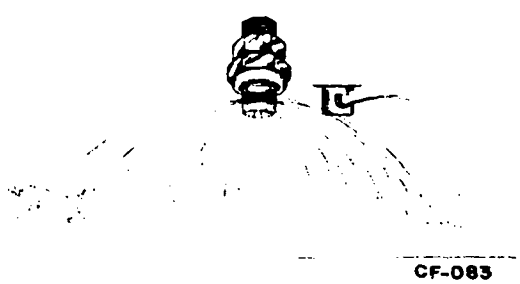


Figure 3-34. Flooding nozzle.

Rotating valves that have some advantages in the pest control industry are available. These valves consist of a metal ball with a hole through it, which is seated in some resilient material inside the valve body. When the ball is turned so the hole is open, material flows through the valve in a full stream rather than in the restricted stream, which is possible through most valves. Where high-flow rates are desirable this type valve is indicated and is particularly useful on termite soil treatment equipment.

It is necessary when using chemicals containing oils or solvents to be certain that the seat in which the ball is seated is not a material that will be affected by the chemical. These seats are available in neoprene and in teflon, which are not affected by most chemicals used in pest control work.

In all power equipment, shutoff valves should be included between the tank and the hose so pressure can be shut off from the hose without shutting down the gasoline engine or the electric motor driving the spray rig. If there is not a valve in this position, then each time it is necessary to replace hose, clean a strainer or replace a spray tip, the entire rig will have to be shut down to do it.

Hose. The hose used in various pest control equipment is of utmost importance to the pest control specialist. It is necessary to use hoses that will not suddenly burst while on the job since this will cause splashing of chemicals, unnecessary loss of time, and perhaps serious personal injury and damage to property. The hose on any sprayer should be long enough for the purpose intended, should be of sufficient diameter to carry an adequate flow of chemicals, should be made of materials that will not be deteriorated by the pesticides and solvent being used, and should have a burst strength greater than the peak-operating pressures of the sprayer.

Hose is now being made of many different materials such as neoprene, thiokol, hycar, and other synthetic rubbers, as well as of plastics such as polyethylene nylon and tygon. Neoprene is tough and is far better suited for the outer covering of hose, while the other synthetics usually make better liners. Polyethylene nylon and tygon are both flexible plastics, but will not withstand very high pressures and must be supported by a stronger outer covering or an inner reinforcing layer where pressures are too great.

Hose with an inside diameter of ⅛" to ¼" will usually be adequate for hand-operated equipment, while ⅜" to ½" may be necessary for moderate size power equipment. Only large high-volume and high-pressure equipment usually requires ¾" to 1" hose. Remember, when you're choosing a hose size, the smallest opening in the spray line will determine the actual capacity for delivery regardless of the outer size of the hose. Thus, if ½" inside-diameter hose is used with couplings that have an inside diameter of ¼", the delivery rate of the hose will only be that of ¼" hose. When choosing the hose size you will use be sure that the couplings you use to join pieces of the hose together have adequate inside openings to deliver the volume of material you require.

Where high pressure spraying is to be done, it is necessary to use heavy-duty hose that will withstand high pressure. These hoses however are quite stiff and heavy and need not be used if lower pressure will do the work satisfactorily. In many instances spray applications require low pressure only, and in this case even hose such as ordinary plastic garden hose can be used quite satisfactorily with water-based pesticides. Incidentally, the use of this lightweight hose in a spray operation where you are dragging and carrying hose all day can result in lifting and carrying several tons less weight in 1 day's work.

Exercises (437):

1. What type of agitator is suitable for
   a. emulsion-type pesticides?

   b. wettable powders?

2. Where is a pressure regulator located? What are two purposes it serves?

3. What advantages and disadvantages are offered by the use of stainless steel pesticide tanks?
   a. Advantages:

   b. Disadvantages:

4. What are two advantages of using fiberglass tanks for large spraying operations?

5. What two purposes does a strainer serve?

6. What purposes do pressure devices serve on high-pressure tanks? On small tanks?
   a. High-pressure tanks:

   b. Small tanks:

7. What is the primary function of a nozzle?

8. What are six commonly used types of nozzles?

9. Identify which type of nozzle you can use in each of the following situations:
   a. Spraying into small cracks.

   b. Spraying large outdoor areas with a boomless sprayer.

   c. Applying pesticides at low pressures to turf and foliage.

   d. Applying an even coating to walls and other flat surfaces.

10. What type of valve should your sprayer have close to the nozzle? Why?

11. List four qualities a sprayer hose should have.

438. Differentiate between typical numbers that may appear on nozzles and their appropriate meaning.

Interpreting Information on Nozzles. Nozzles supplied with older, 2-gallon compressed-air sprayers often have a nozzle disc with a simple steel plate with a hole in the center instead of the more elaborate tip. These discs often have numbers stamped on them ranging from 1 to 10, representing 64th of an inch; thus, a No. 7 disc would have an aperture of $\frac{7}{64}$ inch in diameter, and would produce larger droplets suitable for heavy applications. A No. 1 disc would produce a very fine spray. Disc nozzles are commonly used for large power sprayers that operate at high pressures, producing a very fine mist. They are also satisfactory for applying pesticide suspensions with the compressed air sprayers.

Several manufacturers have developed nozzle systems in which carefully calibrated nozzles are designated by number.

Teejet nozzles are rated according to the angle at which the spray leaves the nozzle and to the output in tenths of a gallon per minute (gpm) at a pressure of 40 psi. Thus, an 8002 nozzle used in residual spraying of emulsions on ordinary surfaces produces a flat fan spray at an 80° angle with a rate of 0.2 gpm at a pressure of 40 psi. The third number, a "0" in these numbers is used to indicate a decimal point. Similarly, a 5004

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nozzle used in residual spraying of suspensions on porous surfaces produces a flat fan spray with a 50° angle with a rate of 0.4 gpm at a pressure of 40 psi; and a 0001 nozzle used to apply emulsions or solutions to cracks and crevices for cockroach control produces a solid stream at 0.1 gpm with a pressure of 40 psi. Many pest control operators in buildings wish to change the spray pattern from time to time as they work through a building. Therefore, they use a Multeejet nozzle with four openings, two (50015 and 730039) to produce fan-type sprays, and two (000021 and 0001) to produce solid stream sprays.

Exercise (438):

1. Match the nozzle number in column A with its meaning in column B.

Column A	*Column B*
____(1) 0001.	a. Produces a flat fan spray at an 80° angle with a rate of 0.2 gpm.
____(2) 6.	b. $\frac{6}{64}$.
____(3) 5004.	c. Applies emulsions and solutions to cracks for cockroach control.
____(4) 8002.	d. Produces a flat fan spray at a 50° angle with a rate of 0.4 gpm.

3-2. Operating Equipment

Operating equipment properly is just as important in the safe and effective application of pesticides as is selecting the right equipment for the formulation and type of treatment. You can have the right equipment for the formulation and type of treatment, and you can have the right equipment for the formulation to be dispersed and the type of treatment to be implemented; but the pest management program can still be ineffective and unsafe if you operate the equipment improperly.

Another aspect you must consider in operating equipment is that it must be operated properly to prevent damage. If equipment is operated improperly, it is most certain that damage will occur, sooner or later, and the efficiency and safety of the equipment will be reduced.

Proper operation and maintenance of equipment is best done by using the commercial or Government publications that outline operational, maintenance, and safety procedures for a specific item of equipment. As a matter of fact, you are required to follow the operational, maintenance, and safety procedures that are outlined in these publications, provided there is a publication written for the equipment you are to use.

Regardless of the type of publication that is available for operating and maintaining equipment, it must be adhered to and regarded in the same manner as though it were an Air Force regulation.

For equipment items that have any of these types of publications, the equipment must not be operated or maintained unless the publication is being used by the operator or mechanic during the actual operation or maintenance.

439. State the purpose and frequency for conducting preoperational inspections.

Preoperational Inspections. Before operating any item of equipment, you must perform a preoperational inspection on the equipment. Preoperational inspections must be done before each use, regardless of when the equipment was last used. If there is a publication that outlines preoperational procedures for the equipment to be operated, it must be used during the inspection.

Preoperational inspections are done on equipment to make sure it can be safely operated at its optimum efficiency. These inspections must be performed on each item of equipment, regardless of the type, whether it is a mouse trap or the Government vehicle that you drive, and even if there are no written guides pertaining to the equipment.

Besides being required, preoperational inspections are performed to reflect a true professional pest manager, because you are only as good as your equipment. It can be very embarrassing for you and the section when you have a filled compressed-air sprayer ready at the job site to apply the pesticide, and the sprayer doesn't operate or it leaks profusely from the pump handle, simply because you neglected to perform the preoperational inspection on the equipment.

Exercises (439):

1. What is the purpose of conducting a preoperational inspection?

2. How often should you perform preoperational inspections?

3. What are preoperational inspections on equipment designed to insure?

4. Besides being required, preoperational inspections are performed for what reason(s)?

440. Cite correct operational procedures of manual sprayers.

Operating Manual Sprayers. In order to obtain the best operational efficiency of spray equipment, or any other equipment, it must be properly prepared for operation, and then you must operate it in accordance with the appropriate operational guide. Because there are usually several variations for operating each type of spray equipment, discussion in this lesson is restricted to generally common procedures. We will also identify safety precautions you must take while handling the equipment.

Compressed-air sprayer. The compressed-air sprayer has a small ½- to 3-gallon tank with an air pump, hose, spray gun, and other components necessary for applying liquid insecticides. An exploded view (with identified components) of a typical compressed-air sprayer is illustrated in figure 3-36. The tank should be filled ⅔ to ¾ full and air compressed into the remaining space. This compressed air exerts pressure on the liquid and forces it through the lines and to the nozzle. As the liquid leaves the nozzle, the spray pattern will depend on the air pressure maintained in the sprayer and the type of nozzle used. The air should be compressed to 40 psi, after which spraying may continue until pressure drops to approximately 30 psi.

To help you perform a preoperational inspection on the compressed-air sprayer, typical procedures are provided. Refer to figures 3-36, 3-37, and 3-38.

a. If the sprayer is unopened, turn the pump assembly counterclockwise very slowly to make sure all pressure is let out of the tank. If the pump assembly is opened faster than the air is allowed to escape, you might damage the threading at the top of the tank and within the pump assembly; plus, it can cause serious injury to you since the pump assembly could be ejected upward by pressure in the tank.

b. Check the threading on the tank and within the pump assembly to make sure the threads haven't worn out or broken off.

c. Make sure the pressure release opening is clear to allow the release of pressure when the pump assembly is unscrewed. This pressure release opening is located on the outer top portion of the pump assembly.

d. Make sure the pump rod is straight to prevent excess wear to the pump bonnet.

e. Insure the pump gasket is in place, it straight, and is not brittle or deteriorated.

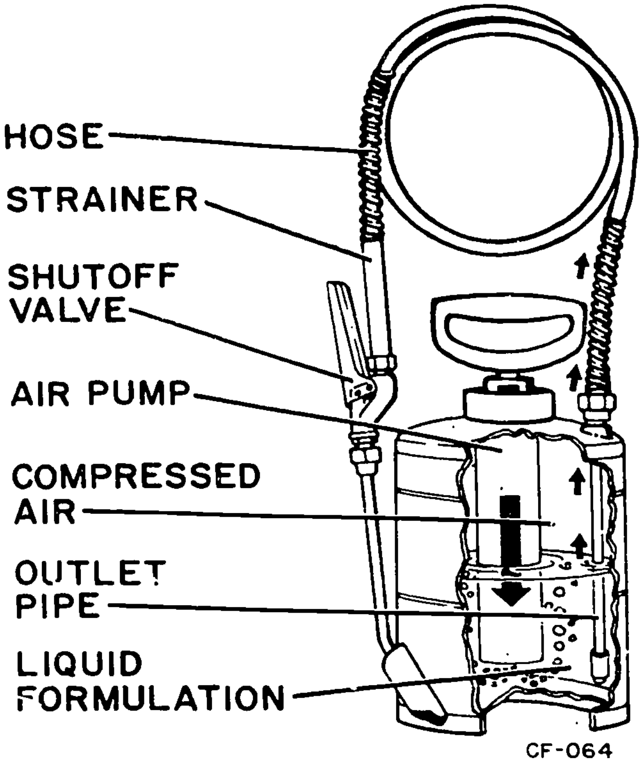

Figure 3-36. Compressed-air sprayer (exploded view).

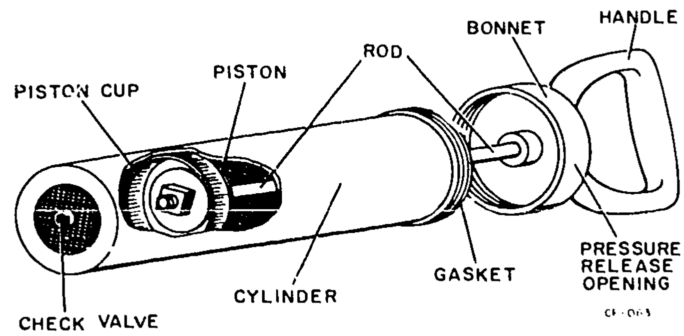

Figure 3-37. Pump assembly (exploded view).

f. Check the pump cylinder to insure that it isn't dented or cracked. Clean the inner portion frequently with a large bottle brush to prevent caking of formulations and to remove any corrosive substances.

g. Use steel wool to clean the check valve. Then, inspect the check valve to be sure it's in place, is not deteriorated, and is not lodged open by debris and metal filings. With water, frequently flush the area between the check valve and the pump cylinder to remove debris and metal filings.

h. Inspect the piston cup to make sure it's firm, but pliable. Lubricate the cup periodically with vegetable oil to prevent it from getting dry.

i. Check the outlet pipe to insure that it is securely attached and free of debris.

j. Check the formulation tank for cracks and holes that may be in the tank or around solder joints.

k. Make sure all hose and wand fittings and couplings are tight.

l. Inspect the hose to insure that it has not become brittle and to be sure there are no cracks or holes.

m. Be sure the cutoff valve is functioning properly.

n. Inspect the spray gun assembly periodically to insure that strainers are unclogged and to insure that O-rings and seats are in good condition and free of debris.

Once you've inspected the sprayer components, pour plain water into the tank, insert the pump assembly and secure it, pressurize the tank, and inspect for leaks and test the shutoff valve. If there are no leaks and the shutoff valve functions properly, the sprayer is ready for use.

Always be sure the pressure is released after each use and never transport the sprayer with pressure applied. Pesticide formulations should not remain in the sprayer for an extended period of time. (Usually no more than 24 hours, but

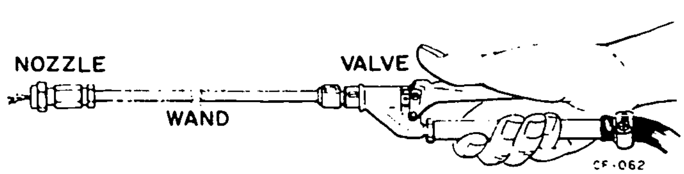

Figure 3-38. Spray gun assembly (exploded view).

sometimes less, depending on the pesticide and formulation used.)

Aerosol dispenser. The small, low-pressure aerosol dispenser consists of a can with a discharge valve and nozzle at the top, and a tube extending from the valve to the bottom of the can. The insecticide, a concentrated oil solution, is mixed with a propellant (usually a nontoxic gas) and placed in the can when assembled. When the discharge valve is pressed, propellant gas within the can forces the insecticide-propellant mixture through the nozzle and it is atomized into spray.

Pressurized cylinder. Before you begin using a pressurized cylinder, make sure it's properly charged and the nozzle is clear. If either of this is a problem, the unit won't work properly or may not work at all. If you must clean the nozzle, do it as gently as possible. Use warm running water at first. If this doesn't work you may use a fine straight pin, but be careful not to alter the size and shape of the nozzle opening since it will increase the droplet size, reducing the aerosol's effectiveness. If the unit wasn't properly charged with propellent at the factory, dispose of the can in an appropriate manner, but never in an incinerator or the can may explode when heated. These cylinders have a much heavier constructed tank, extended nozzle, and shutoff valve you turn to regulate the rate of discharge.

A preoperational inspection on this item of equipment consists of checking the container, valve, and nozzle to insure that these items are not corroded or damaged.

To test for leaks, first turn on the cylinder valve. Purge any air from inside the hose. Then place the ULV jet or injection gun in water and watch for bubbles. If a hose connection or the gun leaks, retighten and/or retape and retighten the fittings. If you can't correct any leaks by this method, refer to the manufacturer's instruction for further information.

Exercises (440):

1. What is the ideal pressure for operating a compressed-air sprayer?

2. What are two reasons for releasing the pump assembly slowly when there is pressure in the tank?

3. What items on the compressed-air sprayer should you check to insure proper flexibility?

4. Before you use an aerosol bomb, what should you check?

5. List the steps involved in checking a pressurized cylinder for leaks.

441. Specify preoperational inspections and operational procedures for manual dusters.

Operating Manual Dusters. Proper operation of manual dusters requires you to know preoperational and operational procedures; therefore, this lesson will identify these procedures and applicable safety precautions.

Hand shaker. This shaker is rectangular with a handle attached to one side. The detachable lid has a screen end to sift the insecticide dust when the duster is shaken. You may attach a long handle to the duster to treat overhead beams and rafters. If the shaker is fitted with a 16- to 20-mesh screen, or a perforated lid, a baffle isn't needed to keep the dust from being dispensed in too great quantities.

Be careful when applying dust to high areas to prevent dumping dust on yourself. To prevent electrical shorts and possibly fires, do not use this shaker in areas that contain electrical wiring.

Hand bellows. This is a rubber cylinder about 3 inches tall with a metal top and bottom. The top is open and fitted with a cork. The bottom has a metal extension tube. A large coil spring touching the top and bottom supports the device inside. Dust is placed inside the cylinder from the top, the cork is inserted, and dust is blown out through the extension tube by hand pressure on the top and bottom.

A preoperational inspection involves nothing more than checking the rubber cylinder for cracking and splitting, and insuring that the spring has proper tension and the extension tube is not clogged.

Bulb duster. The bulb duster is normally a 4-inch rubber bulb fitted with a screw cap containing a dust nozzle. After the bulb is filled with dust and the cap replaced, hand pressure on the bulb disperses the dust.

Before operating the bulb duster, make sure the bulb is not cracked and the nozzle fits tightly and is not clogged.

Plunger duster. This item has an air pump with a metal reservoir into which the air blast is directed to disperse the insecticide as a fine cloud or as a more or less solid blast. If the duster is turned so the delivery tube is beneath the dust, very heavy dust patterns will be produced.

To perform a preoperational inspection on this item of equipment, follow these procedures:

(1) Check the dust bin and pump cylinder for deterioration.

(2) Make sure the gasket beneath the filler cap is in position and is not deteriorated.

(3) Insure the plunger cup is firm but pliable.

(4) Make sure that the nozzle and siphon tube are not damaged and are free of debris.

Rotary duster. This duster has a 5- to 10-pound capacity hopper from which dust is fed by a mechanism into a fan case. When the crank is turned, the fan blows the dust through a long tube. Most dusters may be adjusted to deliver from 5 to 20 pounds of dust per acre under normal conditions.

To perform a preoperational inspection on a rotary hand duster, check the crank to be sure it's operable and straps are not frayed to the extent of possible breakage.

When operating this equipment outdoors, keep the wind to your back and let the dust blow downwind from you.

Foot pump duster. The foot pump duster is a hand-operated plunger-type blower with a container for rodenticide dust or fumigant. A stirrup is provided so that the pump can be held down with one foot while you pump air and rodenticide into the burrow through a short length of hose. The 1- and 5-pound capacity foot pumps are most commonly used for fumigating rodent burrows.

A preoperational inspection for this item of equipment includes checking the pump assembly in the same manner as for the hand plunger duster and insuring that the air-selector valve is operable. Check the hose to make sure it is not cracked and is tightly secured to the duster frame.

You should wear a gas mask, long-sleeved shirt, and rubber gloves when using calcium cyanide in a foot pump duster. Always stand upwind from the point where the hose is inserted into the burrow to avoid breathing in dust or cyanide gas.

Granular spreader. The type of granular spreader illustrated in figure 3-11 has a rotary slinger plate operated by gears and a hand crank, and a cylindrical metal hopper or cloth bag granule holder. There is a possibility when this equipment is being used in tall grass and cat tails the gears and rotating plate may get clogged with vegetation, which then causes breakdowns. A protective sheet of metal can be mounted parallel to and below the slinger plate and ahead of the latter to divert the vegetation away from the moving parts.

Before operating this equipment, make sure there are no obstacles that would prevent the rotating plate from turning, check that the crank handle is securely attached, and inspect the grease fitting for dryness or excessive grease.

Operate this equipment with the wind to your back, making one complete revolution of the crank handle per normal walking step taken, and wear appropriate safety equipment.

Exercises (441):

1. Why are hand shakers equipped with a long handle?

2. What is one action you take in the preoperational inspection of hand bellows?

3. Before operating the bulb duster, what should you do?

4. The preoperational inspection of the hand plunger duster is the same as which other assembly?

5. What should you do when operating the rotary hand duster outdoors?

6. What is a foot pump duster often used for?

7. What preoperational checks should you make before operating the granular spreader?

442. Identify correct statements relative to operating portable powered equipment with the appropriate equipment item.

Operating Portable Powered Equipment. Although the proper operation of portable powered equipment is no more important than that of the other types of equipment, it is more essential in reducing hazards to the operator and in reducing maintenance costs.

Frame-mounted hydraulic sprayer. This sprayer is generally designed to disperse pesticidal sprays at pressures from 150 to 300 psi at 2 to 4 gpm. Operating pressures of over 300 psi will damage the pump. It is provided with handles for carrying by two people, a suction hose with a strainer for insertion into a separate formulation tank, a return hose, and a discharge hose.

A preoperational inspection includes a check of the following items:

- Fuel level.
- Fuel tank for cracks and holes.
- Engine oil level.
- Engine cylinder head for foreign debris.
- Pump piston for required oil.
- Unsealed lubrication points for dryness or excessive grease.
- Starter rope for excessive fraying.
- Engine air filter for cleanliness.
- Suction, return, and discharge hoses for cracks and holes.
- Spray gun for operability.
- Nozzles for foreign debris.
- Couplings and fittings for tightness.
- Screws, nuts, and bolts for tightness.
- Drive belt for excessive fraying and proper tension; drive pulleys for tightness and alignment.
- Shutoff and regulating valves to insure they are operative.

Before performing the operational test on this (or any other) equipment, remove all jewelry and wear form-fitting protective clothing along with the required safety protective equipment. Make sure the discharge hose is capable of withstanding pressures in excess of the pressure that is capable of being produced by the pump to prevent hose rupture. Don't operate this unit dry; always make sure liquid is in the pump before you start or stop it.

To conduct the operational test, place the suction hose in a sufficient amount of water, place the pressure regulator control lever in the release position, and close off the discharge hose. Then start the engine and allow it to warm for 2 or 3 minutes. While waiting for the engine to warm, reinspect the equipment for leaks, pulley alignment, and other malfunctions. If no discrepancies are noted, adjust the pressure regulator to the desired operational pressure and open the discharge hose while holding it firmly. If all systems are functioning properly, the equipment is ready for use; if not, don't use it until all problems are corrected.

Backpack mist-dust blower. As the name implies, this unit is carried on the back of an operator. These blowers have a tank capacity of 2 to 4 gallons and are powered by a small air-cooled gasoline engine. They can disperse liquids, dusts, or granules. They're extremely useful in dispersing adulticides or larvicides over terrain where wheeled vehicles cannot travel. In general, the effective swath is reported as 30 to 80 feet.

In performing a preoperational inspection on this equipment check the following items:

- Formulation tank and return line for cracks.
- Formulation tank cap gasket to be sure it's in place and in good condition.
- Harness straps to make sure that they are not frayed to the extent of possible breakage and to see that all buckles are intact and operable.
- Dust and liquid formulation dispersal hoses to insure they aren't cracked or don't have holes and to insure all couplings are in their proper place and are secure.
- Dust control valve and lever to insure they work properly.
- Liquid control valves to insure they work.
- Liquid nozzle to make sure it is free of debris.
- Turbine blower oil level.
- Fuel level.
- Fuel cap to insure that the gasket is in place and has not deteriorated.
- Turbine blower filter for cleanliness.
- Air filter for cleanliness.
- Starter pull rope to insure it's operative and is not excessively frayed.
- All screws, nuts, and bolts to be sure they are tight.
- The proper type of gasoline (regular) and oil (nondetergent SAE-30) is used.
- Insure that the proper mixture of gas and oil fuel is being used (1 ounce of oil to 16 ounces of gasoline).

The safety precautions you must observe when using the backpack mist-dust blower are as follows:

- Do not operate the equipment beyond the recommended engine rpm.
- Do not overfill the fuel tank or oil reservoir.
- Do not remove the fuel tank cap when the tank is full and the engine is warm.
- Start the engine before placing the equipment on your back to prevent the possibility of gas spilling on you and the engine while trying to start it.
- Keep the equipment as level as possible on your back and avoid excessive shaking to prevent spillage of pesticide and gasoline on you and the engine.
- Operate the engine at low rpms for a short time before turning it off.

Hand-carried ULV generator. Most hand-carried ULV generators use a small engine similar to the one used with the backpack mist-dust blower. The units weigh 15 to 25 pounds and have a dispersal rate of ½ to 2 ounces per minute.

A preoperational inspection includes a check of the following items:

- Fuel level.
- Oil level in the supercharger.
- Starter pull rope for fraying.
- Carburetor and supercharger air filters for cleanliness.
- Carburetor sediment bowl for cleanliness.
- Fuel and pesticide tanks for holes and cracks.
- Dispersal hose for crack and holes.
- Nozzle fins for foreign debris.
- Couplings and fittings for tightness.
- Screws, nuts, and bolts for tightness.
- Pesticide tank cap gasket for firmness and pliability.
- Regulating and control valves to insure they are operative.

The hand-carried ULV generator uses a gas and oil fuel mixture. Therefore, you must be sure to use the proper mixture as prescribed by the operational manual for your particular unit. Generally, the gas and oil fuel mixture will be 5 ounces of outboard motor oil to 1 gallon of regular gasoline. Prepare this mixture in a clean container and mix thoroughly before putting it into the tank.

The engine must be operated at full rpm, and a pressure of 3 to 4 psi should be maintained in the air manifold and pesticide tank to be most effective.

High-pressure pesticide sprayer. As you learned earlier, you need an electric source and a water source to use this unit. Before you begin using it, make sure it's in a secure location so pets and children won't tamper with it while you work. Make sure your water source is clear and cold or you may damage the unit or prevent its effective performance. Make sure you have a waterflow of at least 3 gpm. To determine this, use a 1-gallon container and make sure it's filled in no more than 20 seconds.

Here are preoperational procedures for the high-pressure pesticide sprayer.

- Attach garden hose to the on/off adapter, which is connected to the water inlet.
- Connect the high-pressure spray hose to the outlet side of the unit.
- Don't turn on the unit, but start the water and spray for a short time to clear air from the lines.
- Connect a grounded extension cord to the electrical inlet.
- Based on pesticide label instructions, determine what percentage of finished spray you need. Set the blue pointer handle (fig. 3-14) to this percentage. *Be precise.*
- Refer to the label and find out the percent of active ingredient in the concentrate. Set the red pointer handle to this percentage. If the label indicates more than one pesticide, set the handle to the highest percentage listed.
- Turn the power switch to the pump position. Make sure the pump is getting water to avoid burning out the pump. *Do not attach the siphon tube yet.* Start spraying without the pesticide.
- Adjust the pressure regulator so the pressure gauge indicates 125 psi.

- Attach the pesticide concentrate container to the side of the unit with tiedown straps.
- Connect the siphon tube to the unit at the concentrate siphon tube connector. Be sure to wear neoprene gloves when you handle the concentrate.
- Place the siphon tube in the concentrate container, insuring the tube and filter screen drop to the bottom of the can.
- Before you start spraying, record the setting on the digital gallonage meter on top of the sprayer. This will make it easy for you to find the number of gallons of finished spray used on each operation.

Rotor hammer. This is a large industrial drill with a hammering mechanism. In pest management, it's used to drill holes through masonry for sub-slab injection of termiticides. (Demolition experts also use it to drill holes into which explosives are placed. However, this isn't a recommended pest management method, no matter how desperate you get.) A spring-action stop bracket holds the drill bit in place and shifts easily for fast tool changes; no hand turning of bits is needed. An adjustable hex rod helps you drill holes to a uniform depth and a pipe handle on either side to ease operation and handling. This handle must be used when you're using rotating bits.

Follow these preoperational procedures before you use a roto hammer. Refer to figure 3-39 as needed.

- Oil the hammer by putting 3 squirts of SAE 10W turbine oil into the nose and in the oil reservoir for the automatic oiler.
- Make sure the shank of the bit is clean before you install it.
- Make sure the drill is properly grounded before you use it.

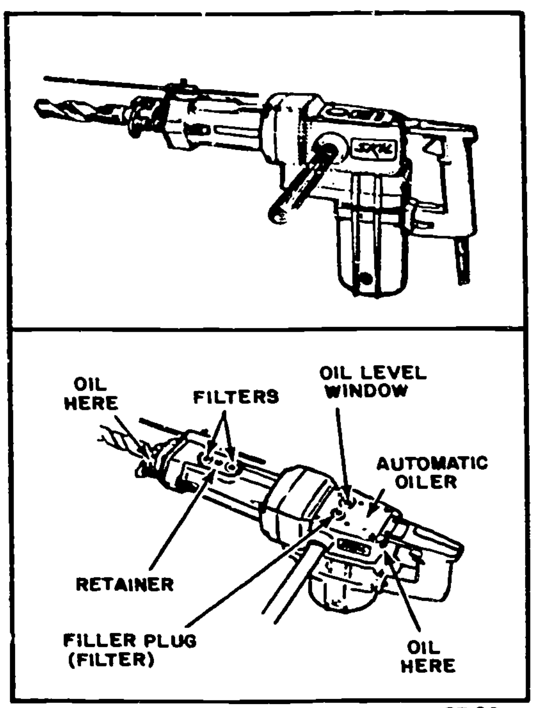

Figure 3-39. Roto hammer.

- Adjust the clutch as needed to be sure the hammer won't spin at full torque if the bit binds. *This is an important safety factor with the drill.*
- If the clutch slips too often, tighten it one-half turn at a time until the bit drills efficiently with clutch slippage. If the clutch doesn't slip when the bit binds, loosen it one-half turn at a time.

As you operate the roto hammer, you only need to apply as much pressure as is needed to keep the bit in the desired position. Keep the pipe handle against a bended knee to reduce your chances for injury if the bit binds. Hold the hammer in line with the hole you're drilling horizontally, and apply enough pressure to keep the bit firmly seated.

Exercise (442):

1. Match the operational statements in column B with the applicable equipment in column A. Column B items may be used more than once.

Column A	*Column B*
____(1) The gas-oil mixture is 5 ounces outboard motor oil to 1 gallon regular gasoline.	a. Backpack mist-dust blower.
____(2) Lubricate by adding SAE 10W turbine oil to the oil reservoir and nose.	b. Hand-carried ULV generator.
____(3) Before operating, remove all jewelry and wear form-fitting clothing along with other required safety equipment.	c. Frame-mounted hydraulic sprayer.
____(4) The effective swath width is 30 to 80 feet.	d. High-pressure pesticide sprayer.
____(5) If the clutch is too tight or loose, adjust it one-half turn at a time.	e. Roto hammer.
____(6) Insure a waterflow of at least 3 rpm before using this equipment.	
____(7) Operate at full rpm and a pressure of 3 to 4 psi in the manifold and pesticide tank.	
____(8) The pressure regulator must be adjusted to provide 125 psi.	
____(9) Use this to apply adulticides or larvicides over terrain where wheeled vehicles can't travel.	
____(10) With this item, the maximum psi should never exceed 300 and the unit should never be operated without liquid in the pump.	

443. Cite operational characteristics, inspection requirements, and safety precautions regarding nonportable mist-dust blowers.

Operating a Nonportable Mist-Dust Blower. This type of equipment has a four-cylinder gasoline engine, a fan, a hopper to hold pesticide dusts or granules, and a tank to hold liquid pesticides. The high-velocity fan forces air through the large air discharge boom and blows the pesticide up to several hundred feet into the control area. The liquid pesticide is forced through special small nozzles into the large air discharge boom and blown from the machine as a spray or mist.

Check the following items when you do a preoperational inspection on the unit.

- Fuel level.
- Engine oil level.
- Battery water level.
- Battery terminals and cables.
- Gasoline sediment bowl, blower fan, air boom, and nozzles for foreign debris.
- Fuel pump for leaks.
- Fuel and pesticide tanks for cracks and holes.
- Pesticide hopper for cracks and holes.
- Hopper agitator for security.
- Fuel and liquid pesticide lines for cracks and holes.
- Couplings and fittings for tightness.
- Screws, nuts, and bolts for tightness.
- Unsealed lubrication points for dryness or excessive grease.
- Drive pulleys for tightness.
- Drive belts for fraying and proper tension.
  Hopper drive chain and boom-steering chain for weak links and lubrication.
- Shutoff and regulating valves for operability.

Again, before performing the final phase in the preoperational inspection on this equipment (operational test using water or talc), make sure all jewelry is removed and put on form-fitting protective clothing. Excessively loose-fitting clothing and jewelry have a tendency to be caught in drive belts and pulleys (and other protruding objects) and can cause serious injuries. You must also be sure no one is standing in front of the air boom or beside the air fan, because these items create extreme suction and air velocity. The air boom should be pointed upward before you start this unit.

After you have completed the first step in the preoperational inspection and have taken the prestarting precautions, start and operate the equipment to be sure there are no leaks and all parts are operational.

Most models of this equipment are not designed to produce high pressures, because they rely on the air velocity to disperse the pesticide; therefore, you must not operate the equipment with pressures exceeding the recommendations set forth in the operation manual for your particular unit.

Exercises (443):

1. The high-velocity fan forces air through the large air discharge ________.
2. The liquid pesticide is forced through small nozzles into the large air discharge boom and blown from the machine as a ________ or ________.
3. What parts of the electrical system should you check?
4. The fuel pump should be checked for ________.
5. An operational check should be performed using ________ or ________.
6. When operating this equipment, you should remove all ________ and wear ________. ________ protective clothing.

446. Cite characteristics and operational features of trailer-mounted hydraulic sprayers.

Operating a Trailer-Mounted Hydraulic Sprayer. With this type of unit the liquid pesticide is pressurized by means of a power-driven hydraulic pump with regulators that maintain the desired pressure. Pressures range from 20 to 800 psi. The spray pattern is determined by the pressure and the type of nozzle used, varying from a solid stream to a fine mist. The power sprayer has a tank of 50- to 600-gallons capacity, with a rotating agitator to keep pesticides in suspension. A gasoline motor or power takeoff operates a piston or diaphragm pump. The power sprayers most used in Air Force pest management operations are small outfits of not more than 200-gallon capacity mounted on trailers. These sprayers deliver a maximum of 1 to 10 gallons of spray per minute and have pressure regulators so the recommended pressure is maintained.

The pressure regulator is typically a large, steel ball bearing forced against a valve seat by a spring. A nut, thumb screw, or lever adjusts the spring tension to provide high or low pressure. When pressure exceeds that which is desired, the ball bearing is displaced and the surplus spray recirculates through the pump or is forced back into the spray tank. The power sprayer has one or more hose leads to which you attach spray guns similar to those used with the small compressed-air sprayers. You can also use these sprayers with the orchard gun ordinarily purchased with the sprayer. The orchard gun is adjustable to provide any pattern from a solid stream to a fine-cone spray. The orchard gun, or a spray boom with several nozzles, may be used to treat fields or other areas requiring heavy applications.

Most engines used on this type of equipment are designed to be operated at a minimum of 1,800 rpm and a maximum of 2,800 rpm; but refer to the operator's manual and operate the engine according to recommendations.

Pumps should not be regulated to exceed the maximum pressure prescribed in the operator's manual. Pressures usually don't exceed 400 psi for Air Force pest management operations.

Check the following items when performing a preoperational inspection on the trailer-mounted hydraulic sprayer:

- Fuel level.
- Oil level.
- Carburetor air filter for cleanliness.
- Starting rope for excessive fraying.
- Engine cylinder head for foreign debris.
- Fuel and pesticide tanks for cracks and holes.
- Hoses for cracks and holes.
- Couplings and fittings for tightness.
- Screws, nuts, and bolts for tightness.
- Drive belts for fraying and proper tension.
- Drive pulleys for tightness.
- Unsealed lubrication points for dryness and excessive grease.
- Agitator for paddle condition and security.
- Shutoff and regulating valves for operability.
- Nozzles for foreign debris.

Before performing the operational test with water, remove all jewelry and be dressed in form-fitting protective clothing. Be sure the pesticide dispersal hose and return hose are designed and capable of withstanding pressures well above the pressure range of the pump to prevent them from bursting. Make sure the spray gun and/or boom are shut off. If the sprayer contains an airdome that must be precharged, you should charge it with the amount of air specified in the operator's manual.

Exercises (444):

1. What is the range of pressures in the hydraulic sprayer and how are they controlled?

2. What is the power sprayer tank capacity?

3. How are pesticides kept in suspension?

4. These sprayers deliver from ________ to ________ gallons of spray per minute.

5. Which source is best to refer to when operating hydraulic sprayers?

6. Pumps should not be regulated to exceed the ________ pressure prescribed in the operator's manual.

445. Specify characteristics and operational features of nonportable ultralow volume generators.

Operating a Nonportable ULV Generator. This equipment item is relatively small in comparison with the other types of nonportable equipment. The insecticide tank is generally a 5- to 16-gallon capacity tank and the equipment is usually mounted on a small half-ton pickup. The nozzles used on it must be capable of producing droplets in the 5- to 27-micron range. The average droplet size should not exceed 12 microns in diameter.

To perform a preoperational inspection on this item of equipment, check the following:

- Fuel level.
- Engine oil level.
- Air pump oil level.
- Battery water level.
- Battery terminals and cables for tightness and corrosion.
- Air intake filter pad for cleanliness.
- Formulation filter for cleanliness.
- Pop safety valve for operability.
- Drive belts for excessive fraying and proper tension.
- Drive pulleys for tightness and alignment.
- Nozzles for foreign debris.
- Gasoline and insecticide tanks for cracks and holes.
- Gasoline and insecticide hoses for cracks and holes.
- Couplings and fittings for tightness.
- Screws, nuts, and belts for tightness.
- Engine cylinder head for foreign debris.
- Carburetor filter for cleanliness.
- Shutoff and regulating valves for operability.

Before performing the operational test on the ULV generator, remove all jewelry and put on form-fitting protective clothing along with other required safety protective equipment. Make sure no one is in front of the nozzle and keep the nozzle pointed away from individuals.

Once the preoperational inspection is complete and all safety precautions have been observed, you're ready to do the operational test.

Start the engine and allow it to warm to the point of the aluminum separator being hot enough to sizzle a drop of water. While waiting for the engine to warm, reinspect the equipment for leaks, excessive vibrations, and pulley alignment.

After the engine has warmed, turn on the chemical flow switch and monitor the air-pressure gauge. Maintain the air pressure to the air tip between 75 to 85 psi, and the air pressure to the formulation tank between 12 to 17 psi. These pressures are regulated and maintained by the engine and pump rpm. The engine should normally be operated at 2,500 rpm and the pump operated at approximately 900 rpm. Leaking couplings, fittings and hoses, and improper drive belt tension can cause a drop in pressure, which would necessitate an increase in the engine and pump rpm. This is just one more reason for performing the preoperational inspection and operational test on this equipment before taking it out on a job. If everything checks out okay, then the equipment is ready for use; however, if malfunctions or discrepancies are detected the item should be corrected before you use it.

Exercises (445):

1. How is a nonportable ULV generator usually mounted?

2. What is the micron range for pesticide particles from the nozzles for this unit?

3. What is the average pesticide droplet size?

4. What action should you take before you turn on the chemical flow switch and monitor the air-pressure gauge?

5. What is the pressure within the formulation tank?

6. What three conditions may cause a drop in pressure and require you to increase engine and pump rpm?

3-3. Maintaining Equipment

Besides having to select the right equipment for the job to be done, perform preoperational and operational inspections, and having to operate equipment properly, you must also maintain your equipment in peak-operating condition to help you to conduct effective and safe pest management programs.

This section will identify organizational maintenance tasks you must conduct as part of your responsibility in maintaining pesticide dispersal equipment.

446. Define organizational maintenance and list tasks related to it.

Organizational Maintenance Responsibilities. Organizational maintenance is maintenance performed by personnel within the squadron; this includes operator maintenance. Organizational maintenance consists of performing all maintenance within the capability of the section. It is your responsibility; therefore, you must be knowledgeable of the common tasks that you will be required to perform. These tasks include cleaning, servicing, adjusting, repairing, replacing, and calibrating dispersal equipment and/or equipment components. Remember that all maintenance must be done in accordance with appropriate publications that identify the tasks and frequency of tasks to be performed.

Exercises (446):

1. Define organizational maintenance.

2. List the tasks that are included in organizational maintenance, dispersal equipment and components.

3. All maintenance must be done in accordance with ________ ________.

447. List the purposes for cleaning pesticide dispersal equipment and specify the cleaning methods to be used on identified types of dispersal equipment.

Cleaning Equipment. To prolong the life of the equipment, you must clean each item after you use it, because dirt and pesticidal formulations can damage protective coatings and internal parts of the equipment. Another purpose for frequent cleaning is to reduce contamination hazards. The cleaning methods you use to clean pesticidal equipment will depend upon the type of equipment you're cleaning. These cleaning methods, along with the types of equipment that can be cleaned by each method, will be discussed.

Flushing. Any equipment item designed to disperse liquid pesticidal formulations must be flushed after each day's use or chemical change.

Flushing applies to cleaning the entire inner portions of the pesticide dispersal system to remove dirt and pesticides from the tank, pump, hoses, and nozzles.

Flushing this system is very important because many pesticides are corrosive, and if left inside the system they can be very damaging.

Flush equipment used to disperse oil solutions with a solvent such as kerosene or No. 4 grade fuel oil and never with water. Equipment used to disperse emulsion and suspension-type formulations must be flushed with water and never with a solvent. For those items of equipment designed to disperse solutions, emulsions, and suspensions, regular flushing with water is most practical; however, an occasional flushing with a solvent may be required, especially if you're preparing the equipment for extended storage.

Washing. All items of nonportable powered equipment, along with the compressed-air sprayer, and the frame-mounted hydraulic sprayer, can be washed with a detergent and water solution. Wash all exterior surfaces of the equipment after each day's use to remove damaging dirt and pesticide particles. Take care to avoid applying water to engine components. Wash the inner portions of dust hoppers and give plenty of drying time after you're done. If possible, force-air dry these areas. Rinse thoroughly and wipe the item dry to remove any remaining corrosive substances.

Triple rinsing. The triple-rinse method of cleaning equipment is flushing the liquid pesticide dispersal system three times; the first two times using separate solutions of detergent and water, and the third time using water only. This method must be used to flush an equipment item designed for applying solutions, emulsions, and/or suspensions before it's used to apply a type of pesticide different from the type just previously used.

Vacuuming. For items of equipment designed strictly for applying dusts and/or granules, clean by vacuuming. Hoppers on other equipment parts used strictly for dusts and granules should also be cleaned by vacuuming.

Wiping. Wiping with a damp or dry cloth is the method you use to clean engines and equipment where water would be damaging and would cause the equipment to be inoperable for a period of time.

Steam cleaning. The steam cleaning method is primarily restricted to removing heavy deposits of oil and grease from nonelectrical powered equipment.

Waxing. Wax all items of nonportable powered equipment periodically to further help remove dirt and pesticide particles and to give protection to painted surfaces.

Exercises (447):

1. List the two purposes for cleaning pesticide dispersal equipment.

2. Why should you flush items of equipment?

3. How do you flush equipment used to apply oil solution formulations?

4. Equipment used to apply emulsion- and suspension-type formulations must be flushed with ________ and never with ________.

5. When washing equipment, take care to avoid applying water to ________ ________.

6. The third rinse of the triple-rinse process uses ________ only.

7. Clean equipment designed for applying dust or granules by ________.

8. You should clean engines by wiping with a ________ or ________ cloth.

9. What type of cleaning is used to remove heavy deposits of grease and oil?

10. To provide added protection, you should ________ equipment periodically.

448. Indicate whether given statements reflect the correct practices and procedures for servicing equipment.

Servicing Equipment. Proper servicing is vital to the operation and maintenance of equipment, because improper servicing may cause equipment not to operate, or if it does operate, you could damage equipment components and present hazards to yourself and others.

Fuel. Use the proper type and quantity of fuel for powered equipment. For some items you need a gasoline and oil mixture to operate the equipment. However, most equipment only requires regular gasoline. Do not overfill fuel tanks, especially those that are pressurized. If fuel tanks are overfilled, spillage will result due to the expansion of the fuel and moving the equipment.

Lubricant. There are many types of lubricants used to maintain pesticidal equipment. The type of lubricant used depends on the type of equipment and where you use it. For this reason, always refer to the equipment manual before lubricating.

For most items of powered dispersal equipment, SAE 30W detergent oil is normally used in the engine block. The type of oil normally used in gearboxes of equipment is SAE 90W nondetergent oil. Regardless of the type of oil used or where it is used, it requires changing periodically and must be changed according to manufacturer's recommendations.

General-purpose grease is normally used for lubricating shaft bearings and other movable parts that are provided with unsealed grease fittings. These items must be maintained with the proper amount and type of grease. Grease these fittings just to the point before the grease begins to ooze. Sealed grease fittings require less frequent lubrication. You must never over-lubricate these fittings, because this will cause the seal to break and damage the bearings.

Water. Not many items of dispersal equipment are equipped with radiators, but if they are, make sure the proper water level is maintained at all times. If the water level in the radiator is very low, it will cause the equipment to overheat and damage the engine.

Unsealed batteries on equipment must be filled to the proper level with water and maintained at this level at all times. Use distilled water when possible.

Air. Some hydraulic sprayers (those with pressure domes) and the compressed-air duster require precharging before operation.

Vehicle tires must be inflated and maintained with the proper air pressure to prevent uneven wear and blowouts.

NOTE: Use extreme caution at all times when servicing equipment with air, and always service equipment according to the information provided in the appropriate publication.

Exercises (448):

Identify the statements below as true (T) or false (F). Make corrections to any false statements.

____ 1. Improper servicing may cause equipment not to operate.

____ 2. If not properly serviced, the equipment will not operate.

____ 3. The type of fuel used in equipment is not important as long as it runs.

____ 4. Overfilling tanks is hazardous.

____ 5. The type of lubricant used depends on the equipment.

_____ 6. The type of oil used in gearboxes is SAE 30W detergent.

_____ 7. When greasing equipment, apply the grease until it begins to ooze.

_____ 8. Water is not required in dispersal equipment engines.

_____ 9. Service batteries with distilled water when possible.

_____ 10. Vehicle tires are the only components requiring air on dispersal equipment.

449. Point out reasons and requirements for making adjustments to equipment components?

Adjusting equipment. Many items of powered dispersal equipment, especially the items of equipment that are nonportable, have several components that require periodic adjusting. Proper adjustments must be made in order for the equipment to operate effectively and safely. All adjustments must be made in the manner specified by the appropriate equipment operation publication.

Spark plugs. Most manufacturer's operation manuals specify the frequency for inspecting, cleaning, and replacing spark plugs. However, you can inspect plugs more frequently for proper gap settings. Before installing new spark plugs into equipment, adjust the spark gap by gently spreading or squeezing the ground electrode away from the center electrode or toward the center electrode, as directed by the manufacturer's specifications.

NOTE: When removing or installing spark plugs, use a spark plug socket wrench and apply straight and even pressure on the wrench as you turn it to avoid breaking the porcelain that surrounds the plug. Tighten the plug snugly into the block but don't overtighten it.

Points. Points must be adjusted according to the equipment manufacturer's specifications. Points require periodic inspections to determine their condition. Burned point contacts can and most often will cause the engine to run very rough, or may keep it from running at all. Points that are being installed must be adjusted after they have been placed inside the distributor by using a point gauge and a screwdriver. Make sure the ignition switch is off or the battery is disconnected before you begin working with points.

Carburetor. Many items of powered dispersal equipment come with a preset governor to control the engine rpm. The governor should never be tampered with; however, idle screws and fuel/air-mixture screws on the carburetor do require minor adjustments from time to time. These adjustments must be in accordance with the manufacturer's recommendations and can be done with a small screwdriver or open-end wrench.

Control valves. Control valves require frequent adjustments that are determined by the amount of flow desired or engine rpm you want.

Drive pulleys. Pulleys must be properly aligned on pulley shafts to prevent excessive wear to drive belts and pulley shafts. Extreme vibrations and poor pump operation in equipment can also be caused by improperly aligned pulleys. Pulleys must be adjusted to the proper distance between pulleys to provide proper tension on drive belts. As a general rule, allow ¾ inch of sag for each foot of distance between pulley centers when you apply thumb pressure to the belt.

Exercises (449):

1. Why are proper equipment adjustments necessary?

2. What actions should you periodically take regarding spark plugs? How often?

3. Why must points be periodically inspected, adjusted or replaced?

4. What setting on a carburetor can you adjust? Not adjust?

5. For what reasons are control valves adjusted?

6. What impact may improperly aligned pulleys have on an equipment item?

7. What rule should you follow to obtain proper pulley adjustment?

450. Indicate whether given statements correctly reflect policies and procedures in repairing pesticide dispersal equipment.

Repairing Equipment. Repairing pesticide dispersal equipment can be a very challenging and interesting task, especially if you happen to be mechanically inclined. There are many repairs that are simple to do, but others may be more difficult; for example, replacing a plunger cup on a compressed-air sprayer is a very simple repair task, but freeing a sticking valve in an engine can be very difficult.

Most repairs are done by either replacing parts of a component or replacing the entire component. Naturally, it is less expensive to replace parts than to replace the component; therefore you should repair equipment by replacing parts rather than the entire component when possible.

An adequate supply of parts and components that require frequent replacement should be maintained within the section at all times to speed up repairs to equipment. Most manufacturers of equipment provide a complete parts list in the equipment operations manual for that item of equipment to assist you in ordering replacement items. The manufacturer is the best source for obtaining parts and information pertaining to the equipment. In many cases, the manufacturer is the only source for obtaining certain parts for the equipment.

Control valves, pumps, and spray guns are equipment components that normally require frequent repairs. Generally, repairing these components requires replacing certain parts such as valve seats, O-rings, packing, gaskets, springs, gears, bearings, and pistons.

Inoperative or damaged indicator gauges, shaft bearings, hoses, and drive belts are components that should always be replaced instead of repaired. When pump and control valve housings are cracked, replacement of these components is normally required.

Replacing parts in a carburetor can be very tedious and should not be attempted by an unskilled individual or without specific instructions. Repairing carburetors requires exactness.

Exercises (450):

Identify the following statements as true (T) or false (F) and correct any false statements.

_____ 1. Most repairs are done by replacing parts or complete components.

_____ 2. Equipment repairs are done by replacing components when possible.

_____ 3. A parts supply is not maintained within the section.

_____ 4. The manufacturer's manual usually contains a parts list.

_____ 5. Control valves, pumps, and spray guns do not usually require frequent repairs.

_____ 6. Replacing carburetor parts requires a skilled technician.

3-4. Calibrating Equipment

The final step in preparing your equipment for effective and safe application of pesticides is calibrating the equipment.

You can select the right equipment for the job, have it in proper operating condition, adhere to safety precautions, and operate the equipment properly, and still not be able to do the job effectively and safely without calibrating it.

Calibration is simply adjusting your equipment to apply the desired rate of pesticide. You need to do this so that you can be sure you are using each pesticide as directed on the label. Too much pesticide is dangerous; too little will not do a good job. Only by calibrating correctly can you safely get the best results.

After you have completed this section, you will understand the procedures used for calibrating equipment, which is a must for pest managers.

451. Specify procedures used for calibrating pesticide dispersal equipment.

There are many ways to calibrate equipment. The preferred methods differ according to the type of equipment that is to be used.

Calibrating Sprayers. To apply a pesticide evenly and accurately, your sprayer must move at a constant speed. It must also operate at a constant pressure. Each nozzle must be clean, at the right height and of the correct type and size for the job. All nozzles in the system must deliver its rated amount of pesticide.

First, choose the speed, pumping pressure, and nozzle or nozzles that you want to use. Fill the spray tank with water and operate the sprayer in place to fill the plumbing. Top off the tank and spray a measured area as if you were applying the pesticide. Measure the amount of water needed to refill your tank. This is the application rate per unit of area. If it takes 8 gallons to refill the tank after spraying 1 acre, you are spraying at the rate of 8 gallons per acre. If your sprayer has a tank of more than 100 gallons capacity, you should spray an area large enough to use at least 10 percent of the tank capacity.

If your sprayer is delivering more or less spray than the label directs, you can change the rate three ways:

(1) You can change the pressure. Lower pressure means less spray delivered; higher pressure means more spray delivered. This is NOT a good method, however, because a pressure change may change the nozzle pattern and droplet size. Pressure must be increased four times to double the output.

(2) You can change the speed of your sprayer. Slower speed means more spray delivered; faster speed means less spray delivered. This method is practical for small changes in delivery rate. If you drive half as fast, you double the delivery rate.

(3) You can change the nozzle tips to change the amount

delivered. The larger the hole in the tip, the more spray delivered. This is the best method of making major changes in the delivery rate of sprayers. Always select nozzles for the job you want done. Use the manufacturer's performance charts to make your selection.

After making a change, recalibrate your sprayer to make sure the rate is correct.

You have adjusted your sprayers, and you know how many gallons of spray per unit of area your equipment will apply. Next, you must find out how much pesticide to put in the tank to apply the correct dosage of pesticide. To do this you need to know two more facts:

(1) How much your sprayer tank holds.

(2) The amount of formulation to be used per unit of area. This will be given on the label.

Suppose your tank holds 50 gallons of spray. The directions say to apply 1 pint of formulation on each acre. In our example, you found that your sprayer applies 8 gallons per acre. First, find the number of acres one tank load will spray. Divide 50 gallons by 8.

$$\frac{50 \text{ gallons per tankful}}{8 \text{ gallons per acre}} = 6\tfrac{1}{4} \text{ acres per tankful}$$

To find the amount of formulation, you must add to your tank so you can spray 6¼ acres with 1 pint per acre, and multiply 1 pint by 6¼.

$$1 \text{ pint per acre} \times 6\tfrac{1}{4} \text{ acres per tankful} = 6\tfrac{1}{4} \text{ pints per tankful.}$$

Suppose the formulation of a pesticide is a 50-percent wettable powder and you want to apply ½ pound of active ingredient per acre. In our example, your tank will cover 6¼ acres.

Find how many pounds of formulation are needed to apply ½ pound of active ingredient per acre. There is ½ pound of active ingredient in 1 pound of 50-percent wettable powder formulation. So you need to use 1 pound of formulation for each acre your sprayer will cover.

$$1 \text{ pound per acre} \times 6\tfrac{1}{4} \text{ acres per tankful} = 6\tfrac{1}{4} \text{ pounds per tankful.}$$

You should add the 6¼ pounds of wettable powder to a small amount of water in a clean bucket. Stir until it is mixed well, and then add this mixture (called a slurry) to the partly filled tank. Remember to operate the sprayer's agitator while adding the slurry and filling the tank.

Even after your sprayer is calibrated, recheck it often. Be sure you are spraying the same size area for each tankful you figured on. If you are spraying more or less acres than you planned, stop spraying and recalibrate. If you have figured wrong or your sprayer changes its delivery rate, you will be able to catch it before you make a major mistake.

Calibrating Dusters and Granular Applicators. These items of equipment are calibrated as follows:

a. Read the manufacturer's operator's manual. Follow these instructions to set the gate openings for the product you are going to use.

CAUTION: Always set the openings from the same direction, such as from closed to open. This will minimize variations in settings.

b. Fill each hopper to an easily determined level, typically 25 percent of capacity.

c. Operate the equipment over a measured area or distance at your normal working speed. The area should be large enough to use most of the hopper contents.

d. Refill the hopper to the same level, weighing the amount of pesticide needed to replace what was used.

e. The amount of pesticide it takes to refill the hopper is the amount applied to the measured area. If the amount applied does not fall within 5 percent of the recommended dosage per unit of area, reset the gate opening and repeat the previous three steps.

f. Keep a record of the area treated with each filling of the hopper. This will let you see any slight change in rate of application and make the necessary adjustments.

Calibrating ULV dispensers. In this method, allow the machine to run until the air pressure in the insecticide tank builds up to normal. Then shut off the engine and retain air pressure in the insecticide tank. With the adjustable insecticide discharge nozzle set in a horizontal position, the insecticide flow from the nozzle can be directed into and contained in the beaker or measuring container because it emerges in the form of a gentle, solid stream. Since the engine is stopped and no air is being pumped through the nozzle, the fluid output from the nozzle is not aerosolized and of course there is also no air blast to interfere. The solenoid valve functions to turn the insecticide flow on and off, just as in normal operation. The engine on-off switch must be in the ON position. The flow rate can be adjusted by the flowmeter control valve and monitored by the flowmeter reading, just as in normal operation.

Be sure to return engine switch to "OFF" position, after using this procedures.

Exercises (451):

1. What is required to apply a pesticide evenly and accurately?

2. If your sprayer has a tank capacity of 100 gallons or more, you should spray an area large enough to use how much of the tank capacity?

3. What is the best method of changing the delivery rate?

4. What percentage of a hopper capacity should you fill when calibrating a duster or granular spreader?

5. In calibrating a ULV generator, how long do you run the engine?

6. How is the flow rate adjusted and monitored on the ULV generator?

Answers for Exercises

CHAPTER 1

References:

400 - 1. The study of the relationship between living things and their environment.
400 - 2. The thin layer of the atmosphere where life exists.
400 - 3. Abiotic elements are required for the growth and development of the biotic elements.
400 - 4. Green plants transpose carbon dioxide into oxygen, which is needed by animals. Then the animals expel carbon dioxide, which plants need for photosynthesis.
400 - 5. Green plants. Because only they can make food from sunlight and inorganic matter.
400 - 6. Minute green plants and consumers of green plant matter. They produce 70 percent of the Earth's oxygen.
400 - 7. These act as decomposers of dead plants and animals. They return essential organic matter to the soil, supporting more plant, and thus, animal, growth.

401 - 1. In food production and property protection.
401 - 2. Reduces insect-related diseases and populations of venomous pests.
401 - 3. The effect they may have on nontarget organisms.
401 - 4. If we used pesticides consistently without regard for their hazards.
401 - 5. Soil contamination can result when the rain cleanses the atmosphere, trees, shrubs, grasses, and structures of chemical particles.
401 - 6. The process of a chemical compound being transformed into one more toxic than the original substance.

402 - 1. The ability of a pest population to withstand pesticide treatments that were generally lethal to earlier populations.
402 - 2. Physiological resistance is the ability of an organism to physically negate the effects of the pesticide. Behavioristic resistance refers to their ability to move to a new habitat or to avoid contact with pesticides.
402 - 3.
  a. Poison is absorbed too slowly by some pests for them to receive a lethal dose.
  b. The ability of some pests to transfer body system functions from damaged body systems to undamaged ones.

403 - 1. The ability of one or more pests within a population to withstand pesticide treatments that are lethal to other pests within the population.
403 - 2. The main difference is that pesticide resistance can be inherited, while tolerance is acquired.
403 - 3.
  a. Use IPM to the fullest possible extent.
  b. Insure proper sanitation.
  c. Use pesticides in accordance with label instructions.
  d. Place pesticides in locations where pests will be forced into contact with them.

404 - 1.
  a. Carefully determine pest management program requirements.
  b. Implement nonchemical control when possible.
  c. Use chemical controls as a last resort.

404 - 2. Survey the concerned area.
404 - 3. Only after you have determined that natural controls aren't adequate.
404 - 4. Nonchemical controls.
404 - 5. Yes.
404 - 6. Because they are designed to forestall buildups of pest populations, and they are almost always more effective and economical in the long run.
404 - 7. Because mechanical and other nonchemical controls may be inadequate, or because of natural disasters and migrating pest populations.
404 - 8. By mixing and applying pesticides in accordance with the pesticide label.

CHAPTER 2

405 - 1. Herbicide.
405 - 2. Ovicide.
405 - 3. Contact poison.
405 - 4. Rodenticide.
405 - 5. Adulticide, insecticide, contact.
405 - 6. Preemergence herbicide.
405 - 7. Stomach.

406 - 1. The likelihood that a compound will cause death or injury in a given situation.
406 - 2. The ability of compound to cause death or injury when used in a particular way.
406 - 3. It's the lethal dose of a toxicant necessary to kill 50 percent of the test animals.
406 - 4. Milligrams toxicant necessary to kill 1 kilogram of body weight.
406 - 5. The exposure routes. Oral exposure.

407 - 1. They are derived from phosphoric acid, and they work as cholinesterase inhibitors.
407 - 2. They are biodegradable and don't accumulate in human tissue.
407 - 3.
  (1) f.
  (2) g.
  (3) c.
  (4) a.
  (5) i.
  (6) e.
  (7) h.
  (8) b.
  (9) d.

408 - 1. Because they break down rapidly within the environment.
408 - 2. They inhibit production of the enzyme cholinesterase and attack the nervous system.
408 - 3. The acute oral toxicity is high, but the acute dermal toxicity is low.
408 - 4. Wear protective clothing and equipment, and don't smoke, eat, or drink when handling carbamates.
408 - 5.
  (1) b.
  (2) a.
  (3) c.

(4) a.
(5) c.
(6) b.

409 - 1. Because they are very persistent in the environment.
409 - 2. Only under buildings for termite treatment.
409 - 3. It acts as a stomach and contact poison, and as a fumigant.
409 - 4. Always wear gloves to handle it, avoid contamination of food and water sources, and no smoking, eating, or drinking when handling it.
409 - 5. As a bait for cockroach and ant control.
409 - 6. To protect wood from attack by termites, fungi, and lyctus beetles.
409 - 7. As an oil solution or a creamy emulsion paste.

410 - 1. (1) b.
(2) f.
(3) a.
(4) e.
(5) c.
(6) d.

411 - 1. (1) d.
(2) a.
(3) b.
(4) g.
(5) f.
(6) c.
(7) e.

412 - 1. They reduce the blood's ability to clot, resulting in internal bleeding and eventual death.
412 - 2. Their low effective concentrations alm[illegible] ate the hazard of acute toxicity to people and great[illegible] ce hazards to domestic animals.
412 - 3. (1) b.
(2) c.
(3) a.
(4) d.

413 - 1. Because it's highly toxic and slowly releases phosphine gas.
413 - 2. One percent.
413 - 3. You must take every precaution to avoid food and water contamination, and to prevent children and animals from coming in contact with it.
413 - 4. As a premixed bait and tracking powder.
413 - 5. They act as single-dose anticoagulants instead of multiple-dose, and they control resistant rodents.
413 - 6. Remove and bury rodent bodies and uneaten bait.

414 - 1. For gassing rodent burrows outdoors.
414 - 2. It kills both the rodent and disease-vectoring fleas and mites.
414 - 3.
a. Never use it near a building occupied by people.
b. Only allow well-trained people to use it.
c. Stand upwind when you use it.
d. Use appropriate gas masks and canisters.

414 - 4.
a. When burrows are within 15 feet of a building.
b. If burrows possibly open into or under a building.
c. When restrictions apply regarding endangered species.
d. When special local restrictions apply.

415 - 1. (1) b.
(2) c.
(3) c.
(4) a.
(5) b.
(6) a.

416 - 1. Plant; animal; mineral.
416 - 2. Organic.
416 - 3. Postemergence.
416 - 4. Insure that these compounds don't contaminate any water source during or after applicatio[illegible]

417 - 1. They are moderately toxic herbicides.
417 - 2.
a. They won't likely irritate skin or eyes.
b. They aren't readily absorbed through the skin.
c. Amounts likely to be inhaled aren't hazardous.
d. Ingestion of harmful amounts isn't likely.

417 - 3. To control herbaceous broadleaf weeds.
417 - 4. On warm, sunny days when photosynthesis is active.
417 - 5. Depending on the weeds being controlled, it may be more or less effective than 2,4-D.

418 - 1. As soil sterilants.
418 - 2. They are only slightly soluble in water, have a low volatility, are noncorrosive and nonflammable.
418 - 3. As water-dispersible powders and granular products.
418 - 4. They don't move far laterally, but may be washed down slopes to kill vegetation below, and they leach deeply to affect vegetation with deep roots.
418 - 5. (1) d.
(2) b.
(3) c.
(4) a.

419 - 1. Soil sterilants.
419 - 2. Simazine.
419 - 3. Atrazine.
419 - 4. Simazine.

420 - 1. DNAP, DNBP and DNC; they are yellow dyes and are not soluble in water, but are in oil.
420 - 2. They are highly poisonous if swallowed, absorbed through the skin or inhaled.
420 - 3. As nonselective, contact herbicides.
420 - 4. Herbaceous.

421 - 1. They are translocated and kill through both root and foliage absorption.
421 - 2. Dicamba.
421 - 3. Wear protective equipment and clothing.

422 - 1. Sodium salt.
422 - 2. As selective translocative, preemergence, and postemergence herbicides.
422 - 3. TCA.
422 - 4. Grasses.
422 - 5.
a. Don't apply near desired vegetation.
b. Don't apply near irrigation water.
c. Don't apply when heavy rains are expected.

422 - 6. Washed, corrosive.

423 - 1. (1) a.
(2) d.
(3) f.
(4) c.
(5) b.
(6) e.

424 - 1. (1) See exercise No. 1 in text.
(2) a. Chlorinated hydrocarbon.
b. Snow mold and pythium blight.
c. Slightly toxic.
(3) a. Carbamate.
b. Leaf spot, rust, and brown patch.
c. Slightly toxic.
(4) a. Systemic fungicide.
b. Dutch elm disease, sycamore anthracnose.
c. Slightly toxic.
(5) a. Systemic fungicide.
b. Use to control diseases on flowers, turf, tree, and other foliage.
c. Moderately toxic.
(6) a. Fungicide, seed protectant, animal repellent.
b. Any three of the following: damping off, seedling blights, brown patch, dollar spot, and snow mold.
c. Slightly toxic.

d. Protects shrubs and ornamentals from rabbit and deer depredation.

425 - 1. (1) e.
(2) a.
(3) d.
(4) f.
(5) h.
(6) c.
(7) g.
(8) b.
(9) h.
(10) i.

426 - 1. (1) e.
(2) i.
(3) d.
(4) h.
(5) g.
(6) f.
(7) b.
(8) c.
(9) a.

427 - 1. Step 1: 1 gallon per 5 acres.
Step 2: 20 acres.
Step 3: $20 \div 5 = 4$ "groups of 5 acres."
Step 4: $4 \times 1 = 4$ gallons of concentrate.

427 - 2. Step 1: 1 quart per acre.
Step 2: First convert miles to feet:
$2.5 \times 5{,}280 = 13{,}200$ feet
Step 2: Second, find total square feet:
13,200 (length) × 2 (width) = 26,400 square feet
Step 3: Convert square feet to acres:
$26{,}400 \times 23 = 607{,}200.0$
Move decimal place 6 places to get .607200, and round off to .6 acre.
Step 4: 1 quart × .6 acre = .6 quart. Since there are 32 ounces in a quart, multiply .6 × 32 to get *19.2 fluid ounces concentrate.*

CHAPTER 3

428 - 1. Because different pests require different controls and therefore require different types of equipment.
428 - 2. Effective.
428 - 3. Available; effectively; safely.
428 - 4. Safe.
428 - 5. Cost; inexpensive.
428 - 6. Durable.

429 - 1. (1) b.
(2) e.
(3) a.
(4) d.
(5) c.
429 - 2. 100.
429 - 3. Size.
429 - 4. Increase.

430 - 1. (1) b.
(2) c.
(3) a.
(4) b.

431 - 1. (1) e.
(2) a.
(3) h.
(4) b.
(5) g.
(6) f.
(7) d.
(8) c.

432 - 1. (1) c.
(2) a.
(3) b.
(4) a.
(5) d.
(6) b.
(7) d.
(8) c.

433 - 1. (1) c.
(2) d.
(3) a.
(4) b.

434 - 1. Polyethylene.
434 - 2. Masking tape.
434 - 3. Sand snakes.
434 - 4. Fans.
434 - 5. Aluminum trays.
434 - 6. Metering.
434 - 7. In moisture-permeable envelopes.
434 - 8. Respiratory.

435 - 1. (1) f, g.
(2) h.
(3) b.
(4) d.
(5) f, j.
(6) a.
(7) e.
(8) c.
(9) i.

436 - 1. a. Type of pump.
b. Pesticide formulation.
c. Pressures.
d. Corrosion, abrasion.
e. Dry, restricted.

436 - 2. (1) b.
(2) a.
(3) b, c.
(4) a.
(5) b, c.

437 - 1. a. Bypass.
b. Mechanical.
437 - 2. In the line between the pump and discharge valve. It serves to prevent wear on other sprayer parts and to provide for bypass agitation.
437 - 3. a. Durable, long lasting, and they don't rust.
b. Heavy to use and expensive.
437 - 4. They are light in weight and comparatively low in cost.
437 - 5. Prevent pump damage and prevent clogged nozzles.
437 - 6. a. To prevent putting too much pressure into the tank and to help you set the pressure regulator or power unloader properly.
b. To help maintain the proper spray pressure so the nozzle performs properly.
437 - 7. To obtain uniform distribution and particle size of pesticide whether the material is placed on a surface or in the air.
437 - 8. Fan, pin stream, solid cone, hollow cone, flooding, and broadcast.
437 - 9. a. Pin stream.
b. Broadcast.
c. Flooding.
d. Flat fan.
437 - 10. A quick-acting valve. To prevent leakage and to give optimum control over where a pesticide is applied.
437 - 11. a. Should be long enough for your intended purpose.
b. Should be of sufficient diameter to carry an adequate chemical flow.
c. Should be made of materials that won't be deteriorated by the chemical you use.

d. Should have a burst strength greater than the peak-operating pressure of the sprayer.

438 - 1. (1) c.
(2) b.
(3) d.
(4) a.

439 - 1. To determine if the equipment is operational.
439 - 2. Before each use.
439 - 3. That the equipment can be operated correctly and safely.
439 - 4. To reflect a true professional pest manager.

440 - 1. 40 Psi.
440 - 2. To prevent damage to the sprayer and possible injury to yourself.
440 - 3. The pump gasket, check valve, piston cup, and hose.
440 - 4. Make sure it's properly charged and the nozzle is clear.
440 - 5. a. Turn on the cylinder valve.
b. Purge air from the hose.
c. Place the ULV jet or injection gun in water and watch for bubbles.

441 - 1. To help treat overhead beams and rafters.
441 - 2. Check the rubber cylinder for cracking and splitting.
441 - 3. Insure the bulb is not cracked and the nozzle is fitted tightly and is not clogged.
441 - 4. Siphon atomizer pump assembly.
441 - 5. Keep the wind to your back and let the dust blow downwind from you.
441 - 6. Fumigating rodent burrows.
441 - 7. Check for obstacles that would prevent the rotating plate from turning, check the crank handle for service attachment, and inspect the grease fitting for dryness or exessive grease.

442 - 1. (1) b.
(2) e.
(3) c.
(4) a.
(5) e.
(6) d.
(7) b.
(8) d.
(9) a.
(10) c.

443 - 1. Boom.
443 - 2. Spray, mist.
443 - 3. The battery water level, terminals, and cables.
443 - 4. Leaks.
443 - 5. Water, talc.
443 - 6. Jewelry, form-fitting.

444 - 1. 20 to 800 psi and are controlled by regulators.
444 - 2. 50 to 600 gallons.
444 - 3. By a rotating agitator.
444 - 4. One, ten.
444 - 5. Operator's manual.
444 - 6. Maximum.

445 - 1. On a small, half-ton pickup truck.
445 - 2. Five to 27 microns.
445 - 3. About 12 microns.
445 - 4. Let the engine warm up.
445 - 5. 12 to 17 psi.
445 - 6. a. Leaking couplings.
b. Fitting and hose leaks.
c. Improper drive belt tension.

446 - 1. Maintenance performed by personnel within the squadron, including operator maintenance.
446 - 2. Cleaning, servicing, adjusting, repairing, replacing, and calibrating.
446 - 3. Appropriate publications.

447 - 1. a. Prevent damage to protective coatings and internal parts.
b. Reduce contamination hazards.
447 - 2. To remove dirt and pesticides from the tank, pump, hoses, and nozzles.
447 - 3. With a solvent such as kerosene or No. 4 fuel oil.
447 - 4. Water; solvent.
447 - 5. Engine components.
447 - 6. Water.
447 - 7. Vacuuming.
447 - 8. Damp, dry.
447 - 9. Steam.
447 -10. Wax.

448 - 1. T.
448 - 2. F. The equipment may operate but could be damaged.
448 - 3. F. Some equipment needs special fuel or a mixture of gasoline and oil.
448 - 4. T.
448 - 5. T.
448 - 6. F. SAE 90W nondetergent for gearboxes; SAE 30W detergent for crankcases.
448 - 7. F. Only on unsealed fittings.
448 - 8. F. Some engines are liquid cooled and water levels must be maintained.
448 - 9. T.
448 -10. F. Some hydraulic sprayers and the compressed air duster require air.

449 - 1. So equipment operates efficiently and safely.
449 - 2. Inspect, clean, and replace them. At least so often as is specified in the manufacturer's instructions.
449 - 3. Because burned contacts or points will cause the engine to run very rough, or may keep it from running at all.
449 - 4. You can adjust idle screws and fuel/air-mixture screws. The governor should never be adjusted.
449 - 5. To adjust the amount of pesticide flow or to regulate engine rpm.
449 - 6. There may be excessive wear to drive belts and pulley shafts, the engine may vibrate heavily, and the pump may operate poorly.
449 - 7. Allow ¾ inch of sag for each foot of distance between pulley centers when you apply thumb pressure to the belt.

450 - 1. T.
450 - 2. F. Parts should be replaced when possible since it's cheaper.
450 - 3. F. Parts should be kept on hand to speed up repairs.
450 - 4. T.
450 - 5. F. These items usually do need frequent repairs.
450 - 6. T.

451 - 1. Moving your sprayer at a constant speed.
451 - 2. At least 10 percent.
451 - 3. Change the nozzle tips.
451 - 4. 25.
451 - 5. Until the air pressure in the insecticide tank builds up to normal.
451 - 6. By adjusting the flowmeter control valve and is monitored by the flowmeter.

AU GAFS, AL (854568) 350

STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 03 22

PEST MANAGEMENT CHEMICALS AND EQUIPMENT

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the *best* answer to each question.

1. (400) The study of the relationship between living things and their environment is called

   a. biology.
   b. ecology.
   c. entomology.
   d. environmentology.

2. (401) The hazard from pesticide drift is greatest during

   a. fogging application.
   b. dust application.
   c. aerial application.
   d. flooding or raining.

3. (402) The ability of a pest population to withstand pesticide treatments which were generally lethal to earlier populations defines

   a. pesticide immunity.
   b. pesticide resistance.
   c. pesticide negation.
   d. pesticide tolerance.

4. (403) Which of the following methods is *not* recommended for preventing pesticide resistance or tolerance?

   a. Use pesticides only when absolutely necessary.
   b. Use pesticides according to label instructions.
   c. Use the strongest possible dosage of pesticide.
   d. Use integrated controls as much as possible.

5. (404) Pesticides should be used *only* when

   a. no other technique will do the job.
   b. the area is overpopulated with pests.
   c. mechanical devices are not effective.
   d. biological methods are not available.

6. (405) Which of these systems is attacked by fumigants?

   a. Digestive.
   b. Nerve.
   c. Respiratory.
   d. Circulatory.

7. (405) A pesticide which kills by ingestion is classified as a

   a. fumigant.
   b. stomach poison.
   c. contact poison.
   d. rodenticide.

8. (406) What terms are used to express the exposure routes of toxicity?

   a. Oral and dermal.
   b. Lungs and skin.
   c. Mouth and skin.
   d. Intravenous and digestive.

9. (407) Which of the following insecticides is incorporated into resin strips which give off toxic vapors for a long time?

   a. Dichlorvos.
   b. Malathion.
   c. Dimethoate.
   d. Propetamphos.

10. (407) Which of these organophosphate insecticides is widely used for ultra low volume spraying for adult mosquitoes?

a. Dichlorvos.
b. Malathion.
c. Propetamphos.
d. Dimethoate.

11. (407) Which organophosphate insecticide is low in odor, generally nonstaining, and can be used in several areas except where food is processed or prepared?

a. Dursban.
b. Diazinon.
c. Propetamphos.
d. Malathion.

12. (408) Which of the following carbamate insecticides should *never* be stored with other pesticides having a strong odor?

a. Bendiocarb.
b. Carbaryl.
c. Propoxur.
d. SMDC.

13. (409) Which organochlorine may be mixed with peanut butter or other materials for use as a cockroach and ant bait?

a. Chlordane.
b. Chlordecone.
c. Lindane.
d. Methoxychlor.

14. (409) The organochlorine pesticide used to preserve and protect wood from termites, fungi, and lyctus beetles is

a. pentachlorophenol.
b. methoxychlor.
c. chlordecone.
d. chlordane.

15. (410) The insecticidal fumigant which is nonflammable and noncorrosive, and is used for fumigating buildings with drywood termites is

a. aluminum phosphide.
b. methyl bromide.
c. sufuryl fluoride.
d. dichlorovos.

16. (410) Which of these insecticidal fumigants is nonflammable, heavier than air and has chloropicrin added as a warning agent?

a. Paradichlorobenzene.
b. Aluminum phosphide.
c. Sulfuryl fluoride.
d. Methyl bromide.

17. (411) Which of these pesticides is highly effective but slow acting against fire ant colonies?

a. Amdro.
b. Boric acid.
c. Methoprene.
d. Silica aerogel.

18. (411) A powdery, light pesticide which causes a loss of body fluids in insects is

a. pyrethrum.
b. resmethrin.
c. boric acid.
d. silica aerogel.

19. (412) How do anticoagulant rodenticides work?

a. By reducing the rodent's ability to digest food.
b. By reducing the blood's clotting ability.
c. By causing heart paralysis.
d. By causing the rodent's body to dehydrate.

20. (412) Which of these rodenticides requires a stabilizing agent to be added for making water baits?

a. Warfarin.
b. Fumarin.
c. Diphacinone.
d. Pival.

21. (413) Which of the following rodenticides is capable of acting as a single-dose anticoagulant?

a. Thallium sulfate.
b. Zinc phosphide.
c. Brodifacoum.
d. Diphacinone.

22. (413) Because of its toxic vapors, which rodenticide should be handled outdoors or in well-ventilated areas?

a. Zinc phosphide.
b. Thallium sulfate.
c. Strychnine.
d. Pival.

23. (414) Which of the following products are used as fumigants in rodent burrows?

a. Methyl bromide and chloropicrin.
b. Calcium cyanide and aluminum phosphide
c. Aluminum phosphide and methyl bromide.
d. Chloropicrin and calcium cyanide.

24. (414) What condition triggers the release of gas in rodenticidal fumigants?

a. Very dry ground conditions.
b. Contact with body hairs.
c. Moisture in the air.
d. Temperatures over 65° F.

25. (414) Aluminum phosphide should *not* be used within how many feet of an occupied structure?

a. 15.
b. 20.
c. 25.
d. 30.

26. (415) Which of these avicides can be used as a repellant at low concentrations?

a. Ornitrol.
b. Avitrol.
c. DRC-1339.
d. BCR-180.

27. (415) A chemical which results in sterility in pigeons is

a. Starlicide.
b. DRC-1339.
c. Ornitrol.
d. Avitrol.

28. (416) Arsenical compounds should *not* be used as

a. aquatic herbicides.
b. terrestrial herbicides.
c. postemergence herbicides.
d. turf herbicides.

29. (417) The phenoxy formulations are

a. moderately toxic.
b. corrosive.
c. highly toxic.
d. nontoxic.

30. (418) Phenylureas are used as

a. general herbicides.
b. selective herbicides.
c. growth retardants.
d. soil sterilants.

31. (418) What type of soil is *best* suited for the application of monuron?

a. Sandy soils with high organic content.
b. Sandy soils with high mineral content.
c. Light clay soils with high mineral content.
d. Light clay soils with high organic content.

32. (419) Under what conditions is a simazine *most* desirable to use as a soil sterilant?

a. When you do not want to kill aquatic plants.
b. When selected plants are to be killed.
c. Where the soil has a high clay content.
d. Where any plant growth is undesirable.

33. (419) Atrazine is more effective in dry areas than Simazine because Atrazine is

a. less soluble.
b. more penetrating.
c. more soluble.
d. less penetrating.

34. (420) How are dinitro compounds generally used?

a. As soil sterilants and preemergence herbicides.
b. As contact herbicides and to fortify oils.
c. Only as soil sterilants.
d. Only as contact herbicides.

35. (420) As contact herbicides, dinitto compounds are highly effective against what type of vegetation?

a. Cool-season grasses.
b. Warm-season grasses.
c. Woody ornamentals.
d. Herbaceous plants.

36. (421) Which of the following pests is controlled by the use of benzoic acid compounds?

a. Spiders and mites.
b. Mosquitoes and flies.
c. Perennial and annual weeds.
d. Cockroaches and bedbugs.

37. (421) What precautions must be taken when using benzoic acid solutions?

a. Be alert for fire and explosion.
b. Do not use on broad leaf plants.
c. Apply on windy days to insure good coverage.
d. Wear protective clothing and avoid drifts.

38. (422) What are the *most* commonly used forms of alaphatic acids?

a. Powder or emulsifiable concentrates.
b. Pellets or emulsifiable concentrates.
c. Pellets or solutions.
d. Powder or pellets.

39. (422) Since TCA has a higher percentage of sodium salt than Dalapon, how is it more commonly used?

a. As a contact herbicide.
b. As a temporary soil sterilant.
c. As a herbicide and fungicide.
d. As a fungicide and nematicide.

10. (423) Which of the following chemicals is a nonvolatile, nonflammable, and nonselective aquatic herbicide?

a. Diquat.
b. Paraquat.
c. Glyphosate.
d. Trifluraline.

11. (423) Which of these herbicides is nonselective and can be applied in the spring, summer, or fall for cropland or noncropland weed control?

a. Trifluraline.
b. Glyphosate.
c. Endothall.
d. Bromacil.

12. (424) Which of the following is a chlorinated hydrocarbon fungicide used to control snow mold and pythium blight?

a. Methyl thiophanate.
b. Thiabendazole.
c. Benomyl.
d. Chloroneb.

13. (425) A substance that produces sensory stimulation is called

a. an attractant.
b. a dessicant.
c. a solvent.
d. an emulsifier.

14. (425) Sulfonated oils are used as a

a. sticking agent.
b. masking agent.
c. wetting agent.
d. synergist agent.

15. (426) Solution concentrates that are diluted at their destination are called

a. emulsifiable solutions.
b. field strength solutions.
c. anticaking solutions.
d. wettable powder.

16. (426) Emulsifiable concentrates consist of a

a. field strength solution, wettable powders, and an emulsifying agent.
b. technical grade pesticide, an inert carrier, and a solvent.
c. technical grade pesticide, a solvent, and an emulsifying agent.
d. wettable powder, water, and a solvent.

17. (426) Emulsions or solutions diluted to field strength are called

a. emulsifiable concentrates.
b. pesticide solution.
c. finished sprays.
d. inert carrier.

18. (427) You are to treat a 3600-square-foot area with a wettable powder turf fungicide containing 2.5 pounds active ingredient per bag. The application rate is .5 pound per 1000 square feet. How many pounds of active ingredient will you use?

a. 1.8 pounds.
b. 3.6 pounds.
c. 5.4 pounds.
d. 7.2 pounds.

19. (427) If an insecticide label states an application rate of 5 pounds per acre and the product contains 4 pounds of active ingredient per gallon, how many pounds are needed to treat an area 3 miles long and 150 feet wide?

a. 218.4 pounds.
b. 273.0 pounds.
c. 515.0 pounds.
d. 546.5 pounds.

50. (128) When you are selecting special equipment to be used for a particular pest management situation, you should refer to the

a. Table of Insects.
b. Table of Allowance.
c. Table of Equipment.
d. Cost vs Life Table.

51. (129) The effectiveness of pesticide

a. decreases with an increase of its exposed surface.
b. decreases with a decrease of its exposed surface.
c. increases with a decrease of its exposed surface.
d. increases with an increase of its exposed surface.

52. (130) Which manual sprayer is *best* suited for flushing insects from cracks and crevices?

a. Compressed-air sprayer.
b. Pressurized cylinder.
c. Aerosol dispenser.
d. Siphon atomizer.

53. (130) Which spray system is *best* suited for injecting fine pesticide particles into cracks and wall voids?

a. Siphon atomizer.
b. Pressurized cylinder.
c. Aerosol dispenser.
d. Compressed-air sprayer.

54. (130) Which of the following pieces of spray equipment is *most* widely used by pest managers?

a. Compressed air sprayer.
b. Disposable aerosol dispenser.
c. Refillable aerosol dispenser.
d. Siphon atomizer.

55. (131) When neatness and careful placement of insecticidal dust are required, which duster should be used?

a. Hand bellows.
b. Hand shaker
c. Hand plunger duster.
d. Rotary hand duster.

56. (131) What type pesticide equipment is *best* suited for applying pesticide over small outdoor ground areas?

a. Hand shakers.
b. Hand bellows.
c. Foot pump dusters.
d. Granular spreaders.

57. (132) Which of the following pieces of portable powered equipment are primarily designed to apply highly concentrated pesticide formulations?

a. Frame-mounted hydraulic sprayers.
b. Backpack mist-dust blowers.
c. Hand-carried thermal fog generators.
d. Hand-carried ultra-low volume generators.

58. (133) Which of the following pieces of nonportable powered equipment are designed to disperse liquid, dust, and granular formulations?

a. Trailer-mounted hydraulic sprayers.
b. Mechanical aerosol generators.
c. Thermal fog generators.
d. Mist dust blowers.

59. (133) Which of these equipment items can you use to apply undiluted pesticides at extremely low rates?

a. Nonportable ULV generator.
b. Boomless hydraulic sprayer.
c. Boom hydraulic sprayer.
d. Mist-dust blower.

60. (134) What is a *primary* requirement for inplace stock and structural fumigation operations?

a. All openings must be taped.
b. All pesticides used must be nontoxic to humans.
c. A liquid-tight cover over the stack or building.
d. An air-tight cover over the stack or building.

61. (134) What is the purpose of a sand snake in the fumigation process?

a. To seal the corners of stack or buildings.
b. To seal the air-tight cover at the floor or ground.
c. To act as a weight for covers at roof edges.
d. To act as a weight for door and window ledges.

62. (135) Which of the following traps are *best* suited for crawling pests where the use of pesticides would be unsafe?

a. Baited jar traps.
b. Light traps.
c. Cage traps.
d. Snap traps.

63. (135) Which type of rodent trap is recommended for trapping rodents in areas where baits and snap traps would be hazardous?

a. Light trap.
b. Glue board.
c. Baited jar trap.
d. Bal-Chatri trap.

64. (136) Which of the following pumps provides a large volume at a moderate pressure?

a. Rotary gear.
b. Piston.
c. Centrifugal.
d. Diaphragm.

65. (136) Which of the following pumps is suitable for high pressure, stands abrasives well, and is easy and inexpensive to repair?

a. Diaphragm.
b. Piston.
c. Nylon-roller.
d. Rubber-impellar.

66. (137) What type of sprayer tank is *best* for large pest control operations?

a. Fiberglass.
b. Stainless steel.
c. Steel.
d. Plastic.

67. (137) The *most* suitable tanks for use in pest control operations are

a. plastic and iron.
b. iron and stainless steel.
c. fiberglass and stainless steel.
d. fiberglass and plastic.

68. (138) What is indicated by the number 9 on a disc nozzle?

a. The output is .9 gal per minute.
b. The output is rated at 90 psi.
c. The spray angle is 90°.
d. The disc has a 9/64 opening.

69. (438) Select the Teejet nozzle you should use to spray an emulsion on an ordinary surface at an angle of 60° with rate of 0.3 gallons per minute at 40 psi.

a. A 3006 nozzle.
b. A 3008 nozzle.
c. A 6003 nozzle.
d. An 8003 nozzle.

70. (439) A preoperation inspection should be performed on your equipment before

a. every operation.
b. the first operation of the day.
c. the first operation of the week.
d. the first operation in the morning and afternoon.

71. (440) What is the *final* step in the preoperational inspection of a compressed air sprayer?

a. Place the pressurized tank under water to check for leaks.
b. Pressurize without liquid to see if it will hold.
c. Fill with pesticide and start spraying.
d. Test with plain water.

72. (441) Which of the following precautions is standard for operating *most* manual dusters?

a. Insure proper lubrication and adjustments.
b. Operate them with the wind at your back.
c. Use an inert dust for preoperational inspection.
d. Do not try to carry them by yourself.

73. (442) What is the *final* step in the operating procedures for the backpack mist-dust blower?

a. Shut off pesticide before stopping engine to clear chamber.
b. Shut off fuel to engine to stop it.
c. Operate the engine at low rpm prior to shutdown.
d. Use all pesticide in unit before stopping.

74. (442) When operating a high-pressure pesticide sprayer, the pressure regulator should be set at

a. 200 PSI.
b. 175 PSI.
c. 150 PSI.
d. 125 PSI.

75. (443) Before you start the nonportable mist-dust blower, you should make sure that the boom is

a. removed.
b. pointed upward.
c. pointed downward.
d. in a horizontal position.

76. (443) What materials are recommended for conducting the operational test on a nonportable mist-dust blower?

a. Emulsion or granules.
b. Solution or granules.
c. Emulsion or talc.
d. Water or talc.

77. (443) After you have started the nonportable mist-dust blower, what should your *final* check ensure?

a. Proper pesticide flow and air velocity.
b. No leaks and all parts are operational.
c. Correct pesticidal formulation and clean water.
d. Proper air velocity and throttle operation.

78. (444) For the trailer-mounted hydraulic sprayer, you should *not* generally allow pump pressure to exceed

a. 200 PSI.
b. 300 PSI.
c. 400 PSI.
d. 500 PSI.

79. (444) What are the minimum and maximum rotations per minute (RPM) for engines on trailer-mounted hydraulic sprayers?

a. 1500 to 2500.
b. 1500 to 2800.
c. 1800 to 2500.
d. 1800 to 2800.

80. (445) If the engine of a nonportable ultra-low volume generator is operating at 2500 rpm and proper pressure cannot be maintained, *most* likely the

a. engine vacuum is low.
b. drive belt tension is loose.
c. viscosity of pesticide is too high.
d. lines are clogged with pesticide residue.

81. (445) After you have started the nonportable ULV generator, you should check all of the following *except*

a. leaks.
b. excessive vibration.
c. pulley alignment.
d. pesticide level.

82. (446) Which of the following types of maintenance is *not* considered organizational maintenance?

a. Equipment repair.
b. Component replacement.
c. Equipment overhaul.
d. Calibration and adjustment of controls.

83. (447) To triple rinse equipment, you should use

a. two rinses with detergent and water, and one rinse with clear water.
b. one rinse with detergent and water, and two rinses with clear water.
c. three separate rinses with detergent and water.
d. three separate rinses with plain water.

84. (447) Equipment designed for applying dusts and/or granules is *best* cleaned by

a. vacuuming.
b. washing.
c. flushing.
d. rinsing.

85. (448) What type of oil is generally used in the engine block of *most* powered dispersal equipment?

a. SAE 90W nondetergent.
b. SAE 30W nondetergent oil.
c. SAE 30W detergent oil.
d. SAE 10-40W detergent oil.

86. (449) The key reasons for adjusting equipment properly are

a. efficiency and cost effectiveness.
b. safety and durability.
c. cost effectiveness and safety.
d. efficiency and safety.

87. (449) What actions should you periodically take regarding contact points on an engine?

a. Repair and adjust.
b. Repair, adjust, and replace.
c. Inspect, adjust, and replace.
d. Adjust, repair, and inspect.

88. (150) Which of the following components is normally repaired rather than replaced?

a. Worn drive belts.
b. Damaged shaft bearings.
c. Inoperative indicator gauges.
d. Spray guns.

89. (150) Which of the following components is normally replaced in. .ead of repaired?

a. Sprayer pumps.
b. Carburetors.
c. Spray guns.
d. Gauges.

90. (151) In calibrating sprayers, what original choices *must* you make?

a. Speed, pump pressure, and nozzles to use.
b. Size at areas, speed, and pump pressure.
c. Nozzles to use, size of area, and speed.
d. Pump pressure, nozzles to use, and size of area.

END OF EXERCISE

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012 and EO 9397. PRINCIPAL PURPOSES: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package. It is utilized by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's need. Failure to provide all information would result in slower action or inability to provide assistance to the student.

SECTION I: CORRECTED OR LATEST ENROLLMENT DATA: *(Mail to: ECI, Gunter AFS AL 36118)*

1. THIS REQUEST CONCERNS COURSE (1 - 6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7 - 15)	6. GRADE/RANK	7. NAME *(First initial, second initial, last name)* (17) (18) (19-32)
— —		

8. ADDRESS *(OJT Enrollees -- Address of unit training office with zip code. All others -- current mailing address with zip code.)*	(33-53)
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9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33 - 39)

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(Place an 'X' through number in box to left of service requested)

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1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction (Provide Old or Incorrect data)
4	Request Grade/Rank change/correction.
5	Correct SSAN. (List incorrect SSAN here) (Correct SSAN should be shown in Section I)
6	Extend course completion date. (Justify in REMARKS)
7	Request enrollment cancellation. (Justify in REMARKS)
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 Originals were: ☐ Not received ☐ Lost ☐ Misused
9	Send course materials. (Specify in REMARKS) ☐ Not received ☐ Lost ☐ Damaged
10	Course exam not yet received. Final VRE submitted for grading on ____________ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 not yet received. Answer sheet(s) submitted ____________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on ____________ (date).
13	Previous inquiry (☐ ECI Fm 17, ☐ Ltr, ☐ Msg) sent to ECI on ____________ (date).
14	Give instructional assistance as requested on reverse.
15	Other (Explain fully in REMARKS)

16		
G	33	
K	Vol 33 - 35	GR 36 - 38
M	33 - 34	35 - 40
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P	Vol 33 - 35	
P	TC 36 - 37	38
P	DOE 39 - 45	
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REMARKS *(Continue on Reverse)*

OJT STUDENTS must have their OJT Administrator certify this request.	I certify that the information on this form is accurate and that this request cannot be answered at this station. *(Signature)*
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NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

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VRE Form No ________

VRE Item No ________

Answer You Chose ________ (Letter)

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☐ Yes ☐ No

REFERENCE

(Textual reference for the answer I chose can be found as shown below)

In Volume No ________

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In ☐ left ☐ right column

Lines _____ Through _____

MY QUESTION IS:

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ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

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CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 4

Disease Vectors

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GUNTER AIR FORCE STATION, ALABAMA 36118

Preface

VOLUME 4 OF CDC 56650 gives you knowledge on a wide variety of pests which vector, or transmit, disease to humans.

You'll begin Chapter 1, Mosquitoes, with some background information on methods and cycles of disease transmission. Then you'll learn about mosquito development and habits; important mosquito species; and survey and control methods.

In Chapter 2, you'll study flies: why they're important to people, general characteristics, important fly species, and survey and control methods. This general pattern will prevail in Chapters 3 and 4, as you learn about fleas, lice, ticks, and mites.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in this publication is for information purposes only and does not imply indorsement by the Air Force.

This volume is rated at 30 hours (10 points).

Material in this volume is technically accurate, adequate, and current as of March 1984.

Acknowledgement

PREPARATION of this volume was aided through the cooperation and courtesy of Harcourt Brace Jovanovich Publications, publishers of the *Scientific Guide to Pest Control Operations*, 3rd edition; and *Pest Control* Magazine. Information from these sources helped in developing text on several differently medically important pests.

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Course development was further enhanced through the cooperation and courtesy of Gie, Inc. Publishers, publishers of *Pest Control Technology* Magazine. Past issues of this magazine assisted greatly in developing control information related to flies and fleas.

Permission to use materials by these publishers is gratefully acknowledged.

Contents

Mosquitoes

MOSQUITOES *have probably* caused more human disease and suffering than any other group of insects. Diseases like malaria and yellow fever kill thousands of people each year in some parts of the world. Mosquitoes are very important in the epidemiology of many diseases. *Epidemiology* is the study of factors that determine the occurrence of disease in populations. More simply, it's the study of the history of diseases. For this reason, the Air Force is vitally interested in the mosquito and its control. After reading this chapter you should know (1) the methods and cycles of disease transmission, (2) the significance and characteristics of important mosquito species, (3) the development and habits of mosquitoes, and (4) the techniques of surveying, collecting, and controlling mosquitoes.

1-1. Methods and Cycles of Disease Transmission

It has been estimated that in the aftermath of a nuclear war (heaven forbid), more people would be killed by epidemics of arthropod-borne diseases than by the war itself. Of course, this is an extreme example of why you need a basic knowledge of disease cycles; but given the right circumstances, vector-borne disease can occur almost any place at any time.

Hopefully, you'll never need to apply the information included in this section. But if you do, you'll be in a better position to discuss problems associated with disease transmission and vector control.

Diseases can be transmitted mechanically or biologically by an arthropod. Within these two methods, there are two cycles by which an arthropod can infect humans and animals; the host-parasite cycle and the host-parasite-vector cycle.

600. Identify elements and cycles of disease transmission and indicate how diseases may be transmitted.

Host-Parasite Cycle. A *host* is a living animal or plant which provides subsistence, and often, lodging to a parasite. A *parasite* is a small organism or virus living in or on, and at the expense of a larger organism. The host-parasite cycle of disease transmission involves these two factors, as illustrated in figure 1-1. The two-factor diseases are transferred from human to human without the assistance of any other living organism.

Some common diseases transmitted through the host-parasite cycle are measles, pneumonic plague, cholera, typhoid fever, gonorrhea, and syphillis.

As a pest manager, you cannot play a role in controlling them because there is no arthropod involved in their transmission. These must be controlled by medical service personnel with immunization, innoculation, quarantine, and decontamination programs.

Host-Parasite-Vector Cycle. The host-parasite-vector cycle of disease transmission involves three primary living factors. Note the presence of a third factor, the *vector*. This is an organism which acts as a living transporter and transmitter of disease agents. This disease transmission cycle can be separated into two categories: a human as the principal or only host and a human as the incidental host.

Diseases involving humans as the principal or only host. These diseases include filariasis, dengue, malaria, yellow fever, dysentery, and epidemic typhus (fig. 1-2). Although in the broadest sense, vector-borne diseases may include those transmitted from human to human, general usage in the United States restricts the term "vector-borne disease" to those transmitted to humans by arthropods or nonhuman vertebrates.

Diseases involving humans as the incidental host. These diseases include rabies, plague, tularemia, spotted fever, murine typhus, and encephalitis (fig. 1-3). These disease are transmitted from animals to humans and are usually called zoonoses. In this cycle, nonhuman vertebrates arthropods act as the vectors and are the normal hosts for the disease while humans and domestic animals are the incidental hosts. The incidental hosts are nonessential and at times are dead ends in this chain of disease transmission.

In this cycle of disease transmission, you can direct control programs toward the vector, because in most cases the vector is the most susceptible link in the chain.

Mechanical Disease Transmission. Mechanical disease transmission occurs when an arthropod transports microorganisms, such as dysentery, typhoid, or cholera bacteria, on its feet, body hairs, or other surfaces to human food or to the human.

In mechanical transmission, the parasite neither changes nor multiplies significantly within the vector. The arthropod is simply a vehicle that transports the parasite. Some examples are:

(1) Houseflies and cockroaches.	- The typhoid fever bacillus is carried on the feet and body hairs, or the bacillus, which causes dysentery passes through the digestive canal with feces or through regurgitation.
(2) Stable flies.	The anthrax bacillus is carried on the mouthparts.
(3) Deerflies.	The tularemia bacillus is carried on the mouthparts.

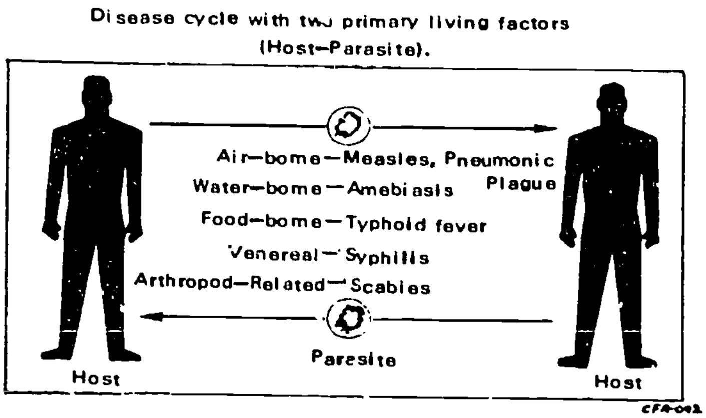

Figure 1–1. Host-parasite cycle.

The housefly, *Musca domestica*, is probably the most loathsome mechanical transmitter of disease. Throughout much of the world, people commonly see flies which have recently bred or fed in filth, crawling over human food and dishes and even on people's faces. Scientific studies have shown a close relationship between the incidence of bacillary dysentery and the abundance of flies in a community. Flies may also carry the virus of trachoma from one person to another. Cockroaches and vinegar gnats are known to visit sewers or decaying food and later feed on human food in houses.

Biological Transmission Methods. Biological transmission of disease occurs when the arthropod not only transmits the microorganisms from one host to another host, but is essential to the life history of the parasite.

When the parasite multiplies, changes in form, or passes through part of its life cycle in the arthropod vector, which serves as an essential host, the transmission is termed "biological". There are three basic types of biological transmission.

Propagative. The parasites multiply within the vector but undergo no change in form. Examples are: mosquitoes with encephalitis or yellow fever viruses that multiply in the cells of the gut and the salivary glands, ticks with spotted fever rickettsiae in various tissues, and fleas with plague bacteria in the gut cavity.

Cyclo-developmental. The parasites undergo changes in form within the vector but do not multiply. An example is the filarial worm in a vector mosquito.

Cyclo-propagative. The parasites undergo change in form and also multiply within the vector. Examples are: malarial parasites in an anopheline mosquito and trypanosomes (which causes Chagas' disease) in a triatomine kissing [illegible].

Exercises (600):

1. What is a host?

2. What is a parasite?

3. What is a vector?

4. When working in a disease control program, which element of disease transmission should you attack?

5. How may flies and cockroaches transmit typhoid fever?

6. What happens to the parasite when a disease is transmitted biologically?

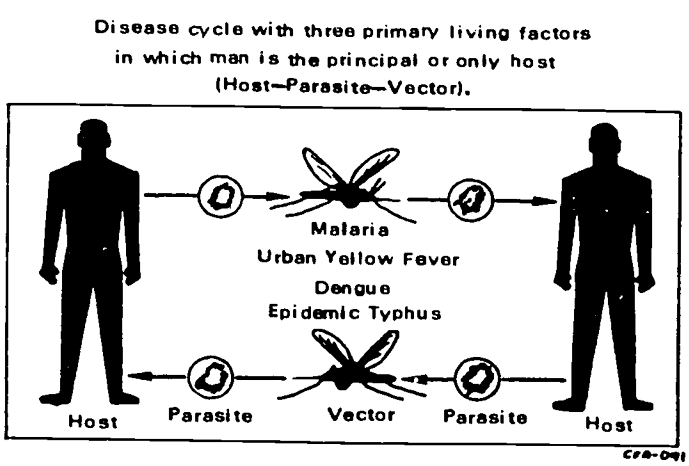

Figure 1–2. Host-parasite-vector cycle.

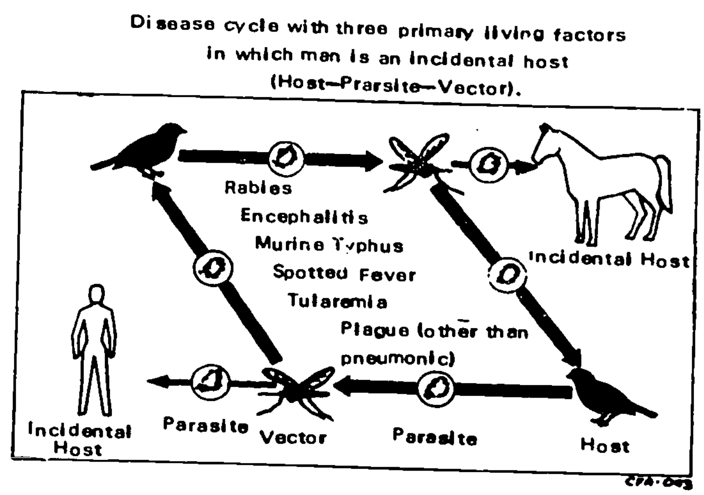

Figure 1–3. Disease cycles with humans as incidental hosts.

601. Associate certain mosquito species with diseases they transmit.

Mosquitoes and Their Significance. As we said earlier, mosquitoes are the most important group of arthropods that transmit disease to humans. Because numerous species are involved, there are marked differences in their breeding habits, behavior, and dispersal. Three genera are of particular concern as carriers of disease: *Anopheles, Aedes,* and *Culex*. These genera are shown in figure 1-4.

Little was known of the mosquito's role in the transmission of disease until 1877, when it was discovered that a filarial worm was transmitted by a mosquito. The transmittal of the worm was proven in 1897 by a scientist named Sir Roland Ross. In 1900, after years of extensive experimentation, Dr. Carlos Finlay and Walter Reed proved that *Aedes aegypti* was the vector (carrier) of yellow fever.

Malaria. The various types of malaria are acute or chronic diseases caused by parasites, which are transmitted from person to person by the bite of Anopheles mosquitoes. Although there are 15 Anopheles species in the United States, only 2 seem to be particularly important in malaria transmission: *Anopheles quadrimaculatus* east of the Rockies, and *Anopheles freeborni* west of the Rockies.

Yellow fever. This viral disease may be acute and fatal or so mild that infections are not apparent. The two epidemiological types, urban and jungle yellow fever, are caused by the same virus, and protection is given by the same vaccine, but the mosquito vectors and vertebrate hosts are quite different.

Urban yellow fever. This disease is transmitted by the yellow fever mosquito, *Aedes aegypti*. Although no epidemics have occurred in the United States since the outbreak at New Orleans in 1905 and no major epidemic has occurred in the Americas since 1942, epidemics were once reported for most of the large seaports in southern United States, and sometimes as far north as Philadelphia, New York, and Boston.

Jungle yellow fever. This disease, also called sylvan or sylvatic yellow fever, is normally a disease of monkeys and some other wild animals. The occasional human cases are contracted when people in the forest are bitten by infected mosquitoes.

Dengue. Dengue, also known as breakbone fever, is an acute, rarely fatal disease caused by a virus. It is characterized by sudden onset, high fever, severe headache, backache, joint pain, and a rash appearing the 3rd or 4th day, particularly on the hands and feet.

Dengue fever is transmitted from person to person by the yellow fever mosquito, *Aedes aegypti*. The cycle, therefore, is similar to that of urban yellow fever. *Aedes albopictus* is an important vector in Hawaii, the Philippines, and Southeast Asia. Mosquitoes obtain the virus from the blood of infected persons. The virus multiplies in the mosquito, which becomes infective in from 8 to 14 days after the infected blood meal. Under favorable temperature conditions, the mosquitoes remain infective for the rest of their lives, which may be 1 or 2 months or more.

Encephalitis. A number of arthropod-borne viral (arbovirus) diseases affect the central nervous system, causing an encephalitis, or inflammation of the brain (encephalon). Eastern (EE), Western (WE), St. Louis (SLE), California (CE), are the types of encephalitis occurring in the United States; each is caused by different viruses.

Human cases of the arthropod-borne encephalitides (plural of encephalitis) vary from mild, inapparent infections to very severe illnesses with permanent damage to the the nervous system, or even death. Horses may have similar mild or severe infections with EE and WE, whereas the SLE virus causes only inapparent infections. Birds may die from encephalitis, particularly red-winged blackbirds, house sparrows, and pheasants infected with EE virus. The basic transmission cycle from bird to bird is maintained by mosquitoes with the human and horse cases considered as accidents and dead end hosts in the chain of infection.

Eastern encephalitis. This form is one of the most serious arbovirus disease with 50 to 75 percent of the human cases ending fatally. This disease is found along the Atlantic and gulf coasts and inland in the Mississippi River Valley in limited areas. It occurs commonly in horses and in game farm pheasants. *Aedes sollicitans, Aedes vexans*, and *Mansonia perturbans* are suspected vectors of this disease in the bird to human cycle.

Western encephalitis. This disease is found in all of the states west of the Mississippi river as well as in Wisconsin and Illinois. WE virus has been found in limited areas in the eastern United States in birds and mosquitoes. More encephalitis was reported in 1965 than at any times since a 1941 epidemic, 172 reported human cases occurring primarily in five states. Western encephalitis is generally a milder disease than Eastern encephalitis, with human deaths reported in 2 to 5 percent of the cases.

Culex tarsalis is the most important mosquito vector of Western encephalitis, particularly west of the Mississippi. Isolations of WE virus have been made from many species of mosquitoes and birds throughout the United States. However, the rarity or absence of *Culex tarsalis* in the Eastern United States may help to explain the small number of cases of Western encephalitis east of the Mississippi river.

St. Louis encephalitis. This disease has been found in all of the states west of the Mississippi river, in the Ohio River Valley, in Florida, and in the Camden, New Jersey—Philadelphia, Pennsylvania area.

Birds are considered to be the main reservior of St. Louis encephalitis virus, particularly house sparrows, house finches, and domestic pigeons. St. Louis encephalitis is considered to be a more serious disease than Western encephalitis, but less so than Eastern encephalitis. The majority of cases occur in older people. Mortality rates vary from about 5 percent to as high as 33 percent, particularly in people over 60 years of age. Members of the *Culex pipiens-quinquefasciatus* complex are the chief urban vectors. *Culex tarsalis* is the chief vector in rural areas in Western States. *Culex nigripalpus* is the vector in the Tampa Bay area, Florida.

St Louis encephalitis is the one type of this disease abundant enough in densely populated areas, as Houston and Dallas, to justify mosquito control as a method of

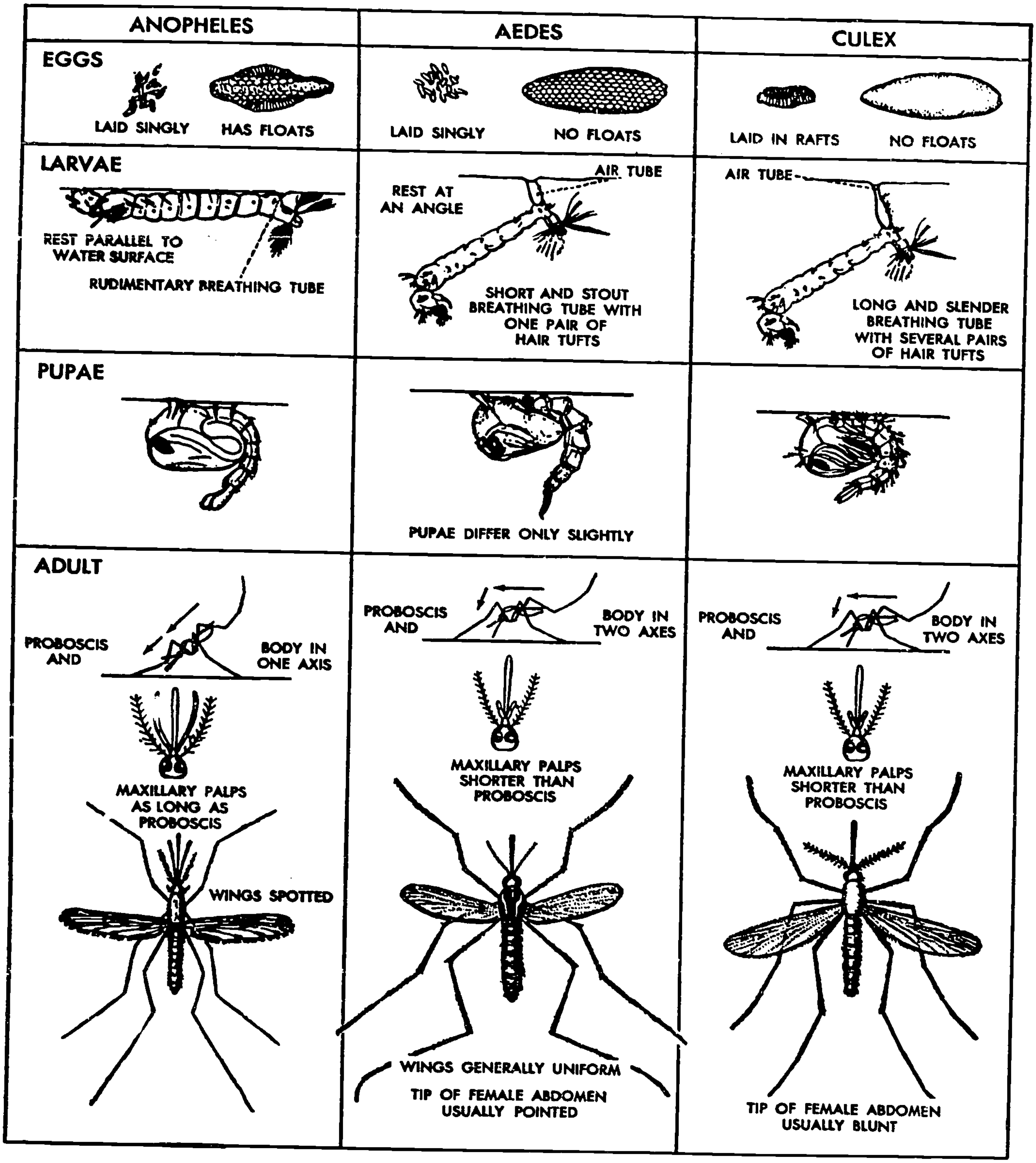

Figure 1–4. *Anopheles*, *Aedes*, and *Culex* mosquitoes.

encephalitis control. Cases of the three other types in the United States, Eastern, Western, and California, on the other hand, occur generally in small numbers over wide areas, with lower human populations per square mile, making it difficult to obtain funds to operate effective encephalitis programs by mosquito control.

California encephalitis (CE). This virus was first isolated from *Aedes melanimon* (originally identified as *dorsalis*) and *Culex tarsalis* in California in 1943 and 1944. Most cases of this disease are reported for the Midwestern States, such as Ohio, Indiana, and Wisconsin.

The CE virus differs from Western, Eastern, and St. Louis encephalitis because mammals rather than birds act as reservoirs. This virus, or antibodies against the virus, has been found in a number of small- and medium-sized mammals, such as snowshoe hares, cottontails, tree squirrels, and ground squirrels. *Aedes triseriatus, Aedes canadensis,* and *Aedes trivittatus* are suspected vectors of this virus since these species are forest- or woodland-dwelling mosquitoes and most of the human cases have occurred in rural, forested areas where the mammal reservoirs live.

Filariasis. This disease as occurs in humans is caused by nematodes. These nematodes may live in various parts of the lymphatic system and people may harbor them with no apparent symptoms, or the filarial worms may cause inflammation and other complications. Prolonged or repeated infections may cause extreme enlargement of external genitalia, breasts, or legs in some people, and is often referred to as elephantiasis.

Filariasis is widespread in many tropical and subtropical regions throughout the world. In the Western Hemisphere it occurs in the West Indies, Colombia, Venezuela, Panama, and the coastal portions of the Guianas and Brazil.

A small endemic center existed for many years near Charleston, South Carolina, but it has now disappeared. In many parts of the United States, Puerto Ricans and other people who have recently left the Tropics may have the microfilariae circulating in their blood. However, the disease is not now known to be naturally acquired in the United States. Many species of mosquitoes are known to be capable of transmitting filariasis, though these may not all be important in nature. Some important known vectors are *Culex quinquefasciatus, Culex pipiens, Aedes polynesiensis,* and *Anopheles gambiae,* and mosquitoes in the genus *Mansonia*.

Exercises (601):

1. Match the mosquito species in column A with the statement describing it in column B.

Column A	*Column B*
____ (1) *Aedes aegypti.*	a. Carrier of yellow fever.
____ (2) *Anopheles quadrimaculatus.*	b. Transmits malaria west of the Rockies.
____ (3) *Anopheles freeborni.*	c. Filariasis vector.
____ (4) *Aedes sollicitans.*	d. Transmits malaria east of the Rockies.
____ (5) *Culex tarsalis.*	e. Suspected vector of Eastern Enc 'alitis.
____ (6) *Culex nigripalpus.*	f. Vector of St. Louis Encephalitis around Tampa, Florida.
____ (7) *Culex quinquefasciatus.*	g. Most important vector of Western encephalitis.

1-2. Mosquito Development and Habits

For you to control mosquito populations effectively, you need to know how mosquitoes develop from eggs to adults as well as how they behave as adults.

602. Identify the stages of the development process of mosquitoes.

Mosquitoes have four distinct stages in their life history: the egg, larva, pupa, and adult (see fig. 1-4). The first three stages occur in water, but the adult is an active, flying insect that feeds on the blood of man and animals or upon plant juices.

Eggs. Eggs are white when first deposited but become dark within an hour or two. In general, mosquito eggs fall into three distinct groups: (1) those laid singly on the water surface; (2) those laid together to form rafts which float on the water surface; and (3) those laid singly out of the water. These differences are reflected in the structure of the egg.

Anopheline eggs are laid singly on the water surface. They are elongate oval, usually pointed at one end and have a pair of lateral floats (fig. 1-4). They average about one-half millimeter in length. Hatching usually takes place within 2 or 3 days. The eggs of *Toxorhynchites* are also laid singly on the water surface and kept afloat by means of air bubbles that form among the spines of the eggshell.

The eggs of *Culex*, and *Mansonia* are laid side by side to form a raft and often contains 100 or more eggs. They remain afloat on the surface of the water until hatching occurs, usually only a few days.

Eggs that are laid out must be placed so that the larvae can readily reach the water or they must be able to survive long periods of drying until such time as they may be flooded. The eggs of *Aedes aegypti, Aedes triseriatus,* and *edes orthopodomyia* are laid on the sides of containers or tree holes just above the water level so that when the water rises, the eggs hatch. Other species of *Aedes* and all species of *Psorophora* lay their eggs on the ground where they remain until flooding occurs. Some species may survive in the egg stage for 3 to 5 years if flooding does not occur. In some cases, hatching occurs as soon as the eggs are flooded; thus, several generations per year may occur. This is typical of the *Psorophora* group and of *Aedes vexans* and *Aedes sollicitans*. Others must be subjected to freezing before they will develop; thus, there is only a single generation per year. Many species of *Aedes* belong in this group, including *Aedes stimulans* and *Aedes abserratus*.

Larvae. The larvae of all mosquitoes live in water: in permanent ponds and marshes, in temporary flood waters or woodland pools, in water contained in tree holes, leaves of plants, or artificial containers. Mosquitoes have adapted themselves to almost all kinds of aquatic situations except flowing streams and the open waters of large streams, lakes, and seas. Although mosquito larvae get their food from the water where they live, they must come to the surface for air or, as in the case of *Mansonia*, obtain air from the underwater portions of plants.

The larval period includes four developmental i· ·ars which usually require 4 to 10 days for completion. A\ the end of each instar the larva sheds its skin, or molt . The fourth instar is the mature larva and with the fourth r lt the pupa appears.

Mosquito larvae move about in two ways: by jerks of the body and by propulsion with the mouth brushes. Movements of anopheline larvae at the surface are generally of the first type. The "crawling" movements of ·:licine larvae over the bottom and the slow movement at the water surface are probably due to propulsive action of the mouth brushes. Mosquito larvae assume characteristic positions in the water. Anopheline larvae lie parallel to the surface, while most other groups hang head down with only the tip of the air tube penetrating the surface film. Although larvae are heavier than water, they can rest just beneath the surface without effort. Certain nonwetting structures, such as the air tube in the culicines and the spiracular plate and palmate hairs in the anophelines, serve to suspend them from the surface film.

Many physical, chemical, and biological characteristics of water affect mosquito larvae. These characteristics include temperature, light, movement, dissolved gases and salts, and other living organisms present. Vegetation is important as protection for the larvae. Predators, such as fish and insects, destroy great numbers of mosquito larvae.

The three body regions of the larva, head, thorax, and abdomen, are distinct. The head bears the antennae, eyes, and mouthparts. The antennae are located on each side toward the front. Behind the antenna near the hind margin of the head are the eyes. The mouthparts are at the underside of the head near the front. They consist of a series of brushes in addition to the grinding and grasping structures. Thus, the larvae is able to strain out small aquatic organisms and particles of plant and animal material present in the water. A few predaceous species have mouthparts adapted for grasping and swallowing their prey.

The thorax is broader than the head or abdomen and is somewhat flattened. It has several groups of hairs which are useful in identification of species.

The abdomen is long and subcylindrical, consisting of nine well-defined segments. The first seven segments are similar, but the eight and ninth are considerably modified. The eighth segment bears the respiratory apparatus. In the anophelines this apparatus consists of paired spiracular openings, while in the other groups a prominent air tube is present. The ninth segment is out of line with the other segments and bears two to four membranous tapering appendages commonly known as anal gills. These anal gills seem to serve more for the regulation of osmotic pressure than for respiration.

Pupae. The mosquito pupa also lives in water and is very active. It does not feed, but it must come to the surface for air, except in the case of *Mansonia* species (spp.). The pupa differs greatly from the larva in shape and appearance, the front part, consisting of the head and thorax, being greatly enlarged and enclosed in sheath. On the upper surface is a pair of respiratory trumpets. The abdomen consists of eight freely movable segments with a pair of paddles at the tip.

Mosquito pupae are undoubtedly the most active of all insect pupae. Most species are lighter than water, because of an air space between the wing cases near the combined head and thorax. By vigorous movement of the abdomen, the pupae move about with considerable speed, rising directly to the surface when movement stops.

The pupal stage lasts from 1 day to a few weeks, no species being known to pass the winter as pupae. At the end of the pupal stage, the pupal skin is broken and the adult works its way out, crawls onto the surface of the water, and is soon ready to fly away.

Adults. The adult mosquito (fig. 1-5) is a small fragile insect with a slender abdomen, one pair of narrow wings, and three pairs of long, slender legs. It varies in length from slightly over 1/16 inch to about 1/2 inch. The three body regions, head, thorax, and abdomen, are well defined.

The head of a mosquito is almost spherical and is joined to the thorax by a narrow membranous connection. It bears a pair of large compound *eyes*, a pair of *antennae*, a pair of palpi and the *proboscis*. The antennae arise on the front of the head between the eyes. They are long, slender structures with 15 segments, only 14 of which are ordinarily visible. Each of the last segments bears a whorl of hairs that are short and sparse in the females but long and bushy in the males. Entomologists believe the antennae serve as organs of hearing and smell. The palpi are five-segmented structures originating at the lower front margin of the head near the proboscis. In anophelines, the palpi of the female are about as long as the proboscis, while those of the male are enlarged at the tip. In culicines the palpi of the females are short, while those of the male are usually long, densely haired, and pointed. The proboscis projects downward and forward from the lower front margin of the head. It consists of a labium or sheathlike structure enclosing a group of six stylets. The labium serves as a protective sheath for the stylets, but does not enter the wound when the mosquito is biting. The stylets serve to penetrate the skin of the host animal and also form a small duct through which saliva is injected into the wound, as well as a canal through which liquid food is drawn. The mouthparts of the male aren't strong enough to pierce human or animal skin, so they feed on plant juices instead of blood.

The thorax or middle region of the body bears the wings and legs. The upper surface of the thorax or *mesonotum* is covered with coarse hairs or scales and bears several groups of hairs or bristles used for identification purposes. The long slender legs arise from the lower sides of the thorax. Each leg consists of a short conical *coxa*, a small hingelike *trochanter*, a stout *femur*, a long slender *tibia*, and a five-segmented *tarsus*. The first segment of the tarsus is the longest and is often equal to the tibia in length. The fifth tarsal segment bears a pair of small claws. The legs are covered with scales of varying colors, forming patterns which are often useful in separation of species. The wings are long and narrow with venation. The veins are covered with scales, often of varying colors which may form definite patterns. The hind margin of the wing also has a close-set row of long, slender, fringe scales. A pair of small knobbed structures known as *halteres* is found behind and

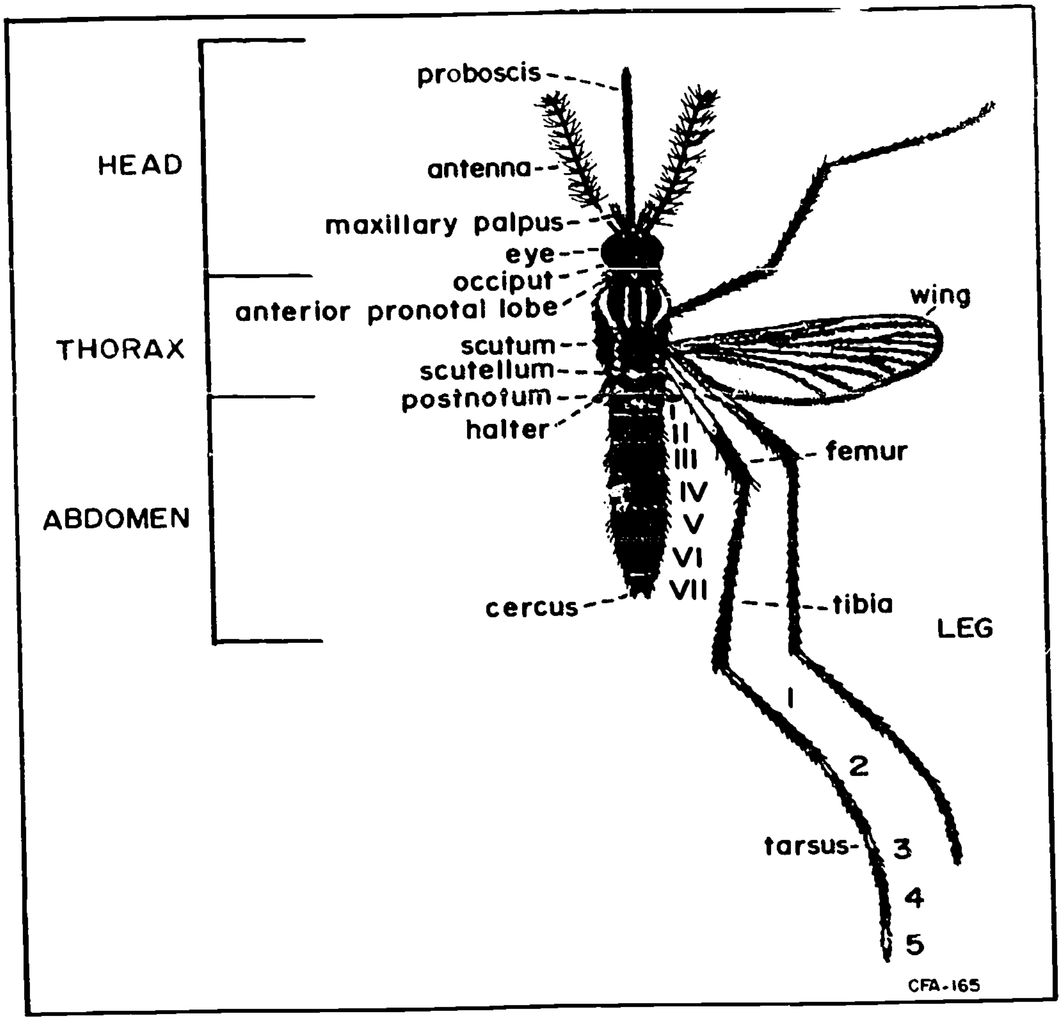

Figure 1–5. Adult female mosquito.

slightly below the wings. They vibrate rapidly when the mosquito is in flight and serve as organs of equilibrium.

The elongate abdomen is nearly cylindrical and has 10 segments, only 8 of which are readily visible. The 9th and 10th segments are greatly modified for reproductive functions. North American species of *Anopheles* have no scales on the upper surface of the abdomen. In the cullicines, the abdomen is covered with scales which often form characteristic markings. In *Aedes* and *Psorophora*, the female abdomen is tapered, with the eight segment withdrawn into the seventh. In other genera in the United States the abdomen is bluntly rounded at the apex. The terminal segments of the male abdomen are greatly modified for mating. These structures are often of value in ification of the species.

ises (602):

osquitoes have __________ distinct stages in their e history; the ________, ________, ________, and ________.

2. Anopheline eggs are laid ________ on the ________ surface.

3. Eggs which are laid out of the water must be placed so the larvae can ________________________.

4. Some species may survive in the egg stage for how many years and under what conditions?

5. The eggs of some species must be subjected to _______ before they will develop.

6. The larvae of all mosquitoes live in __________ .

7. Mosquitoes have adapted themselves to almost all kinds of aquatic situations except ________ ________ and ________ ________ .

8. What are the water characteristics that affect mosquito larvae?

9. Mosquito larvae have three distinct body regions, list them.

10. The head bears the ________ , ________ , and ________ .

11. The thorax is broader than the ________ or ________ and is somewhat ________ .

12. The abdomen is long and subcylindrical, consisting of ________ well-defined ________ .

13. The mosquito pupa lives ________ ________ and is ________ ______ __ .

14. How long does the pupal stage last?

15. Describe the adult mosquito.

16. The head of a mosquito is almost ________ and is joined to the thorax by a narrow ________ connection.

17. The thorax, or middle region of the body, bears the ________ and ________ .

603. Identify the general habits of adult mosquitoes.

General Habits of Adult Mosquitoes. About equal numbers of male and female mosquitoes are produced. Males usually emerge first and remain near the breeding places, mating with the females soon after their emergence. Only the females bite and most (but not all) species require a blood meal before they can lay fertile eggs. Females tend to travel further and live longer than males.

Flight habits vary considerably. *Aedes aegypti*, probably the most domesticated of all mosquitoes, breeds mainly in and around human habitations and flies short distances, usually a "block" or about 100 yards. Most anophelines have a maximum flight range of about 1 mile. However, other species, such as *Aedes vexans* and *Aedes sollicitans* can fly 10 to 20 miles or more.

Mosquitoes also differ greatly as to their preferred hosts, some species feeding on cattle, horses, or other domestic animals, while others prefer humans. A few species feed only on cold-blooded animals and some subsists entirely on nectar or plant juices. Some are active during the daytime and others only at night.

The female mosquito needs 2 days or more to digest the blood meal she has ingested, lay a batch of eggs, and then seek another blood meal. This cycle of feeding, laying eggs, and feeding again may be repeated four or five times or more in the time between the first blood meal and the later one (10 to 14 days afterward) when the mosquito is infective and can pass on parasites which have developed in her body.

Our understanding of the lifespan of adult mosquitoes is poor. Some species apparently live 1 or 2 months during the summer, although under unfavorable conditions this time may be greatly reduced. Adults that hibernate may live for 6 months or more.

Exercises (603):

Place the letter "T" in front of the correct statements. Correct any false statements.

____ 1. There are more female than male mosquitoes.

____ 2. Males ordinarily emerge first.

____ 3. Males usually leave the breeding places soon after emergence.

____ 4. Males mate with females soon after emergence.

____ 5. Only females bite.

____ 6. All species require a blood meal before they can lay fertile eggs.

____ 7. Flight habits vary considerably and distances range from several feet to as much as 20 miles.

____ 8. Mosquitoes show no preference as to their host.

____ 9. The female mosquito requires 2 days or more to digest a blood meal, lay a batch of eggs, and seek another blood meal.

____ 10. Hibernating mosquitoes may live as long as 6 months or more.

1-3. Important Mosquito Species

As you should know by now, the most important species of mosquitoes are in the genera Anopheles, Aedes, and Culex. We can also add to these genera Masonia, and Coquilletidia. Your knowledge of several genera of these species is important if you are to effectively manage them for medical or nuisance reasons. As you progress, you'll come to recognize the importance of properly surveying and identifying mosquitoes so your controls will meet your needs as safely and effectively as possible.

604. List the general features you should look at to identify various genera of mosquitoes, and solve problems on mosquito identification based on given information.

Important Aedes Mosquitoes. The genus *Aedes* contains more than 500 species scattered from the polar regions to the Tropics. Almost half of all North American mosquitoes belong to this genus, which includes many of the major pest species as well as important disease vectors. There are some 60 species of *Aedes* known from the United States, of which, about 40 may be rather common, at least in certain regions. In general, the *Aedes* mosquitoes assume greater importance as one goes from the Tropics northward. In the northern United States, as well as in Canada and Alaska, many species of *Aedes* occur and are often present in huge numbers. Refer to figure 1-6 during the following discussion. Also, tables 1-1, 1-2, and 1-3 are included here to help you study and compare the various mosquitoes discussed in this and the next three lessons.

Aedes aegypti. This mosquito is commonly called yellow fever mosquito. It is a small, dark species that you can recognize by the lyre-shaped silvery-white lines on the thorax and by the white bands on the tarsal segments. It vectors urban yellow fever and dengue. It is a pest of some significance when it occurs in large numbers.

This species has a limited distribution within the United States. It occurs in the Southeastern and Southern States, extending northward to North Carolina, Tennessee, and Arkansas.

Aedes aegypti is semidomesticated, breeding almost exclusively in artifical containers in and around human habitations. The eggs are laid singly on the sides of the container at or above the waterline, or, less commonly, on the water surface. They are able to withstand drying for several months and hatch quickly when the container is again filled with water. Hatching may take place in 2 or 3 days if temperatures are high. Typical breeding places are flower vases, tin cans, jars, discarded automobile tires, unused water closets, cisterns, rain barrels, and sagging roof gutters. *Aedes aegypti* breed also in tree holes, their traditional breeding site. Under favorable conditions, the larvae complete their development in about 6 to 10 days, or in much longer periods in cool weather. The pupal period is normally about 2 days. The life cycle may be completed in 10 days, although it may vary up to 3 weeks or more. It breeds throughout the year in the Tropics with generations succeeding each other rapidly. In the Southern United States, the reproduction rate slows down during the winter, and the eggs may remain dormant for several weeks or months. This species is very susceptible to cold and does not survive the winter except in the Southern United States.

The adults apparently prefer the blood of humans to that of other animals. It readily enters homes, even those that are well screened. *Aedes aegypti* bites mainly in the morning and late afternoon. It attacks quietly, preferring to bite around the ankles, under coat sleeves, or at the back of the neck, often becoming a troublesome pest. The adults appear to be rather long-lived as they live 4 months or more in the laboratory. Their flight range is normally about 100 feet to 100 yards, but long distances have been recorded.

Aedes canadensis. This dark mosquito has the tarsi banded with white at both ends of the segments. It's widely distributed in the U.S., being particularly common in the Northern States. It is often a serious pest in woodland situations but rarely migrates far from its breeding places. California encephalitis has been found in this species.

Aedes canadensis is one of the first mosquitoes to appear in early spring. The larvae breed in woodland pools filled with melting snows or by spring rains. This mosquito prefers pools with a bottom of dead and decaying leaves, although it may also be found in roadside puddles, sink holes, and wooded swamps. There may be more than one generation per year and the adults live for several months.

Aedes dorsalis. This mosquito is medium sized and varies in color from dark brown to a whitish straw color. The upper surface of the abdomen is marked with a longitudinal stripe of pale scales and the hind tarsi are banded with yellowish scales at both ends of the segments. Aedes dorsalis is a severe pest of humans and cattle throughout the arid and semiarid regions of Western United States. It occurs over most of the country, but it is rare and unimportant in the Eastern and Southern States. *Aedes melanimon* is very similar to *Ae dorsalis* in the West.

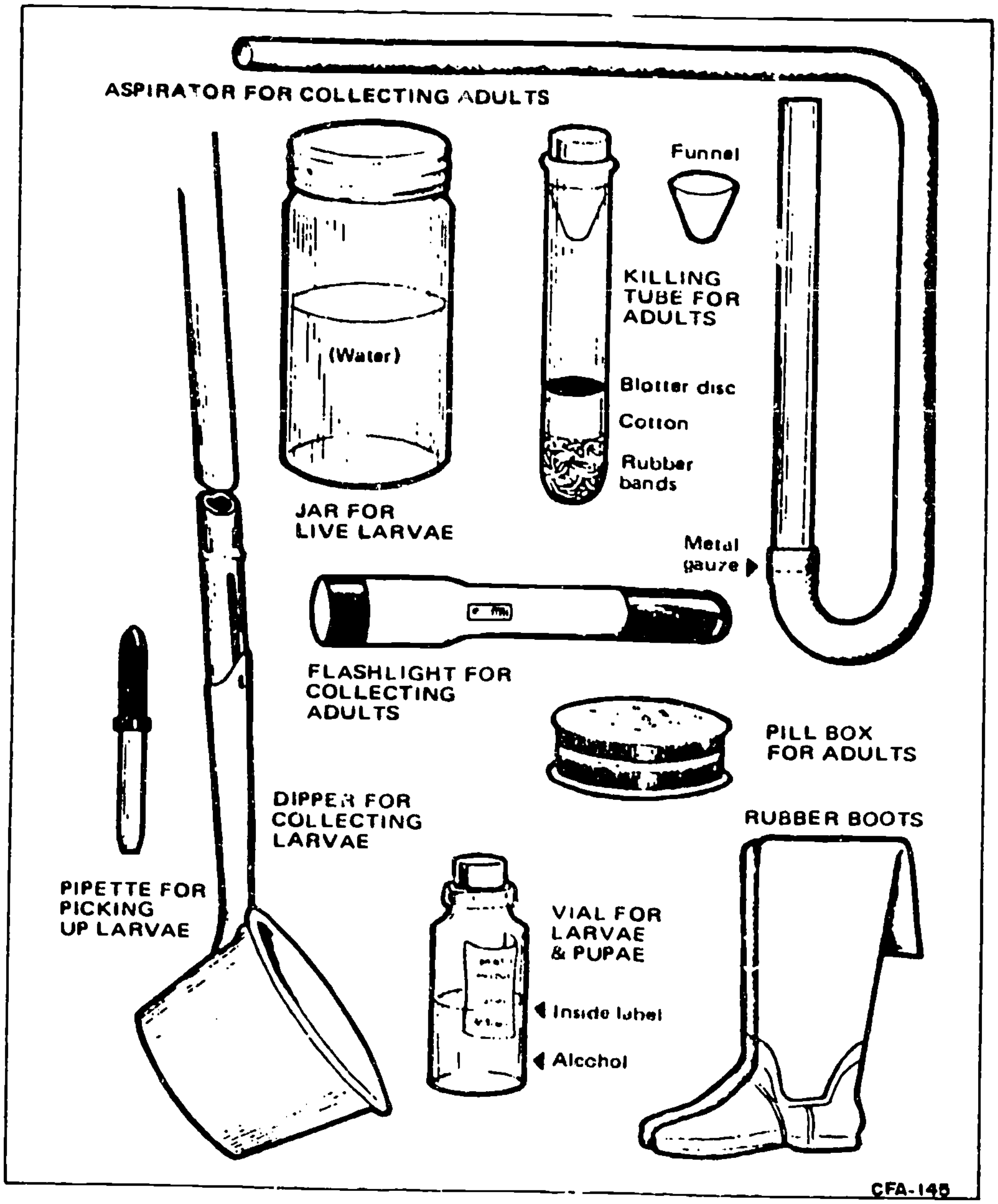

Figure 1–6. Equipment for mosquito surveys.

The larvae develop in the salt marshes of the Pacific Coast and in irrigation and flood waters of the interior. It commonly breeds in irrigated pastures and waste water pools. Several broods are produced each year in irrigated areas, a brood following each flooding.

The females of *Aedes dorsalis* are vicious biters. They attack day or night, being particularly active in the evening or on calm, cloudy days. They are strong fliers and occasionally migrate in large broods. They are commonly found 10 miles from their breeding places; a flight of 22 miles has been recorded in Utah. The females, and at times, the males, may be taken in great numbers in light traps. Overwintering takes place in the egg stage, moreover the eggs may remain viable for several years.

TABLE 1-1
IMPORTANT *AEDES* MOSQUITOES

SCIENTIFIC/COMMON NAMES	MAIN FEATURES (ADULT)	REGIONS OCCUPIED	BREEDING AREAS	DEVELOPMENT TIME			FLIGHT RANGE (TYPICAL)	OTHER
				EGG	LARVA	PUPA		
Aedes aegypti Yellow fever mosquito	Lyre-shaped silver markings on thorax. white bands on tarsal segments.	Southern and Southeastern U.S.	Tree holes. Artifical Containers.	2-3 days	6-10 days	2 days	100-300 feet	Adults prefer human blood.
Aedes canadensis	Tarsi are banded with white at both ends of segments.	Widely distributed, mainly in northern U.S.	Woodland pools with melting snow or spring rains.	Over winters in this stage.			Limited	One of the first mosq. to appear in early spring
Aedes dorsalis	Upper surface of abdome marked with longitudinal stripe. Hind tarsi banded.	Aird and semi-arad regions of western U.S.	Salt marshes of the Pacific coast.	Over-winters in this stage.			100 or	Severe pest of adults and cattle.
Aedes sollicitans Salt marsh mosquito	Golden color on upper thorax. White-yellow stripe on abdomen.	Atlantic and Gulf coastal plains from Maine to Texas	Where brackish waters are available	2-14 days, Hatch quickly when wet.	Seven to ten days		5-10 miles or more	Fierce biters, attack even in daylight
Aedes Taeniorhynchys Black salt marsh mosquito	White crossbands on abdomen. White rings on tarsi and proboscis.	Coastal plains from Massachusetts to Texas and S. California	Fresh-water pools near salt marshes.				4 miles	Strong fliers, biters.
Aedes Triseriatus Tree-hole	Blue-black with Silvery-white scales on thorax and sides.	Most of eastern U.S.	Old tree holes, artifical containers.	Nearly	one month		.5-1.0	Painful bites.
Aedes Trivittatus	Upper surface of thorax marked with two conspicuous whitish stripes.	Widely distributed in Northern U.S. from Main to Idaho.	Flood-water pools and temporary rain pools.	Unknown	Eight	days.	Limited	Fierce biters.
Aedes nigromaculis	Yellowish-white longitudinal stripe on upper abdomen. White banded tarsi.	Throughout the western plains, from Minnesota and Texas to Calif.	Open sunlit pools of waste irrigation, other intermit-tent water.	2-6 days upon flooding			2-5 miles	Rapidly replacing Ae.dorsalis in open, sunlit pools.

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TABLE 1-2
IMPORTANT *ANOPHELES* AND *CULEX* MOSQUITOES

SCIENTIFIC/COMMON NAMES	MAIN FEATURES (ADULT)	REGIONS OCCUPIED	BREEDING AREAS	DEVELOPMENT TIME			FLIGHT RANGE (TYPICAL)	OTHER
				EGG	LARVA	PUPA		
Anopheles quadrimaculatus Common malaria mosquito	Fairly large with 4 dark spots near center of each wing.	Eastern half of U.S.	Clean, partially shaded water with some vegetation.	30 to 35 days.			0.5 to 1.0 mile.	Most important vector of malaria in U.S.
Anopheles freeborn; Western malaria mosquito	Similar to above	Most of the area west of Continental Divide.	Clean, clear, slightly alkaline waters, partially exposed to sun.				1-2 miles	
Culex pipens northern house mosquito	Brown with white crossbands on abdomen. Medium in size.	Throughout the northern U.S. as far South as Oklahoma and Georgia.	Practically all types of artificial containers, plus storm sewer catch.	1-2 days	8 to 10 days		Limited, except wher lar[illegible] mb[illegible] are i[illegible]ved.	not a severe pest to people; "sings".
Culex quinqucfasciatus Southern house	Similar to above, difficult to distinguish between the two.	All southern states coast-to-coast, plus Nebraska, Iowa, Ohio and Illinois.	Basins, poorly draines street gutter, etc.	1-2 days	8 to 10 days In warm weather		Same as above	Severe pest to people; "sings."
Culex Tarsalis	Dark with white bands at each end of tarsal segments.	Widely distributed west of the Mississippi River.	Water flowing from cesspools, high in organic waste.	Less than 2 days	Develop rapidly		1 mile	Large no.'s caught in light traps Birds are preferred hosts.

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TABLE 1-3
MISCELLANEOUS MOSQUITO SPECIES

SCIENTIFIC/COMMON NAMES	MAIN FEATURES (ADULTS)	REGIONS OCCUPIED	BREEDING AREAS	DEVELOPMENT TIME			FLIGHT RANGE (TYPICAL)	OTHER
				EGG	LARVA	PUPA		
Psorophora confinnis Glades mosquito (Florida)	Medium to large, narrow white ring near apex of the hind femur.	Throughout the southern U.S., and northward to Nebraska, Iowa and New York	Temporary rain pools, irrigation waters, and seepage pools.	Overwinters in this stage	4-5 days	1-2 days.	Up to 10 miles	Eggs laid on ground, subject to flooding.
Psorophora	Large, yellowish-brown with shaggy legs.	Through the eastern U.S.	Temporary pools often in association with P. confinnis and Ae. vexans.		Very short			Severe daytime and night time pest in large no.'s
Coquillettidia perturbans	Large, speckled with pale band on outer third of hind femur and tibia.	Most of eastern U.S., and some Pacific States.	Marshes, ponds, and lakes with thick aquatic vegetation.		Several months.	5-6 days	1-2 miles.	1 generation per year. Adults emerge in spring & summer
Mansonia Titillans	Similar to above.	Florida and South Texas.	Similar to above.				1-5 miles.	

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Aedes sollicitans. The salt-marsh mosquito, *Aedes sollicitans*, is the most important of the salt-marsh species and one of the most severe mosquito pests known. It occurs along the Atlantic and Gulf Coastal Plains from Maine to Texas and has been reported from many inland areas where brackish waters are available. Such inland records include New York, Indiana, Kentucky, Illinois, Oklahoma, Arkansas, and New Mexico. You can recognize the adults by the golden color of the upper side of the thorax and a longitudinal stripe of white or yellowish-white scales on the abdomen. The proboscis and tarsi also have wide pale bands. The eggs of this species are laid on the mud of marshes and remain until flooded by high tides or rains. Breeding generally occurs on the parts of the marsh not covered by daily tides; usually potholes and depressions of various sizes are used, but sometimes they occur over extensive level areas. The eggs must remain dry for at least 24 hours before they will hatch. After having been dry for a week or two, they hatch within a few minutes when covered with water. Development of the larval and pupal stages requires 7 to 10 days during warm weather. Several generations can be produced each year.

The adults of *Aedes sollicitans* are strong fliers and often migrate in large swarms from the marshes to cities and towns many miles away. They very commonly fly 5 to 10 miles and may travel up to 40 miles or more. The migratory flights begin just before dark and may include huge numbers of mosquitoes. During the day they rest among the grasses, though they will readily attack anyone who disturbs them, even in full sunlight. They are fierce biters and may literally drive a person from the marsh areas. Fortunately, they don't often come indoors. They have been a very severe deterrent to the development of some of the coastal resort areas. They are often collected in light traps in great numbers.

Aedes taeniorhynchus. The black salt-marsh mosquito has crossbands of white scales on the upper side of the abdomen and white rings on the proboscis and tarsi. This mosquito is found on the coastal plains from Massachusetts to Texas and on the Pacific coast in southern California. It has also been reported from certain inland areas around salt pools in oil fields. It is the most abundant and troublesome salt-marsh species along the south Florida coasts and may be a severe pest as far north as New Jersey.

The breeding habits are similar to those of *Aedes sollicitans*, though it also breeds in freshwater pools near the salt marshes. The adults are strong fliers and fierce biters. They are active mainly at night and are suspected vectors of California encephalitis. They may be very annoying in the shade during the day, but are less likely than *Aedes sollicitans* to attack in bright sunlight. The flight range for most females is about 4 miles.

Aedes triseriatus. The tree-hole mosquito is blue-black in appearance with silvery-white scales at the sides of the thorax. It's found throughout most of eastern United States. It breeds principally in tree holes, old tires, tin cases, barrels, and other artificial containers. Because the bite is painful, this species can be troublesome in the woods. It is suspected of carrying California encephalitis. Adults apparently don't wander far from their breeding places. Larval development is rather slow, as nearly a month is required to reach maturity.

Aedes trivittatus. This species is widely distributed in Northern United States from Maine to Idaho. It has been taken as far South as Georgia, Louisiana, and Arizona. It is a fierce biter and an extremely annoying pest in some of the Northern States. It is a suspected vector of California encephalitis. The upper surface of the thorax has two conspicuous whitish stripes.

The larvae are mostly found in flood-water pools and temporary rain pools. The young larvae feed at the surface of the water, but the later instars spend most of their time concealed in the vegetation at the bottom of the pool. This is possibly why larvae are seldom found even though adults may be present in large numbers. Emergence of adults begins about 8 days after the eggs hatch. The adults rest among grasses and other vegetation during the day. They will bite when disturbed, but are especially active in the evening. They apparently don't migrate far.

Aedes nigromaculis. This medium-sized dark mosquito has a longitudinal line of yellowish-white scales on the upper surface of the abdomen. It has bands of white scales at the base of the tarsal segments but not at the apex. This species is an important pest mosquito throughout the western plains, extending from Minnesota west to Washington and south to Texas and Mexico. During recent years it has assumed great prominence in the irrigated pastures of the West, especially in the Central Valley of California. The remarkable spread of this species is indicated by the fact that it was not known from California until 1937. It now occurs over most of the State at the lower elevations and is rapidly replacing *Ae. dorsalis* in open sunlit pools of waste irrigation and other intermittent water.

This species has proved to be extremely well adapted to pasture irrigation. The eggs will hatch within 2 to 6 days after they are deposited, if flooding occurs. It is able to produce a brood following each irrigation, which is usually at intervals of 8 to 12 days in the Central Valley of California. Under favorable conditions, a brood may be produced within 5 days, and as many as 20 broods can be produced in one season. In most areas of the San Joaquin Valley, *Ae. nigromaculis* is now the number one pest problem, and is present in huge numbers. For example, a light-trap operating for 3 nights near an irrigated pasture collected almost a gallon of mosquitoes, predominantly Ae. nigromaculis. As many as 20 million eggs of this species may be found in a single acre of irrigated pasture.

The adult is a severe pest of man and animals, it attacks readily and inflicts a painful bite. It will bite during the daytime but is most active during the evening hours. It is a strong flier and may migrate several miles from its breeding ground. The winter is passed in the egg stage.

Exercises (604):

1. Based on species descriptions in the text, what general features should you inspect to determine the genus of an adult mosquito?

2. What mosquito species would you expect to find if you encountered the following situations?

   a. At a southern California base, mosquitoes are greatly aggravating base personnel and appear to be coming from freshwater pools about 3 miles from the base.

   b. At a Southern U.S. base, mosquitoes breeding in tree holes just off base are inflicting painful bites to base residents.

   c. After spring rains at a Northern U.S. base, populations of mosquitoes are increasing rapidly.

   d. Base residents at an east coast base complain of being bitten by mosquitoes even during daylight hours.

   e. At a western base surrounded by irrigated pastures, residents are reporting severe mosquito bites both in the daytime and at night.

605. Given specific characteristics, differentiate between species of *Anopheles quadrimaculatus* and *Anopheles freeborni*.

Important Anopheles Mosquitoes. *Anopheles* mosquitoes are distributed throughout the United States, one or more species being present in every state. Most have spotted wings. The females are easily distinguished from other genera in that they have palpi about the same length as the proboscis. With Aedes and Culex mosquitoes, the palps are shorter than the proboscis. *Anopheles* mosquitoes can usually be distinguished also by their resting position. They rest with the head, thorax, and abdomen in a straight line normally at an angle of from 40° to 90° while other genera rest nearly parallel to the surface.

***Anopheles quadrimaculatus*.** This fairly large, dark-brown mosquito has four dark spots near the center of each wing. The palpi and tarsi are entirely dark.

This is the most important vector of malaria in the United States. It's frequently found in houses, and is more likely to attack humans than any other anopheline of the United States, with the possible exception of *Anopheles freeborni*. Studies have shown that about 5 percent of the meals are human blood. *Anopheles quadrimaculatus* has probably been responsible for vectoring almost all human malaria east of the Rocky Mountains. The bites are less painful than those of many other species of mosquitoes and often unnoticed.

This species is found from the southeastern U.S. northward to southern Quebec and Ontario and westward to the Dakotas, central Nebraska, Kansas, Oklahoma, and Texas. It has been of greatest importance in the South Atlantic and Gulf Coastal Plains and The lower Mississippi River Valley. It may also be abundant at times in areas as far north as Minnesota, Michigan, New York, and New England.

Anopheles quadrimaculatus breeds chiefly in permanent freshwater pools, ponds, and swamps with aquatic vegetation or floating debris. It's most abundant in shallow waters. In some areas it appears to favor open, sunlit waters while in others it is found in densely shaded swamps. This species shows a preference for clear, quiet waters neutral to alkaline (it does not usually occur where the pH is lower than six).

Anopheles quadrimaculatus larvae can withstand rather low temperatures, but they do not complete their development at temperatures below 50° to 55° F. and no appreciable development takes place until the water temperature reaches 65° to 70° F. Even at these temperatures, from 30 to 35 days may be needed for the aquatic stages to develop. The most favorable temperature for the development of *Anopheles quadrimaculatus* is between 85° to 90° F. at which only about 8 to 14 days are required.

The males emerge first, remaining near the breeding places and mating with females soon after their emergence. This often happens during their first day, either before or after the first blood meal. A female may mate repeatedly, although one mating is sufficient to insure the production of fertile eggs during her entire life. Egg laying begins about 2 or 3 days after the first blood meal. A single female may lay as many as 12 batches of eggs and a total of over 3,000 eggs.

During the daytime adults remain inactive. They rest in cool, damp, dark shelters, such as buildings, caves, and under bridges. Feeding and other activity occurs almost entirely at night. They enter houses readily to feed on human blood, but they feed more frequently on other warm-blooded animals, such as cows, horses, mules, pigs, and chickens. Most adults fly less than one-half mile from their breeding place and only a few fly farther than 1 mile. *Anopheles quadrimaculatus* in not usually caught in light traps in great numbers.

In the most southern part of the country, *Anopheles quadrimaculatus* breeds continuously through the year. Over most of its range, however, it spends the winters as fertilized adult females in caves, hollow trees, basements, and other protected places. In all but the most northern areas it may emerge from hibernation, move about and take blood meals on warm days during the winter. In the spring, the females emerge, take a blood meal and deposit their eggs. There may be as many as 9 or 10 generations each season. Populations often reach a peak during July or August and decline rapidly in September and October. Hibernating females may survive for 4 to 5 months.

***Anopheles freeborni*.** The western malaria mosquito is similar in appearance to *Anopheles quadrimaculatus*. It is the most important vector of malari.. ıe western U.S. It readily enters homes and bites avidly at dusk and dawn. Th's species occurs over most of the area west of the Continental Divide, from southern British Columbia to Lower California and may occur eastward to West Texas.

Anopheles freeborni breeds in permanent or semipermanent waters at least partially exposed to the sunlight with vegetation or floating debris. It prefers clear, clean slightly alkaline water. Larvae may also be found in slightly brackish water near the ocean or in desert pools. It normally avoids water polluted with sewage or other organic materials. Breeding may take place in habitats very similar to those where *Anopheles quadrimaculatus* is found, but for the most part it has adapted itself to seepage areas, borrow pits, hoof prints, improperly irrigated fields, and the edges of streams and irrigation canals. Rice fields are a particularly favorable breeding place for this species. This mosquito is well adapted to the semiarid region in which it occurs.

In California, *Anopheles freeborni* leave their hibernating places in February, get a blood meal, and lay eggs for the first generation. Because of the abundance of breeding places at this time of year and the scarcity of predators, large broods develop. Succeeding generations are greatly reduced in range and size by the recession of waters, except where irrigation waters maintain their breeding places. In late fall at the end of the dry season, females migrate long distances, sometimes 10 to 12 miles to look for shelter in outbuildings, homes, and cellars. In the winter they go into a state of semihibernation from which they emerge on warm days and nights for feeding. Some people refer to the winter biting as "nibbling." They move about nervously, often attack the ankles and seldom feed until they're full. These winter feedings don't usually result in development of eggs. They may, however, result in malaria transmission.

The midseason flight range of *Anopheles freeborni* is generally restricted to a 1-mile radius. In cases of very heavy production in rice fields, longer flights up to 2½ miles have been noted. Males are seldom found more than 1/4 mile from their breeding places.

Exercises (605):

In the space provided, determine if the following statements apply to *An. quadrimaculatus,* (AQ) or *An. freeborni,* (AF) mosquitoes.

____ 1. Most important vector of malaria in the U.S.
____ 2. Bites aren't very painful and may go unnoticed.
____ 3. Enters homes and shelters, bites avidly at dust and dawn.
____ 4. Most abundant in shallow water.
____ 5. Prefers clear, quiet waters where pH is neutral to alkaline.
____ 6. Found over most of the area west of the Continental Divide.
____ 7. Prefers clear, clean, slightly alkaline water.
____ 8. Water must be 65° to 70° F. for development to occur.
____ 9. Well adapted for semiarid regions.
____ 10. Breeds continuously throughout the year.

606. Given specific characteristics or situations, differentiate them as being applicable to the species Culex *pipiens*, *C. quinquefasciatus*, or *C. tarsalis*.

Important Culex Mosquitoes. The genus *Culex* includes about 300 species. Most of these occur in the tropical and subtropical regions of the world. Although some 26 species have been reported in the United States, only 12 of these are at all common. The group includes several important pest species and disease vectors.

***Culex pipiens* and *Culex quinquefasciatus*.** The northern and southern house mosquitoes are closely related and difficult to separate. They are medium-sized, brown mosquitoes with crossbands of white scales on the abdominal segments but no other prominent markings. *Culex pipiens*, the northern house mosquito, is found throughout the Northern U.S. and extends as far south as Georgia and Oklahoma. *Culex pipiens quinquefasciatus*, the southern house mosquito, is in all the Southern States from coast to coast and extends northward to Nebraska, Iowa, Illinois, and Ohio. One or both of these mosquito species can be found in every state.

The house mosquitoes are the most common species in many of our urban communities and rural premises. They often enter houses where their habit of "singing" is very annoying. *Culex quinquefasciatus* is a severe pest and *Culex pipiens* may also feed on people. Members of the *Culex pipien quinquefasciatus* complex are important vectors in urban epidemics of St. Louis encephalitis, particularly in the Midwest.

Culex pipiens and *quinquefasciatus* breed heavily in rain barrels, tanks, tin cans, and practically all types of artificial containers. Other important sources of these mosquitoes are storm-sewer catch basins, poorly drained street gutters, polluted ground pools, cesspools, open septic tanks, and effluent drains from sewage disposal plants. A heavy production of house mosquitoes is often associated with unsanitary conditions.

These mosquitoes lay their eggs in clusters of 50 to 400 eggs; these clusters, called rafts, float on the surface of the water. The eggs hatch within a day or two in warm weather. From 8 to 10 days are required for them to complete the larval and pupal stages. In somewhat cooler weather or early spring or late fall these aquatic stages may take 2 weeks or more. Breeding continues throughout the warmer months of the year. Some can survive and produce fertile eggs without a blood meal.

These species don't migrate far except when great numbers are produced. Ordinarily, when adults are present, larvae will be found nearby. They are active only at night and may be found resting during the day in and around houses, outbuildings, and various shelters near their breeding places. They are readily attracted to light traps.

***Culex tarsalis*.** This is a dark, medium-sized, mosquito with a broad, white band on the middle of the proboscis and white bands at each end of the tarsal segments. It is a fairly important pest species in some areas. It's active soon after dusk and may enter buildings in search of blood. *Culex tarsalis* may carry both St. Louis and Western encephalitis viruses. Laboratory experiments have also demonstrated its ability to transmit both diseases. Epidemiological studies carried on in several Western States indicate that it is more frequently infected with these viruses than are other mosquitoes. The infection is apparently acquired from feeding upon birds and later transmitting it to other birds, or to horses or people. It's one of the most, or possibley the most important vector of encephalitis to humans or horses in the Western States.

Culex tarsalis is widely distributed west of the Mississippi River including southern Canada and northern Mexico. It is essentially a rural mosquito.

The larvae develop in a wide variety of aquatic situations. In arid and semiarid regions, they use almost all types of water, but are mostly found in temporary to semipermanent bodies of water associated with irrigation. These areas include canals, ditches, borrow pits, impoundments, ground pools, and hoof prints. They breed in water flowing from cesspools and other waters containing large quantities of organic material from human wastes. They also breed in artificial containers such as cans, jars, barrels, drinking troughs, ornamental ponds, and catch basins. Females deposit at least two rafts of eggs, usually having 100 to 150 eggs each. Hatching normally occurs within 48 hours. The larval and pupal stages develop rapidly and breeding continues from early spring until late fall.

Adults are active mainly from dusk to dawn. During daylight hours they rest in secluded spots. They can often be found on porches, shaded sides of buildings, or under bridges. Most, however, rest in grass and shrubs, or along cut banks of streams. *Culex tarsalis* apparently must have a blood meal to produce fertile eggs. It has a wide range of hosts but shows some preference for birds, though it also commonly feeds on cows, horses, and humans. Studies show that *Culex tarsalis* will fly at least 11 miles, although most probably remain within a mile of their breeding sites. Large numbers of *Culex* tarsalis may be collected in light traps and carbon dioxide traps.

Exercises (606):

1. In the space provided, determine whether the following statements apply to *Culex pipiens* (CP), *C. quinquefasciatus* (CQ), or *C. tarsalis* (CT). Some statements may apply to more than one species.

____ a. You may expect to find these larvae in storm sewers at a Southeastern U.S. base.

____ b. Adults are medium in size with white crossbands on the abdomen.

____ c. Larvae are commonly found in flowing water high in organic wastes.

2. Which species would you expect to find in areas where lots of people are complaining of "singing" mosquitoes?

3. In areas where all the discussed *Culex* species are found, which would you expect to find the most in daily light-trap surveys?

4. Which larval species would you most likely find in a canal which carries off water from a sewage disposal plant?

5. Why would you expect to find large numbers of both larval and adult *Culex pipiens* and *C. quinquefasciatus* in a poorly maintained garbage dump?

607. Determine the identity of various mosquitoes based on given characteristics.

Miscellaneous Important Mosquitoes. Mosquitoes in genera other than *Aedes*, *Anopheles*, and *Culex* are also important in various parts of the country. In this section, we discuss mosquitoes in the genera *Psorophora*, *Coquillettidia*, and *Mansonia*.

Thirteen species of *Psorophora* are known from the United States, 10 of which are rather widely distributed in the Southern and Eastern States. These mosquitoes are not known to be vectors of human disease in the United States but some of the species are extremely severe pests. The breeding habits of this group are similar to those of the typical *Aedes*, to which they are closely related. The eggs are laid on the ground and are adapted to withstand drying. They may lie dormant for long periods. They hatch quickly upon being flooded and development of the larvae is very rapid.

Psorophora confinnis. The *Psorophora confinnis* is known as the glades mosquito in Florida, and the dark rice field mosquito in Arkansas and adjacent rice-producing areas. It's a medium to large dark species with a narrow ring of white scales near the apex of the hind femur. *Psorophora confinnis* is the most widespread and important species of *Psorophora* in the United States. It occurs throughout southern United States, extending westward to South California and northward to Nebraska, Iowa, and New York. It reaches its greatest abundance in the Florida Everglades and in the rice fields of Arkansas and Mississippi. The females are fierce biters, attacking anytime during the day or night. Great numbers of these mosquitoes may occasionally kill livestock and can make it almost unbearable for humans to remain in infested outdoor areas.

Psorophora confinnis breeds in temporary rain pools, irrigation waters, and seepage pools. Eggs are not laid on water surfaces but on ground subject to flooding from rainfall, overflow, or irrigation. Soil with low, rank vegetation seems to be ideal for depositing eggs. Drained rice fields are among the most favorable sites. Eggs will hatch after 4 or 5 days if they are submerged at that time. If they remain on the soil's surface for 2 or 3 weeks or longer and are then flooded, hatching may begin within a few minutes. *Psorophora confinnis* passes the winter in the egg stage. The larval period for *Psorophora confinnis* is very short. During midsummer in Arkansas, it may be completed in as little as 4 days. The average time at a mean temperature of 79° F. is slightly over 5 days. The pupal stage is completed in 1 or 2 days. The number of generations per season varies from one to many, depending upon how often suitable hatching conditions occur. Areas that dry up and are then flooded a few days later may produce a brood with each flooding. Such conditions are provided with certain types of irrigation, particularly rice culture. Adults live 1 to 2 months. They have a flight range of up to 10 miles.

Psorophora ciliata. The *Psorophora ciliata* is a very large, yellowish-brown mosquito with shaggy legs, which is commonly known as the gallinipper. It is a vicious biter and because of its large size presents a terrifying appearance. *Psorophora ciliata* is widespread through Eastern United States from Mexico to Canada, being abundant locally in the South and Middle West. When present in numbers it is a severe pest, attacking readily during the daytime as well as in the evening.

It is one of the few species whose larvae feed on other aquatic insects including mosquito larvae. It breeds in temporary pools, often in association with *Psorophora confinnis* and *Aedes vexans* upon which it feeds. The fourth instar larvae may consume three or four other larvae in 1 day. *Psorophora cilita* larvae are easily recognized in the field as they are two or more times as long as most other species. They hang almost straight down from the water surface. The larval and pupal life is short as is characteristic of this group of mosquitoes. The eggs are laid on the surface of drying soil and hatch when flooded as with *Psorophora confinnis*.

The closely related genera *Coquillettidia* and *Mansonia* include three species in the United States, one of which is very widespread and common. They are troublesome biters and severe pests in many areas. *Mansonia* eggs are laid in rafts on marshes or lakes. After hatching, the larvae descend below the surface of the water and insert their air tubes into the stems or roots of aquatic plants. They remain below the water surface throughout the larval and pupal stages obtaining air from these plants. Because of this unique habit, you can't control *Mansonia* and *Coquillettidia larvae* by using ordinary surface larvicides.

***Coquillettidia perturbans* (previously *Mansonia perturbans*).** This mosquito is large, speckled, and brown and white with a characteristic pale band at about the outer third of the hind femur and tibia. It's found in the Southern and Eastern States from the gulf coast to Canada. It is also known from some of the Great Plains and Rocky Mountain states and from the four Pacific Coast States. This species has been found naturally infected with the virus of Eastern encephalitis in Georgia. Its role in the epidemiology of this disease has not been established.

Coquillettidia perturbans breeds in marshes, ponds, and lakes having a thick growth of aquatic vegetation. Larval development is unusually slow, requiring several months. The larvae that hatch one season do not ordinarily complete their development until the following spring. They remain below the water surface throughout this period though they may detach from their host plants and move about. The pupae also have breathing tubes adapted for penetrating plant tissues and they too attach to plants from which they get their air. The pupal stage takes 5 to 6 days. The adults emerge in late spring or early summer. There appears to be only one generation per year throughout most of the range of this species. It is possible that a partial second brood may be produced in Florida. Larvae have been found associated with a number of plants. Some of the more important ones are pickerel weed, cattail, water lettuce, arrowhead, aquatic sedges, and swamp loosestrife.

The females will bite during the daytime in shady, humid places, but are principally active in the evening part of the night. They readily enter houses and bite viciously. These strong fliers are frequently taken in light-trap collections.

Mansonia titillans. This tropical species is fairly common in Florida and has also been reported from South Texas. It has been found in nature infected with Venezuelan equine encephalitis virus. The adults are severe biters and fairly important pests in Florida. The eggs of *Mansonia titillans* are laid on the under surface of the leaves of water lettuce. The larvae and pupae attach to the roots of this plant, developing in the same manner as described for *Coquillettidia perturbans*. The adults are frequently taken in light traps.

Exercises (607):

Determine which mosquito(es) are described by the following statements.

1. These larvae are predaceous on other mosquito larvae.

2. As adults, these are large and speckled with a pale band on the outer third of the hind femur and tibia.

3. These adults are medium to large with a narrow white ring near the apex of the hind femur.

1-4. Mosquito Surveys and Control Methods

Adult and larval mosquito surveys are essential for any effective mosquito control program. Because the larval stage of development is the most susceptible to control, you should direct your efforts toward this stage whenever you can. However, there will be times when you must control adult mosquitoes by mechanical and chemical means. The adult survey will help you know when such a control program is necessary.

608. Complete given statements regarding the purpose for conducting mosquito surveys, and specify which survey techniques are suitable for various species of adult mosquitoes.

Surveys are essential for planning, conducting, and evaluating an effective mosquito control program, whether for the prevention of mosquito-borne diseases or the lowering of populations of these biting insects to a level permitting normal activities without undue discomfort.

Before you proceed with this lesson, you may want to review Volume 2, objectives 211 and 212.

Reasons for Adult Mosquito Surveys. Adult surveys help you evaluate the incidence of mosquitoes in a community where they may bite people, and show you the relative abundance of the various species present at any time. Using this information and reference material on the breeding sites and habits of mosquito species, you and other specialists can determine the need for a management programs and conduct a more effective search for larval breeding places. Adult mosquito surveys provide data for using space spraying equipment at the best time and place. It is also used to determine the extent of the problem, ways your superiors and the public can help, and results of your control operations. Interpreting adult mosquito survey reports and translating this information to action will save work hours, materials, equipment, and give you justification for the entire operation.

Equipment. The required equipment is simple and inexpensive. It includes a collecting tube or aspirator, pill boxes, cages (for live collections), field record forms or notebook, pencil, flashlight, and map. (See fig. 1-6).

Collection Methods. The methods you use to collect mosquitoes depend upon the species to be collected. Remember, mosquito species vary greatly in their habits.

Biting collections. Collecting mosquitoes as they bite is a convenient method of sampling populations. (Any volunteers?) In making biting collections or counts, you (or someone in need of a "9" on their next Airman Performance Report) should expose part of your body by rolling up your sleeves, trouser legs, or by removing your shirt. Sit quietly for a designated period of time (usually 10 or 15 minutes). The mosquitoes are collected with an aspirator or chloroform tube, either by the collector or a coworker. In many parts of the Tropics it is customary to make biting collections about sundown from a domestic animal, such as a white horse. If you take collections at night, you need a flashlight. Whether you take counts from people or animals, you should remember that certain individuals are more attractive to mosquitoes than others. It is therefore desirable for the same person or animal to be used throughout a given survey. Collections must be made at regular intervals and at approximately the same time of day so that biting rates at different stations may be compared to show trends in mosquito populations.

With day-biting species, the index may be based upon the number of mosquitoes that alight upon one's clothing in a given time interval (the landing rate), rather than those actually in biting position. This method is more practical when populations are very high and is useful for a rapid check of mosquito abundance before and after treatment. The landing-rate method has been used especially with certain species of *Aedes* or *Psorophora* found in salt marshes, rice fields, or the arctic and subarctic tundras.

Carbon dioxide traps. Solidified carbon dioxide (dry ice) will attract large numbers of some mosquito species. This type of trap is generally baited with about 3 pounds of dry ice and wrapped in newspaper. It is very effective in collecting large numbers of *Culex tarsails*.

Insect nets. Insect nets are used to collect mosquitoes from grass and other vegetation. This type of collection is of value in helping determine the abundance of those species that rest in these habitats during the daytime, such as many *Aedes* mosquitoes.

Daytime resting stations. Adults of many species are inactive during the day, resting quietly in dark, cool, humid places. Careful inspection of daytime shelters will give you an index to the population density of these mosquitoes. This method is especially useful for anopheline mosquitoes and is commonly used for *Anopheles quadrimaculatus* and *Anopheles freeborni*. It is also of value in estimating populations of other species such as *Culex quinquefasciatus*, and *Culex tarsalis*. Mosquito resting stations may be divided into two general types: natural and artificial.

Natural resting stations are places normally present in an area, such as houses, stables, culverts, bridges, caves, hollow trees, and overhanging banks along streams. With experience you can evaluate the suitability of shelters by casual inspection. Dwellings, especially when unscreened, are often satisfactory resting stations, being especially important when mosquito-borne diseases are investigated. Under such conditions they furnish an index to the number of mosquitoes that may bite people and transmit encephalitis or other diseases.

Suitable resting stations may not be available in sufficient numbers to give a satisfactory evaluation of the mosquito population. It may be necessary to construct special shelters or to use boxes, barrels, kegs, etc., as artificial resting stations. Many different types of artificial shelters have been used. They should always be placed near the suspected breeding places in shaded, humid locations. Mosquitoes enter such shelters at dawn, probably in response to changes in light intensity and humidity and ordinarily do not leave before dusk.

Light traps. Mosquito light traps attract adults from a considerable area when they are placed in locations remote from competing light sources.

The mosquito light trap is mounted on a post, or hung from a tree, with the light 5½ to 6 feet above the ground. It should be located 30 or more feet from buildings in open areas near trees and shrubs. It should not be placed near other lights, in areas open to strong winds, or near industrial plants giving off smoke or gas. The traps are operated on a regular schedule from 1 to 7 nights per week. They are turned on just before dark and turned off after daylight. You can use an automatic time clock or photoelectric cell to start and stop the trap, or you can turn the trap on and off by hand. Remove the collection each morning and place it in a properly labeled box until it can be sorted and identified. Refer to figures 1-7 and 1-8 for examples of how to record various types of survey results.

Wide differences have been noted in the reactions of different species of mosquitoes to light. Therefore, light-trap collections must be used in conjunction with other methods of sampling mosquito populations. They have proven very useful in measuring densities of some mosquitoes, such as *Aedes sollicitans*, *Aedes nigromaculitis*, *Culex pipiens*, and *Coquillettidia perturbans*. Some anophelines are also readily taken in light

Base ____________________ Date ____________________

Collector ____________________ Supervisor ____________________

LARVAL COLLECTIONS

Station Number	Date of Collection	No. of Dips	No. of Larvae Collected	Larvae per Dip	Larval Collections	Description Collection Site

ADULT COLLECTIONS

Station Number	Date of Collection	Type of Collection	Females per Trap Night	Landings per Minute	No. of Females (Resting Station)

CPA-154

Figure 1–7. Mosquito collection record.

traps. The common mosquito, *Anopheles quadrimaculatus*, however, is seldom taken in significant numbers.

Exercises (608):

1. Surveys are essential for ______ , ________ , and _______ an effective mosquito control program.

2. Interpreting adult mosquito survey results and translating this information to action will save ________ ________ , ________ , and ________ , and give you ________ for the operation.

3. Carbon dioxide traps are effective in collecting ________ _________ mosquitoes.

4. Mosquitoes usually enter shelters at __________ , probably in response to changes in __________ ________ and ________ .

5. What survey techniques are suitable for each of the following mosquitoes?
   a. *Aedes sollicitans*.

   b. *Psorphora spp*.

   c. *Culex tarsalis*.

d. *Annopheles quadrimaculatus.*

e. *Culex quinquefasciatus.*

609. Identify the purpose for conducting larval mosquito surveys and the equipment required, and cite survey techniques for various genera of mosquito larvae.

Larval Mosquito Surveys. Mosquito larvae are found in all types of aquatic habitats from warm, brackish, seaside marshes to the pure, cold water of the melted snows. You can find them in such diverse locations as rivers, lakes and ponds, carb holes, pitcher plants, eaves, troughs, bottles, cans, reservoirs, tree holes, old tires, and vases.

You must assume that mosquitoes have adapted themselves to almost every conceivable type of aquatic situation. You must have information regarding the general breeding habits of the species known or suspected to be present in the area before you begin larval surveys. An experienced person may be able to spot the probable mosquito breeding places in specific areas by means of a rapid reconnaissance survey. These places should be carefully numbered and marked on a map such as the one in figure 1-9.

Purpose. Larval surveys help you determine the specific breeding sites and establish permanent sampling stations. Larval surveys show the exact areas in which mosquitoes breed and their relative abundance. For this reason they are of special value in control operations.

Equipment. A white enamel dipper about 4 inches in diameter is used most for collecting mosquito larvae. You can extend the handle of such a dipper to a convenient length by inserting a suitable piece of cane or wood. Many special dippers are used for specific purposes so that their capacity can be related directly to the water surface area examined. Thus, you can compute the number of larvae per square foot of square meter with reasonable accuracy.

To inspect small artificial containers or cisterns, you may need a flashlight or a mirror to reflect light into the breeding place. You can use large bulb pipettes or siphons made of rubber tubing to remove water from small obscure areas, such as tree holes. The water may then be put in a dipper or pan where the larvae are counted and collected. Widemouthed pipettes (eye droppers) are used for removing larvae from the dipper or pan; small vials, preferably with screwcaps, serve to hold the larvae until they can be identified or mounted on slides. Screened-bottom spoons may be substituted for pipettes if the larvae are to be transferred to widemouthed bottles. Alcohol of 95 percent strength is a most satisfactory preservative but 70 percent alcohol is in common use.

Collection methods. You'll usually find mosquito larvae where surface vegetation or debris is present. Thus, in larger ponds or lakes, larvae are ordinarily confined to the marginal areas. Proceed slowly and carefully in searching for mosquito larvae, as disturbing the water or casting shadows may cause the larvae to dive to the bottom.

Base________________ Date Received________________

Determined by________________ Date________________

Station Number	Date of Collection	Type of Collection	Mosquito Species	No. of Larvae	No. of Males	No. of Females

CPA-155

Figure 1-8. Mosquito identification record.

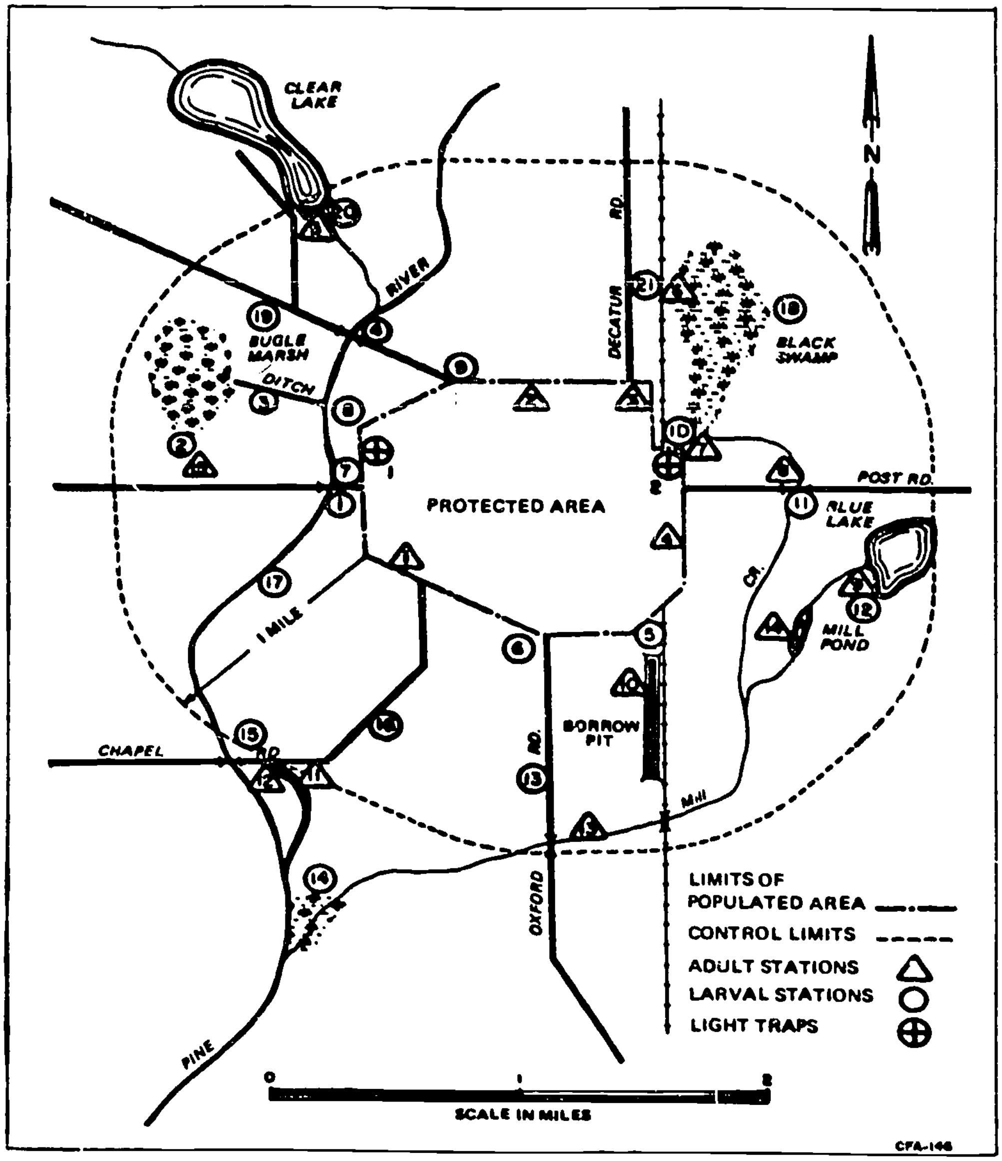

Figure 1–9. Schematic map showing mosquito sampling stations.

Anopheline larvae are collected by a skimming movement of the dipper with one side pressed just below the surface. The stroke is ended just before the dipper is full, since larvae will be lost if the dipper if filled to the point that it runs over. Where clumps of vegetation are present, press the dipper into the clumps with one edge depressed so that the water flows from the vegetation into the dipper. Some larvae, such as *Aedes vexans, sollicitans,* or *taeniorhynchus* or the species of *Psorophora,* require a quicker dipping motion because they are more likely to dive below the surface when disturbed.

Always record the number of dips made and the number of larvae found. Transfer the larvae to small vials with a widemouth pipette and preserve them in alcohol for later identification. You can then get a rough idea of the breeding rates by computing the number of larvae of each species per dip. The number of dips required depends on the size of the area, but for convenience they should be made in multiples of ten. You should make your inspections at intervals of 1 to 2 weeks during the breeding season because areas entirely negative at one time may be found breeding heavily at other times.

Variations in the procedure described above are called for when you're inspecting for certain species. For example, *Mansonia* and *Coquillettidia* larvae remain below the water surface throughout their development. You can find these larvae by pulling up aquatic plants (cattail, sedges, pickerelweed, etc.) and washing them in a pan of water. A search of the bottom muck and trash from the area where the host plants have been uprooted may be productive. Scoop this material and examine it in pans of clear water.

Inspection for *Aedes aegypti* involves a careful search for artificial containers where these domestic mosquitoes breed. Such inspections are usually made on a premises-by-premises basis where bottles, tin cans, vases, automobile tires, and all other containers of water are examined. You can find the *Aedes aegypti* index by dividing the total number of premises inspected into the number in which breeding is found. Collection of the larvae may require a dipper but is more frequently accomplished directly by means of a widemouthed pipette.

Inspection for *Aedes triseriatus* and *Aedes aegypti* involves searching for tree holes and artificial containers in which these species breed. These are often too small to admit an ordinary dipper, but water may be siphoned into a dipper or pan where you can see the larvae.

Exercises (609):

1. Larval surveys help you determine ______ ______ ______ and establish permanent ________ _______ .

2. You should always record the number of __________ made and the number of _________ found.

3. Inspections should be made at intervals of _______ - _______ weeks.

4. What are the suitable survey techniques for the following mosquito genera? (Refer to previous lessons as needed.)

   a. *Anopheles.*

   b. *Aedes.*

   c. *Culex.*

   d. *Mansonia/Coquillettidia.*

610. Describe the categories of IPM applicable to adult and larval mosquito control, and develop a control program for mosquitoes based on a given situation.

Cultural Controls for Mosquitoes. As you learned earlier, cultural control involves manipulating the environment to make it less favorable for pests: disrupt their reproductive cycles, eliminate their food sources, and increase numbers of predators. With mosquitoes, as with several other pests, this boils down to a sound program of *habitat modification*.

Good area mosquito control begins when you work to get better water management both on and around the base. This is easily the most permanent measure and, likewise, the most desirable approach. This is because in the long run, you get better control, save money, and reduce chemical hazards in the environment. Some water management practices include:

(1) Ditching and cleaning stagnant streams to maintain adequate waterflow and to get rid of vegetation and debris that reduce waterflow and give mosquitoes breeding opportunities.

(2) Using herbicides to eliminate or prevent plant growth in breeding areas or potential breeding areas.

(3) Draining or filling back-water pools and swamps where stagnant water accumulates.

OK, all of this looks good on paper but at this point, you might be thinking that except for the herbiciding, this type of work isn't your job. This is true, but you can still play a role in bringing about needed cultural controls on your base. First, of course, is *surveying* to specifically identify problem areas, and then, *increasing awareness* of these problems to your bosses to get action taken on the situation.

Mechanical/Physical Controls. This category includes measures to destroy pests outright or make the environment unsuitable for their entry, dispersal, survival, or reproduction. Like the cultural controls you just learned about, M/P controls exploit weak links in a mosquito's life cycle or behavioral patterns. Unlike cultural mosquito controls, however, M/P controls apply to mosquito adults, not the aquatic stages.

The bottom line in M/P control is—keep them from getting to where you are! Adequate screening of all occupied structures is a must. Bed nets should be used under field conditions when screening of structures isn't possible or practical.

Screening. Screens are made of galvanized iron, copper, bronze, aluminum, or plastic. Near the ocean, iron and copper screens are not recommended because of the corrosive action of salt sprays. Plastic screens have given years of good service in these areas. Screens must be of the proper mesh, must fit tightly and be kept in good repair. Screening with 16 mesh to the inch will keep out most of the bloodsuckers, but 18 mesh may be needed to keep out some small species, such as *Aedes aegypti* and *Aedes taeniorhynchus*. Frequently, mosquitoes follow people into buildings or enter on the human host. For this reason, screen doors should open outward and have automatic closing devices. Residual insecticide applications on and around screen doors give added protection. Xylene emulsions of insecticides often affect the galvanizing on ordinary iron screens, with subsequent rust problems, and may affect some plastic screens. Therefore, kerosene solutions are preferable for such residual sprays.

Bed nets. The bed nets, or mosquito bar, is a useful item in temporary camps and in the Tropics. Mosquito netting is a cotton or nylon cloth with 23 to 26 meshes per inch.

White netting is best, as mosquitoes accidentally admitted into the net are easily seen and killed. Most bed nets are rectangular in shape and large enough to permit a person to sit up in bed. The net is suspended over the bed and tucked in under the mattress. An aerosol bomb may be used to kill mosquitoes in the net before the person retires, or they can be killed by hand.

Biological Controls. Classical biological control involves our deliberate introduction of natural enemies which reduce pest populations. In larval mosquito control programs, biological control actions you can take include using predatory fish and commercially available pathogens, such as BTi (refer to Volume 3).

Mosquito-eating fish offer a good opportunity in biological control for some areas. Many mosquito abatement districts raise and distribute top minnows (such as Gambusia) and other small fish to control mosquitoes in cisterns, water tanks, garden pools, and marshes.

In Hawaii and the South Pacific, not-too-successful control has been attempted using the larvae of *Toxorhynchites* to devour the larvae of *Aedes aegypti* and Aedes albopictus. In Canada and Alaska, careful observations have been made of the predaceous larvae of *Chaoborus, Machlonyx,* and *Eucorethra* in the biological control of Aedes larvae.

BTi is the most common microbial mosquito larvicide in use today. This spore-forming pathogen produces endospores that help it live in a dormant state in an unfavorable environment for a limited time. When a larva eats the spores, it remains alive for several days, but its gut becomes paralyzed and it cannot eat.

Chemicals Controls. Pesticides of various types lend themselves to both larval and adult control programs.

Larval insecticides. Larval control is of primary importance in areas where you need immediate control of pest or disease-carrying mosquitoes, particularly in cases of extensive flooding following natural disasters, such as hurricanes, or long rainy seasons.

You can apply synthetic organic insecticides as dusts, pellets or granular formulations, wettable powders, solutions, emulsions or technical grade material. Dusts have been widely used as mosquito larvicides, but they are light, subject to air currents and spotty applications, and may stick to leaves. Pellets or granular formulations have a larger particle size, permitting them to slip through leaves or dense vegetation reaching the water surface to kill mosquito larvae. Wettable powders are frequently used in the prehatch treatment of areas for the control of mosquito larvae. These wettable powders may be applied on snow and ice or on earth in dried-up mosquito breeding areas seeded with eggs of temporary pool mosquitoes. Oil solutions may be sprayed on water surfaces to kill both anopheline and culicine larvae and pupae, particularly in waters with high organic content. Most mosquito control organizations continue to use some petroleum oil to kill mosquito larvae that are resistant to the organic insecticides. Emulsions have been employed extensively in treating irrigated waters, such as rice fields, where oil solutions would be toxic to cultivated plants. The water in the emulsion serves as a carrier for the minute oil droplets containing insecticides, facilitating treatment of large areas with hydraulic equipment. The emulsion breaks almost immediately after the spraying operation, producing an oil film upon the surface of the breeding area. Technical grade insecticides are used particularly with the ultralow volume (ULV) method of control, often from airplanes.

Petroleum oils were the first of the larvicides to be widely used, following the pioneer research of L.O. Howard in 1892, on the use of kerosene to kill mosquito larvae. Petroleum oils are toxic to the eggs, larvae, and pupae of both anopheline and culicine mosquitoes. There are two lethal fractions in petroleum oils used for mosquito control: a toxic fraction, with low boiling range and high volatility, which penetrates the tracheae of larvae and pupae and produces an anesthetic effect; and a lasting fraction which acts much slower and generally does not have any direct toxic action, but suffocates by mechanical interference with breathing.

NOTE: It is recommended that the larvicide be a different chemical from that used for adult control. For example, it may be desirable to use fuel oil with a spreading agent as a larvicide, and malathion as an adulticide. Prior to implementing any type of control program, insure that the program is one that has been approved by appropriate agencies.

Methoprene offers the newest approach in larval mosquito control. It's a type of insect growth regulator that acts as a selective chemical control agent. Applied during the 2nd, 3rd, or 4th larval instar, methoprene prevents development beyond the pupal stage. It's effective against all genera of mosquitoes discussed except *Coquillettidia* and *Mansonia*. (These species develop well below the water surface, but methoprene tends to stay near the water surface, so know what you're controlling—survey—before you use methoprene.)

Adult mosquito control. You can effectively control adult mosquitoes by applying chemicals as aerosols, mists, fogs, dusts, and residuals.

Aerosol bombs are used to kill mosquitoes in homes, temporary lodging facilities, and field tents. A few seconds' release of the aerosol will kill all species of mosquitoes (and flies, midges, and gnats) in an ordinary-sized room, tent, or trailer. It is not hazardous to humans if used as directed on the container.

Ultralow volume aerosoling operations are conducted during the late afternoon and early evening, at night, or in the early morning when the air is calm, or winds vary from 1 to 6 miles an hour. If winds are exceptionally strong, droplets are dispersed so swiftly that effectiveness is reduced.

Space spraying is the chief activity of many organized mosquito abatement districts and is (wrongly) the only method used by an even larger number of communities that attempt to reduce mosquito annoyance.

Control of adult mosquitoes by space spraying gives only temporary control. If mosquito populations are high, and the species are strong fliers, such as pest mosquitoes in the genera *Aedes, Culex, Mansonia,* and *Psorophora,* migration back into the area may occur following treatment making daily applications necessary.

Exercises (610):

1. What major categories of IPM are applicable to larval mosquito control?

2. What major categories of IPM are applicable to adult mosquito control?

Questions 3 through 5 are based on this situation:

At a Southeastern U.S. base, you've been getting high counts of *Aedes aegypti* and *Anopheles quadrimaculatus* in your surveys. The area involved is an old base housing area with many large trees. On one side it's surrounded by trees and fields; on another side is a periodically stocked pond with slow-moving water and patches of tall aquatic vegetation.

3. What actions would you take regarding the pond?

   a. Cultural control.

   b. Biological control.

   c. Chemical control.

4. What actions would you encourage from housing residents?

   a.

   b.

   c.

5. What chemical controls would you use in the housing area?

   a.

   b.

Flies

FLIES ARE PESTS both indoors and out. More important, many flies breed in excrement and filth from which they carry disease-causing organisms to food, drinking water, or directly to the human body. Throughout the world, flies serve as mechanical and biological carriers of organisms that cause some of the most common and important diseases, such as typhoid fever, diarrhea, dysentery, and cholera. Larvae of some fly species infest man or animals and cause serious sickness or even death, while other species attack and destroy crops. Today, we know that reducing fly populations is essential to human well-being and reducing many serious and widespread diseases.

You can control flies most effectively if you can identify each species, know the life cycle and habits of problem species, and understand the dynamics of fly populations. Present fly control methods are only partially effective; ready answers cannot be given to every fly problem. However, recognized techniques, judiciously employed, can often reduce the numbers of flies and decrease the transmission of flyborne diseases. Improved environmental sanitation, the primary control measure, reduces the prevalence of many fly species and furnishes dividends in better living conditions for people.

2-1. The Importance of Flies to People

Flies are important to us because of their annoying habits and ability to spread diseases and destroy agricultural products.

611. List the ways flies are important to people and name diseases certain flies carry or create.

Annoy. Domestic flies can affect individual efficiency and productivity because of the amount of time expended swatting and driving them away. Domestic flies can affect morale of individuals because of disruptions to picnics and other outdoor recreational activities.

Bite. Not all flies bite, but those that do may cause serious trouble. Biting flies do not have venom in the usual sense. Instead, the effects of their bites result from the human reaction to saliva poured into the bite wound to prevent clotting of the blood during feeding. Frequently, biting flies, such as blackflies, punkies, horseflies, and deerflies, seriously interfere with such activities as farming, hiking, camping, and outdoor sports, particularly in coastal areas or in the northern part of the United States. For susceptible people, bites may produce severe lesions, hard knots beneath the skin, secondary infections, high fever, and general disability. The stable fly is common around human habitations and its bite can be quite severe. Blackflies bite viciously, sometimes attacking in such numbers that they kill the victim. In the Balkans in 1923, over 16,000 domestic animals were killed by blackfly attack. Eye gnats do not bite, but their rasping mouthparts damage the delicate membranes of the eye.

Transmit Diseases. Flies transmit disease both mechanically and biologically. Many flies, particularly the housefly and other domestic flies, have filthy habits that make them efficient vectors of disease. Flies spread pathogens (disease-causing organisms) in five ways: (1) on their mouthparts, (2) through their vomitus, (3) on their body hairs, (4) on the sticky pads of their feet, and (5) through the intestinal tract by means of fly feces. The housefly is considered by many authorities to be the most widely distributed as well as the most dangerous insect closely associated with humans.

Mechanical vectors. Under optimum conditions, flies can be as effective in spreading enteric infections as are fingers, dirty eating utensils, and contaminated food. As a typical example, a housefly feeds on human feces in a privy used by a person suffering from diarrhea and later alights on food being prepared in a kitchen. The fly inoculates the food with pathogenic bacteria, such as the diarrhea bacteria (Shigella) or the typhoid bacillus (*Salmonella* typhi), which multiply rapidly in the food. When, hours later, the food is eaten, the people become infected and develop diarrhea.

Domestic flies (particularly the housefly) mechanically transmit organisms causing bacillary dysentery, infantile diarrhea, typhoid fever, paratyphoid fever, cholera, amoebic dysentery, giardiasis, and pinworm, roundworm, and tapeworm infections.

Flies with rasping mouthparts, such a eye gnats, are reported to carry the organisms that cause trachoma, epidemic pinkeye or conjunctivitis, and yaws. There is also evidence that the organisms that cause tularemia and anthrax are transmitted mechanically on the mouthparts of deerflies and horseflies from an infected animal to a healthy one.

Biological vectors. Many species of bloodsucking flies serve both as vectors and as intermediate hosts of pathogens, particularly of protozoa and helminths causing human diseases. This phenomemon is known as the biological transmission of disease-causing organisms. Examples include the tsetse flies of Africa, which transmit the trypanosomes causing African sleeping sickness of humans and nagana of animals, the blackflies which transmit the worms causing onchocerciasis (blinding filariasis) in Africa and Latin America, and the sandflies which transmit protozoa causing many forms of leishmaniases in Europe, Asia, Africa, and Central and South America. Other diseases having this type of epidemiology include loasis (African eye worm disease), bartonellosis (oroya fever) of South America, and sandfly fever of the Mediterranean region.

Cause of Myiasis. Many species of flies lay their eggs or larvae on the flesh of mammals, including man. The larvae then invade the flesh of the host animal, producing a condition known as myiasis. Cattle and sheep are commonly afflicted, as are many wild animals, such as rabbits and deer. Typical examples of this type of myiasis are the screwworm maggots in cattle and the botfly larvae in horses. In addition, people may eat food infested with fly larvae. If the larvae survive the gastric juices and live in the alimentary canal, intestinal myiasis manifested by queasiness and diarrhea frequently results. Typical examples of intestinal myiasis are caused by eating such foods as fish, meat, or cheese infested with flesh fly larvae or cheese skippers, or by drinking water containing rat-tailed maggots.

Destroy Agricultural Products. Many species of flies, such as the Hesshan fly, cabbage maggot, onion maggot, apple maggot, clover seed midge, and seed corn maggot, attack and damage plants directly. Some flies transmit organisms causing plant disease, such as bacterial soft rot of vegetables; fire blight of apple, pear, and quince; ergot of rye and wheat; olive knot; and bacterial rot of apple. In addition, flies suck blood and annoy cattle to such an extent as to decrease milk and meat production, cause myiasis in many domestic animals, and transmit diseases such as anthrax.

Exercises (611):

1. What are the ways flies affect humans?

2. In what five ways do flies spread pathogens?

3. List six diseases that domestic flies can transmit mechanically.

4. What disease can occur if people eat food infested with fly larvae and the larvae survive the gastric juices?

2-2. General Characteristics of Flies

There are certain anatomical and life cycle characteristics common to most flies. Flies are insects belonging to the order Diptera.

612. Indicate the general characteristics of flies.

Anatomy. Adult Diptera are distinguished from all other insects by the following two characters: (1) two wings (the scientific name is derived from Di = two; pteron = wing), whereas most other adult insects have four wings; and (2) two halteres, the tiny knoblike structures located behind the wings that represent the rudimentary second pair of wings. The relatively few wingless adult flies always have halteres.

Adult flies have three distinct body regions: head, thorax, and abdomen. The head bears a pair of very large compound eyes which often comprise most of the head, one pair of antennae and the mouthparts, which are adapted for piercing and sucking, rasping, or sponging, depending on the species. The thorax consists of three segments called the prothorax, mesothorax, and metathorax, each of which bears a pair of legs. Each leg is composed of a basal, coxa, short trochanter, relatively strout femur, slender tibia, and a five-segmented tarsus. The single pair of wings is fastened to the mesothorax and the halteres to the mesothorax, each of which bears a pair of legs. The long veins which reach the wing margin in domestic flies are termed Sc (for subcosta), then 1, 2, 3, 4, 5, 6. The shape of the vein 4 (straight, curved, or angled) is used in identification (figs. 2-1 and 2-2). The abdomen is composed of from four to nine segments and the genital organs.

Life Cycle. Flies have four stages in their life cycle: egg, larva, pupa, and adult. They develop by complete metamorphosis (fig. 2-3). A few species, such as some flesh flies, retain the eggs within the body of the female until hatching and give birth to larvae. In general, the larvae feed differently and occupy a different habitat from that of the adult. Larvae of most flies are commonly called maggots. The pupae of many flies are enclosed in a tough skin known as a puparium and do not move very much. The time required for development from egg to the adult varies greatly, from a few days to more than a year, depending on the species of fly, and environmental conditions, particularly the temperature and humidity.

Exercises (612):

Place the letter "T" in front of the correct statements. Correct any false statements.

____ 1. Flies belong to the order Diptera and have two wings.

____ 2. All flies have mouthparts that are adapted for piercing and sucking, rasping, and sponging.

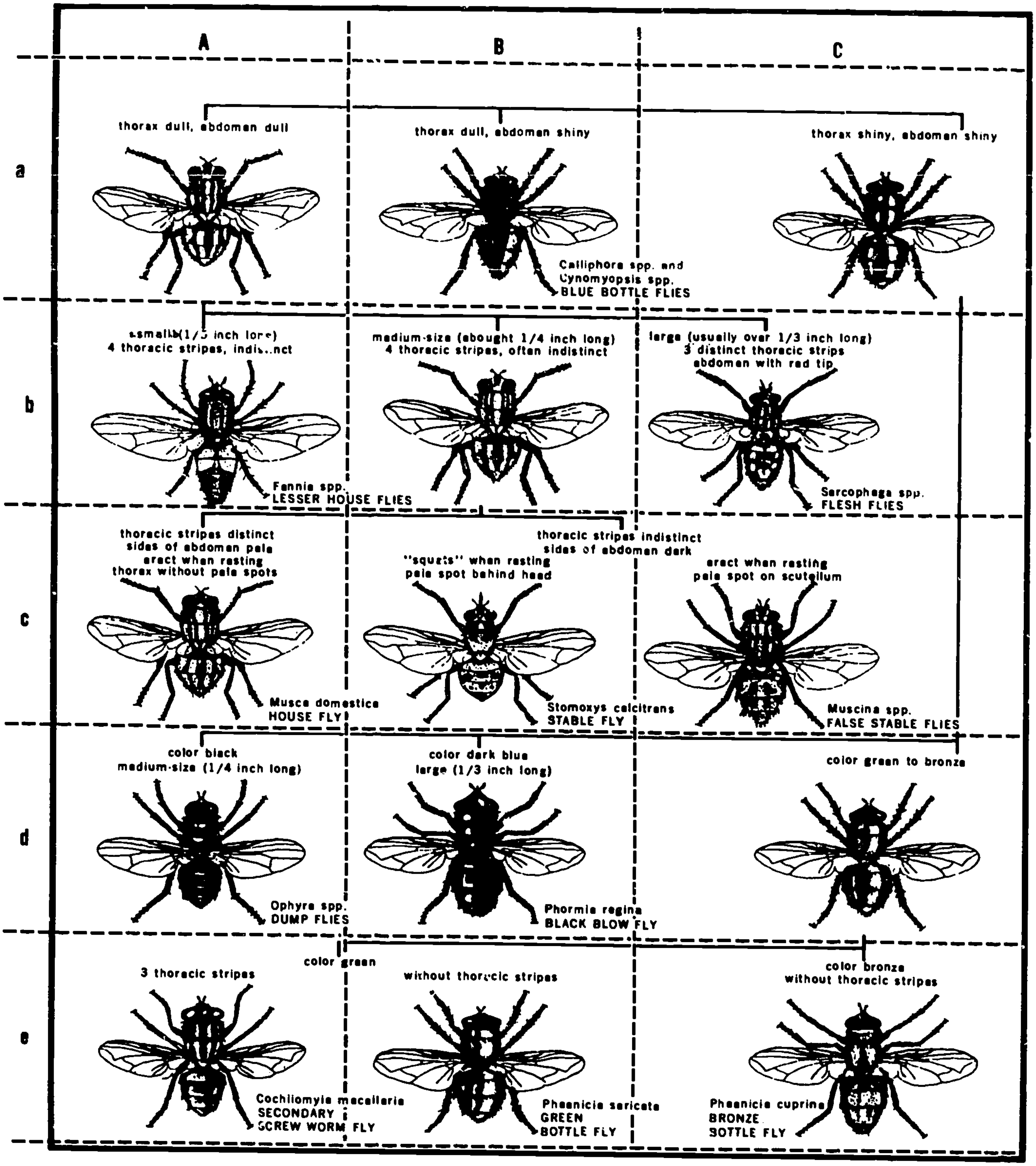

Figure 2–1. Pictoral key to common domestic flies.

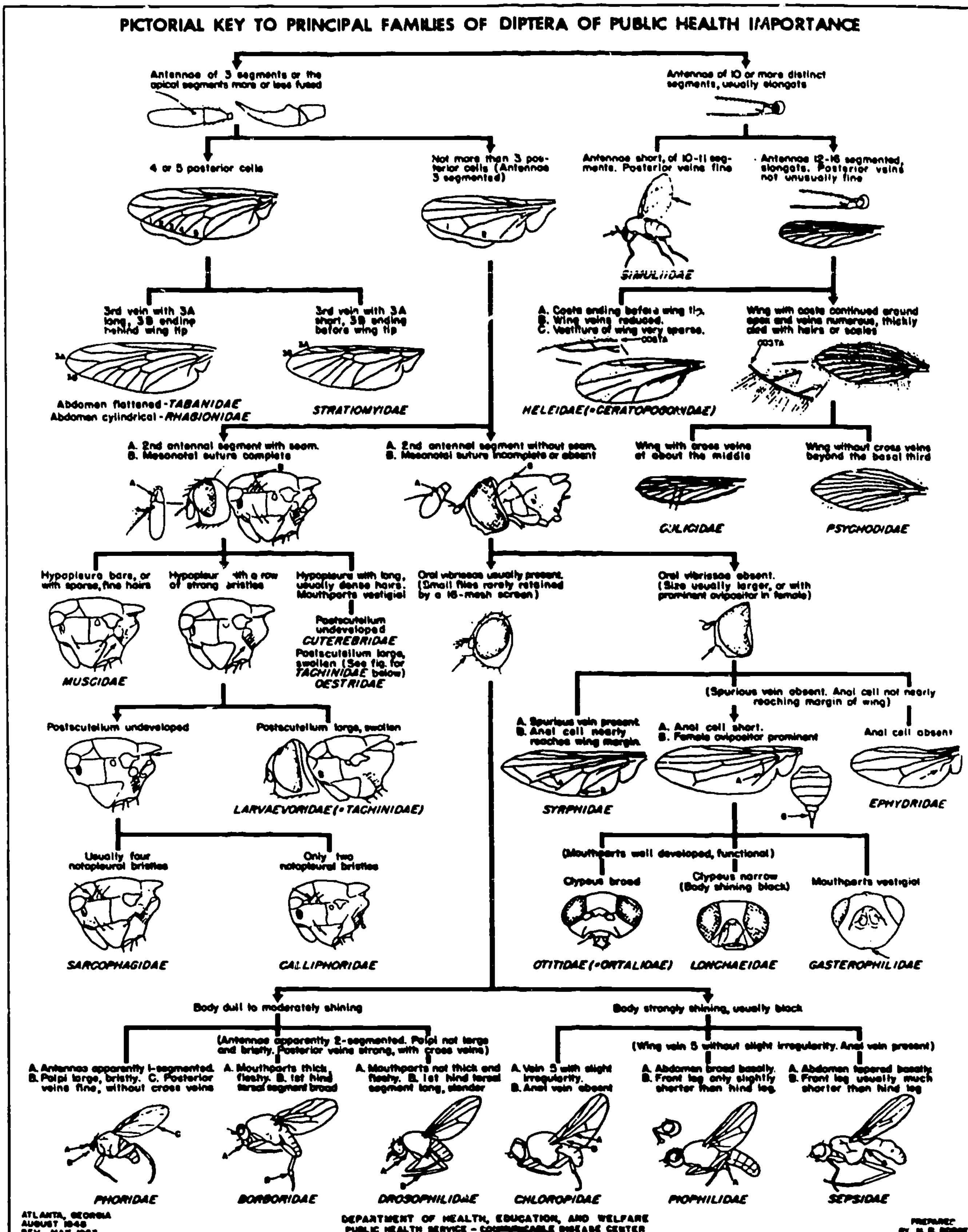

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Figure 2–2. Pictoral key to families of flies.

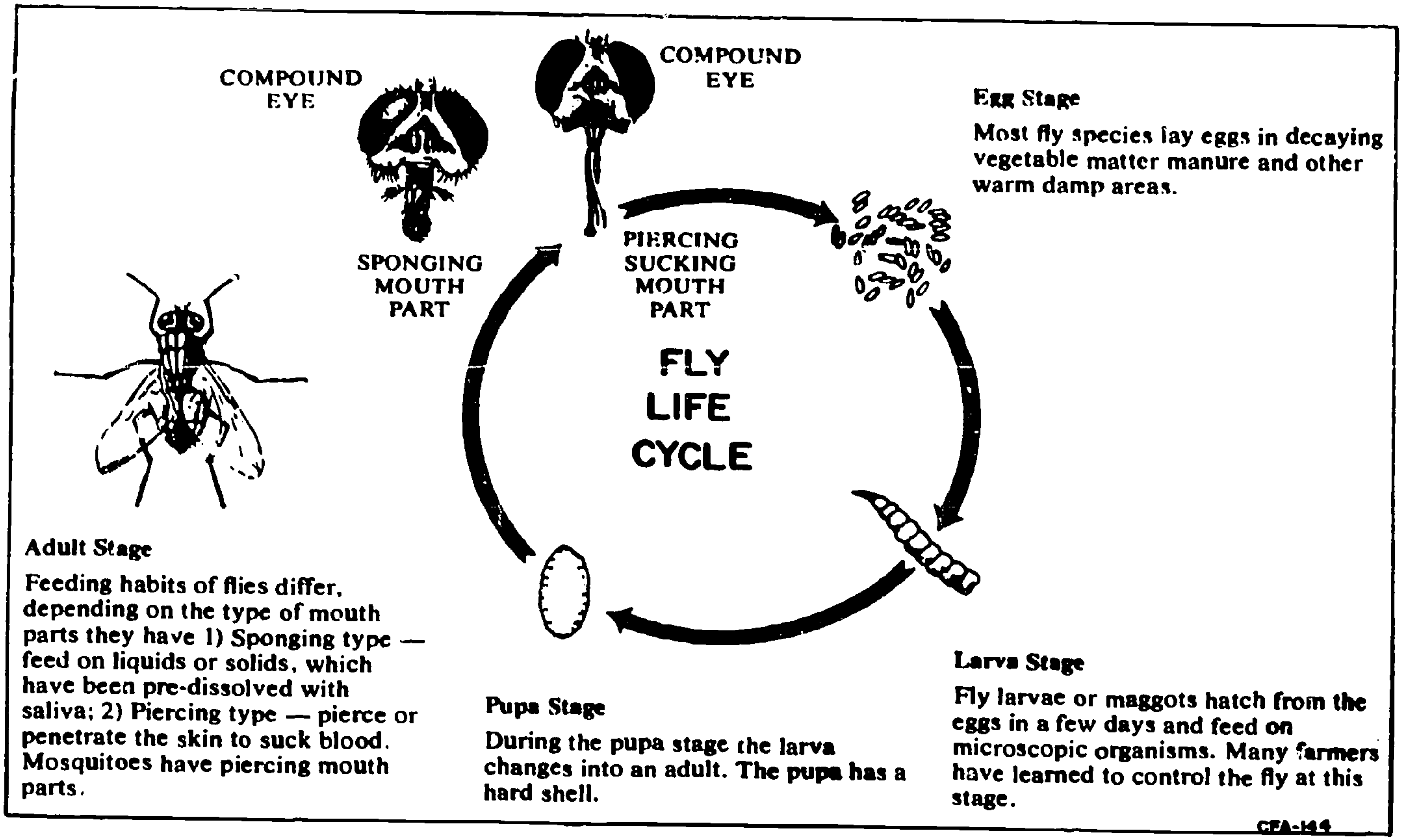

Figure 2–3. Fly life cycle.

—— 3. Each section of the thorax has a pair of legs.

—— 4. The abdomen is used for identification.

—— 5. Flies have five stages in their life cycle: egg, larva, pupa, maggot, and adult.

—— 6. Some female flies give birth to larvae.

—— 7. The larvae of most flies are commonly called maggots.

2-3. Important Fly Species

There are many fly species with which you should be familiar. First, you will read about the housefly, one of the most common around humans.

613. Cite identification features and biological characteristics of houseflies.

Houseflies. The housefly (*Musca domestica*), (fig. 2-4) is a small species, 6 to 9 millimeters (mm) long with a dull thorax and abdomen. The thorax has four longitudinal dark stripes, the sides of the abdomen are usually pale and the fourth wing vein is sharply angled, ending before the wing tip.

The housefly and its relatives are often termed domestic species because of their close association with people. Adult flies feed on human foods (which is what makes them pests in the first place), and the larvae are often most abundant in human wastes such as excrement, garbage, and open dumps.

You can find the housefly throughout the United States and it is usually the most abundant species found in homes and restraurants.

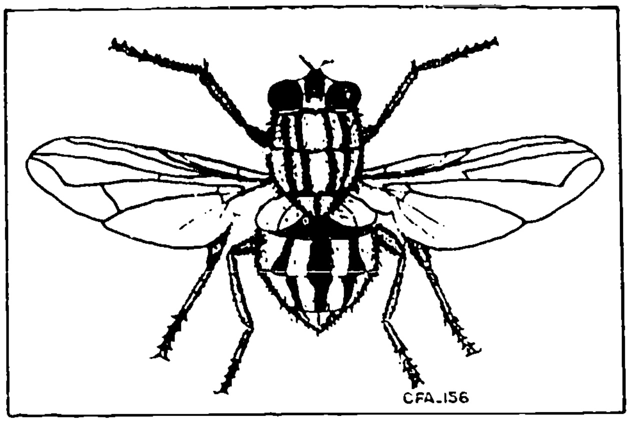

Figure 2–4. Housefly (*Musca domestica*).

Because of the housefly's close association with people and their food, its habit of breeding in human excrement and other filth, its abundance, and its ability to transmit germs, it is considered to be a greater threat to human welfare than any other species of flies.

Life cycle. The development stages of the housefly take 8 to 20 days under average summer conditions. The female begins egg laying 4 to 20 days after she emerges as an adult. The small, white, oval eggs about 1 millimeter long are deposited in batches of 75 to 150. Five or six batches are laid during the lifetime of the average female, for a total of about 500 eggs per female. Eggs are usually placed in cracks and crevices in the breeding material away from direct light. Hatching occurs in 12 to 24 hours during the summer months. The active young larva burrows at once into the breeding media, using its two mouth hooks for tearing and loosening food particles and for working its way along. The three larval instars last 3 to 24 more days. The usual time during warm weather is 4 to 7 days. Larvae regulate their temperature by moving to various levels in the breeding material. Studies indicate that feeding larvae choose temperatures from 86° to 95° F.; those ready to pupate prefer lower temperatures. The distribution of larvae in the breeding media under natural conditions is believed to depend chiefly on temperature and moisture and, to a lesser extent, upon odors. When growth is completed, larvae migrate to drier portions of the media or leave it entirely to burrow into soil or under debris to pupate.

The mature larva is about 12 mm long and creamy white in color. It is conical and has two dark mouth hooks at the anterior (front) end and two oval spiracular plates at the broad posterior end. It is easily distinguished from other fly larvae by the three sinuous slits in each spiracular plate.

When ready to pupate, the larva contracts until the skin forms a capsulelike case about 6 mm long. This case (the puparium) encloses the true pupa that is immobile and takes no food. The pupal stage ordinarily lasts 4 to 5 days, but may be as short as 3 days at temperatures around 95° F., or up to several weeks at low temperatures. When the pupal period is complete, the fly breaks open the end of the puparium by the expansion of a bladderlike organ, the ptilinum, located on the front of the head. The fly then works its way out of the puparium and up to the surface of the soil. Here the wings unfold and the body expands, dries, and hardens. This change takes about 1 hour under summer conditions. Adulthood is reached in about 15 hours. Mating may then take place.

Breeding media. Almost any type of warm moist organic material contains suitable nourishment for housefly larvae. Animal manure is an excellent breeding medium, accounting for as many as 95 percent of the houseflies in some rural areas. Fresh horse manure may produce as many as 1200 larvae per pound. Manure of other animals (cows, pigs, rabbits, fowl, etc.) is also very suitable. Human excrement, often loaded with organisms pathogenic to humans, is a dangerous source of fly breeding. Breeding occurs in privies, in exposed feces, and in incompletely digested sludge from sewage treatment plants. Garbage and pet manure are almost always the most important source of houseflies in urban communities. Fly breeding may be a problem if garbage is dumped indiscriminately on the premises or if it is stored in inadequate containers. Open garbage dumps produce large numbers of flies.

Adult food. The adult housefly is very active, moving about busily from one attractant to another throughout most of the daylight hours. It is strongly attracted to feces and other types of decaying organic material, as well as to milk and foods intended for human consumption. Under natural conditions, houseflies seek a wide variety of food substances and thereby obtain a balanced diet. Because of the nature of the houseflies' mouthparts, their food must be in liquid form or must be readily soluable in their salivary and crop secretions. The liquid food is sucked up through the spongy labellum at the tip of the proboscis. Water is essential, and houseflies will not ordinarily live more than 48 hours without it. Sugar or starch is necessary for long life, and protein is required for egg production. Common sources of food are milk, sugar, blood, meat broth, and many other foods found commonly in and around human habitations. Two or three feedings a day are necessary. As the housefly moves about over various items, it periodically regurgitates liquid from the crop and tests the surface with its proboscis, producing light, straw-colored spots known as vomit spots. Darker spots which may be observed are fecal spots, which you may find on glass, walls, ceilings, light strings, electric wires, and on other surfaces where flies rest. Accumulations of fly specks are good indicators of habitual resting places of flies.

Resting places. Flies rest much of the time and show a strong preference for edges. They rest indoors on light strings and electric wires, walls, ceilings, and other places. They rest outdoors on fences, electric wires, edges of buildings, weeds and vegetation, particularly branches. Flies are essentially inactive at night and their nighttime resting places are usually protected from the wind.

Flight. Housefly populations can disperse rapidly into new areas by flight. Although houseflies cruise at only about 4 miles per hour and wander somewhat aimlessly, they travel as far as 6 miles (as the crow flies) within 24 hours, and eventually, as far as 20 miles.

Longevity. Adult lifespan depends mainly on the availability of food and water, and upon temperature. Observations during midsummer in Texas indicate that when well fed, flies live 2 to 4 weeks. In another test, adult flies survived 70 days under experimental conditions. In hibernation, flies may live over winter, often from October to April.

Temperature. Flies are inactive at temperatures below 45° F. and are killed by temperatures slightly below 32° F. Flight begins when air temperature is about 53° F. and complete activity occurs when it reaches about 70° F. Maximum activity is reached at 90° F. with a rapid decline at higher temperatures until 112° F. which produces paralysis and death. (This is proof that there is at least one advantage to living in a hot spot like Texas.)

Humidity. The effects of humidity are closely related to those of temperature, and it is difficult to assess one without considering the other. Lethal effects of both high and low temperatures are more marked when humidity is high. Above 60° F., flies live longest at a relative humidity of 42 to 55 percent. Below 68° F., they are active and long-lived. Flies reach a physiological optimum at high temperatures and low humidities. This characteristic correlates with their great abundance in desert areas.

Light. Flies are phototropic; that is they generally move toward light. The success of the ordinary fly trap depends upon this trait. The bait attracts flies to the lower part of the trap, and they are captured when they leave the bait and move around toward the light. Flies are inactive at night, but they will resume activity under artificial illumination. The effects of light on fly activity are closely correlated with those of temperature and humidity.

Wind. Flies are sensitive to strong air currents and are not likely to venture out on extremely windy days. However, some are caught and carried great distances by high winds (such as hurricanes). Houseflies, probably windborne, have been collected over the ocean more than 100 miles from shore. At lower velocities, flies may travel with the wind or against it. They will move upwind against moderately strong winds toward an attractive odor, but downwind on light breezes not bearing attractive odors.

Natural enemies. Organisms in its environment are of great importance to the housefly. Most of these organisms do no harm, but some are parasites or predators. Natural enemies of flies include fungi, bacteria, protozoa, roundworms, other arthropods, amphibians, reptiles, birds, and certain mammals, especially people.

Exercises (613):

1. Cite the general identification features of houseflies for each of the following:

   a. Length.

   b. Thorax.

   c. Abdomen.

   d. Fourth wing vein.

2. Under summer conditions, how long is the developmental period for houseflies?

3. Where does the female housefly usually lay her eggs?

4. List the types of breeding media commonly used by houseflies.

5. What four basic food elements do houseflies need?

6. How often must houseflies feed?

7. At what temperatures do houseflies

   a. become inactive?

   b. begin flight?

   c. die?

8. In general, how does humidity affect the lethal effects of high and low temperatures?

9. In general, how does humidity affect the lethal effects of high and low temperatures?

614. Associate various characteristics of domestic flies with the fly described.

Little Houseflies (*Fannia* spp.). Little housefiles are small flies seldom more than 7 mm long. They resemble houseflies in having a dull thorax and abdomen, but differ in having only three relatively inconspicuous dark longitudinal stripes on the thorax and the fourth wing vein is straight (fig. 2-1). Also unlike the housefly, the little housefly can be found throughout a house, seldom on a spread table. The adults are frequently seen hovering in midair outdoors or less commonly in the middle of a room. Little houseflies lay their eggs particularly in the excrement of humans, horses, cows, and poultry, or sometimes in piles of decaying grasses piled up on lawns. The eggs hatch in about a day and the flattened, spiny larvae complete their development in a week or two depending on temperature. Fannia are of less importance as household pests or disease vectors than the housefly. However, there are numerous records of larvae of this genus causing myiasis in man.

Stable Fly (*Stomoxys calcitrans*). The stable fly is distinguished from all other common domestic flies by its piercing proboscis, which protrudes bayonetlike in front of the head (fig. 2-1). This species is 5 to 7 mm long, has a dull thorax with four dark longitudinal stripes, a pale spot behind the head, and a dull abdomen with dark spots. The fourth wing vein is gently curved and ends near the wing tip. Both males and females are vicious biters, attacking people and a variety of animals. The female lays her eggs in plant waste more often than in manure. She may lay eggs in old strawstacks, piles of fermenting weeds, grass, peanut hay, or stable manure well mixed with straw or hay. The stable fly is a major pest along the seashore, particularly on the gulf coast, where it is known as the dog fly. It lays its eggs in piles of marine weeds on the beaches and is a serious pest in late summer and early fall. Larval development takes 8 to 30 days or more, depending on temperature. The stable fly is not considered an important agent in mechanical transmission of organisms causing intestinal diseases. It does not breed in human excrement and is not commonly attracted to feces or garbage. It is therefore, less likely to pick up germs of diarrhea and other intestinal diseases.

Because of its bloodsucking habits, the stable fly has been suspected of transmitting a number of diseases, especially anthrax. Stable fly larvae have been reported as causing myiasis in humans and domestic animals.

False Stable Flies (Muscina spp.). False stable flies are slightly larger and have heavier bodies than house flies, averaging about 8 mm long. These insects have a dull thorax and abdomen, with blackish markings, like the housefly, but differ in having a pale tip of the scuttellum and the fourth wing vein gently curves and ends at about the wing tip (fig. 2-1).

False stable flies breed in decaying animal and vegetable matter and are commonly found in scattered garbage. The larvae become carnivorous as they near maturity and destroy other fly larvae they encounter. Larval development averages 15 to 25 days. The adult fly enters houses frequently and is attracted to like foods, meat, fruit, and vegetables. It vectors disease organisms, and there are reports of human intestinal myiasis that probably resulted from ingesting foods containing eggs of Muscina.

Dump Flies (Ophyra spp.). Dump flies are shiny black flies, smaller than the housefly, with the fourth wing vein straight (fig. 2-1). They're widely distributed throughout the United States and are often abundant in cities. You may often find them in fly trap collections, particularly those set near garbage disposal sites, hence their common name. Some researchers report that the larvae develop in human and animal excrement, kitchen wastes, and animal carcasses. Second and third stage larvae are predaceous on other fly larvae and may help reduce populations of housefly larvae.

Exercises (614):

1. Match the domestic flies in column B with their characteristics in column A. Column B items may be used only once.

Column A	*Column B*
____ (1) These flies are of less importance than houseflies as household pests or disease vectors.	a. False stable flies.
____ (2) Second- and third-stage larvae are predaceous on other fly larvae and may help reduce housefly populations.	b. Dump flies.
____ (3) Both males and females are vicious biters, attacking people and many other animals.	c. Little house flies.
____ (4) These breed in decaying animal and vegetable matter and are commonly found in decaying garbage.	d. Stable flies.

615. Specify the identification and characteristics of flesh flies.

Identification and Biology of Flesh Flies (Family Sarcophagidae). Flesh flies resemble the housefly in general appearance, but usually are larger (up to 2 or 3 times larger) and differ in having three dark longitudinal stripes on the thorax, a checkerboard pattern of grayish and dark spots on the abdomen, and the tip of the abdomen is usually reddish brown. The fourth wing vein is sharply angled and ends before the wing tip (fig. 2-1). There are hundreds of species of flesh flies in the family Sarcophagidae. They're commonly called flesh flies because the larvae of most species are found in meat, cheese, fish, and other foods left exposed. Flesh flies are unusual in that the females deposit living larvae rather than eggs. Some species breed prolifically in animal excreta, especially in dog stools, and may be very abundant in urban communities. They don't enter homes nearly as often as houseflies. When they do, they are often found in kitchens and bathrooms. The females are strongly attracted by the scent of food, such as fish and meat, and to the odor of human excrement. They have been observed depositing larvae in containers with fecal samples in laboratories, which led to false reports of human intestinal myiasis. Some species of flesh flies in the genus *Wohlfahrtia* cause cutaneous myiasis in humans.

Exercises (615):

1. Give the general characteristics of flesh flies as regards to:

   a. Size.

b. Thorax.

c. Abdomen.

d. Fourth wing vein.

2. In what materials do flesh flies commonly breed?

3. How do flesh fly breeding habits differ from those of other flies?

4. Within homes, where are flesh flies most commonly found?

616. Identify various bottle flies and blowflies with statements regarding their characteristics.

Bottle Flies and Blowflies. Bottle flies and blowflies (family Calliphoridea) lay their eggs upon animal carcasses and meat products, causing them to swell, "bottle," or "blow" with maggots. Many of the adult flies have a shiny blue or green color. They are common in most urban areas and are often abundant about garbage dumps and meat processing plants. They have long flight ranges and a keen sense of smell that guides them to dead animals and other attractants, even when located in remote areas. They enter houses much less frequently than houseflies. Although these flies usually deposit their eggs upon meat, they will oviposit upon a wide range of fresh and decaying plant refuse if meat isn't available. Eggs may be deposited on living animals, although clean, healthy animals are rarely attacked. Upon emerging from the egg, the larvae feed for a short time upon the surface of the food near the egg mass, then bore into the less putrid material within. When fully developed, they leave the breeding material and burrow into the ground. The puparium is formed within a few days and emergence occurs from 3 to 20 days after pupation. Calliphoridae serve as mechanical vectors of disease organisms just as do houseflies. They have similar nonpiercing mouthparts and feed in much the same way. However, since they enter homes and food preparation facilities less frequently than houseflies, they appear to have less opportunity for disseminating disease organisms to food. The larvae of many species cause animal and human myiasis.

Bluebottle flies (Cynomyposis cadaveina and Calliphora spp.). Bluebottle flies are medium to large species, 10 to 15 mm long or more, with a dull thorax and shiny metallic blue, green, or purplish abdomen (fig. 2-1). They frequently enter buildings to hibernate during the winter and emerge when buildings are heated, or on warm winter days, causing annoyance as they fly around with a loud, buzzing sound. Bluebottle flies take 15 to 20 days or more to develop from egg to adult. The adult flies are attracted to flowers, feces, overripe fruits, and other decaying vegetable matter as well as to sores of living animals. Bluebottle fly larvae may cause intestinal myiasis.

Greenbottle/bronzebottle flies (Phaenicia spp. and others). See figure 2-1. Greenbottle and bronzebottle flies include many species in the genera *Phaenicia*, *Lucilia*, *Burolucilia* and other less common genera. These insects are found throughout the world. Two of the species most commonly associated with people in the U.S. are the greenbottle fly (*Phaenicia sericta)*, which has a shiny greenish thorax and abdomen, often with reddish or coppery reflections, and the bronzebottle fly (*Phaenicia pallescens*), which has a shiny thorax and abdomen, usually with coppery or bronzy reflections predominating over the greenish color. The life cycle is normally completed in 9 to 21 days with four to eight generations per year. The eggs are deposited on decomposing animal matter or in garbage containing mixtures of animal matter. Females are strongly attracted to flesh, and oviposition begins within a few hours after an animal dies. Fresh meat is often attacked within a few minutes after exposure. They also deposit eggs on wounds and occasionally cause intestinal myiasis. The average number of eggs produced at one time is about 180, although single females have been reported to deposit over 2,000. The optimum temperature for egg development is about 94° F. and they hatch in about 8 hours at this temperature.

The larvae complete their development in 2 to 10 days and then move away from the breeding medium and burrow in the soil. The larval stage may be greatly prolonged if temperatures are low. These files normally overwinter as full-grown larvae in the soil. Pupation occurs within 3 days if temperatures are favorable, the pupal stage lasting 3 to 6 days under warm conditions. The adults may successfully emerge through several inches of earth (half of the flies emerging from puparia buried under 3 feet of loose soil reached the surface in experiments). Adults mate and deposit eggs 5 to 9 days after emergence. The greenbottle flies are most active on warm, sunny days. They are attracted to garbage (particularly where it contains mixtures of meat and fruit), plant juices, and nectar. They are often seen in large numbers on shrubbery, leaves of cucumbers and other melons, and on other plants. At times, particularly in the spring and fall, they enter homes and restaurants where they usually attract attention because of their buzzing flight. They may fly 10 miles from their breeding places within a few days. Favored nighttime resting places include trees, bushes, and sides of buildings.

Black blowfly (Phormia regina). The black blowfly has a shiny black thorax and abdomen with a metallic blue-green luster. The setae on the top of the thorax are noticeably shorter than in other calliphorid flies and the mesothoracic

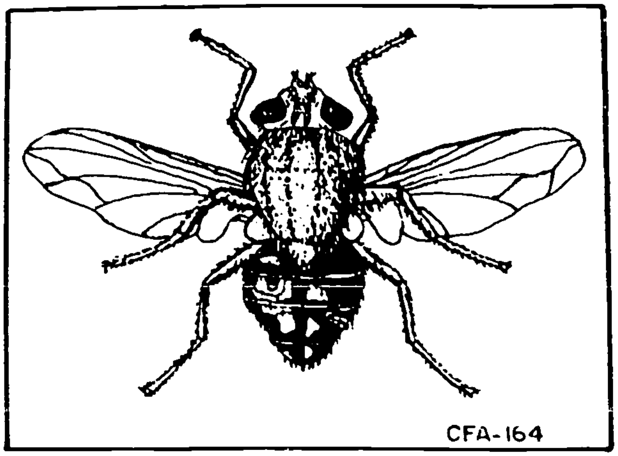

Figure 2-5. Cluster fly (*Pollenia rudis*).

spiracle (on the side of the mesothorax behind the head) is brick red (fig. 2-1). It's found throughout the U.S. and is most abundant in the early spring. In the Southern United States it may be uncommon in summer, but is active on warm days throughout the winter. It is a mechanical carrier of organisms causing diarrhea and dysentery. The life cycle takes 10 to 25 days or more and is generally similar to that of the greenbottle flies. The eggs are laid in masses in animal carcasses or in the edges of wounds in living animals. Larvae may occur in great numbers in animal carcasses or in paunch contents of slaughtered animals. They also breed abundantly in garbage. The larval stage takes 4 to 15 days and the pupal stage 3 to 13 days. The adults can deposit eggs 7 to 17 days after emergence. The adults are strong fliers and have an effective flight range of 6 to 10 miles. In the North they overwinter as full-grown larvae, but in the South as adults.

Cluster fly (Pollenia rudis). The cluster fly (fig. 2-5) is slightly larger than the housefly and the abdomen often has a slightly metallic reflection beneath a dusty checkerboard pattern. It is easily recognized by the thick, yellowish-to-brassy crinkled hair between the black setae on the top of the thorax and the tufts of yellowish hairs on the sides of the thorax. The cluster fly is distributed throughout the Northern Hemisphere and is very common in the northern United States. The eggs are deposited in the soil and hatch in about 3 days. This species is most unusual in that the larvae are parasites of earthworms, within which they feed and grow for about 2 weeks. They then leave the earthworm and pupate in the soil for about 2 weeks. Newly emerged adults are often most abundant after rainfall, suggesting that the adults can burrow from their puparia to the surface easier when the soil is soft and moist. There are probably four generations or more a year in the U.S.

Cluster flies derive their names from the fact that the adults enter buildings in the fall to hibernate and gather in clusters, in closets, attics, and unused rooms. They may be concentrated in open ceilings or walls, or may crawl behind window casings, moldings, loose wallpaper, pictures, or furniture. During mild winter weather or early spring, or if a cold building, such as a church, is heated occasionally, they move about sluggishly, often with a loud buzzing noise, thus attracting attention to their presence. They aren't of direct public health importance, but they may be a nuisance in buildings where they hibernate. In hospitals in the Northern U.S., there have been many complaints, for example, of cluster flies in operating rooms. The flies apparently entered these rooms through small openings around air ducts or electric fixtures from the cold attic above.

Exercises (616):

1. Match the bottle flies and blowflies in column A with their identifying characteristics in column B. Column B items may be used only once.

Column A	*Column B*
____ (1) Bluebottle flies.	a. Derives its name from the fact that it accumulates in closets, attics, and unused rooms to hibernate.
____ (2) Greenbottle flies.	b. They are 10 to 15 mm long or more, with a dull thorax and shiny metallic blue, green, or purplish abdomen.
____ (3) Black blowflies.	c. The optimum temperature for development of eggs is about 94° F.
____ (4) Cluster flies.	d. In the North they overwinter as full-grown larvae, but in the South, as adults.

617. Identify various flies of moderate importance with their descriptions and characteristics.

There are several flies that are important to us (but to a lesser degree) than those we have already discussed because of their limited association with people.

Midges (Families Chaoboridae and Chironomidae). Midges are tiny flies, usually 1 to 4 millimeter long, which breed in water or damp soil. Adult midges don't bite, but they may occur by the millions and be most annoying. It's sometimes difficult to keep them out of people's eyes and nostrils, particularly when the midges are attracted to lights. The Clear Lake gnat, a species of Chaoborid midge, is a serious pest in parts of California.

Adult midges cause trouble by getting into fresh paint, getting into paper factories and ruining sheets of paper, and staining the sides of painted buildings. Chironomid midge larvae are sometimes found in water reservoirs and are carried throughout the distribution system.

Eye Gnats (Family Chloropidae). Eye gnats are tiny, shiny black flies with reduced wing venation. The important genus *Hippelates* has a curved, blackish spine on the hind tibia (fig. 2-6). Eye gnats are often very abundant in the Southern U.S. They swarm about the face and eyes and rasp the eye membranes with their mouthparts. In the Southern U.S. and the Coachella Valley in California, eye gnats transmit organisms causing epidemic pinkeye, or conjunctivitis. Sometimes so many children are affected that the schools are actually closed for a week or more. The larvae of eye gnats breed in loose soil, frequently over vast

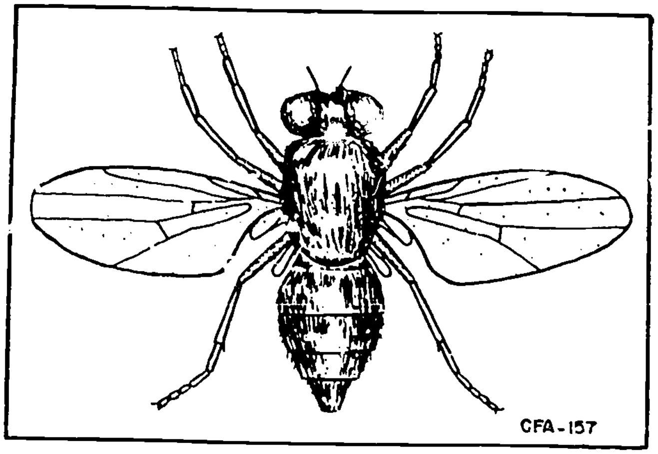

Figure 2–6. Eye gnat (*Hippelates* spp.).

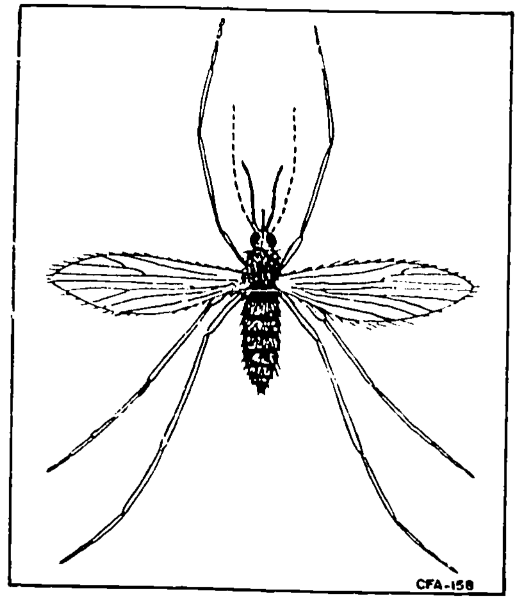

Figure 2–8. Sandfly (*Phlebotomus* spp.).

areas of rich agricultural land, which makes control very difficult. The life cycle is completed in 2 to 4 weeks.

Biting Gnats, Punkies, No-See-Ums (Family Ceratopogonidae). Some of the ceratopogonid midges in the genera *Culicoides* and *Leptoconops* are vicious biters. *Culicoides* are tiny flies, about the size of the head of a pin, generally with spotted wings and reduced wing venation (fig. 2-7). Their bites often cause intense pain, for many people worse than that of a mosquito. Several species of *Culicoides*, called punkies, no-see-ums, or sandflies, are so small they can crawl through the ordinary 16-mesh window screen and be serious pests at summer camps, shore restaurants, and beaches.

Sandflies, Filter Flies and Moth Flies (Family Psychodidae). The family Psychodidae contains small fuzzy flies with hairy wings divided into two distinct groups: the filter and moth flies in the subfamily Psychodidae, whose females are not bloodsuckers, whose wings are held rooflike over the body, and whose larvae are commonly aquatic; and the sandflies in the subfamily Phlebotominae (fig. 2-8), whose females are bloodsuckers, whose wings are not held rooflike over the body, and whose larvae are typically terrestrial. The filter and moth fly group is widely distributed and abundant in most parts of the U.S. Adult moth and filter flies are often found on bathroom and kitchen windows. Some common sources of domestic infestations are dirty garbage containers, water traps in plumbing fixtures, and accumulated gelatinous debris around the edge of sinks and wash basins built into counter tops. A common American moth fly is *Psychoda Alternata*. Outdoors the larvae may be found in collections of dirty water and in decomposing organic materials, such as grass, plant litter, sewage, and garbage. Filter flies (*Psychoda* spp.) are a serious problem at many sewage treatment plants and some larvae cause myiasis in man. In the Near and Far East, North Africa, and Central and South America, sandflies in the genera *Phlebotomus* and *Lutzomyia* may bite humans and transmit organisms causing sandfly fever, several types of leishmaniases and bartonellosis. Bloodsucking sandflies are comparatively rare and aren't known to transmit human diseases in the U.S. The adults have been found most often in hollow trees or in rodent burrows, and their immature stages may breed there.

Blackflies (Family Simulliidae). Blackflies (fig. 2-9) are nearly worldwide in distribution and second only to mosquitoes as bloodsucking pests of people. They are small, 2 to 5 millimeters long, stout-bodied flies with short antennae, wings with well-developed anterior veins and a humped thorax which has given them the common name buffalo gnats. Both sexes suck nectar from flowers and most females feed on blood. The eggs are laid in or near flowing water and the larvae and pupae are found attached to submerged rocks, sticks, or vegetation. The adult emerges from the pupae in a submerged cocoon and floats to the surface of the water in a bubble of air. Many species mate soon after emergence.

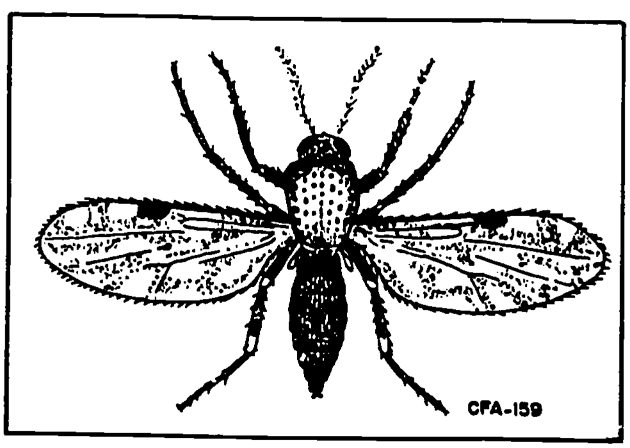

Figure 2–7. The biting midge.

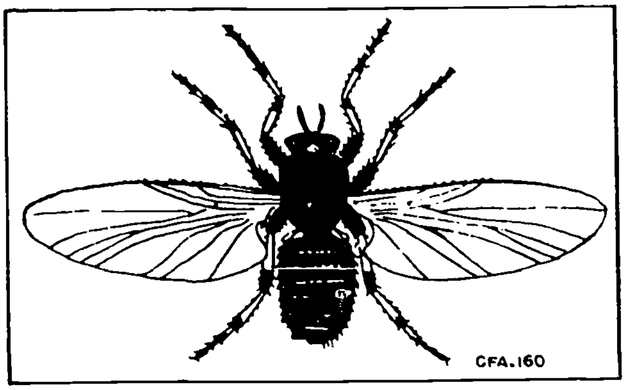

Figure 2–9. Blackfly, or buffalo gnat.

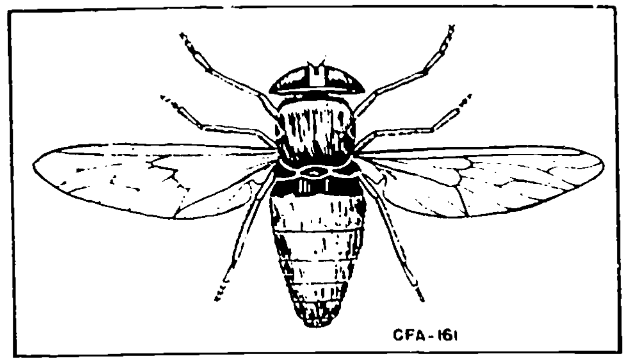

Figure 2–10. Horsefly.

Blackfly bites are painless at first, but later become swollen, hard, and painful, sometimes infected from scratching. Females of some species attack people while others confine themselves to mammals or birds. They swarm around exposed parts of the body, particularly the head, and get into the nose, eyes, ears, and mouth. Heavy attacks may be fatal to humans, cattle, horses, and poultry, possibly from toxemia, anaphylastic shock, or suffocation brought about by inhalation of large numbers of swarming insects. Several species transmit tularemia in North America, human onchocerciasis (blinding filariasis) in Africa and Central America and bovine onchocerciasis in Europe and Austrilia.

Crane Flies (Family Tipulidae). Crane flies, which resemble mosquitoes superficially, are slender flies with long legs. They differ in having a V-shaped suture on the thorax and no scales on the wings. They breed in water, moist soil, and damp, rotting vegetation. Many species, 12 to 25 mm or more long, are attracted to lights and enter homes, thus causing complaints about invasion by "giant mosquitoes" even though they can't bite people.

Hover or Flower Flies (Family Syrphidae). Hover or flower flies are small to large flies resembling bees or wasps. Many of them are conspicuously marked with yellow and black. The distinguishing family characteristic is a pigmented line, called a spurious vein, on the wing. The larvae of some species breed in highly polluted water and have long breathing tubes which have caused them to be called rat-tailed maggots. Sometimes these are very abundant at sewage treatment plants. Species of *Eristallis* and Helophilus occasionally cause human myiasis.

Horseflies and Deerflies (Family Tabanidae). Horseflies and deerflies rival mosquitoes and blackflies as annoying pests of people and animals. Many are vicious biters and can inflict painful wounds that itch for days. Only the females suck blood; the males feed on plant nectar. In most parts of the United States deerflies (*Chrysops*) are more serious pests of man than horseflies (*Tabanus* and *Hybomitra*), which are major pests of cattle and horses. However, along the Atlantic coast, the salt-marsh greenheads (*Tabanus nigrovittatus*) are vicious pests of people, particularly at beaches. Other species of horseflies may be serious bloodsucking pests elsewhere. Many species deposit their eggs on vegetation near water, and their larvae develop in damp soil or water but some develop in dry pasturelands. In general, most species have one generation a year, but some of the larger species such as the black horsefly (*Tabanus atratus*. fig. 2-10) may take 2 or 3 years for development.

The family Tabanidae contains small to very large flies, 6 to 33 mm long, generally recognized by the five posterior cells on the wing and the 3-segmented antenna. Horseflies are usually larger than deerflies and lack spurs on the hind tibiae.

Deerflies average 6 to 12 mm long, generally have spotted wings, and have two spurs on the hind tibia (fig. 2-11).

Tabanidae are vectors of several diseases to people and animals caused by viruses, bacteria, rickettseae or rickettsia-like organisms, trypanosomes, and filarial worms. In the United States deerflies, particularly Chrysops discalis, are important in the mechanical transmission of tularemia in the West, where it's sometimes known as deerfly fever. Both deerflies and horseflies may serve as mechanical carriers of anthrax bacteria from domestic animals to man, particularly in the Southern U.S.

Figure 2–11. Deerfly.

Cheese Maggots and Related Forms (Family Piophilidae). The cheese skipper or maggot (*Piophila casae*) is about the size of a housefly. The larvae are slender and pointed toward the head. At one stage the larvae are able to skip as much as 10 inches horizontally and 6 inches vertically by curving their bodies into rings, fastening their mouth hooks onto their abdomens, suddenly releasing their holds, and throwing themselves into the air. The life cycle takes 12 days or more. The adult deposits 140 to 500 eggs on cheese or hams. The adults transmit disease agents mechanically, and the larvae cause intestinal myiasis in humans.

Vinegar and Fruit Flies (Family Drosophilidae). Vinegar and fruit flies breed in decaying fruit and may suddenly become numerous in a house. The usual sources in the home are overripe fruit and dirty garbage containers. The fruit fly (*Drosophila melanogaster*) belongs in this family. Much of the knowledge of the science of genetics is based upon studies with this insect. Some species of *Drosophila* cause intestinal myiasis in humans.

Exercises (617):

1. Match characteristics in column A with the name of flies in column B. Column B items may be used only once.

Column A

____ (1) They have a "humped" thorax, earning them the common name buffalo gnats.
____ (2) They may transmit organisms causing pinkeye or conjunctivitis.
____ (3) Sometimes called giant mosquitoes even though they can't bit people.
____ (4) Breed in decaying fruit and may suddenly become numerous in a house.
____ (5) Tiny flies, usually 1 to 4 mm long, which breed in water or damp soil.
____ (6) By curving their bodies, they can throw themselves 6 to 10 inches.
____ (7) They rival mosquitoes and blackflies as the most annoying pest to people.
____ (8) So small they can crawl through ordinary 16-mesh screen.
____ (9) Often found in bathrooms and kitchen windows, these flies are widely distributed and abundant in most parts of the U.S.
____ (10) Larvae are sometimes called rat-tailed maggots.

Column B

a. Midges.
b. Eye gnats.
c. Biting gnats, punkies.
d. Sand, filter, and moth flies.
e. Blackflies.
f. Crane flies.
g. Hover or flower flies.
h. Horse and deerflies.
i. Cheese maggots and related forms.
j. Vinegar and fruit flies.

____ (10) Larvae are sometimes called rat-tailed maggots.

2-4. Survey Methods and Controls Measures

Fly surveys reveal what species of flies are present and furnish an index as to fly abundance in an area. By comparing your successive surveys, you can evaluate control effectiveness. Since it is not possible to determine the precise number of flies, surveys are designed to give an index of the population. A good survey will also show relative numbers of the various species. The method you use must be reliable enough that successive surveys can be compared. Reliability is limited by your skill, the errors inherent in the methods, and the fluctuations of fly population in response to environmental conditions.

The control measures we'll cover in this section include several categories of IPM—including natural, cultural, and mechanical controls. You'll also study some controls as they relate to some of the more troublesome fly species. First, though, let's examine some methods for conducting surveys.

618. Identify and describe facts regarding fly survey methods, and determine suitable survey locations for various flies based on their habits.

Methods for Conducting Surveys. In determining fly populations and the need for control, adult surveys are usually more practical and reliable than larval surveys. Consequently, all commonly employed techniques are related to adult populations. The most often used methods are the *insect net surveys, fly trap surveys,* and *fly grill surveys*. The insect net and fly trap surveys are used to determine the types of flies present in an area, whereas the fly grill surveys provide an index to the relative numbers of the various species in the fly population. None of these surveys gives an absolute count of the fly population present in an area.

Insect net surveys. The standard sweep net is often used to make a quick survey for adult flies, particularly at open dumps, cattle feed lots, or in epidemic or disaster areas where there are large amounts of decaying vegetables and fruits, dead animals, garbage, or refuse. You can then kill the specimens with a chloroform or cyanide killing tube, determine, count, and record the species you found.

Fly trap surveys. Trap surveys have the advantages of giving you a reasonable cross section of the population for careful identification, making an approximate count of the relative numbers of the various species, and trapping live flies for laboratory study. The two commonly used fly trap survey techniques are the baited trap and the cone trap (see figs. 2-12 and 2-13 respectively). Bait traps are useful when you want to determine the species present and, roughly, the relative numbers of the various species. A good bait trap must be durable, attractive, easily used, and should have some device for fastening it to the ground. Attach a suitable sign, such as "Do Not Touch, Conducting Fly Survey."

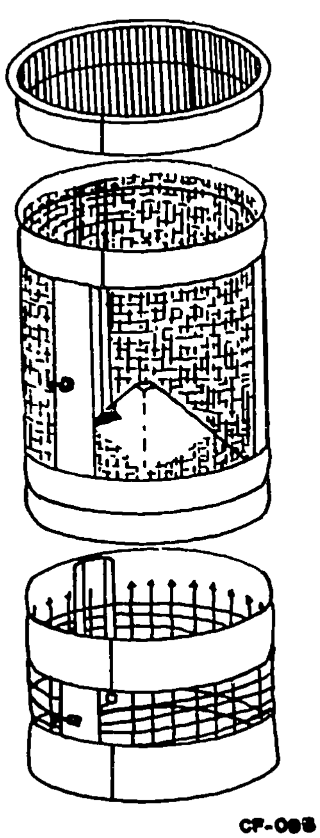

Figure 2–12. Baited fly trap.

Place an attractant in the pan under the trap. After the flies feed or deposit eggs on the bait, they move toward the light and enter the trap through a small opening in the cone. Since they don't generally fly downward to escape, and since the cone opening is difficult to find, few escape. Because not all flies respond to the same attractant, use an all-purpose bait; fish heads, chicken entrails, vegetables, and fruit. Place traps in different sections and in different types of locations (housing areas, dining halls, industrial areas, and other buildings, etc.). Kill the flies in chloroform jars, then identify and count them. You can then store collections in boxes, such as ice cream cartons. Label each collection with the date, location, method of collection, and your name. In extensive surveys a special form may be designed for recording data.

Fly cones are used primarily to collect live flies for bacteriological and virological study. The fly cone trap, made of screen wire, is placed over a natural attractant (garbage, manure, etc.), trapping flies beneath it. A dark cloth is thrown around the cone and the apparatus is carefully agitated. Attempting to escape, the flies move upward toward the light and enter the cage; then, the sliding door of the cage is closed and the collection is labeled. Flies may be taken to the laboratory for bacteriological and virological study.

Fly grill surveys. Fly grills (fig. 2-14) are used widely in modern evaluation of fly populations. Fly grill surveys are faster than baited trap or fly cone surveys and give a valid picture of the fly situation. The fly grill depends upon the tendency of flies to rest on edges; it presents many attractive resting sites. Place the grill over natural attractants (garbage, manure, etc.) and then tabulate the number of flies landing on the grill during a 30-second interval. You can record necessary information on a form similar to the one in figure 2-15. When the grill is put down, the flies are disturbed from the attractant and fly upward for a short distance. When all is again quiet, they come back down, alighting on the grill instead of the attractant. If fly counts are so high that total counts become impracticable, you can divide the grill into halves, quarters, or sixths, with painted markings. You must count at least one-sixth of the grill. Make a minimum of 10 counts in each block sampled, and record the five highest counts.

Reconnaissance surveys. Reconnaissance surveys are ordinarily used as a supplement to fly grill surveys. You take them in a vehicle or on foot to observe the abundance of flies in favored resting places and then record densities as estimated grill readings. These surveys give you information to guide control operations in areas lacking grill coverage, to facilitate rapid control in times of epidemic or disease, to serve as posttreatment evaluations of space spray applications, and to serve as preventive maintenance inspections during times of low fly density. Reconnaissance surveyors should be very familiar with fly grill survey methods.

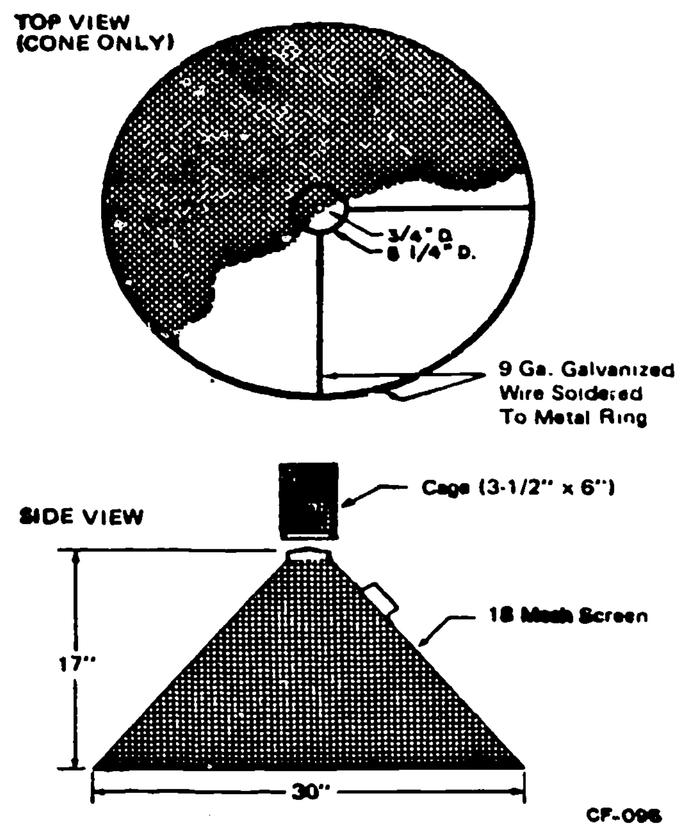

Figure 2–13. Fly cone trap.

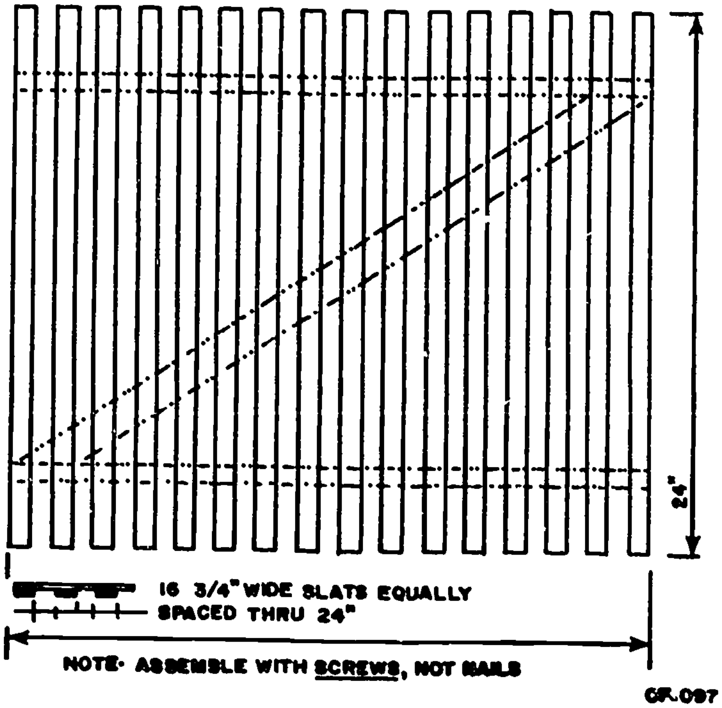

Figure 2–14. Fly grill.

Using Survey Information. The success of fly control programs depends largely on close coordination of pest management surveillance and control activities. By comparing data from survey to survey you can more easily find problem areas and concentrate your control efforts to eliminate the most important breeding sites of flies. Give primary emphasis to environmental sanitation rather than insecticidal application. One of the best uses of survey data is in reports and publicity programs to make key officials and other base personnel more aware of program activities and get their support.

Exercises (618):

1. What are the three most commonly used methods of conducting fly surveys?

2. What are the two main uses of bait traps?

3. Of what fly characteristic do fly traps take advantage?

4. How are fly cones primarily used?

5. What two advantages do fly grills offer in comparison to the other survey methods?

6. Of what fly characteristic does the fly grill take advantage?

7. How are reconnaisance surveys used? Conducted? Recorded?

8. Under what four conditions are reconnaissance surveys appropriate?

9. Based on their habits and other information, where would you conduct adult surveys for the following flies?

   a. Little houseflies.

   b. Stable flies.

   c. Bottle and blowflies.

   d. Midges.

   e. Moth and filter flies.

619. Specify natural action which control flies.

Natural Fly Control Actions. There are several environmental factors which limit the density of fly populations. These include:

(1) Availability of food, water shelter, and suitable breeding media.

(2) Parasitism by viruses, rickettsiae, spirochetes, bacteria, fungi, protozoa, and roundworms.

(3) Predation by centipedes, mites, spiders, pseudoscorpions, other insects, amphibi[illegible] [illegible]iles, birds, and mammals.

(4) Competition of one fly with anot[illegible] [illegible]or the benefits of the environment.

INSTALLATION | AREA | DATE: | HOUR:

GRILL READINGS	Tabulate the five highest counts 1	2	3	4	5	6	7	8	9	10	
ATTRACTANTS											TOTALS
HOUSE FLY Musca domestica											
FLESH FLIES Sarcophage spp.											
LESSER HOUSE FLIES Fannia spp.											
STABLE FLY Stomoxys calcitrans											
FALSE STABLE FLIES Muscina spp.											
BLUE BOTTLE FLIES Calliphora & Cynomyopsis spp.											
DUMP FLIES Ophyra spp.											
SECONDARY SCREW WORM FLY Cocbhomyia macellaria											
BLACK BLOW FLY Phormia regina											
GREEN BOTTLE FLY Phormia regina											
BRONZE BOTTLE FLY Phaemeia cuprina											
OTHERS											
TOTALS											

AREA AVERAGE | HIGH COUNT: | INSPECTOR:

CF-099

HIGH COUNT: The highest count of the five high grill readings.

BLOCK AVERAGE: Total the five high grill readings and divide by five.

ATTRACTANTS:

A. Garbage (mixed)
B. Excrement
C. Fruits
D. Vegetables
E. Dishwater
F. Dead anaimals
G. Seafood wastes
H. Feeds
I. Bones
J. Decaying Vegetation
K. ____________
L. ____________

Figure 2–15. Fly grill record.

Fly populations are modified by reproduction, which is often tremendous; mortality, which is also enormous; and migration, which varies with the degree of environmental pressure. Many more flies are born than can survive. The numbers of flies an area can support is limited by the physical and biological environment. Excess flies must either migrate or die.

Example: Block A has an environment capable of supporting 1,000 houseflies and of producing 125,000 additional flies every 2 weeks. The newly developed flies face severe competition for food, water, and shelter. They are killed by disease and predation. Some migrate and compete with neighboring fly populations. The small surviving percentage mate, and the females compete for suitable media in which to lay their eggs. Another 125,000 eggs hatch and the great struggle begins anew.

Many parasites and predators decrease domestic fly production and are normal inhabitants of manure. The protozoan, *Octosporea muscaedomesticae*, may be an important factor in controlling the housefly and several other domestic flies. Some species of mites prey upon flies. The larvae of a number of domestic flies, such as *Ophyra* and *Muscina*, feed on other species of fly larvae and may help control housefly pupulations.

Exercises (619):

1. The numbers of flies an area can support is __________ by the nature of the _________ and ________ environment.

2. The biological aspects that modifies fly populations are ________ , __________ , and migration.

3. The three most important physical environment factors that limit the density of fly populations is the availability of ______ , _______ , and _______ .

620. Identify particular aspects of nonchemical fly control.

Cultural Control. Modern fly control programs are highly dependent on both refuse management and environmental sanitation efforts that combine to reduce breeding opportunities for flies. One of the most favorable aspects of cultural fly control is that it's carried out by many people as a basic aspect of base maintenance and beautification programs. Some examples of the most effective approaches to cultural fly control include:

- Breeding source reduction.
- Steam cleaning dumpsters and other trash recepticles.
- Manure removal.
- Soil and water management.
- Regularly scheduled garbage removal.
- Landscape management.

Good sanitation is the most fundamental step in a fly control program. Whenever possible, food and materials on which flies can lay their eggs must be removed, destroyed as a breeding medium, or isolated from the egg-laying adult. Killing adult flies will reduce any infestation, but elimination of breeding areas is necessary for good control. Where flies are a problem in buildings, the occupants can do this work; your job is to seek out the breeding places and determing how more detailed work should be done. This step often requires positive corrective action on your part.

The houseflies and many flesh flies, bottle flies and blowflies breed in similar substances such as decaying organic materials, garbage, animal excrement, or polluted ground. Removal of these from the vicinity of infested premises will frequently give control sufficient to make other measures unnecessary. The importance of twice-weekly garbage removal does not seem to be a necessity for fly control when the length of the life cycle required by the immature stages is kept in mind. The important thing to remember here is that the final larval instar leaves the larval food medium and wanders for considerable distances before pupation; so it is the length of time from egg laying to the molt of the last larval instar that's important and which necessitates twice-weekly pickups.

Any sanitation program in fly control must be tailored to fit each specific situation. Basically, it should include any steps that help eliminate or prevent the establishment of any medium in which fly larvae can develop or which will be attractive to adult flies. Don't overlook the importance of moisture in fly-breeding media. Simple drainage will often aid control. Although it may not always be possible or economically feasible to practice all the sanitary measures that would contribute to fly control, simple and practical sanitation will frequently make the difference between satisfactory and unsatisfactory fly control. Sometimes, striking results can be obtained through sanitation alone.

Mechanical Control. Controlling flies by means of mechanical measures includes the use of screens, fly traps, electrocution devices, and electric fans.

Screening. Screening buildings is the most widely used fly exclusion technique. Although costly, and not detrimental to the fly populations, this method can keep buildings relatively free of flies and will therefore be continued as long as major insect problems remain unsolved. Screens should be made of copper, aluminum, plastic, or some other noncorrodible material. They should be mounted in durable frames and should not detract from the appearance of a building. The screen size should be about 16 mesh (16 strands to the inch) in order to give the greatest protection without undue loss of light or air circulation. The screens should fit tightly in the window or doorframes so that the flies and other insects can't enter around the edges.

Electrocution. Electrocution has proven effective under certain situations. Two common techniques are used. In the first, a fly trap is electrified. In the second, electrification of window and door screens is accomplished by using house current transformed to low amperage and high voltage

(3,500 to 4,000 volts is desirable). When the flies alight on the screens, they are immediately killed, yet these screens will not harm a human being or other large animal. Since Electrocution units with ultraviolet lights have gained in popularity in recent years the ultraviolet light is attractive to flies and other insects, which are electrocured by a screen surrounding the light. While these units are benefical in some situations, keep in mind that they will attract insects only if they choose to be attracted to the units instead of to something else. Think of it this way: if you were a fly which had just entered a dining hall serving line area with one these units mounted nearby, which would you most likely be attracted to, the light or the food? Installation of electric screening is very expensive, it should only be used to supplement other control measures when a fly problem is acute.

Electric fans. Fans mounted over all doorways leading to food service establishments will keep out a significant percentage of flies. Large buildings sometimes have air barriers or doors, to keep out dust, smoke, and insects, but which are hardly noticeable to persons passing in and out. Air velocities should be greater than 1,500 feet per minute at a 3-foot level to obtain a reasonable degree of efficiency.

Exercises (620):

Place the letter "T" in front of the correct statements. Correct any false statements.

____ 1. Landscape management is one of the cultural controls which can help reduce fly populations.

____ 2. Modern fly control programs highly depend on both chemical controls and environmental sanitation.

____ 3. The need for twice-weekly trash pickups is due since, in the last larval instar, fly maggots will leave the breeding media and travel quite a distance before pupation.

____ 4. Effective sanitation programs rarely have more than a minor role in reducing fly populations.

____ 5. If food-handling facilities are equipped with air curtains, they only need to be installed over doors between food preparation areas and the garbage disposal area.

____ 6. Electrocution can be a useful form of mechanical fly control but only as a supplement to other control measures.

____ 7. Electrocution units with ultraviolet lights may be useful only if there aren't other stronger attractants in the area.

621. Relate given statements with the appropriate chemical control measures for flies.

Residual Sprays. Pest managers are most frequently called on to control adult flies. Where the breeding areas cannot be eliminated or treated, chemical control of adults may be the last resort you have.

House fly resistance to the chlorinated hydrocarbon insecticides is so widespread, you're not advised to use these chemicals to control this pest. They can still be used with success in situations where the problem species are blowflies or flesh flies. Organic phosphate insecticides are still generally effective, but locally resistant populations may be a problem with some of these chemicals. Adulticides currently recommended are 1 percent diazinon, 3 percent malathion, 1 percent Ronnel, and 1 percent Dibrom. These are applied most effectively as coarse, wet sprays to surfaces on which flies prefer to rest such as walls, overhead areas and vegetation. For outdoor applications, you may add some sugar to help increase effectiveness. Sun-exposed surfaces on outside walls should be give special attention.

Fly Baits. Baits of DDVP, diazinon, Dibrom, malathion, or Ronnel on either sugar or mixed with sugar and water can be used effectively in some situations. Such baits are particularly effective when placed around garbage areas and outside doorways. Inside they can be scattered on floors or used more heavily near windows. In all cases, baits should be scattered thinly and according to directions on the container so as not to be unsightly or create a hazard to people or pets.

By using permanent bait stations in safe locations, you can reduce the time and effort needed and keep constant insecticidal pressure on the fly populations. These bait stations include simple plywood trays covered with hardware cloth for dry baits and chicken-watering fountains with a cellulose sponge in the trough to prevent clogging with dead flies for liquid baits. If the emulsifiable concentrate of the organophosphate insecticide is not readily available, you can place a piece of dichlorvos resin strip in the sugar water in the chicken-watering device. These are sometimes used to provide fly control in backyards near barbecue grills. People using fly baits should check regulations before applying them. Data from studies in Georgia and Florida indicate that flies resistant to residual sprays were killed by baits containing these same organophosphate insecticides.

Space Sprays. Space sprays are based on the concept of actually hitting the insects with a lethal particle of the insecticide. They do not provide a residual deposit of the toxicant and must be repeated periodically, sometimes before each meal in food-handling establishments.

Fly larvae may be controlled in breeding media by the application of chemicals to the medium. This method should only be considered when sanitation cannot be employed to do the job, since beneficial predators and parasites are often susceptible to common larvicides. As a result of using larvicides, fly populations may increase when the insecticide has lost its residue and natural control organisms do not return as rapidly as do the flies. Larvicides currently recommended include 2 percent malathion and 1 percent Ronnel.

You can get temporary fly control indoors by the use of contact sprays. These should contain synergized pyrethrins, DDVP or Resmethrin, and should be dispensed as very fine mists or aerosols. These can be applied with any of the fogging, aerosol or misting equipment. Before making such an application, food, food-handling equipment and utensils should be covered completely so no spray will fall on them.

Fly Cords and Resin Strips. The installation of insecticide-impregnated cotton cords at a rate of 30 linear feet of cord per 100 square feet of floor space has provided good fly control in stables for periods varying from 6 weeks to an entire season. The flies rest on the cords and absorb a lethal dose of insecticide through their feet. Research has shown that better fly control occurs when the cords are hung vertically (as 15 pieces of cord 2 feet long, or 10 pieces of cord 3 feet long, per 100 square feet of floor space) rather than horizontally (as 30 feet of cord parallel to the floor). Dichlorvos-resin strips have been used as residual fumigants in fly control, giving off a lethal dose of dichlorvos vapor for periods as long as 3 to 4 months when used at a rate of one unit per 1,000 cubic feet. In Georgia, dichlorvos-resin strips gave 95 percent reduction of all flies trapped from garbage pits (with a diameter of about 30 inches and 72 inches deep) in a recreational area when installed at a rate of one-half to one unit per pit. Dichlorvos-resin strips have also given effective control of flies indoors with minimal ventilation when used at a rate of one unit per 1,000 cubic feet. They should not be used in rooms where infants, sick or aged people stay, or where food is prepared or served.

Exercises (621):

1. Match the chemical control measures for flies in column B with the description in column A. Column B items may be used only once.

Column A	*Column B*
____ (1) Installing insecticide-impregnated cotton lines at 30 feet/100 square feet for fly control in stables.	a. Residual sprays.
____ (2) Chlorinated hydrocarbons and some organophosphates are often useless in this form due to fly resistance problems.	b. Fly baits.
____ (3) Use of these must be frequent since there is no residual action.	c. Space sprays.
____ (4) These can be used in permanent locations to keep a constant insecticide pressure on the fly population.	d. Fly cords/Resin strips.

622. Determine appropriate control measures for a given fly control situation.

Applying IPM to Control Flies. Integrated fly control takes the principle of environmental sanitation and supplements it with the use of both nonchemical methods and careful well-planned chemical controls.

Since most fly control requires the cooperation of the entire base, education is the number one requirement of a good program. It begins with a realization of the problem by responsible individuals, extends to gaining official support, and reaches its peak when all people on the base are made aware of the problem. Fly surveys, to determine the extent of the problem and to guide the control operations, must be made. Then, efficient and effective control measures must be taken. Additional surveys are used to evaluate the results of the effort and point out where more control measures are necessary.

Once a high degree of fly [illegible] has been achieved, a continuing program is nec[illegible] maintain the gain. Yet, it is in this area that fly control programs most often fail. When flies are no longer a serious problem, group interest lags, other problems take away the attention of officials, and the flies begin a gradual but certain return. Organized fly control should be incorporated into the regular program of every pest management section.

Of course, all this isn't to say that IPM only applies in a major fly control program on your base; you should seek to apply IPM in every situation you encounter. In addition to all the reason you've already studied, there are two more you should keep in mind:

(1) Most of your fly control jobs will be small, limited to one building or less, so you increase the number of opportunities you have to apply effective nonchemical controls.

(2) Especially where flies are involved, integrated controls will almost always have a greater impact than will chemicals alone.

As you complete the following exercise, keep in mind all you've learned about IPM, flies, and work responsibilities. All of these factors apply in determining fly control needs.

Exercises (622):

This Exercise is based on the following situation: You get a work order from the base hospital to control a sudden and extremely bad fly problem. During your building survey, you discover a broken garbage disposal pipe that is dumping raw food in the crawl space under the building. There are thousands of maggots in the garbage.

1. What should the four main parts of your control program have (include efforts by both you and other sections)?

Fleas

FLEAS CARRY DISEASE in many parts of the world. They carry the organisms of bubonic plague and fleaborne typhus from rats to humans. In addition, they make insidious attacks on humans and domestic animals. After studying this chapter, you should know the names, characteristics, and controls of important flea species.

3-1. Characteristics and Habits

Since fleas differ in their host preferences, vector ability, and degree of association with people, you need to know which species are prevalent in order to judge the possible disease significance and to plan suitable control methods. This section covers the identifying characteristics and the habitats of the important flea species. But first let's study the general characteristics and habits of fleas during each of their developmental stages.

623. Distinguish between statements regarding flea habits and characteristics.

Adults. Fleas are small, wingless insects varying from 1 to 9 millimeters in length, averaging 2 to 4 millimeters. The name of the flea order, Siphonaptera, refers to their method of feeding through a siphon or tube and to their lack of wings. The flea (fig. 3-1) is compressed laterally with spines directed to the posterior, features which adapt it for moving about between the hairs and feathers of mammals and birds. Most species move about a great deal and remain upon the host only part of the time to get a blood meal. The mouthparts consist chiefly of three stylets that are used to penetrate the skin of the host and form a tube for sucking blood. The paired maxillae, acting as cutting organs, enter the skin with the epipharynx. On reaching a small blood vessel, the tip of the epipharynx enters the human while the maxillae (which form the salivary canals) remain outside emiting saliva from time to time. Thus, fleas may be characterized as capillary feeders—a fact of importance in transmission of pathogens. Both sexes feed upon blood, and the female must have a blood meal before producing eggs. The long, powerful legs of some species are adapted for jumping 7 to 8 inches vertically and 14 to 16 inches horizontally.

Most species infest the smaller mammals, such as rodents, rabbits, moles, and bats. Fewer species are parasitic upon larger animals and birds. Most fleas are specific in their host preference, feeding on only one type of host (or closely related species in the same genus), while others have developed an ability to feed upon various hosts. Fleas are very sensitive to extremes of temperatures and humidity. This explains the relative abundance of fleas infesting animals that live in burrows and sheltered nests and the light infestations of fleas on mammals or birds that have no permanent abode or live in nests exposed to the elements. Nests furnish an abundance of organic food for flea larvae leading to a high rate of survival. Fleas infesting burrowing or nocturnal animals tend to have poorly developed eyes, or eyes may be absent. Those infesting animals, active during the day are more likely to have well-developed eyes. Some fleas feed at frequent intervals—once a day or more often. They are easily disturbed and seldom complete a meal at one feeding. The human flea continues feeding after the digestive tract is gorged, causing the passage of undigested blood from the anus.

Adults are usually ready to feed in 24 hours after emergence from the cocoon. Mating usually follows the initial blood meal and usually occurs on the host animal. Fleas have a complete metamorphosis as shown in figure 3-2.

Eggs. Eggs are usually deposited among the hairs or feathers of the host or in the nest. They are smooth, spherical to oval, light colored, and large enough to be seen with the naked eye. Since they are not sticky or attached to the host, the eggs drop onto the ground or into the nest or bedding of the host, a factor important in explaining the later high concentration of adult fleas in dog or cat boxes or kennels, and on certain rugs or in portions of a building. A flea doesn't lay her full quota of eggs at one time, but after blood meals, which are necessary for egg development. Successive matings are not necessary for the fertilization of future eggs, as the sperm cells from the initial mating are stored in the spermatheca of the female and are used as required. The eggs hatch in 2 days to several weeks, depending upon temperature and humidity.

Larvae. Larvae are small, 13-segmented, wormlike creatures without legs but with chewing mouthparts. The blind, active, whitish flea larvae are often found in the house in floor cracks and rugs, or in kennels, stables, animal burrows, and nests. The larvae feed on all types of organic debris or flea feces, which are composed of more or less digested blood. The three larval stages may be completed in a week to several months.

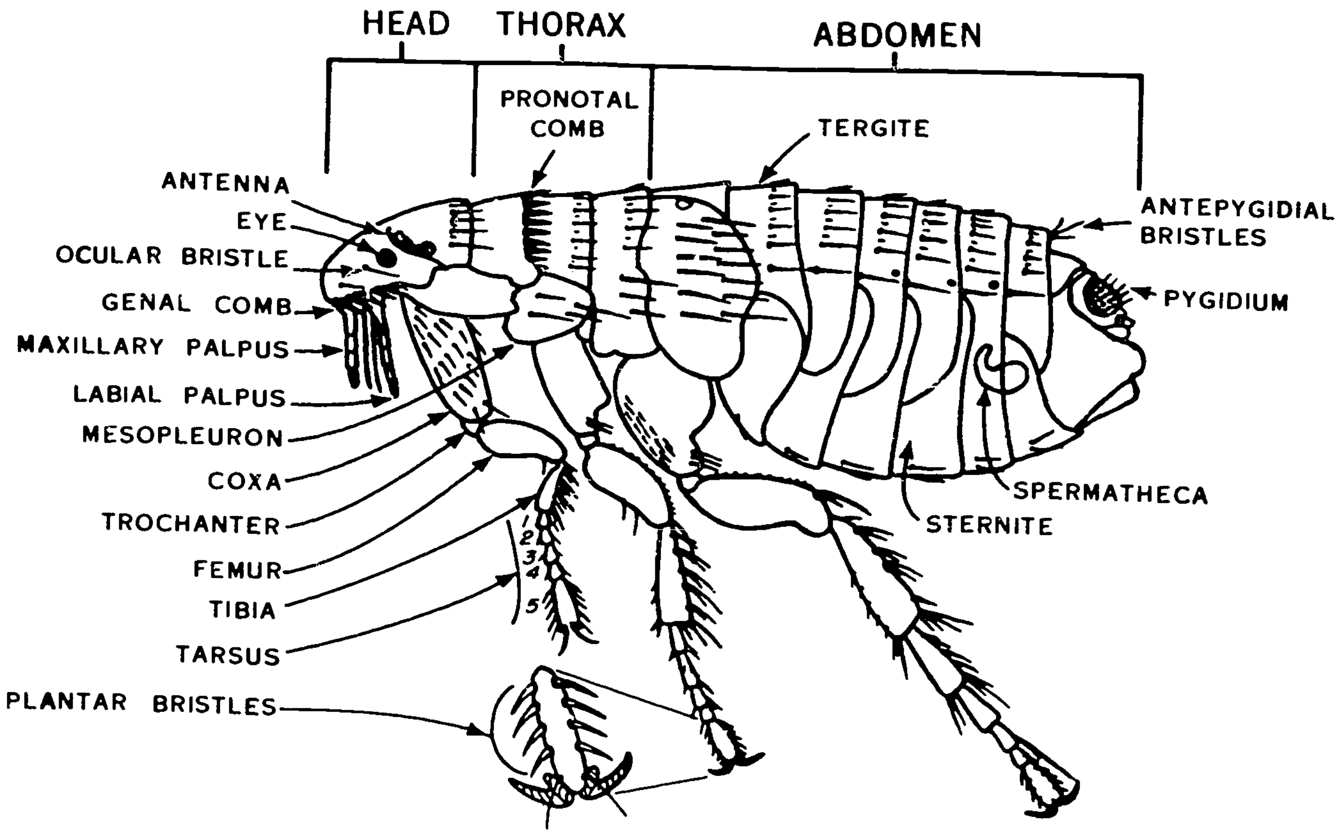

Figure 3–1. Flea diagram.

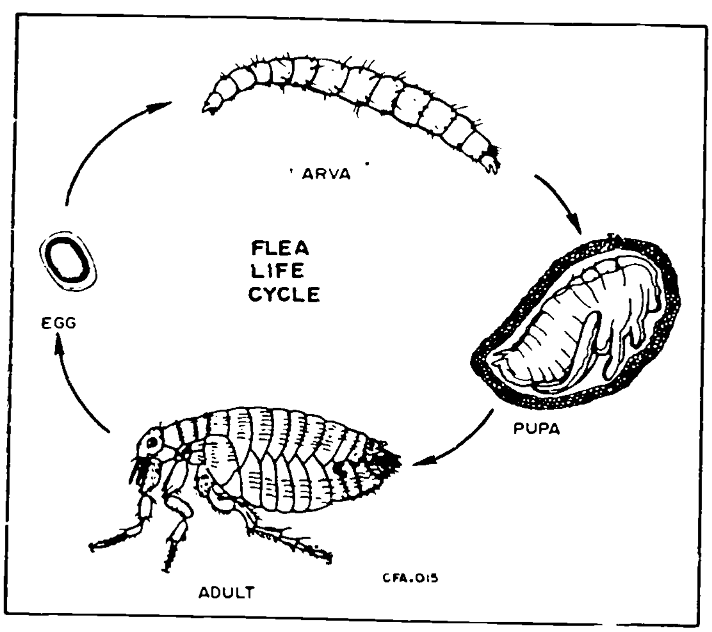

Figure 3–2. Flea life cycle.

Pupae. Pupae are usually enclosed in cocoons of finely spun silk encrusted with granules of sand or various types of debris. The pupal stage is usually completed quickly, but the newly formed adult may remain resting within the cocoon from which it emerges on stimulus, depending on the species. Cat fleas emerge in response either to vibrations or carbon dioxide which would indicate proximity to a host. This factor may help explain the large number of hungry cat fleas that attack people returning home after an absence of several weeks. Certain wild rodent fleas emerge in response to an increase in humidity which may occur only once a year in some [illegible].

Most of the important characteristics of adult fleas are shown and labeled in figure 3-1.

Genal Comb. The presence or absence of a genal comb is a quick way to identify certain flea species. This is your first reference point in identifying a flea species, along with checking for the pronotal comb. If a genal comb is present, the number of teeth contained on the genal comb and the position of the comb are other significant identifying characteristics.

Pronotal Comb. The presence or absence of a pronotal comb is an important identifying characteristic of certain flea species. Some flea species are identified by the presence of the genal comb and the absence of the pronotal comb, or vice versa, and some may have neither or both.

Other Characteristics. The shape of the head, length of the labial palpi, position of the ocular bristle, number and position of the plantar bristles, and shape of the spermatheca in female specimen are also used extensively in the identification of flea species.

Exercises (623):

For each of the following, identify it as being true (T) or false (F). Correct any false statements.

____ 1. The average length of a flea is 5 to 7 mm.

____ 2. Most flea species move very little, remaining with one host for a long time.

____ 3. Only female fleas feed on blood.

____ 4. Most flea species are specific in their host preference, feeding on only one type of host, or closely related species.

____ 5. Fleas are very sensitive to extremes in temperature and humidity.

____ 6. Fleas experience incomplete metamorphosis: egg, nymph, and adult.

____ 7. Flea larvae are small wormlike creatures with short legs and chewing mouthparts.

____ 8. Pupae are usually enclosed in cocoons of finely ... silk encrusted with grains of sand and other ...s.

____ 9. When working to identify a flea species, you should first check for presence or absence of genal and pronotal combs.

____ 10. The shape of the spermatheca can be used to help identify both male and female fleas.

624. Identify flea species with their physical characteristics, and determine the species of fleas you would expect to find in given situations.

Oriental Rat Flea. The oriental rat flea (*Xenopsylla cheopis*) is the chief vector of bubonic plague and feaborne typhus. This insect was first collected in the Nile Valley; hence, the species name "*cheopis*" for Cheops, the Pharaoh who constructed the Great Pyramid at Giza. The oriental rat flea has been introduced into all sections of the world with Norway and roof rats. The flea is established throughout most of this country, being one of the most abundant rat fleas in the South and in Southern California.

The oriental rat fleas do not have a genal or pronotal comb, the ocular bristle is in front of the eye, and the mesopleuron has a vertical rodlike thickening (fig. 3-3). You can easily recognize the females by their darkly pigmented spermatheca; this feature is often of great value in making a quick identification of survey material collected in alcohol or saline water without making a slide preparation of the specimen. The life cycle varies, being completed in as few as 4 to 8 weeks. Adult oriental rat fleas may live for 2 to 4 weeks, depending on the temperature and relative humidity.

Human Flea. The human flea (*Pulex irritans*) is found throughout the warmer parts of the world. It is the most important species attacking humans on the Pacific coast and is often responsible for a dermatitis or allergy due to flea bites. It also causes severe annoyance in the Middle West and south, particularly in homes and surrounding premises. The human flea attacks a wide variety of hosts including hogs, dogs, coyotes, prairie dogs, ground squirrels, and burrowing owls often in areas remote from people. The human flea has been experimentally infected with plague and shown to be capable of transmitting the bacteria in the laboratory. You can distinguish the human flea from other common fleas by the absence of the pronotal and genal combs, the ocular bristle being inserted beneath the eye, and the absence of the internal, rodlike thickening on the mesopleuron (fig. 3-3). A second species of Pulex (*Pulex simulans*) occurs in the central and Southwestern United States and in Central and South America.

Northern Rat Flea. The northern rat flea (*Nosopsyllus fasciatus*) is commonly found on domestic rats and house mice throughout North America and Europe, but it's not abundant in areas having extremely warm climate. It does not readily bite humans and is most commonly found in temperate regions, where plague is not a severe problem. It is the predominant rat flea in the northern United States and ... well established in Canada. This species may be of importance in transmission of plague organisms from rat to rat. It has been taken from wild rodents on a few occasions. In 1971, specimens of the northern rat flea were found infected with plague bacteria in the Tacoma area of Washington.

Dog and Cat Fleas. The dog flea (*Ctenocephalides canis*) and cat flea (*Ctenocephalides felis*) probably occur throughout the U.S. although they are less common in the Rocky Mountain States. The cat fleas seems to be more abundant and widely distributed than the dog flea.

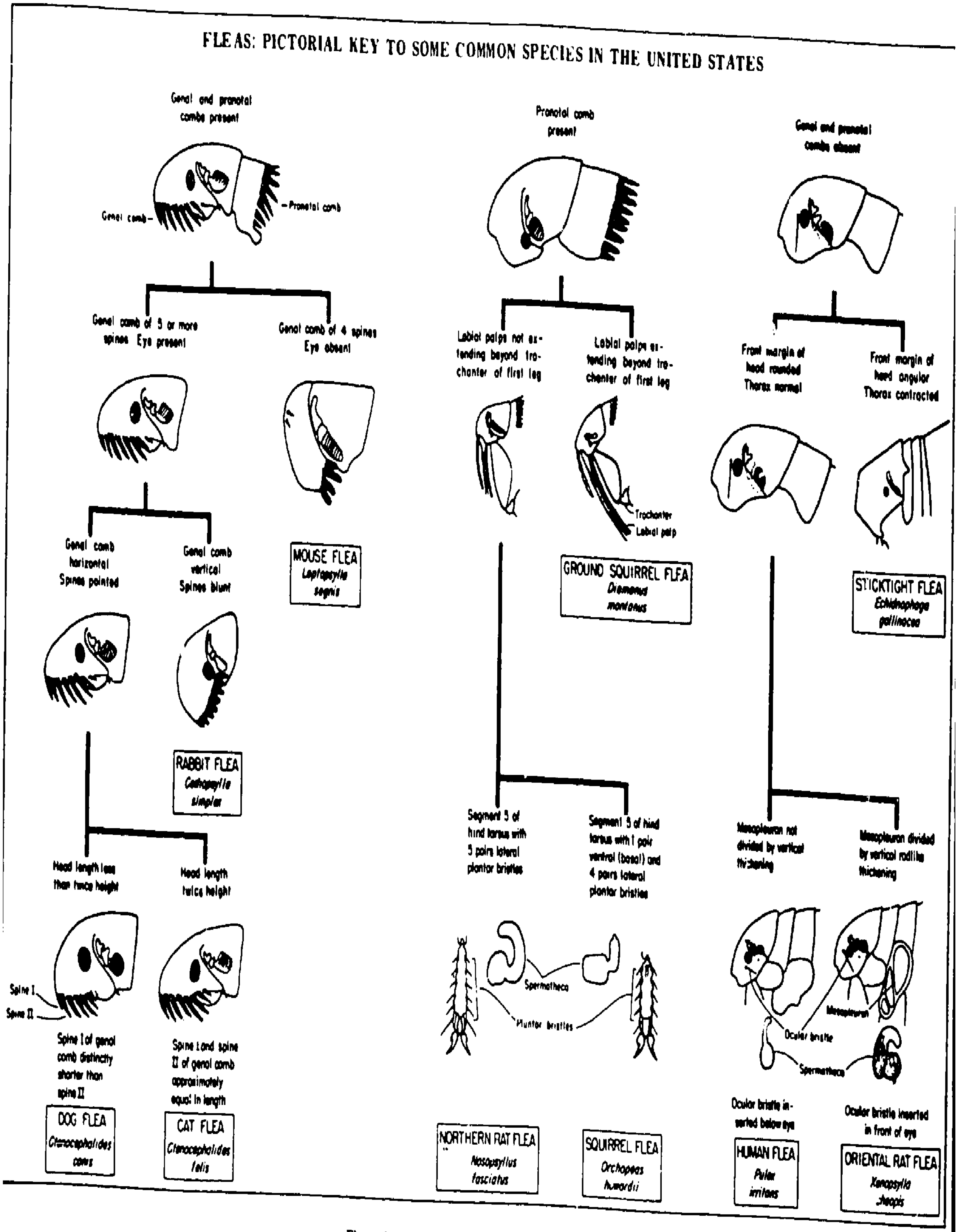

Figure 3-3. Pictoral key to common flea species.

The head is about twice as long and as high in the cat flea, while it is only about as long as high in the dog flea. In addition, the front margins of the heads of these two species have different shapes. The angle is more acute in the cat flea than in the dog flea. In most cat fleas the first and second teeth of the genal comb are approximately equal in length, while in typical dog fleas the first tooth is shorter than the second (fig. 3-3). The dog flea has two stout bristles between the long postmedian and apical [illegible]stle on the hind margin of the hind tibi[illegible] cat f[illegible]as only one bristle in this positio[illegible]

Both species are commonly found in and under homes, or in yards. They prefer locations where dust and organic debris accumulate. These fleas attack cats, dogs, and a wide variety of other mammals, such as foxes, racoons, and rats. They are serious pests of humans, especially in the summer, causing severe bites. Under favorable conditions, a generation of the cat flea takes about 2 to 4 days for the eggs, 8 to 24 days for the larvae, and 5 to 7 days for the pupae to develop.

Sticktight Flea. The sticktight flea (*Echidnophage gallinacea*) is a small species that has no genal or pronotal combs but the front margin of the head is angular. As an adult, it attaches firmly to its host, often forming ulcers on the head and neck of domestic fowl. The eggs are deposited in these ulcers and, after hatching, the larvae crawl out and drop to the ground to feed upon organic matter. All stages may be found in poultry yards and adjacent buildings. This flea attacks rats, cats, dogs, rabbits, ground squirrels, horses, fowl, and many other animals, including humans. This flea has been found infected with plague and can be infected with fleaborne typhus rickettsia. This flea plays a minor role in disease transmission because the females remain permanently fastened to one host by means of their serrated mandibles.

Exercises (624):

1. Match the fleas in column B with their characteristics in column A. Column B items may be used more than once.

Column A

____ (1) The head of [illegible] lea [illegible] high.

____ (2) [illegible] female has [illegible]ted mandibles used to attach permanently to a host.

____ (3) There is no genal or pronotal comb, the ocular bristle is in front of the eye, and there is a vertical rodlike thickening in the mesopluron.

____ (4) A pronotal comb is present and the fifth segment of the hind tarsus has 5 pairs of plantar bristles.

____ (5) Genal and pronotal combs are absent and the ocular bristle is underneath the eye.

____ (6) Genal and pronotal combs are present and the first spine of the genal comb is distinctly shorter than the second spine.

____ (7) What flea would you expect to find commonly in homes in areas where dust and debris collect?

____ (8) At a California base, some residents are complaining about "bugs" which cause dermatitis and allergies. What flea would you expect?

____ (9) In a base housing area, fleas are greatly irritating to both residents and house pets. They often seem to stay attached to their victims.

Column B

a. [illegible] rat flea.
b. [illegible]man flea.
c. Northern rat flea.
d. Dog flea.
e. Cat flea.
f. Sticktight flea.

3-2. Flea Survey and Control Measures

Surveys are an essential part of programs for reducing fleas and their disease-transmitting potential. In this section, you'll learn about two types of flea surveys you can perform: pest flea surveys and surveys for fleas under disease control situations. Similarly, you'll learn about control measures on the same basis.

625. Develop a basic outline depicting the steps involved in conducting pest flea surveys.

Pest Flea Surveys. Surveying is absolutely necessary if you want effective flea control. In doing th[illegible] most basic action is for you to locate [illegible] hosts. This isn't difficult since almost al[illegible] [illegible]estic flea infestations are associated with house pets. [illegible]nce you've done this, you can begin de[illegible]mining the pet's habits. What's the cat's favorite spot on the couch? Is there a dog bed in the den? Once you have answers on these or similar questions, you'll have a good idea of where flea "hot spots" exist. Then, you can check these areas for evidence of fleas. Look at pet bedding, carpets, throw rugs, furniture, near heating units, baseboards, and outdoor areas based on what you learned earlier in the survey.

Make sure you look for larvae, pupae, and adults since this can make an impact on when you might need to retreat the building or area. (Of course, other factors will be what pesticide you use, it's form, and where you apply it.) To do this, you may walk through an area wearing white socks pulled over your shoes, or lay a piece of white cloth on the floor to help you spot fleas. Another way i[illegible] vacuum the area, treat the bag contents with a contac[illegible]cticide, and then sample the contents. (This is especially good if you want to collect fleas for slide mounting, and it sure beats trying to hand pick them from a pet.)

Exercises (625):

Use the information you learned in this lesson to develop the following outline on conducting flea surveys.

1. Step 1:

2. Step 2:

3. Step 3:

4. Areas
   a.

   b.

   c.

   d.

5. Step 4:

   Methods
   a.

   b.

   c.

626. Verify statements regarding flea control.

Flea Control For Disease Prevention. Controlling rodent fleas for disease prevention may be divided into two main categories: control in urban areas and control in rural area. Thoroughness is essential in controlling rodent fleas.

Controlling Rodent Fleas in Urban Areas. Fleas are the most important vectors of plague and fleaborne typhus. Outbreaks of both diseases have been controlled in the past by controlling rats, ratproofing, and improving sanitation, but real progress in controlling these diseases was not achieved until the mid forties with the advent of DDT and the anticoagulant rodenticides. In early campaigns, control measures started outside the infested area and worked towards the suspected center of infection. Today, control operations are started at the suspected focal point and work outwards.

To control an epidemic of plague or fleaborne typhus, the following sequence of control operations has worked in a number of areas:

(1) Applying residual insecticides such as malathion, diazinon, or carbaryl to kill the infected fleas, particularly the oriental rat flea.

(2) Using multiple-dose rodenticides to reduce host populations, or fumigating burrows.

(3) Improving general sanitation to keep rodent populations at the lowest possible level, paying particular attention to refuse storage, collection and disposal, and harborage elimination.

(4) Rodent stoppage or ratproofing.

(5) Followup surveys and maintenance to prevent buildup of disease potentials.

Under the current concept of urban control, emphasis is placed on residual insecticides and anticoagulant rodenticides, plus rat trapping, rodentproofing, and improved sanitation.

Applying residual insecticides at the suspected center of infestation when you start control activities places emphasis on killing the infected fleas as quickly as possible. The anticoagulant rodenticides are also distributed on the first day, because these compounds do not kill rodents until they have eaten these materials for several consecutive days. It is wisest to wait at least 2 or 3 days before rat trapping or area poisoning with single-dose rodenticides so the rodents wandering about treated areas can pick up the insecticide on their feet or fur and carry it into their burrows to kill the greatest number of fleas in these breeding places. More important, as the rodents are trapped or are killed by rodenticides, any fleas still on the rodents will be killed by the "blanket" of insecticide before they can bite other animals, including people. This decreases the disease hazard.

Apply the insecticide dust to rat burrows, holes in floors and walls, and enclosed spaces that may harbor rats. It is especially important to treat spaces between double walls and floors and under merchandise where there are rat entries, because the danger of disease spreading from rodents to people is most severe in buildings. Apply the dust so there is no contamination of food with the insecticide, particularly during application or by blowing or tracking.

Dust patches consist of a layer of insecticide dust around a rat hole, entryway, burrow, or along a rat run th[illegible] use. The thickness of the patch should depend upon the amount of rat travel evidenced by the presence of rat droppings and footprints. It may vary from a thin film to a patch 1/4 to 3/8 inch thick. Rat entries should be dusted thoroughly and an area 6 to 8 inches long placed on the narrowest part of the runway. Patches on stairways should completely cover two adjacent stair treads. When parasites of roof rats are to be controlled, dust alternate spaces between rafters on overhead "swings." Rat swing marks are usually detected by their dark and glossy appearance, because the rat rubs oil from its fur while swinging beneath rafters or traveling along a plate. Place dust patches near feeding, watering, and harboring areas and other locations frequented by rodents.

Personal Protection. You can protect yourself from attack when going into a heavily infested area by treating ankles and trouser legs with dimethyl phthalate. This will give protection for several hours against cat and dog fleas. Clothing may be impregnated in benzyl benzoate to prevent flea att[illegible] Also, diethyltoluamide, sold commercially as OFF or DEET, has shown great promise as a flea repellent. After an area has been dusted, these materials are no longer necessary. Insecticide dusts prevent biting almost immediately, although 3 to 4 hours may be required for complete mortality of dusted fleas.

Sanitation. General sanitation should be improved as quickly as possible as flea control is achieved. Workers in the area should be vaccinated against plague or murine typhus and wear fleaproof clothing that has been treated with repellents. The more time-consuming work of rodent stoppage should not be started until the danger of contracting these diseases is reduced.

Exercises (626):

Identify the following statements as being true (T) or false (F). Correct any false statements.

____ 1. In a disease reduction program, emphasis should be placed on flea control.

____ 2. You can prevent personal flea attack by treating legs and ankles with ronnel before entering a heavily infested area.

____ 3. In efforts to treat for both fleas and rodents at the same time, single-dose rodenticides should be used.

____ 4. Insecticidal dusts should be placed in burrows, holes, floors, walls, and any other enclosed spaces which harbor rodents.

____ 5. General sanitation should be improved before flea control is achieved.

627. Specify basic facts regarding pest flea control, and determine control measures for a given situation.

Controlling Pest Fleas. Pest flea control may be divided into two main categories: control of pest fleas on pets; primarily cats and dogs, and control of pest fleas on premises, including indoor and outdoor areas. The principal approach to control is through insecticides. Insecticides for controlling fleas on pets or inside buildings are usually less toxic and are used at lower concentrations than those applied outdoors.

With cat and dog fleas, reinfestation will occur within a short period of time unless you conduct very thorough controls. Simultaneous treatment of both hosts and premises gives a much better chance for economical and quick control than either alone. Thus, if a cat or dog is treated to kill a flea infestation, it will soon become heavily infested again unless all nearby flea breeding sites are treated. A treatment of the infested animal plus a complete coverage of all breeding sites is much more effective than weekly treatments of the animal alone.

NOTE: This isn't to suggest that you should treat the pets yourself; this is a "hands-off" area for pest managers. Instead, make sure the pet(s) is treated by a veterinarian or the owner at the same time you're treating the premises.

For the most effective flea control, there are some preliminary actions the occupant should take before you apply pesticides. Encourage the occupant to:

- Thoroughly vacuum the premises, with special effort where fleas may be found (resting areas, carpet, etc.)
- Launder or destroy pet bedding if the problem warrants.
- Be prepared to have pets treated while you're treating the premises.

Sanitation alone, however, can't do an adequate job. You'll need to treat the premises with a residual insecticide. This is usually done at the rate of about 1 gallon per 1,000 square feet. Refer to table 3-1 for a list of insecticides labeled for flea control. Give special attention to carpets, floors, over-stuffed furniture, pet resting areas, baseboards, and any other likely harborages as you work. Use a light fan spray to gently wet all surfaces.

Dogs and cats often spend a lot of time outdoors, so don't neglect these areas. Apply an appropriate insecticide to lawns, flower beds, crawl spaces, garbage areas, or dog pens. Especially in the southern and western parts of the U.S., yard infestations are a real problem. For treating these areas, use dusts, suspensions, or granules to help give long-term protection. After your initial treatment, encourage residents to periodically apply commercially available lawn insecticides to keep flea populations down.

For treating lawns and yards, using emulsions or solutions isn't advisable. Wettable powders and dusts are safe on shrubbery and grass and have a long residual action, but they leave a light-colored deposit. The dusts are frequently twice as strong as the sprays. Emulsions containing these insecticides may be used in yards if you're sure the emulsions being used will not harm the plants. Some of the auxiliary solvents used in preparing emulsion concentrates will "burn" foliage or grass. Using solutions on vegetation is even more dangerous since many of the petroleum solvents are known to be phytotoxic. Take care not to release sprays at high pressure close to foliage since this may also damage vegetation.

Exercises (627):

1. What are the two main categories of pest flea control?

2. What approach gives the best chance for quick and economical flea control?

3. What role should you play regarding treating pets for fleas?

4. What two measures should precede chemical treatment of a home with fleas?

TABLE 3-1
INSECTICIDES FOR FLEA CONTROL

Insecticide	Insecticide	Formulation	Indoor	Outdoor	Pets
Baygon	Propoxur	Emulsifiable concentrate		X	
		Wettable powder		X	
		Aerosol		X	
		Aerosol with DDVP	X		
Diazinon	Diazinon	Emulsifiable concentrate	X	X	
		Granules		X	
FICAM-W	Bendiocarb	Wettable powder	X	X	
		Dust	X	X	
Dursban	Chlorpyrifos	Emulsifiable concentrate	X	X	
Dursban LO					
Malathion	Malathion	Dust	X		X
		Emulsifiable liquid	X	X	X
		Spray			X
Pyrethrins and piperonyl butoxide	Pyrethrins and Piperonyl butoxide	Spray	X		
		Aerosol	X		
		Dust with Baygon	X	X	
Pyrethrins	Pyrethrins	Dust	X		
SBP-1382	Resmethrin	Spray	X	X	
		Fogs	X		
		Emulsifiable concentrate	X		
Sevin	Carbaryl	Dust		X	X
		Wettable powder		X	
Safrotin	propetamphos	Emulsifiable concentrate	X		
Precor	methoprene	Fogs	X		
		Emulsifiable concentrate	X		

Questions 5 and 6 are based on the following situation: You've received a work order from a base housing occupant who just returned from a 3-week vacation (some people have all the luck). Their house is "full of fleas" even though they had their dog dipped for fleas before they left.

5. What action should you take?

6. What action should the occupants take?

Lice, Ticks, and Mites

LICE, TICKS, AND MITES have been with us for centuries. Infestations with lice occur today in the United States and many other countries despite great efforts to maintain high standards of health. Pest management and health personnel are often called upon if infestations include or expose large groups of people, particularly in those areas such as schools, dormitories, hospitals, and child care centers.

Ticks, vicious bloodsucking pests, are important to the Air Force because they can disrupt a mission if they are allowed to contaminate areas and infest people and domestic animals. Low morale, sickness, and sometimes death are the result of increased population of these pests.

Mites often infest foods, stuffed furniture, and mattresses. Some of the larger infestations in buildings result from invasions by rodent mites, bird mites, and clover mites. A number of the mites discussed in this chapter are vectors of organisms that cause diseases which affect people and their animals; others cause dermatitis and allergic reactions in humans.

4-1. Lice

The three sucking lice that infest humans are the body louse, the head louse, and the crab louse. The body louse is the species involved in epidemics of louseborne typhus, trench fever, and relapsing fever, but all three cause pediculosis. This section discusses the medical importance, biology, and control of these lice.

628. Identify the general characteristics of lice.

Identification and Classification. Sucking lice belong to the order Anoplura. These wingless insects are flattened dorsoventrally (fig. 4-1) from top to bottom like a pancake. Adult lice have mouthparts consisting of three stylets modified for piercing and sucking; the stylets are retracted within the head when not in use. Their legs are short and stout, with a large claw on one or more of the three pair of legs for grasping and holding onto hairs. The eggs of lice differ from those of most other insects because they are attached by cement and have a distinct cap or operculum. Females are usually larger than males and the tip of the abdomen is notched. Males have the tip of the abdomen rounded with somewhat cigar-shaped genitalia that is often visible through the body wall.

Development. Lice have three immature (nymphal) stages which resemble the adult stage. Most nymphs differ from adults in having fewer hairs on their bodies, fewer sclerotized plates, and in being sexually undifferentiated. Lice are, therefore, good examples of insects with gradual metamorphosis, that is, insects with three stages of life: egg, nymph, and adult (fig. 4-2).

Hosts. Most sucking lice spend their entire life as ectoparasites on mammals. The body louse is a conspicuous and important exception because it rests on clothing except when feeding. Sucking lice occur only on mammals, never on birds, reptiles, or amphibia. Each species of louse generally feeds upon only one species of host animal, one genus, or, more rarely, one group of mammals. In general, closely related groups of mammals appear to be infested by closely related species of lice.

Exercises (628):

Place the letter "T" in front of the correct statements. Correct any false statements.

____ 1. The crab louse is the species involved in the epidemics of louseborne typhus and relapsing fever.

____ 2. All three types of sucking lice cause pediculosis.

____ 3. Adult lice have mouthparts consisting of three stylets modified for piercing and sucking.

____ 4. The eggs of lice are smooth, spherical, and are not sticky.

____ 5. Most sucking lice spend their entire life on mammals.

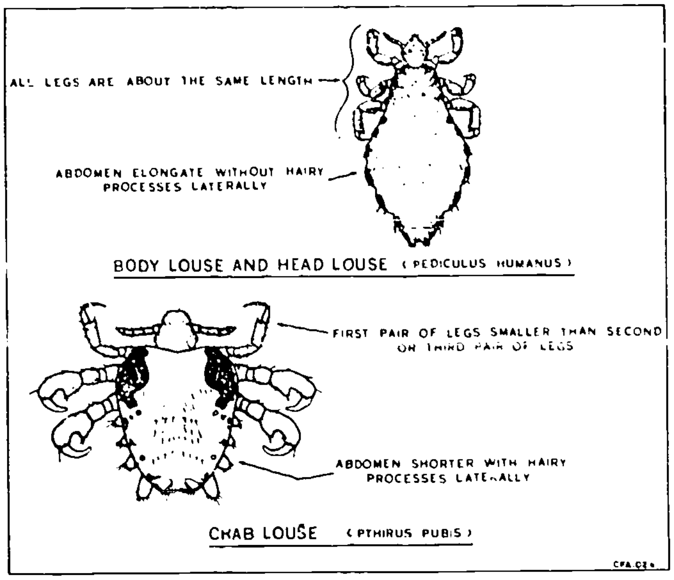

Figure 4-1. Species of lice.

629. Identify given statements pertaining to louse characteristics as applying to the head louse, body louse, or both.

Head and Body Lice. The body louse (*Pediculus humanus humanus*) and head louse (*Pediculus humanus capitis*) are very similar to each other physiologically, but they differ morphologically in size, proportion, and color. They also differ biologically in habits, one form living on the head and neck and the other on the body.

Adult identification. The adult body louse is 2 to 4 millimeters long, greyish white in color, and is generally 10 to 20 percent larger than the head louse. The head louse is 1 to 2 millimeters long and is greyish white with dark margins.

Habitat. Adults and nymphs of head lice are found in the hair and on the scalp; they tend to be most prevalent on the back of the neck and behind the ears. They aren't known to infest eyebrows or eyelashes.

Although as many as 1,000 body lice have been removed from the undergarments of one person, it is more typical to find less than 10 lice per person. Most of the lice are on the inner surface of the clothing, next to the skin. Females tend to congregate along seams for egg laying. Some adults may migrate away from the skin to the outer garments and to other people. Head and body lice can move fairly rapidly and will pass from host to host, or from host to bedding, by simple contact.

It is difficult to find human lice and crab lice away from humans. Beds occupied every night by unsanitary individuals have a greater chance of being infested. If unoccupied for several nights, they tend to be free of lice. Head and body lice may be acquired by personal contact and by putting on infested garments. Head lice may be acquired by contact with upholstered chairs and by using infested brushes and combs. Hairs with eggs attached may be blown about. Lice tend to leave a feverish patient and seek other hosts.

Habits. These lice depend upon human blood as a means of life. They suck blood for long periods of time, but they don't ordinarily become engorged. Some individual lice feed too avidly, causing rupture of their digestive system, and succumb because of their greed. During feeding, dark red feces may be deposited on the skin.

When ready to feed, the louse anchors its mouth to the skin, stabs an opening through the skin, pours saliva into the wound, and pumps blood from the injury into the digestive system by means of the pharyneal pump.

The body louse remains attached to clothing fibers and bends over to feed while the head louse simply remains attached to body hairs.

Entomologists may disagree with one another on a number of issues but one in which there is no disagreement is that lice, including pubic lice, do not jump or fly.

The question of whether head lice can jump or fly may have arisen because static electricity generated by combing the hair can cause them to be suddenly repelled from the comb. It is essential to dispel the notion that lice can jump or fly in order to focus attention on the fact that lice are transmitted principally through contacts with an infested person or to a lesser extent with fomites (infested objects).

The possibility exists that lice could be blown about by wind, but this is remote. There are also rare instances where lice from humans were found on insects, but insects as a means of transferring lice from person to person cannot be realistically regarded as any more than a very infrequent possibility.

Egg laying. Mating occurs frequently and at any time in the adult's life, from the first 10 hours to old age. Eggs are laid 24 to 48 hours later, depending upon temperature conditions. Eggs are cemented on head hairs by head lice or on the underclothing by body lice. If the human is relatively nude, as in some tropical areas, lice may infest beads and necklaces. Body lice may deposit 9 or 10 eggs per day and a total of 270 to 300 eggs in a lifetime. Head lice are less prolific, depositing about 4 eggs per day for a total of about 88 days in a lifetime. The hatching of eggs is greatly

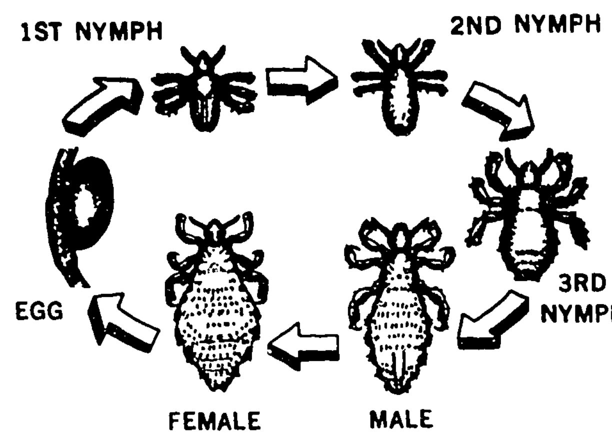

Figure 4-2. Life cycle of a head louse.

reduced or completely prevented by exposure to temperatures above 100° F. or lower than 75° F.

Nymph development. After emerging from the egg, the louse nymph molts three times before becoming a sexually mature adult. Therefore, there are three nymphal instars, differing from each other by the increased length of the abdomen as development progresses. The nymphal stages require 8 to 9 days for lice remaining in contact with the human body, but may take 2 to 4 weeks when the clothing is removed at night. If the clothes aren't worn for several days, all lice will usually succomb. The total life cycle of head and body lice may be completed in about 18 days.

Exercises (629):

1. Match characteristics in column A with head and body lice or both in column B. Column B items are used more than once.

   ____ (1) The adult louse is about 2 to 4 millimeters long and greyish white.

   ____ (2) The adult louse is 1 to 2 millimeters long and is greyish white with dark margins.

   ____ (3) Are not known to infect eyebrows or eyelashes.

   ____ (4) Can move fairly rapidly from host to host by simple contact.

   ____ (5) May be acquired by putting on infected garments.

   ____ (6) Female lays eggs along clothing seams.

   ____ (7) Tend to leave feverish patients and seek other hosts.

   ____ (8) May deposit 9 or 10 eggs per day.

   ____ (9) May deposit 4 eggs per day.

   ____ (10) The nymphal stage requires 8 to 10 days when remaining in contact with human body.

630. Cite information regarding the basic characteristics of crab lice.

Characteristics of Crab Lice. Crab lice (*Pthirus pubis*) are small (0.8 to 1.0 mm), greyish-white insects with a short abdomen bearing hairy lateral tufts and large second and third pairs of legs that give them a crablike appearance (fig. 4-1).

These insects are most commonly found on hairs in the pubic areas, but they may be found on hairy areas of the chest and armpits. Infestations of the eyebrows and eyelashes are frequently reported. Crab lice on the eyebrows feed in a very localized area and cause hemorrhages in the skin which result in a bluish pigment directly above the eyebrows.

The life cycle of the crab louse is similar to that of the head and body lice. The eggs are glued to hairs but are smaller than the body louse eggs.

There are three nymphal stages. In a few specimen that were carefully studied, it took 13 to 17 days for them to become adults. Adult life lasts less than a month. All stages are more sedentary than those of head or body lice. They tend to settle down at one spot, grasping hairs with the legs of both sides of the body, inserting the mouthparts, and taking blood intermittenly for many hours at a time. The legs are adapted for grasping large hairs, and, in the position adopted, the adult prefers hairs widely spaced (compared with the dense hairs of the head). This may partly explain the distribution of the crab louse, which is found most commonly on the hair in the pubic and anal areas. This insect survives only a short time away from the host.

Crab lice are spread chiefly by sexual contact, but they may be acquired by other means, such as infested toilet seats and beds (rare), and by close personal contact. Many authorities believe that there has been a resurgence in the number of cases of crab louse infestations related to the present worldwide climate of cultural permissiveness.

Exercises (630):

1. On what body parts are crab lice most commonly found?

2. Where are crab louse eggs found?

3. How are crab lice chiefly spread?

631. Specify details related to controls for lice.

Controlling Lice. The first thing you need to understand about controlling head, body, or crab lice is that, as a pest manager, there's generally not much you can or should do. Medical personnel are responsible for taking any direct personal action to control lice. If your shop gets contacted, it's usually to treat the quarters of a person who's been identified by a doctor as having lice. Another typical situation is your being contacted by a first sergeant who is working to prevent a severe round of "louse-a-phobia" in a dormitory where one or two people have developed pediculosis.

Your role in a louse control program, however, isn't normally in the realm of control, but of education. Many people associate pediculosis with the lack of sanitation and feel greatly stigmatized when informed that the members of their family or others around them have lice. But as you will see, the relationship between uncleanliness and pediculosis is not that of cause and effect.

Anyone can acquire lice—head, body, or pubic lice—regardless of his or her level of cleanliness, and once a person is infected, ordinary levels of cleanliness such as bathing and frequent changes of clothing can be expected to eliminate body louse infestations. This is because the body louse lives in clothing, and laundering or storage of clothing will result in the death of lice and nits (eggs).

A person wearing the same clothes and not bathing can do so indefinitely without becoming lousy. During a typhus epidemic, for example, an entire population may be treated with a pediculicidal dust to kill body lice without necessarily providing either bathing or laundering facilities. When all the lice are killed, the epidemic is halted but the sanitation level remains low.

However, once an infestation starts, continued neglect of sanitary measures will lead to a rapid increase in the louse population, and crowded conditions will allow the lice to spread to other persons.

Supportive louse control measures. Although complete control is almost impossible without treating the host, there are some supportive measures which can be of value in preventing lice from spreading to groups of people who must closely associate with either other.

You can treat places like dormitories, gymnasiums, and school lockers with residual insecticides so any louse that may fall or be knocked from an infested person may be killed before it gets on another person. Treating the inner surfaces of lockers can be beneficial in body louse control since they can crawl from one clothing item to another. If lousy garments are left in a locker overnight, exposure to a toxicant may keep the problem from spreading. Of course, the extent of this kind of treatment will depend on how widespread the problem is, where it exists, and the potential for spreading to other people.

corrective louse control measures. Body lice eggs are laid on the cloth, attached to the fibers; wool cloth is much preferred to other kinds. In looking for infestations, examine the clothing along the seams and folds, especially on the inside of the underwear.

Ordinary laundering with hot water will destroy all stages of lice on clothing and bedding. Dry cleaning may be used to destroy lice on wool garments. The solvent used in cleaning is toxic to lice, and the steam used in pressing makes certain that control is complete. Pressing woolens at home is also satisfactory, but special attention must be given to the seams.

Head lice spread rapidly through a family and may be transmitted to people throughout a community. They are most abundant in children. In some countries, girls tend to be more heavily infested by both head and body lice than boys.

The eggs, often called nits, are the easiest stage to discover when inspecting for head lice. They are most commonly attached to the hair, close to the scalp behind the ear.

A medical application of 1 percent lindane or 1 percent malathion dust in pyrophyllite or talc is effective, although it is unsightly. The dust should remain on the scalp 24 hours in order to produce a complete kill. A second treatment 7 to 10 days later will kill all lice that have hatched since the first treatment.

The safest and best materials medical personnel may use for head louse control are emulsions containing 0.2 percent pyrethrins, 1 percent lindane (Kwell shampoo), or insecticide dusts containing 1 percent lindane or 1 percent malathion. The following procedure for using emulsions is safe and easy to follow for the distressed victim.

(1) Shampoo and dry the hair thoroughly.

(2) Seat person in chair with head tilted backward and eyes covered with towel.

(3) Apply the emulsion liberally to the hair and scalp with brush and swab. Work against the nap of the hair and touch all hair and the whole scalp.

(4) Comb the hair in the usual manner.

(5) After 10 minutes with the pyrethrin emulsion, or after 24 hours with the lindane emulsion, shampoo the hair.

(6) Dry, comb, and brush hair to remove dead lice and loosened eggs. 5

As with head and body lice, a simple treatment for crab louse control is shaving or cutting the infested hair to remove adults, immature stages, and eggs glued to hairs.

People are very sensitive about infestations of crab lice. A rumor or an infestation in a large office building or dormitory can do much to disrupt normal operations and cause distress. If these problems are dealt with quickly and firmly, they will soon be forgotten.

Lice are highly dependent upon their hosts for warmth, food, and shelter. Most lice live on their human hosts but some can be found in beds, on furniture, clothing, and possibly on the rugs and floors. In the case of head lice, they may also be found on combs, hairbrushes, headgear, and scarves.

After an individual has been successfully treated, the major source of lice will have been eliminated. Clothing and linen washed or dry cleaned would eliminate further possible sources, leaving rugs, furniture, and floors and the remaining possibilities.

The vacuum cleaner is probably the best tool to use on rugs, floors, and furniture. Lice, if present for any length of time, are usually weakened from lack of food or cold or injured by the comb passing through the hair (in the case of head lice). There is no reason to believe the presence of rugs in a room would be a significant factor in maintaining lice.

Fumigation of a room or building will undoubtedly hasten the demise of any lice or eggs present; but its cost is very high, the results are transitory, and the returns are meager. Fumigation is not recommended under any reasonable circumstances.

When you're encouraged (or ordered) to spray infested objects (fomites) you should limit it to special situations. There are presently two sprays available for this purpose—R&C & C spray and Li-Ban. The effectiveness of the spray is greater when the insecticide contacts the louse directly, less so if the louse contacts the treated surface. The effectiveness of the spray is short, probably less than a day.

The caution appearing on the label, "Not for use on humans or animals," should be carefully observed. As with many sprays, the carrier for the insecticide may affect certain synthetic materials. (CAUTION: Test on a small area in an inconspicuous spot first before proceeding with the application.)

Exercises (631):

1. Who is responsible for treating lice on a person's head or body?

2. In a louse control program, what is your primary responsibility?

3. Under what condition will poor sanitation promote louse infestations?

4. How may treating lockers in dormitories, etc. help keep body lice from spreading?

5. What's the most effective means of controlling lice on rugs, furniture, or floors?

4-2. Ticks

The material in this section introduces the tick and reviews the characteristics, distribution, and control of the tick. The material also covers methods of personal protection and treating infested areas.

632. Relate information regarding diseases spread by ticks.

Tickborne Diseases. Ticks are known to spread four groups of deadly diseases to people:

(1) Rickettsial—spotted fever and Q fever.
(2) Bacterial—tuleremia.
(3) Spirochetal—relapsing fever.
(4) Viral—Colorado tick fever.

As you can see, ticks can cause great discomfort to humans. See table 4-1 for the following discussions.

Rocky Mountain spotted fever. This is a febrile disease caused by *Rickettsia rickettsii*. In the west, the Rocky Mountain wood tick (*Dermacentor andersoni*) and the rabbit tick (*Haemaphysalis leporispalustris*) spread the disease from animal to animal. *Dermacentor andersoni* is the most important western vector and both male and female of the species are infectious. The American dog tick (*Dermacentor variabilis*) is the most important vector in the East. *Another species, the lone star tick (Amblyomma americanum)* is probably a vector in parts of the eastern United States and Texas, Oklahoma, and Arkansas.

Dermacentor ticks are well suited as vectors of spotted fever because their larvae and nymphs feed on rodents, and the adults attack man and other large animals. However, fever transmission doesn't occur unless the tick remains attached for more than 2 hours.

Spotted fever has been reported throughout the Continental U.S., but not Alaska or Hawaii. The greatest number of cases have been reported from the South Atlantic States, particularly Virginia, Maryland, and North Carolina. Great differences in the virulence of the disease have been reported. The western strain is considered more deadly than the eastern, but the fatality rate for spotted fever is about as high in the East as it is in the West.

Tularemia. Tularemia or rabbit fever, is a plaguelike disease transmitted to humans from rabbits or rodents. This disease has caused heavy losses in sheep. The disease bacteria infects a wide variety of hosts, but is especially prevalent in rabbits. Tularemia is transmitted to these hosts by ticks of the general *Dermacentor, Amblyomma*, and *Haemaphy*, which may transmit the disease organisms to their offspring in the egg and from one stage to another (cyclo-propogative transmission). People can get the disease by contact with infected rabbits or other animals, the feces of infected ticks, or by tick bites.

Relapsing fevers. There are two distinct diseases known as relapsing fever, one tickbome, the other louseborne. They show only minor clinical variations and are distinguishable by differences in mode of transmission and geographic distribution. These diseases occur on every continent with the possible exception of Australia and are caused by spirochetes in the genus *Borrelia*. The epidemic, louseborne type is most frequently due to *Borrelia recurrentis* and the endemic, tickborne type, is caused by a number of species of *Borrelia*. Louseborne relapsing fever is not known to occur in the United States at this time.

In the U.S. relapsing fever spirochetes are transmitted by soft ticks of the genus *Ornithodoros* in limited areas of 13 Western States. There are four species which are proven vectors relapsing fever spirochetes: *Ornithodoros hermis*; in California, Nevada, Idaho, Oregon, Washington, and Colorado; *Ornithodoros turicata* and *Ornithodoros talaje* in the United States from Florida to California and northward to Kansas, Colorado, and Utah; and *Ornithodoros parkari* in northwestern United States. Ticks remain infective for life and pass the spirochetes to their offspring. Both ticks and their rodent hosts may serve as reservoirs for the disease. Infections of humans are believed to take place by

TABLE 4-1
TICKBORNE DISEASES IN THE UNITED STATES

Name of Disease	Disease Organism	Type Organism	Tick Vector
Rocky Mountain Spotted fever	Rickettsia rickettsii	rickettsia	Dermacentor Variabilis D. Andersoni D. Occidentalis *** Amblyomma americanum Haemaphysalis leporispalustris *
Tularemia	Pasteurella tularensis	bacterium	D. variabilis D. andersoni H. leporispalustris * Amblyomma americanum
Relapsing Fevers	Borrelia spp.	Spirochete	Ornithodoros hermsi O talaje O Parkeri O. turicate
Colorado Fever	Birus	Virus	D. andersoni
Q fever	Coxiella burnetti	rickettsia	D. andersoni A. americanum Otobius Megnini ***
Tick paralysis	----no organism, toxic secretion ----		D. variabilis
Anaplasmosis **	Anaplasma spp.	protozoan	Many tick species
Cattle tick fever	Babesia bigemina	protozoan	Boophilus annulatus, B. microplus
Bullis fever	Unknown	rickettsia	Amblyomma americanum (?)

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* Transmits disease among rabbits.

** Disease of cattle.

*** Found infected in nature but transmission to man has not been reported.

contamination of the wound or skin by tick secretions in some species. *Ornithodoros turicata, Ornithodoros parkeri,* and *Ornithodoros hermsi* definitely infect by the bite.

Colorado tick fever. Colorado tick fever is a viral disease of short duration and low mortality, characterized by sudden onset, leukopenia (reduction of white corpuscles in the blood), and absence of the rash usually associated with rickettsial diseases. Human cases occur in western Canada and in Washington, Oregon, Idaho, Montana, California, Nevada, Utah, Wyoming, Colorado, and South Dakota in an area correlating well with the range of *Dermacentor andersoni*. The virus has been isolated from the Rocky Mountain wood tick and a number of small rodents, particularly ground squirrels. The disease is most common in men, but also occurs in women and children.

Tick bite paralysis. Tick bite paralysis, produced by the engorging female hard tick, is probably caused by a neurotoxic substance in the tick saliva, possibly a foreign protein such as partially digested blood. The symptoms develop about 6 days after the tick becomes attached and while engorgement is well under way. There is a rapid upward progression of paralysis starting with the feet and legs and extending to the face, tongue, and pharynx, sometimes ending with respiratory failure and death. Tick paralysis is most frequently observed in children under 7 years of age and has a high fatality rate. In the United States in 1950, 12 deaths occurred among 94 cases for a 12.7-percent mortality rate. In another study in the Pacific Northwest of the United States, 27 deaths occurred in 238 cases, an 11-percent fatality rate. In North America the wood tick and the American dog tick are the two species that most commonly cause tick paralysis. This disease is most frequently observed in the Northwestern and Southeastern States. The usual site of tick attachment is the scalp, particularly the back of the head. Persons camping and hiking should prevent tick attachment by thorough inspection of the body and garments and the use of tick repellents and protective clothing. Small girls are the most subject to tick paralysis, their long hair can conceal the ticks on the back of the neck. Grown persons are rarely paralyzed. Recovery of patients is rapid following simple removal of the engorging tick and application of a suitable antiseptic. Tick paralysis also occurs in dogs and cattle.

Q fever. Q fever (Query fever) is a rickettsial disease which has also been known as nine mile fever. The causative organism, *Coxiella burneti,* has caused outbreaks among stockyard workers in Australia and the United States, in laboratory workers, veterinarians, and farmers. The disease has been reported from all continents and in ever-widening localities. The Rocky Mountain wood tick, lone star tick, spinose ear tick, and many other species have been found infected. Tick tissue and feces become massively infected with this rickettsial agent. It is suspected that humans may inhale the disease organisms with dust and droplets contaminated with material from infected animals.

Exercises (632):

1. The four groups of deadly diseases transmitted to people by ticks are (a) ______ , spotted and Q fever; (b) ________ , tularemia; (c) ________ , relapsing fever; (d) ________ , and Colorado tick fever.

2. Dermacentor ticks are well suited as vectors of ________ ________ because their larvae and nymphs feed on rodents, and the adults attach to people.

3. Tularemia or ________ ________ is a plaguelike disease transmitted to humans from rabbits or rodents.

4. Colorado tick fever is a ________ disease of short duration and low mortality.

5. Tick bite paralysis is probably caused by a neurotoxic substance in the tick ________ .

633. Identify tick characteristics and habits.

General Tick Characteristics. Ticks have three characteristics which distinguish them from the insects: the head, thorax, and abdomen are fused into one body region; they have no antennae; and in the nymph and adult stages they have four pairs of legs (larvae have three pairs). In true insects, on the other hand, the body is divided into three regions known as head, thorax, and abdomen; they possess a single pair of antennae; and when fully grown they have three pairs of legs.

The order Acarina (ticks and mites) usually differs from other arachnids in that the body is not segmented; the cephalothorax and abdomen are fused to form one body region.

Ticks belong to the suborder Ixodides of the order Acarina. They can be distinguished from other Acarina by two characteristics: the tarsus of the first leg has a conspicuous sensory pore known as Haller's organ, and most species have a prominent, toothed hypostome not found in mites or chiggers.

There are two main groups of ticks: the hard ticks (family Ixodidae) and the soft ticks (family Argasidae). The hard tick is distinguished by a dorsal shield or scutum (fig. 4-3) immediately behind the capitulum (false head). The dorsal shield is small in the female, but in the male it covers the entire dorsal surface. The soft tick has no dorsal shield. Hard ticks also are tapered anteriorly while most soft ticks are blunt.

In the United States, hard ticks are much more abundant than soft ticks, cause greater annoyance, and are far more important in the transmission of disease to humans and their animals. An identification key to some common tick species is shown in figure 4-4 for your use.

Habitats. Hard ticks ordinarily spend much of their life on the ground or on vegetation awaiting hosts. They are most abundant in shrubby areas, especially along paths, and are scarce in deep woodland. *Boophilus* species pass most of their time on animals, being one-host parasites. Generally, hard ticks feed upon three hosts; frequently, but not always, the larvae and nymphs feed on small mammals or birds and the adults feed on large mammals. *Dermacentor albipictus*, a one-host hard tick, is an exception. The soft ticks feed upon a host only a short time and may be called plural-host ticks.

Climatic factors. Temperature is an important climatic factor affecting tick development. Unfed hard ticks can endure the frigid winter weather in their sheltered retreats, but engorged ticks and eggs are less resistant. The spring and summer heat induces greater tick activity. Hard ticks can endure long submergence in water and are not injured by humid weather. They usually die quickly in a dry situation, whereas soft ticks generally exist in much drier situations.

Longevity. Many hard ticks require a year or two to complete their life cycle, but may take longer under unfavorable conditions. Under optimal laboratory conditions, the normal 2-year life cycle of *Dermacentor andersoni* and *Amblyomma americanum* can be reduced to 2.5 to 3.5 months. Some ticks are long lived. Specimens of *Ornithodoros turicata* have been kept under observation for more than 12 years. *Ornithodoros tholozani*, an Old World species, is known to have a lifespan of 20 to 25 years. Ticks are not easily starved out by rotation of cattle pasturage and other cultural measures.

Feeding. Most ticks parasitize a wide range of host animals. Only a few species show a marked preference for feeding upon one animal species. Ticks feed upon mammals, birds, reptiles, and some amphibians. When feeding, the tick inserts the barbed hypostome (fig. 4-5) into an incision made by its chelicerae. Most species cause no pain to the host, and the unsuspecting human host may be completely surprised when he finds a tick attached on his body. However, some tick species, such as the lone star tick, cause a painful bite. Only females of the hard ticks become greatly distended. *Ornithodoros hermsi* become engorged in 15 to 20 minutes while the American dog tick and most other hard ticks require several days.

Transmission of pathogens. Ticks serve both as mechanical and biological carriers of pathogenic organisms. The mouthparts of ticks feeding on infected animals may become contaminated with pathogens, which are inoculated into healthy animals when the tick moves from one animal to another. This mechanical type of transmission is often called infection through interrupted feeding. In addition, ticks serve as reservoirs of viruses, rickettsiae, bacteria, and protozoa, with transmission of the various pathogens from infected adults through the egg to the following larval, nymphal, and adult stages. This method is often termed "transovarial" or "transstadial" transmission of pathogens. Epidemiologically, this last mechanism is of great importance in maintaining the disease-causing organisms in an area during periods of adverse weather conditions, such as cold winters or hot, dry summers; in establishing endemic foci of such diseases as Colorado tick fever, spotted fever, relapsing fever, tularemia, cattle tick fever, and anaplasmosis; and in maintaining areas with virulent strains of a pathogen. Infected ticks may require several hours of feeding before sufficient parasites are passed into a susceptible host to cause infection. Therefore, campers and people who work in tick-infested areas should check themselves periodically for ticks and remove any they find as soon as possible. The feces of infected ticks often contain pathogenic organisms. Some authorities consider that inhalation of dust, containing the minute fragments of tick feces loaded with Q fever organisms, is an important method of contracting this disease.

Mouthparts. Ticks don't have a true head, but have a capitulum (fig. 4-4) that consist of a basal portion, the basis capituli, to which the hypostome, chelicerae, and palps are attached. The hypostome typically bears many rows or recurved barbs which anchor the tick to the skin of its host. The chelicerae serve as cutting organs to permit insertion of the hypostome. The palps have four segments or articles, with the fourth segment very small in the hard ticks and approximately equal to the other segments in the soft ticks. The palps do not penetrate the skin of the host. In the hard ticks the mouthparts project from the anterior end of the body, while in the soft ticks they project on the ventral side, hidden dorsally by the body.

Exercises (633):

Identify the following as being true (T) or false (F). Correct any false statements.

____ 1. Ticks have head, thorax, and abdomen fused into one body region.

____ 2. The hard ticks have no dorsal shield.

____ 3. There are two main groups of ticks: hard and soft.

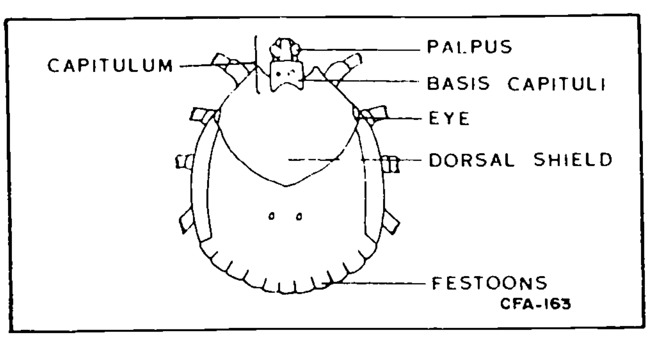

Figure 4-3. Hard tick diagram.

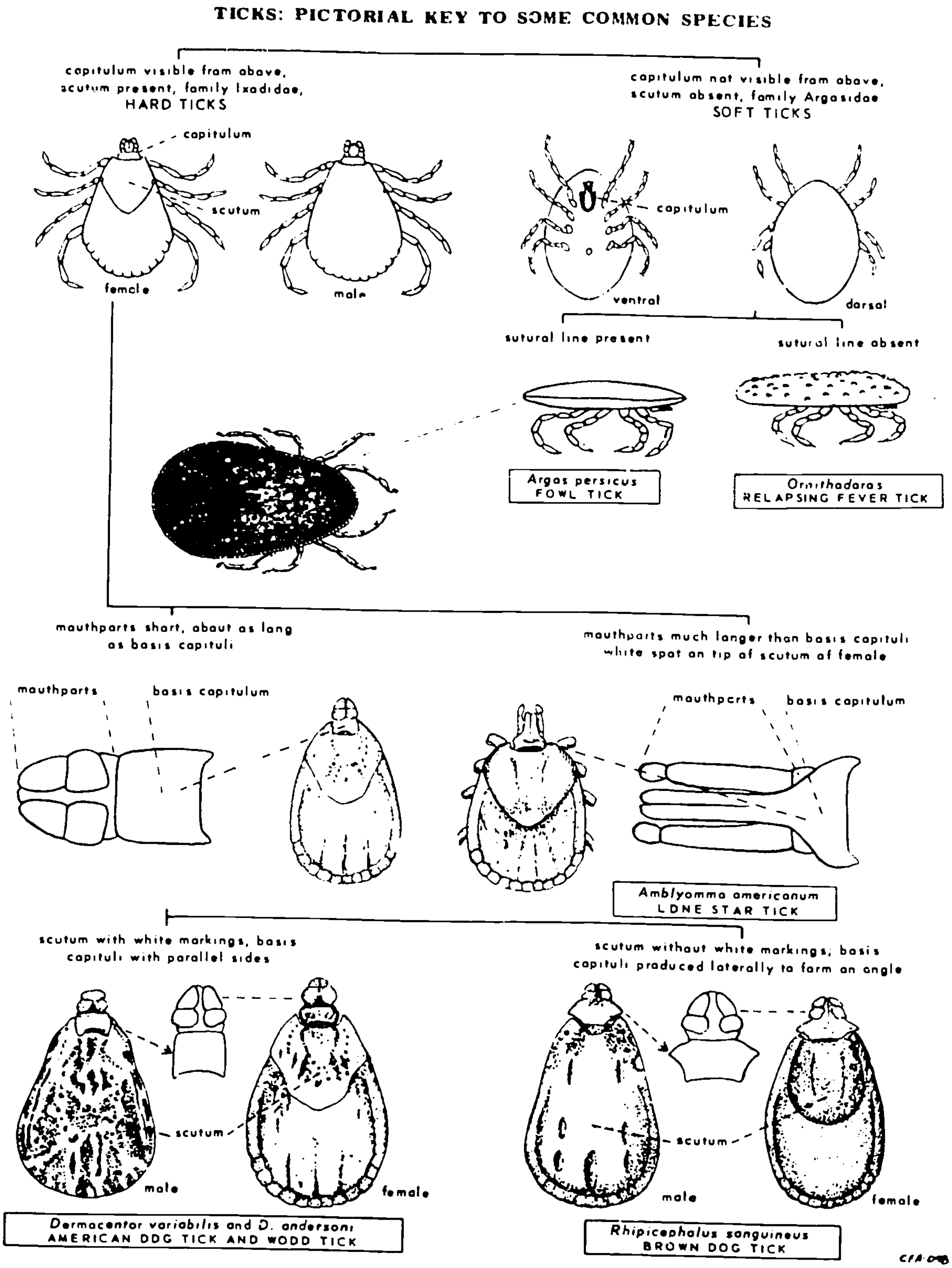

Figure 4–4. Pictoral key to common tick species.

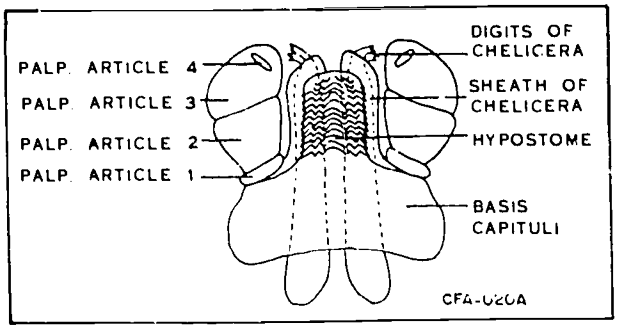

Figure 4–5. Tick mouthparts diagram.

____ 4. Hard ticks ordinarily spend most of their life on the ground or on vegetation, awaiting hosts.

____ 5. Engorged ticks can endure frigid weather better than unfed hard ticks.

____ 6. Soft ticks generally exist in much drier situations than hard ticks.

____ 7. Many hard ticks require a year or two to complete their life cycle.

____ 8. Only the male of the hard tick becomes distended when engorged.

____ 9. Transstadial transmission of pathogens is accomplished by transmitting from the adult to the egg and through the larval, nymphal, and adult stage.

____ 10. One method of contracting diseases is by the inhalation of dusts containing minute fragments of tick feces.

634. Cite details regarding the developmental stages and processes of ticks.

Ticks have four stages of development: egg, larva, nymph, and adult (fig. 4-6).

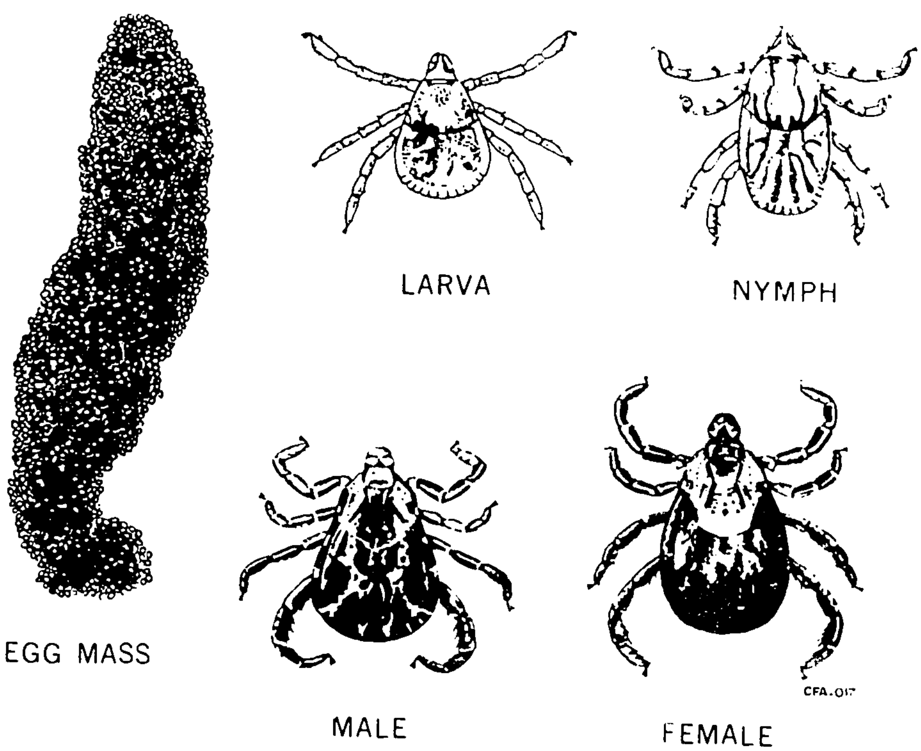

Figure 4–6. Life cycle of an American dog tick.

Egg Stage. Mating of hard ticks usually occurs while the ticks are on the host animal. Afterwards the female drops to the ground and deposits eggs on or near the earth. Several days are required for development of the eggs. The female hard tick feeds once and lays one large batch of eggs, sometimes numbering in the thousands, and dies after oviposition. Most of the soft ticks engorge several times and deposit 20 to 50 eggs in a batch after each blood meal. Eggs hatch in 2 weeks to several months, depending upon temperature, humidity, and other environmental factors.

Larval Stage. The larvae, or "seed ticks" possess only six legs and are not distinguishable as to sex. Because their chance of attaching to a host is not good, sometime prolonged fasts are obligatory.

Despite tolerance to starvation, a very high percentage of larvae fail to survive. Some climb on vegetation, waiting for a small rodent to pass within reach. Others actively seek a vertebrate host, being guided by the scent of the animal. After a blood meal, the engorged larvae usually drop to the soil, shed their skins, and emerge as eight-legged nymphs. The larvae of one-host ticks remain on the host to molt.

Nymphal Stage. The nymph has eight legs like the adult but has no genital opening. This stage also must undergo a critical waiting period for a suitable host. After engorgement, the nymph drops from the host, molts, and becomes an adult. Nymphs may rest for long periods of time before becoming adults. Although the life cycle of some species of hard ticks may be completed in less than 1 year, it may require 2 to 3 years, or longer. Each time a tick leaves its host it risks its survival on the chance that it will find another host. Some species have the advantage of molting on the host. For example, the cattle tick is a one-host tick. Multiple-host ticks are able to live because of their very great reproductive capacity and their ability to survive for long periods without food.

The hard ticks have only one nymphal instar, the nymph becoming an adult after molting. Soft ticks may have several nymphal instars.

Adult Stage. Typically, the nymph molts after engorgement and becomes an adult. Sex then is distinguishable for the first time as the female hard tick differs from the male in having a small scutum. The sex of soft ticks may be determined by the shape of the genital opening located between the second pair of legs. In male soft ticks the genital opening is almost circular, while it is oval, definitely broader than long, in female specimens. Unlike mosquitoes, both male and female hard ticks are bloodsuckers and both require several days feeding before copulation. After the male hard tick becomes engorged, he usually copulates with one or more females and then dies. Following copulation, the female tick drops to the ground. The eggs require several days to develop. Then she begins oviposition. After a few more days, her life's mission accomplished, the spent female hard tick also dies. The female soft tick may lay several small batches of eggs but she requires a blood meal before each episode of oviposition.

Exercises (634):

1. What are the four developmental stages of ticks?

2. Where do female hard ticks deposit their eggs to develop?

3. What two factors help multiple-host ticks live for a long time?

4. How do egg-laying habits differ between female hard and soft ticks?

635. Associate listed characteristics of ticks with the tick species described.

Hard Ticks. The scutum of the hard ticks is one of the chief characters that differentiates them from the soft ticks, which have none (fig. 4-3). In addition, this feature provides a means of immediately differentiating between male and female hard ticks. In the male the scutum is large, completely covering the dorsal surface, while in the female it covers only a part of the dorsal surface and is almost obscured when she becomes engorged. The capitulum of hard ticks extends forward from the anterior end of the body, bearing some resemblence to a true head, while in soft ticks it is found on the under side and is not usually visible from a dorsal view. The spiracles lie behind the fourth pair of coxae, or basal segments of the leg.

Hard ticks typically take one blood meal in each of the three developmental stages—the larval, the nymphal, and the adult stages. Both sexes are blood feeders, but only the female becomes greatly distended during engorgement. Most species feed on a different host during each stage, but there are some one-host and two-host species.

Lone star ticks. The lone star tick, *Amblyomma americanum*, is a vector of spotted fever, tularemia, and possible Q fever. Female specimens are easily recognized by the conspicuous silvery-white spot at the tip of the scutum (fig. 4-4), hence the name "speck-back" in Ozark Mountain region and the common name "lone star tick" for the Lone Star State of Texas. The pale markings are diffuse on the male specimens. In the southern states east of Texas this species will bite man readily in the larval, nymphal, and adult stages. Its bite is quite painful and may itch for a long time. Common hosts are livestock, dogs, deer, birds, and man.

Gulf Coast ticks. The Gulf Coast tick, *Amblyomma maculatum*, is found particularly along the Gulf Coast and South Atlantic coastline. It has spurs on the second, third, and fourth pairs of legs and more diffuse pale markings on the female than does the lone star tick. When it is present in an area, the ears of cattle will often be found infested. Screwworm flies are often attracted by the smell of fresh blood in these wounds and lay eggs in them. Later screwworm larvae may feed voraciously, cause festering sores, and even kill cattle. Common hosts include livestock, deer, dogs, and man.

American dog ticks. The American dog tick, *Dermacentor variabilis* (fig. 4-4), is widely distributed east of the Rocky Mountains and also occurs on the Pacific Coast, and in parts of northern Idaho and eastern Washington. This tick will be discussed in detail as a representative of the hard ticks.

The adult males and females are frequently encountered by sportsmen and people who work out-of-doors. The males and females have pale whitish or yellowish markings on the scutum. Males may be only 1/8 inch long, whole engcrged females may be as much as ½ inch in length.

The dog is the preferred host of adult *D. variabilis*, although it feeds readily on many large mammals and man. The adult ticks are commonly found in the spring in their "waiting position" on grass and other low vegetation. The third pair of legs is used to cling to the grass while the others are waved about ready to grasp any host that comes by. The male remains on the host for an indefinite time, alternately feeding and mating. The female feeds, mates, becomes engorged, and drops off to lay several thousand eggs.

Larval activity begins in March or April in Massachusetts, ceasing in September or October. Larvae seek the host actively, and do not assume the waiting position typical of the adults. They are not captured by means of drags. Meadow mice, white-footed mice, and pine mice are important hosts of larvae.

Rocky Mountain wood ticks. The Rocky Mountain wood tick, *Dermacentor andersoni* (fig. 4-4), is found in the Rocky Mountain States and in southwestern Canada. The life cycle of this three-host tick requires 2 to 3 years for completion. The larvae and nymphs attack small mammals and the adults obtain their blood meals from large mammals including man. The range of this tick coincides with the area in which cases of Colorado tick fever are contracted. It is rather similar to the American dog tick discussed previously, but adults of the wood tick in general have more pale coloring, and larger goblets on the spiracular plates, than does the American dog tick.

Soft ticks. The sexes are similar in appearance in soft ticks, there being no dorsal plate (scutum) to distinguish the sexes as in hard ticks. The capitulum (which bears the mouthparts) is located beneath the anterior margin of the body. The spiracles or respiratory openings lie on the sides of the body above the third and fourth pairs of legs. Although some species of soft ticks feed upon humans, they are more common on birds, and occasionally are found on bats and other small mammals. The sexes can be distinguished by the shape of the genital opening, which in males is circular or crescent-shaped, and in females is a transverse slit wider than it is long.

Soft ticks are typically intermittent feeders and can survive long periods without food. Some species resemble bed bugs in their habits of feeding at night and hiding in cracks and crevices during the day.

Relapsing fever ticks. The relapsing fever ticks, *Ornithodoros* species, are seldom seen by the average person since they are primarily "nest ticks" that can survive starvation for months or even years. Humans are occasionally bitten by these hungry ticks and contract cases of relapsing fever in mountain cabins, caves, or near wild animal burrows. For example, O. hermsi is found at high elevations in the West, particularly Idaho, Oregon, Washington, California, Nevada, and Colorado, where its parasitizes small mammals, such as the western chipmunk or tree squirrels. Occasionally, people sleeping in mountain cabins come in contact with infected ticks and contract relapsing fever. *O. parkeri* is a large species, which attacks human and rodents, and is found in nine western states. It is an efficient vector of relapsing fever and can transmit Rocky Mountain spotted fever. *O. turicata*, also a large tick, is found in the southern and western United States. It is found in caves, holes made by burrowing animals, and at camp sites. Its host include rodents, snakes, terrapins, and various domestic animals, as well as people. Even after long starvation it too, is an efficient vector of relapsing fever. Both *O. turicata* and *O. parkeri* transmit the spirochete of this disease to their offspring, the latter species as far as the fourth generation. *O. talaje* occurs in southern United States.

Exercises (635):

Match the characteristics in column A with the species in column B. Column B items are used more than once.

Column A	*Column B*
____ (1) These adult ticks commonly wait (for a suitable host) on grass and low vegetation.	a. Lone star tick.
____ (2) Females of this species have a conspicuous silvery-white spot at the tip of the scutum.	b. Gulf Coast tick.
____ (3) This tick has spurs on the second, 3rd, and 4th pairs of legs and pale markings which are more difuse than on the female lone star tick.	c. American dog tick.
____ (4) These ticks have a roughned, warty appearance, and a hypostome with well-developed teeth.	d. Rocky Mountain wood tick.
____ (5) In all but the egg stage, this species will readily bite people, as well as livestock, dogs, deer, and birds. I'108u' I Male and female adults have pale whitish or yellowish markings on the scutum.	e. Relapsing fever tick.
____ (6) This is a three-host tick with a life cycle requiring 2 to 3 years to complete.	

Column A

_____ (7) These are primarily "nest ticks" and can survive starvation for months or even years.

_____ (8) Screw worm flies are often attracted to wounds in cattle caused by these ticks

_____ (9) This is similar in appearance to the American dog tick, but has more pale coloring and larger goblets on the spiracular plates.

636. Specify methods and principles involved in surveying for and controlling ticks, and determine necessary actions to control a given tick control situation.

Tick Survey Methods. From tick surveys, you can determine the species present, the degree of tick infestation, whether control is needed, and the results obtained from your control efforts.

To determine the infested host and the degree of infestation, you can pick the ticks from the host animals for analysis. To determine the infestation of vegetated areas, use the tick drag method. To conduct this survey with the tick drag, slowly drag it over low vegetation beside roads and paths. After dragging a specified distance, say 50 feet, pick the ticks from the cloth and put them into vials containing 70 to 80 percent alcohol. From this collection, you can adequately determine the species and calculate the approximate degree of infestation.

You can get some degree of protection against ticks by keeping your clothing buttoned, your trouser legs tucked into the tops of your socks, and your shirttail into your trousers. Avoid sitting on the ground or on logs in brush areas, and at intervals inspect your clothing and body for ticks. If you find and remove them before they become attached to your body you will protect yourself from exposure to tick paralysis and tickborne disease. Clearing and burning brush along paths will reduce the likelihood of tick infestation. In residential areas, closely cut lawns and well-kept yards help control ticks and their small rodent hosts.

If ticks become attached, remove them with a steady pull towards the head so that you don't break off their mouthparts and leave them in the wound. There is no certain way to make ticks detach their mouthparts, but a drop of chloroform, carbon tetrachloride, ether, benzene, vaseline, or fingernail polish helps remove them. Always apply an antiseptic to tick bites. If your hands touch the tick, thoroughly wash them with soap and water.

Tick Repellents. Many repellents have been tested against ticks, but no general chemical is known. The application of a repellent to exposed skin provides little protection against ticks since they crawl underneath clothing and attack untreated portions of the body. For this reason, treating clothes with repellents is suggested instead of treating the skin. Indalone, diethyltoluamide, dimethly carbate, dimethly phthalate, and benzyl benzoate provide up to 90 percent protection. Saturate clothing with a solution or emulsion of the repellent. A 5-percent solution or emulsion will give a deposit of about 2 grams a square foot on denim, ordinary cotton khaki, or light wool. To wet a complete uniform including socks, shirt and trousers thoroughly, about 3 pints are required. After you have saturated your clothing, hang it outdoors to dry. Properly treated clothing will provide good protection against ticks, chiggers, and mosquitoes for several days. You should wash and retreat clothing thoroughly at weekly intervals or before infrequent outdoor excursions.

Indoor Tick Controls. Indoor control aims primarily at the brown dog tick, which is often difficult to control because of its many possible hiding places. Since tick eggs may hatch over a period of 5 months, more than one insecticide application to infested areas might be necessary to completely eliminate the problem. Insecticides available for indoor use include: propoxur, Diazinon, pyrethrins, carbary—as a spray or dust chlorpyrifos, and bendiocarb. Residual sprays and dusts should be applied to areas of the house frequented by the pet, particularly its sleeping quarters, around baseboards, window and doorframes, wall cracks, local areas of floors, floor coverings, and similar places where the ticks might conceal themselves.

If wall-to-wall carpeting is present, treat the edges as best as possible without lifting the carpet. Furniture, especially overstuffed chairs, may need treatment. Remove the cushions and treat all crevices and seams. In animal quarters, remove bedding before treatment. It may be helpful to turn up the heat following treatment, because the higher temperature stimulates the ticks to move and contact the insecticide treatment. If the pet requires insecticidal treatment, a veterinarian should be consulted; he or she may have dipping vats for treating tick-infested dogs. You should never treat an infested pet; this is the owner's responsibility.

Outdoor Controls. Outdoor control aims primarily at the American dog tick and other wood ticks and not the brown dog tick which rarely infests outdoor areas. Since ticks do not favor direct sunlight, the first step in control is to keep overgrown and heavy vegetation cleared and cut in tick infested areas. Vegetation maintenance, such as removal and cutting is very effective at times for controlling ticks, and should be accomplished before establishing field encampments.

Chemical control comes from applying residual insecticides, such as diazinon, chlorpyrifos, malathion, or dichlorvos, as liquids or granular treatments on grass and under shrubbery and trees, especially near houses.

Ticks will congregate in many parks and recreational areas where chemical application may be restricted to a few feet along roads, walks, and trails. Special effort should be made to treat areas where dogs frequent. Dichlorvos, carbaryl, malathion, and pyrethrins can be used to treat outside pet runways, window sills, and ledges of kennels, crawl spaces, dog houses, and other areas accessible to pets. Be careful not to contaminate food or water.

Control by Host Removal. In cases where buildings are severly infested with brown dog ticks which show resistance to insecticides, remove the pet and thoroughly treat the building with an approved insecticide. Have the pet dipped, dusted, or sprayed with a recommended insecticide. Other hosts of different tick species are field rodents. You can control these pest hosts by poisoned bait (warfarin, pival, zinc phosphide, strychnine, etc.), trapping, or rodentproofing with masonry, sheet metal, etc.

Exercises (636):

1. What method is most often used to survey for ticks in outdoor areas?

2. In wooded areas, what mechanical controls can be applied to reduce the likelihood of tick infestations?

3. If ticks become attached to a person or animal, how should they be removed?

4. What action should you take if a person's pet requires insecticidal treatment to control ticks?

5. What types of pesticidal formulations should you use for indoor tick treatments?

6. What areas should you give the most attention when controlling ticks in a home?

7. What is the first step to be taken to control American dog ticks in outdoor areas?

Questions 8 through 11 are based on the following situation: A base housing resident calls saying she has ticks in her backyard. When you arrive, you see that she has two large dogs which are kept in a fenced, shady area with grass that's about 6 to 8 inches tall. She wants you to spray the yard and dogs "with the strongest stuff you've got."

8. Based on this situation, what type of ticks would you expect to find?

9. What actions would you advise the woman to take regarding the dogs?

10. What initial chemical corrective action should you take?

11. What advice should you give the woman regarding the yard?

4-3. Mites

Most species of mites are so small that they are barely visible to the naked eye. Their life cycles are often short, 2 to 3 weeks; thus, mites increase their numbers very rapidly under favorable conditions.

637. Identify statements regarding diseases mites transmit as being true or false and correct any false statements.

Mites as Medical Pests. Mites are important to humans because they cause or are involved in:

(1) Scabies or mangelike conditions, produced primarily by mange, itch, and follicle mites.

(2) Dermatitis, produced primarily by direct attack of chiggers, bird and rat mites, straw-itch mites, and cheese and flour mites.

(3) Infestation of the lungs, intestine, or urinary passages (by lung mites or certain cheese and flour mite).

(4) Tapeworm infestations of domestic animals and man (beetle mites serve as intermediate hosts for certain tapeworms).

(5) Allergic reactions to mites (entire or fragments thereof) and their excreta may produce conditions similar to asthma in some people.

(6) Transmission of organisms that cause diseases, primarily those organisms that cause four groups of diseases:

- Viral—as encephalitis (transmitted by certain bird mites).
- Rickettsial—as rickettsialpox (transmitted by the house mouse mite), scrub typhus (transmitted by the house mouse mite).
- Bacterial—as tularemia (transmitted by the tropical rat mite in the laboratory) and epidemic hemorrhagic septicimia (transmitted by the snake mite).
- Filarial—as in the cotton rat (transmitted by the tropical rat mite)

Scabies and related mangelike conditions. Scabies is the most important disease caused by mites. It occurs throughout the world and is caused by the scabies mite, itch mite, and mange mite. Sometimes the mites cause only a mild rash, but often they cause serious skin irritations that lead to secondary infections that produce either conditions similar to impetigo, or severe allergic reactions that prevent persons from sleeping at night. The scabies mites burrow under the skin, leaving open sores or linear burrows containing the mites and their eggs. The first symptom of scabies is itching, especially at night and frequently over much of the body. The signs of scabies are often obscured by scratching, secondary infections, or impetigo.

Itch mites found on domestic animals are almost indistinguishable from human scabies mites. Cases of mange in humans which probably originated from animal infestations are usually of short duration. Mange mites from animals can live on humans, but are not able to reproduce and establish infestations.

Scrub typhus and hemorrhagic fever. From the viewpoint of disease transmission, chiggers are probably the most important group of mites, because they transmit the rickettsiae that cause scrub typhus (also known as tsutsugamushi disease, Japanese river bottom fever, and Mossman fever). This disease is not found in the United States. However, it has been a disease of importance to American military personnel that have been stationed in the Orient since 1941. Scrub typhus occurs from India, through Southeast Asia, to Japan and Korea. Scrub typhus is transmitted by several species of chiggers.

Chiggers are also suspected of transmitting epidemic hemorrhagic fever. This is a disease, probably caused by a virus that American troops encountered in Korea. It causes fever and kidney damage and is fatal in about 5 percent of the cases.

Rickettsialpox. In 1946 an outbreak of "atypical chickenpox" in some New York City adults led to the discovery of a previously unknown rickettsial disease, which was named rickettsialpox and transmitted to humans by the house mouse mite from house mice, which were the reservoir for the disease. Rickettsailpox has also been reported from Boston, Massachusetts; Philadelphia, Pennsylvania; and Cleveland, Ohio.

The tropical rat mite, (*Ornithonyssus bacoti*), which is far more abundant than the house mouse mite, has been shown capable of transmitting rickettsailpox in the laboratory.

Encephalitis. Encephalitis virus has been found in the chicken mite (*Dermanyssus sylviamum*) and the tropical fowl mite (*Ornithonyssus bursa*). The role of these mites in vectoring this disease to humans has not been confirmed but it is believed that it is minor if it exists at all.

Dermatitis. Skin inflammations (dermatitis) are caused by several types of mites, primarily chiggers, rodent and bird mites, straw-itch mites, and grain or cheese mites. Probably no creatures on Earth can cause more torment for their size than chiggers (redbugs). They are found throughout the Tropics and subtropics. Although they are a little less common in the Northeastern United States, they are quite common in the southern half, in the Mississippi Valley, and the Central Valley of California. They are most abundant in wooded areas, swamps, along roadsides, and particularly where food and shelter for wild rodents and birds are found, as in patches of raspberry and blackberry bushes. The chiggers attach most often in areas where the clothing fits tightly, as at the top of the stockings, the waist area where belts or underwear constrict, and in the armpit area.

Chiggers do not suck blood. The reddish color that is characteristic of some species—hence the name redbug—is due to pigments in the mite's tissue, not to blood. Chiggers inject saliva into the host's skin. The reaction of the saliva and host's flesh forms a feeding tube (stylostome). This feeding tube is filled with lymph and partially digested tissue that the mite sucks up as food. In some specimens the stylostome is twice the length of the engorged chigger. Severe cases of chigger dermatitis can itch for a week or longer and be as irritating as acute cases of poison ivy or poison sumac.

Bird mites also cause irritation and annoyance. Chicken mites often feed on people who work either in chicken houses or in live poultry markets. Chicken and bird mites may swarm from pigeon, starling, and English sparrow nests in the eaves or attics along the outside of buildings and crawl through doors or windows, or through openings into the upper portion of buildings, and bite people.

Tropical rat mites (*Ornithonyssus bacoti*) also bite humans. Very often, though not always, persons are bitten when the usual host, the rat, is not available to the mites. Frequently such attacks are associated with death of the rat as the result of trapping, poisoning, or disease; the destruction of rat harborage; or keeping rats out of premises by rat stoppage.

The straw-itch mite (*Pyemotes ventricosus*) is normally a parasite of the larvae of a number of borers. Outbreaks of straw-itch mite dermatitis are usually associated with infested straw and are most common in the Midwestern United States. Two of the largest of these outbreaks occurred at the State fairs in Indianapolis, Indiana, among farmers, visitors, and attendants, particularly 4-H students who had show animals bedded on infested straw. The grain and cheese mites are frequently found in tremendous numbers in flour, grain, dried fruits, and cheese, particularly when humidity and temperatures are high. Some of these mites cause dermititis among persons who handle the infested foods.

Allergic reactions. In recent years, research workers studying the relationship between asthma and house dust have discovered several species of house dust mites (genus *Dermatophagoides*) in dust from houses. The two most important species in the United States seem to be *DDermatophagoides farinae* and *pteronyssinus*. They are abundant in dust from mattresses and bedroom floors, but are also found in smaller numbers in other parts of houses.

Annoyance. Many species of mites invade houses and are annoying simply by being there; they do not bite man or transmit diseases. The clover mites (*Bryobia praetiosa*) frequently infest houses in great numbers and annoy householders, particularly in the northern half of the United States. They do not bite man, transmit disease, or damage foodstuffs, but their presence is disturbing. They often swarm by the thousands over outer walls of buildings, particularly those with a sunny exposure, and make their way indoors through cracks and crevices about doors, windows, foundations, and elsewhere. They swarm into houses in the fall, seeking, as do box elder bugs or cluster flies, a place to hibernate. The following spring, they become active again, seeking a way out of the house and back to the growing plants on which they feed. Most clover mite complaints come from new residential areas with well-fertilized lawns or shrubbery next to buildings, where the mites have opportunity to build up large populations. They migrate into homes as cold weather approaches. Usually householders report myriads of "tiny bugs" literally coating the walls as they attempt to swarm into or out of a home. When crushed in linens, curtains, walls, or woodwork, they produce a reddish stain.

Exercises (637):

Identify these statements as being true (T) or false (F). Correct any false statements.

____ 1. Scabies is the most important disease caused by mites.

____ 2. The first symptom of scabies is a high fever.

____ 3. Although not found in the U.S., scrub typhus is of importance to American troops in the Orient.

____ 4. Because of the diseases they transmit, chiggers are probably the most important species of mites.

____ 5. Rickettsialpox is transmitted to people by the tropical foul mite.

638. Specify the appropriate term for phrases regarding mites and their suborders.

Mites differ so greatly from one species to another that a short, general description cannot apply to all species. Therefore, our first descriptions are based on various suborders of mites.

General Classification and Description. Mites are members of the class Arachnida and the order Acarina. A typical female mite is usually less than 0.5 mm long with a sac-like body that is often membranous or membranous with hard plates. There is no well-defined segmentation of the body. The head region, known as the capitulum or gnathosome, has cutting structures known as chelicerae which bear two scissorlike blades, called chelae, that are used for biting. Mites undergo four stages of development—egg, larva, nymph, and adult. Six-legged larvae hatch from the eggs, molt, become eight-legged nymphae, and develop into adults.

Description of Mite Suborders. There are three suborders of mites that will be described in this text and each of these suborders contain several important mites.

Suborder Mesostigmata. These mites have a single pair of spiracles lateral to the legs—usually associated with an elongated peritreme (if there is no peritreme, the mite is usually a highly specialized parasite of the respiratory tract of vertebrates). Haller's organ is absent (fig. 4-7); the hypostome is neither toothed nor developed for piercing. Representatives include such species as the house mouse mite (*Liponyssoides sanguineus*), chicken mite (*Dermanyssus gallinae*), tropical rat mite (*Ornithonyssus bacoti*), tropical fowl mite (*Ornithonyssus bursa*), and northern fowl mite (*Ornithonyssus sylviarum*).

Suborder Trombidiformes. Mites of this suborder have a pair of spiracles on or near the head region (the gnathosome). The chelicerae are usually modified for piercing; the palpi are usually free and highly developed. Haller's organ is absent. The coxas seldom form conspicuous internal projections beneath skin. There are no anal suckers.

Representatives include chiggers (*Trombicula* and allies in the family Trombiculidae), gall mites (family Eriophyiidae), follicle mites (*Demodex* spp.), straw-itch mites (*Pyemotes ventricosus*), water mites (*Nydracarina* spp.), spider mites (*Tetranychus* spp. and allies), clover mites (*Bryobia praetiosa*), and other mites (*Myobia, Cheyletus, Cheyletiella,* and other genera).

Suborder Sarcoptiformes. These mites have no spiracles; a few have a system of tracheae that open through stigmata and porose areas on various parts of the body. There is no Haller's organ. The coxae form conspicuous internal projections beneath the skin of the venter of the body. The mouthparts are usually for chewing; they have strong chelae. The palpi are simple. Anal suckers are often present.

Some representatives are the mange and itch mites (*Sarcoptes, Notoedres, Psoroptes* spp.), house dust mites (*Dermatophagoides* spp.), cheese mites (*Tyrophagus, Caloglphyus, Glycyphagus* supp.), feather mites (family Analgesidae), and hair mites (Listrophoridae, Myocoptes of mice).

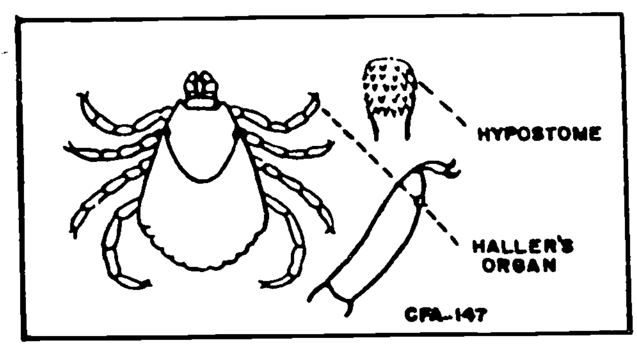

Figure 4–7. Mite diagram depicting Haller's organ.

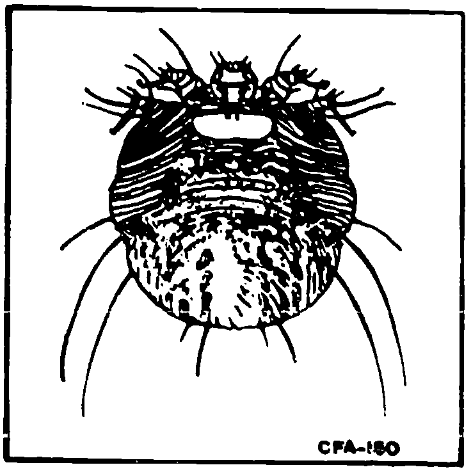

Figure 4-8. Itch mite.

Exercises (638):

Give the appropriate term of the following mites and their subordinates.

1. Mite class.

2. Mite order.

3. Head region of mites.

4. Scissorlike blades used for biting.

5. Four stages of mite development.

6. Representatives of this suborder include the house mouse mite and chicken mite.

7. Representatives include chiggers and water mites.

8. Representatives include the house dust mites, cheese mites, and feather mites.

639. Associate a given list of mites with their appropriate descriptive statements.

Itch Mites. The itch mite (fig. 4-8) is a very tiny mite. The females average 0.2 to 0.4 mm in length. The males are somewhat smaller. Each mite is oval and saclike; the body surface is finely wrinkled. The mouthparts contain paired palps and chelicerae, and are located at the anterior end. The anus is located at the posterior end. The dorsal surface has a number of conspicuous blunt spines and many backward-pointing triangular scales. The legs are short and stocky, the two anterior pairs being well separated from the two posterior pairs.

The female burrows beneath the outer layer of skin and lays her eggs in the sinuous tunnels that she excavates. The eggs hatch into larvae that have six legs. The larvae become nymphs (with eight legs), and finally the nymphs become adults. The adults live about a month. Scabies mites occur most commonly in tiny papules, particularly in the webbing between the fingers and in the folds of the skin at the wrists. Positive identification is made by excising a tiny bit of flesh, treating it with 10 percent sodium hydroxode or potassium hydroxide solution, and examining the tissue on a slide with a microscope that has a magnification of 100 diameters or more. The short, stubby legs, the triangular scales, and the peglike spines on the back are easily seen in good preparations.

Chiggers. Chiggers (fig. 4-9) feed on people and other vertebrates only in the larval stage. They have the following developmental stages: egg deutovum, larva, numphochrysalis, nymph, imagochrysalis, and adult. On humans they attach in those areas of the body where clothing fits tightly, as at the ankles, waistline, and armpits. As a rule, the larva feeds only once, sucking lymph and partially digested skin tissue (not blood) through its stylostome. The nymphs and adults feed on the eggs or

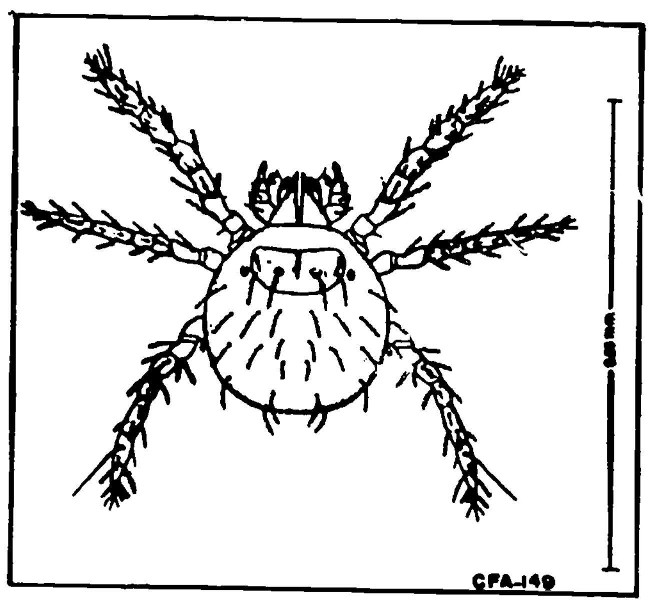

Figure 4-9. Chigger mite.

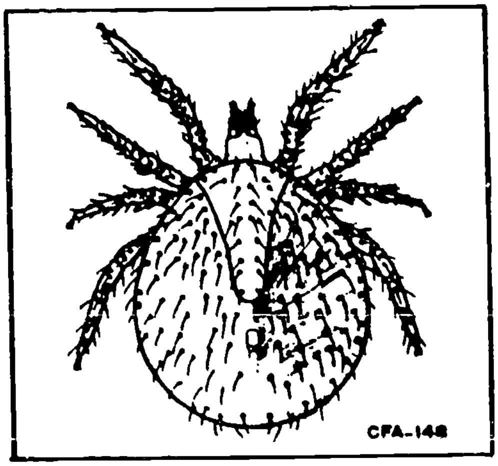

Figure 4–10. House mouse mite.

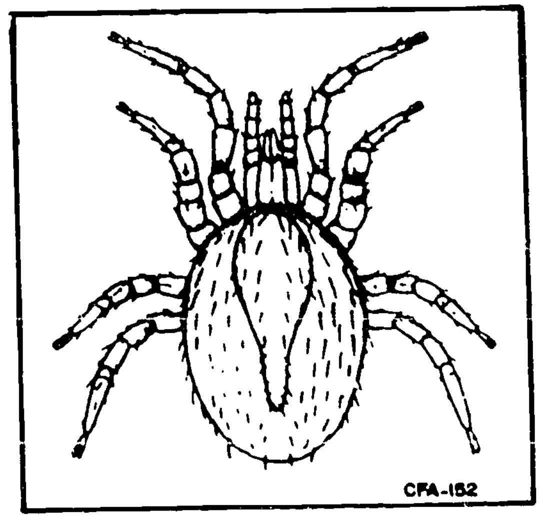

Figure 4–11. Tropical rate mite.

young of various arthropods, such as mosquitoes and springtails, not on humans. Under optimum conditions, the life cycle can be completed in about 50 days. In most of the United States, there are one to three generations a year, depending on latitude. But breeding may be continuous on the gulf coast and in Florida. Chiggers feed on a wide variety of snakes, turtles, birds, and small mammals as well as on humans.

House Mouse Mites. These mites (fig. 4-10) have been found from Utah and Arizona to Boston and Washington. They have been collected by the thousands in apartment houses where house mice were abundant. A few have been collected on rats. The females can be distinguished from most other bloodsucking mites by the presence of two dorsal shields, a large anterior plate and a small posterior plate. The protonymphs, deutonymphs, and adults suck blood. The house mouse mite is a proven vector of rickettsialpox in Massachusetts, Connecticut, New York, Pennsylvania, and Ohio.

Tropical Rat Mites. The tropical rat mite (fig. 4-11) is often responsible for severe "rat-mite dermatitis" all over the world. Females are usually recognized by their scissorlike chelicerae, the narrow, tapering dorsal ;and genito-ventral plates and the egg-shaped anal plate. The protonymphs and females suck blood and are often tremendously distended after feeding. This characteristic is so pronounced that laboratory workers who identify rat ectoparasites often sort the swollen tropical rat mite from among other species without optical aid, and then confirm identification with a microscope.

Chicken Mites. This mite (fig. 4-12) is found throughout most of the world on domestic fowl, pigeons, English sparrows, starlings, and many other birds. The large dorsal and anal plates, short sternal plate, and needlelike chelicerae are important characters for identifying this species. The chicken mite is one of the most common species that cause human dermatitis in houses, on chicken ranches, and in markets where chickens are sold. Infestations of this mite are often first noticed as the mites crawl about on chicken eggs. Chicken mites are intermittent eaters. To feed, they crawl onto the birds at night or when the birds are in their nest. In the daytime, they hide in cracks and crevices in chicken houses, or in floors, walls, and ceilings of buildings in which birds nest.

Northern Fowl Mites. The northern fowl mite is similar to the tropical rat mite, but it has a much shorter sternal plate. This plate has only four setae; the setae on the dorsal plate are quite short. This species is common on domestic fowl, pigeons, sparrow, and starlings. It readily bites people.

Northern fowl mites overwinter in bird nests (as those of barn swallows and pheobes) and in cracks in buildings. There are several generations each year; the buildup in populations is very rapid. In poultry houses, these mites prefer to stay on birds most of the time, but they have been found on eggs and in litter. On birds, they are often abundant about the vent, tail, and neck; there they suck blood and may form scabs.

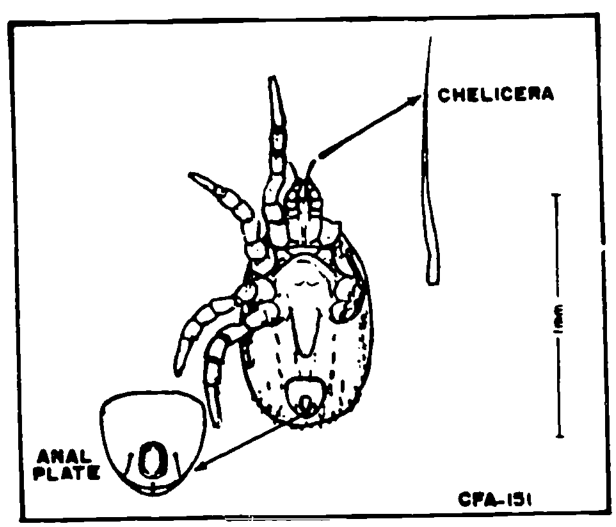

Figure 4–12. Chicken mite.

Straw-itch mites. This mite (fig. 4-13) is normally a parasite of insects that bore into grain or wood. It sometimes, however, severly bites humans. Unfed females of the species are very small, but after mating, the female becomes greatly enlarged. They are then easily visible to the naked eye, resembling a tiny pearl because of the swelling of the body behind the last pair of legs. The first and second pairs of legs are widely separated from the third and fourth pairs. The club-shaped hair between the base of the first and second pairs of legs is an important characteristic in the identification of this mite. A single female may produce 200 to 300 eggs, which are retained within the body until the offspring have passed through all stages of development. The young, males and females, are produced vivaparously and are sexually mature at birth. Mating takes place soon after.

Grain and Flour Mites. The grain and flour mites (families Acaridae and Tyroglyphidae) are tiny, and pale gray or yellowish white. They have conspicuous, long hairs. The anterior two pairs of legs are widely separated from the third and fourth pair of legs. These mites feed on a wide variety of organic material and are sometimes very abundant in leaf mold, flour, hair mattresses, and similar substances. They cause grocers' itch and copra itch.

Exercises (639):

1. Match the name of the mites in column B with their correct description in column A. Column B items may be used only once.

Column A

_____ (1) The large dorsal and anal plate, short sternal plate, and needle-like chelicerae are important characters for identifying this specie.

_____ (2) This is a very tiny mite. The females average 0.2 to 0.4 mm in length. The males are somewhat smaller.

_____ (3) This mite is similar to the tropical rat mite, but has a much shorter sternal plate.

_____ (4) These mites are tiny, and pale gray or yellowish white. They have conspicuous, long hairs. The anterior two pairs of legs are widely separated from the third and fourth pair of legs.

_____ (5) These mites have the following developmental stages: egg, deutovum, larva, nymphochrysalis, nymph, imagochrysalis, and adult.

_____ (6) The females can be distinguished from most other blood-sucking mites by the presence of two dorsal shields, a large anterior plate and a small posterior plate.

_____ (7) This mite is normally a parasite of insects that bore into a grain of wood. Unfed females of the specie are very small, but after mating, the female becomes greatly enlarged.

_____ (8) This mite is often responsible for severe "rat-mite dermatitis" all over the world.

Column B

a. Itch mites.
b. Chiggers.
c. House mouse mite.
d. Tropical rat mite.
e. Chicken mite.
f. Northern fowl mite.
g. Straw-itch mite.
h. Grain and flour mites.

640. Identify the methods used to conduct mite surveys.

Mite Survey Methods. Survey methods vary with the habits of the species being investigated. In chigger-infested areas use black glass plates or cardboard rectangles. Place these vertically and make counts at definite intervals. If chiggers are present, they will climb to the upper edges and congregate there. Test about a dozen spots to locate trouble areas. Use a repellent before you start the survey—otherwise, the chiggers may find you before you find them.

Berlese funnels are frequently used to collect flour and grain mites and other free-ranging species, such as bird mites in nesting material.

Estimates of chigger, bird, and rodent mite population densities can be based on data gathered by:

a. Stunning or killing animal ectoparasites (with ether or chloroform) on dead or trapped animals, and combing (or beating) the parasites form the animal into a white, enameled pan.

b. Picking the mites off with fine forceps, particularly in the case of chiggers that have fastened to an animal.

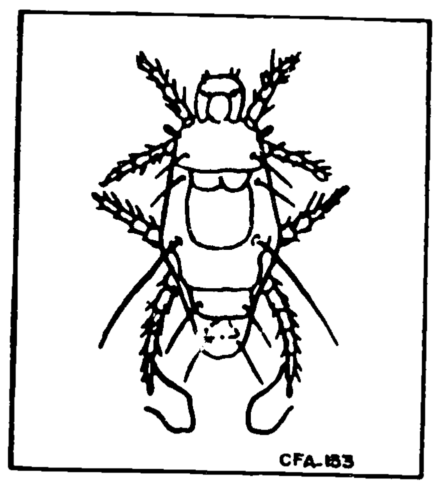

Figure 4-13. Straw-itch mite.

c. Placing the live host animals in cages that have wire or hardware cloth bottoms so that any mites that drop off after engorging will fall into a pan of water put under the cage. (This procedure is often used to collect chiggers from snakes, turtles, or small rodents.)

d. Placing a dead host animal in a glass jar containing water and a detergent. The jar is shaken thoroughly to separate ectoparasites from the animal. The liquid is then poured into a funnel containing filter paper. Any mites will be strained out on the paper.

Exercises (640):

1. Mite survey methods vary with the habits of the speices ________ ________ .
2. Black glass plates or cardboard rectangles are used to survey ________ ________ areas.
3. Berlese funnels are frequently used to collect ________ and ________ mites.

641. Given selected techniques, determine the type of control being used, the mite to be controlled, and complete given statements regarding chemical controls for mites.

Mite Control. Mites can be controlled through environmental methods, including sanitation, mechanical, and construction and maintenance controls, as well as by chemical methods. The method used depends on the mites to be controlled and the circumstances.

Cultural methods. Rat and house mouse mites can be controlled by:

a. Trapping or poisoning rats and mice to eliminate the the source of the blood meal essential for nourishment and reproduction of mites.

b. Starving out rodents by storing garbage and food in ratproof containers, rooms, or buildings.

c. Keeping rodents out of buildings by rodent stoppage.

Bird mites can be controlled by:

a. Modifying buildings so that birds cannot enter or nest. (Give special attention to louvers, gables, eaves and attics—even though the work calls for screening, carpentry, or masonry.)

b. Trapping or poisoning birds to eliminate the source of blood meals for the mites.

Clover mites can be controlled by:

a. Removing vegetation near houses and pruning shrubs so that they are at least a yard from buildings.

b. Maintaining a strip of bare ground 2 to 3 feet wide around buildings.

Chigger control depends on modifying the environment to permit sunlight and air to circulate freely, thus drying the usual damp habitat of the chigger. These modifications consist of:

a. Keeping lawns and gardens closely cut and edged, and keeping flower beds free of weeds.

b. Eliminating tall weeds and shrubs, particularly blackberry and raspberry bushes, which furnish food and shelter for the bird and rodent hosts of chiggers.

c. Using (in scrub typhus areas) mechanical equipment, such as bulldozers and flamethrowers—thus reducing human contact with the mites—to clear campsites, and using rodent control to eliminate chigger hosts.

Grain and flour mites can usually be controlled by:

a. Rotating food materials to remove the oldest items first (to prevent buildup of infestations).

b. Ventilating to prevent the accumulation of moisture (mites thrive on foods that have a moisture content of 20 percent or more).

c. Eliminating foci or infestations (by vacuum cleaning entire warehouses, with attention to horizontal surfaces such as beams and window ledges).

Chemical methods. Sprays or dusts are used for residual treatment indoors and are frequently used as spot treatments in trouble areas—around windows and doors, at the tops of foundations, around plates and at the ends of joists, on baseboards, and at the edges of floors. Dusts are usually applied at higher concentrations than are sprays. They are placed in voids, in louvers near bird nests, in rodent runways, where the mites will, and children will not, normally come into contact with the insecticide.

Residual treatment outdoors has been used for the control of clover mites and chiggers especially, but less commonly on the outside of buildings for control of bird and rat mites.

Fumigation control of flour and grain mites is difficult and should be carried out only by a certified pest control operator. All fumigants are very poisonous and should be used only by qualified operators and only according to the directions on the fumigant container's label.

Sulfur has long been used as a chigger repellent. Although the results are variable, it has often given control when dusted into socks, underwear, and outer clothing. Children at summer camps often prefer sulfur to some of the new repellents that have a disagreeable odor.

Many mosquito repellents, such as Indalone, ethyl hexanediol, and dimethyl phthalate will, when applied to the skin, also repel chiggers for 2 to 4 hours. One of the best of the newer repellents is diethyltoluamide.

Most of the good mosquito repellents are also effective when used to treat clothing. The most durable treatment recommended at this time is benzyl benzoate, which will withstand two or three washings. Resmethrin, which contains 30 percent benzyl benzoate, withstands one or two washings.

Persons who have been in an area infested with chiggers can kill most or all mites that have attached themselves by using a thick lather in a hot bath or shower as soon as possible after exposure. After the bath, an alcohol rubdown will help, particularly on the welts. For temporary relief from itching, compounds such as calomine lotion are available at most drug stores.

Much progress has been made in the treatment of mite infestations on humans and animals. Sulfur ointment, long used in the treatment of scabies, is no longer recommended because it can cause a dermatitis as severe as that caused by the mites. Best results are obtained by taking a hot, soapy bath first, drying the skin thoroughly, and then applying one of the three following remedies to all the body below the neck.

(1) Kwell cream, or a lotion containing 1 percent gamma isomer of benzene hexachloride or lindane:

(2) Eurax, a salve incorporating 10 percent N-ethyl-O-crotontoluide in vanishing cream.

(3) Twelve percent benzyl benzolate.

The next day take a bath and change to clean clothing, night clothes, and bedding. Itching may persist for several days and is not a sign of superinfection. It is important that this be understood; overtreatment is common. In perhaps 5 percent of the cases a second course of treatment is necessary after an interval of 1 to 2 weeks.

In treating scabies, thoroughness is essential. Launder every piece of clothing and bedding that may have come into contact with the infested person. If one member of a family or group of persons has scabies, all close contacts should get treatment.

Exercises (641):

Given some techniques for controlling mites, state whether the type of control is cultural or chemical, and name the mite(s) that it would control.

Starving out rodents by storing garbage and food in ratproof containers, rooms, or buildings.

1. Using diethyltcluamide.

2. Maintaining a strop of bare ground 2 to 3 feet wide around buildings.

3. Rotating food materials to remove the oldest items first.

4. Keeping lawns and gardens closely cut and edged and keeping flower beds free of weeds.

5. Treating clothing with benzyl benzoate.

6. Trapping or poisoning birds to eliminate the source of blood meals for the mites.

Complete the following statements:

7. Persons who have been in an area infested with chiggers can kill most of all mites that have attached themselves by using a ________ ________ in a ________ ________ or ________ as soon as possible after exposure.

8. Fumigation control of ________ and ________ mites is different and should be carried out only by a ________ pest control operator.

9. for controlling mites indoors and outdoors, you should apply sprays and/or dusts around ________ and ________, at the tops of ________, around plates at the end of ________, on ________, at the edges of ________.

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Answers for Exercises

CHAPTER 1

Reference:

600 – 1. Any living animal or plant which gives subsistence, and often, lodging to a parasite.
600 – 2. A small organism or virus living in or on, and at the expense of a larger one.
600 – 3. A living transporter and transmitter of disease agents.
600 – 4. The vector.
600 – 5. The typhoid fever bacillus is carried on the feet and body hairs, or may pass through the digestive tract.
600 – 6. The parasite multiplies, changes in form, or passes through part of its life cycle within the arthropod vector.

601 – 1. (1) a.
(2) d.
(3) b.
(4) e.
(5) g.
(6) f.
(7) c.

602 – 1. Four; egg, larva, pupa, adult.
602 – 2. Singly; water.
602 – 3. Readily reach water.
602 – 4. Three to five, if flooding doesn't occur
602 – 5. Freezing.
602 – 6. Water.
602 – 7. Flowing streams (and) open waters.
602 – 8. Temperature, light, movement, dissolved gases and salts, and other living organisms.
602 – 9. Head, thorax, and abdomen.
602 – 10. Antenna, eyes, and mouthparts.
602 – 11. Head or abdomen; flattened.
602 – 12. Nine; segments.
602 – 13. In water; very active.
602 – 14. From one day to a few weeks.
602 – 15. Its is a small, fragil insect with a slender abdomen, one pair of narrow wings and three pairs of long, slender legs.
602 – 16. Spherical; membraneous.
602 – 17. Wings; legs.
603 – 1. F. About equal numbers are produced.
603 – 2. T.
603 – 3. F. They remain near the breeding places.
603 – 4. T.
603 – 5. T.
603 – 6. T. Most, but not all.
603 – 7. T.
603 – 8. F. They differ greatly as to their preferred host.
603 – 9. T.
603 – 10. T.

604 – 1. Examples in the text include size, color, presence of tarsal bands, markings on the thorax, and shape of abdomen tip.
604 – 2. a. *Aedes taeniorhynchus*, black salt-marsh mosquitoes.
b. *Aedes triseriatus*, tree hole mosquitoes.
c. *Aedes canadensis*.
d. *Aedes sollicitans*, salt-marsh mosquitoes.
e. *Aedes nigromaculis*.

605 – 1. AQ.
605 – 2. AQ.
605 – 3. AF.
605 – 4. AQ.
605 – 5. AQ.
605 – 6. AF.
605 – 7. AF.
605 – 8. AQ.
605 – 9. AF
605 – 10. AQ.
606 – 1. a. CQ.
b. CP, CQ.
c. CT.
606 – 2. *Culex quinquefasciatus*.
606 – 3. *Culex tarsalis*.
606 – 4. All three species discussed.
606 – 5. Because they breed prolifically in artificial containers, and because adults don't normally migrate far from larval sites.

607 – 1. *Psorophora ciliatea*.
607 – 2. *Coquillettidia perturbans* and *mansonia titillans*.
607 – 3. *Psorophora confinnis*.

608 – 1. Planning, conducting, evaluating.
608 – 2. Work hours, materials, equipment, justification.
608 – 3. *Culex tarsalis*.
608 – 4. Dawn, light intensity, humidity.
608 – 5. a. Biting collections, landing rates, insect nets.
b. Landing rate, biting collections.
c. Light traps, carbon dioxide traps.
d. Light traps *not* very effective; daytime resting stations.
e. Daytime resting stations, light traps.

609 – 1. Specific breeding sites; sampling stations.
609 – 2. Dips; larvae.
609 – 3. One; two.
609 – 4. a. Skimming in partically shaded water with some vegetation.
b. Dipping, collecting with a pipette in artificial containers.
c. Same as *Aedes*.
d. Pulling up vegetation, rinsing and inspecting rinse water.

610 – 1. Cultural, biological, and chemical controls.
610 – 2. Mechanical/physical and chemical controls.
610 – 3. a. Control aquatic vegetation to reduce breeding and resting locations.
b. Stock the pond with fish which feed on larvae, or apply a biological insecticide.
c. Apply a selective pesticide such as methoprene to prevent danger to fish.
610 – 4. a. Get rid of artificial containers which trap water.
b. Make sure screen doors and windows are in place and in good condition.
c. Use commercially available aerosols and fly swatters for indoor control.
610 – 5. a. Use a ULV generator to treat for adults.
b. Apply larvicides to tree holes and other appropriate areas using portable equipment.

CHAPTER 2

611 – 1. Not only do flies annoy and bite humans, but they spread and create disease and destroy agricultural products.
611 – 2. On their mouthparts, through their vomitus, on their body hairs, on the sticky pads of their feet, and through the intestinal tract by means of fly feces.
611 – 3. Any six of the following: bacillary dysentery, infantile diarrhea, typhoid fever, paratyphoid fever, cholera, amoebic dysentery, giardiasis, and pinworm, roundworm, and tapeworm infections.
611 – 4. Intestinal myiasis.

612 – 1. T.
612 – 2. F. Different species have mouthparts adapted for different activities.
612 – 3. T.
612 – 4. F. The wings (straight, curved, or angled) are used in identification.
612 – 5. F. Four stages (egg, larva, pupa, adult).
612 – 6. T.
612 – 7. T.

613 – 1. a. 6 to 9 mm long.
b. Dull, with four dark longitudinal stripes.
c. Dull, with sides usually pale.
d. Sharply angled, ending before the wing tip.
613 – 2. 8 to 20 days.
613 – 3. In cracks and crevices within the breeding media away from direct sunlight.

613 – 4. Animal manure, human excrement, and garbage.
613 – 5. Water, sugar, starch, and protein.
613 – 6. Two to three times daily.
613 – 7. a. Below 45° F.
b. About 53° F.
c. Slightly under 32° F or over 112° F.
613 – 8. Lethal effects are more marked when the humidity is high.

614 – 1. (1) c.
(2) b.
(3) d.
(4) a.

615 – 1. a. Up to 2 to 3 times larger than the housefly.
b. Dull with three dark longitudinal stripes.
c. Checkerboard pattern with a reddish-brown tip.
d. Sharply angled and ending before the wing tip.
615 – 2. In meat, cheese, fish, other exposed foods, and animal excreta.
615 – 3. The females deposit larvae rather than eggs.
615 – 4. In kitchen and bathrooms.

616 – 1. (1) b.
(2) c.
(3) d.
(4) a.

617 – 1. (1) e.
(2) b.
(3) f.
(4) j.
(5) a.
(6) i.
(7) h.
(8) c.
(9) d.
(10) g.

618 – 1. Insect net, fly trap, and fly grill surveys.
618 – 2. To determine the species present, and roughly, the relative numbers of the various species.
618 – 3. The tendency of flies to rise vertically when they take off.
618 – 4. To collect live flies for bacteriological or virological studies.
618 – 5. Fly grills are faster and give a valid picture of the situation.
618 – 6. The fly's tendency to rest on edges.
618 – 7. They're used to supplement fly grill surveys. They are taken in a vehicle or on foot to observe the abundance of flies in favored resting places. Finding densities are recorded as estimated grill readings.
618 – 8. a. To provide data for areas lacking grill coverage.
b. To speed up control measures in epidemics or other disease conditions.
c. To serve as a posttreatment evaluation of space spray applications.
d. To serve as preventive maintenance inspections during times of low fly populations.
618 – 9. a. Around horse stables or barns, and around piles of decaying grass.
b. Around plant waste and along seashores.
c. Around dead animal carcasses, at garbage dumps, around meat processing plants, and near decaying vegetation.
d. Near water or damp soil, near well-lit areas, or right under your nose.
e. Around bathroom and kitchen windows, dirty garbage containers, water traps, and outside near decaying organic materials and garbage.

619 – 1. Limited, physical, biological.
619 – 2. Reproduction, mortality.
619 – 3. Food, water, shelter.

620 – 1. T.
620 – 2. F. Refuse management, *not* chemical controls.
620 – 3. T.
620 – 4. F. Sometimes you can get striking results through sanitation alone.
620 – 5. F. They should be mounted over all the doors entering the building.
620 – 6. T.
620 – 7. T.

621 – 1. (1) d.
(2) a.
(3) c.
(4) b.

622 – 1. a. Take immediate chemical action to control adult flies.
b. Control the maggots with a space or residual spray.
c. Arrange to have the breeding material removed.
d. Have the plumbing shop repair the broken pipe.

CHAPTER 3

623 – 1. F. 2 to 4 mm.
623 – 2. F. Most move about a lot and remain on the host only to get needed blood meals.
623 – 3. F. Both sexes are blood feeders.
623 – 4. T.
623 – 5. T.
623 – 6. F. Metamorphosis is complete; egg, larva, pupa, adult.
623 – 7. F. They have no legs.
623 – 8. T.
623 – 9. T.
623 – 10. F. Only females.

624 – 1. (1) e. (2) f. (3) a. (4) c. (5) b. (6) d. (7) d, e. (8) b. (9) f.

625 – 1. Locate possible hosts.
625 – 2. Determine the pet's habits.
625 – 3. Check for flea "hot spots."
625 – 4. a. Pet bedding.
b. Carpets, rugs.
c. Furniture, baseboards.
d. Outside areas.
625 – 5. Look for larvae, pupae, and adults.
a. Lay a white cloth on the floor.
b. Walk through the area with white socks.
c. Vacuum the area and check bag contents.

626 – 1. T.
626 – 2. F. Dimethyl phthalate.
626 – 3. F. Multiple-dose rodenticides.
626 – 4. T.
626 – 5. F. As soon as possible after flea control is achieved.

627 – 1. Flea control on pets and on premises.
627 – 2. Simultaneous treatment of both pets and premises.
627 – 3. Encourage the pet's owners to have the animal treated by a veterinarian.
627 – 4. Pet bedding should be thoroughly cleaned or destroyed, and the house vacuumed.
627 – 5. Survey to determine the degree of infestation, and make appropriate recommendations to occupants regarding animal dipping and sanitation requirements. Then treat the home and outdoor areas as needed when all conditions are met.
627 – 6. Plan to have the animal treated, and carry out sanitation requirements before you treat.

CHAPTER 4

628 – 1. F. Change crab to body.
628 – 2. T.
628 – 3. T.
628 – 4. F. Lice eggs are attached by cement.
628 – 5. T.

629 – 1. (1) b.
(2) a.
(3) a.
(4) c.
(5) c.
(6) b.
(7) c.
(8) b.
(9) a.
(10) c.

630 – 1. On hairs in the pubic areas.
630 – 2. Glued to pubic hairs.
630 – 3. By sexual or other close personal contact.

631 – 1. Medical personnel *only*.
631 – 2. Educate the people involved.
631 – 3. After an infestation starts, continued poor sanitation will help the problem spread.
631 – 4. If lousy garments are left in a locker overnight, exposure to a toxicant may keep the problem from spreading.
631 – 5. Vacuuming.

632 – 1. (a) Rickettsial, (b) bacterial, (c) spirochetal, (d) viral.
632 – 2. Spotted fever.
632 – 3. Rabbit fever.
632 – 4. Viral.
632 – 5. Saliva.

633 – 1. T.
633 – 2. F; Hard, not soft, ticks.
633 – 3. T.
633 – 4. T.
633 – 5. F. Unfed hard ticks endure better.
633 – 6. T.
633 – 7. T.
633 – 8. F. Only the *female*.
633 – 9. T.
633 – 10. T.

634 – 1. Egg, larva, nymph, and adult.
634 – 2. On or near the ground.
634 – 3. Their great reproductive capacity and their resistance to starvation.
634 – 4. The hard tick lays all her eggs at once and then dies. The soft tick may lay her eggs in several small batches.

635 – 1. (1) c.
(2) a.
(3) b.
(4) e.
(5) a.
(6) c.
(7) d.
(8) e.
(9) b.
(10) d.

636 – 1. Using a tick cloth drag.
636 – 2. Clearing or burning brush along paths.
636 – 3. With a steady pull towards the tick's head.
636 – 4. Refer the owner to a veterinarian but don't treat the pet yourself.
636 – 5. Residual sprays and dusts.
636 – 6. Around dog sleeping areas, baseboards, window and doorframes, wall cracks, and any other areas where ticks may hide.
636 – 7. Keep overgrown and heavy vegetation cleared and cut.
636 – 8. American dog ticks.
636 – 9. Take the dogs to a veterinarian for dipping or dip them herself.
636 – 10. Apply a quick knockdown pesticide to get initial control of ticks in the yard. Make sure you use an approved insecticide that won't harm the dogs.
636 – 11. Cut the grass and maintain it at a proper height; keep dog droppings cleaned up; take whatever action possible to let more sunlight into the area.

637 – 1. T.
637 – 2. F. Itching.
637 – 3. T.
637 – 4. T.
637 – 5. F. By the house mouse mite.

638 – 1. Arachnida.
638 – 2. Acrina.
638 – 3. Capitulum or gnathsome.
638 – 4. Chelae.
638 – 5. Egg, larva, nymph, and adult.
638 – 6. Mesostigmata.
638 – 7. Trombidiformes.
638 – 8. Sarcoptiformes.

639 – 1. (1) e.
(2) a.
(3) f.
(4) h.
(5) b.
(6) c.
(7) g.
(8) d.

640 – 1. Being investigated.
640 – 2. Chigger infested.
640 – 3. Flour, grain.

641 – 1. Environmental; rat and house mouse mite.
641 – 2. Chemical; repel chiggers.
641 – 3. Cultural; clover mite.
641 – 4. Cultural; grain and flour mites.
641 – 5. Cultural; chiggers.
641 – 6. Chemical; mosquito.
641 – 7. Cultural; bird mites.
641 – 8. Thick lather; hot bath; shower.
641 – 9. Flour, grain, certified.
641 – 10. Windows, doors; foundations; joists; baseboards; floors.

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STOP -

1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 04 22

DISEASE VECTORS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student. Consider all choices carefully and select the *best* answer to each question.

1. (600) Select the *true* statement regarding mechanical transmission of diseases.

   a. During transmission, the parasite changes significantly.
   b. During transmission, the parasite multiplies significantly.
   c. As a mechanical transmitter, the arthropod is simply a vehicle which transports the parasite.
   d. As a mechanical transmitter, the arthropod is essential in the life history of the parasite.

2. (600) Which of the following is *not* a type of biological disease transmission?

   a. Cyclo-developmental.
   b. Cyclo-mechanical.
   c. Cyclo-propagative.
   d. Propagative.

3. (601) Which of the following is called the yellow fever mosquito?

   a. *Aedes aegypti.*
   b. *Anopheles quadrimaculatus.*
   c. *Culex nigripalpus.*
   d. *Culex quinquefasciatus.*

4. (601) *Culex tarsalis* is the most important mosquito vectoring

   a. Western encephalitis.
   b. yellow fever.
   c. filariasis.
   d. malaria.

5. (601) Which of the following mosquitoes is a vector of filariasis?

   a. *Culex tarsalis.*
   b. *Aedes aegypti.*
   c. *Aedes sollicitans.*
   d. *Culex quinquefasciatus.*

6. (602) How many distinct stages do mosquitoes have in their life history?

   a. 2.
   b. 3.
   c. 4.
   d. 5.

7. (602) In which genus of mosquitoes are single eggs kept afloat on the water surface by air bubbles among the spines of the eggshell?

   a. *Culex.*
   b. *Mansonia.*
   c. *Psorophora.*
   d. *Toxorhynchites.*

8. (602) Concerning mosquitoes that do *not* lay eggs in water, how long may the egg stage of these mosquitoes survive (maximum) if flooding doesn't occur?

   a. Less than 1 year.
   b. 1-3 years.
   c. 3-5 years.
   d. 5-7 years.

9. (603) How much time does an adult female mosquito need to digest a blood meal, lay eggs, and seek another blood meal?

   a. Two days or more.
   b. Three days or more.
   c. Four days or more.
   d. Five days or more.

10. (604) Which mosquito species is widely distributed in the northern United States, and has banded tarsi with white bands at both ends of the segments?

    a. *Aedes taeniorhynchus.*
    b. *Aedes triseriatus.*
    c. *Aedes sollicitans.*
    d. *Aedes canadensis.*

11. (604) Which mosquito is the most important salt marsh species and one of the most severe mosquito pests known?

a. *Aedes aegypti.*
b. *Aedes dorsalis.*
c. *Aedes canadensis.*
d. *Aedes sollicitans.*

12. (604) Which of the following mosquitoes is known as a fierce biter, even during daylight hours?

a. *Aedes sollicitans.*
b. *Aedes dorsalis.*
c. *Aedes aegypti.*
d. *Aedes canadensis.*

13. (605) What is the most favorable temperature for the development of *Anopheles quadrimaculatus*?

a. 35°–40° F.
b. 55°–60° F.
c. 85°–90° F.
d. 95°–100° F.

14. (606) Which genus of *Culex* mosquitoes would you expect where people complain of bites by "singing" mosquitoes?

a. *C. nigripalpus.*
b. *C. restuans.*
c. *C. tarsalis.*
d. *C. quinquefasciatus.*

15. (606) Which species of *Culex* mosquitoes would you expect to find in large numbers in light trap surveys?

a. *C. tarsalis.*
b. *C. pipiens.*
c. *C. nigripalpus.*
d. *C. quinquefasciatus.*

16. (607) Which of the following mosquito larvae are predaceous on other larvae?

a. *Psorophora confinnis.*
b. *Psorophora ciliata.*
c. *Mansonia titillans.*
d. *Coquillettidia perturbans.*

17. (607) Which mosquito larvae *cannot* be controlled with ordinary surface larvicides?

a. *Anopheles.*
b. *Coquillettidia.*
c. *Culiseta.*
d. *Culex.*

18. (607) Which of the following mosquitoes generally produces one generation per year?

a. *Psorophora confinnis.*
b. *Psorophora ciliata.*
c. *Mansonia titillans.*
d. *Coquillettidia perturbans.*

19. (607) Which genus of mosquito remains below the water surface throughout the larval and pupal stages, obtaining air through the stems of aquatic plants?

a. *Aedes.*
b. *Culex.*
c. *Anopheles.*
d. *Mansonia.*

20. (608) Which genus of mosquitoes would most likely be detected by using the landing-rate collecting method?

a. *Aedes.*
b. *Mansonia.*
c. *Anopheles.*
d. *Culex.*

21. (608) Which of the following mosquito species can be effectively trapped by carbon dioxide traps?

a. *Aedes vexans.*
b. *Anopheles freeborni.*
c. *Culex tarsalis.*
d. *Culiseta melanura.*

22. (609) Why are special dippers used to collect mosquito larvae?

a. To avoid disturbing the larvae.
b. To enable a more accurate count per surface area of water.
c. To attract the larvae and entrap them.
d. To avoid harming the larvae.

23. (609) If an area is void of larvae during one collection, what should be done on future collections?

a. Bypass the area.
b. Search the area more thoroughly.
c. Check the area again.
d. Spray the area before taking a new sample.

24. (610) In a base housing mosquito control program, which of the following actions would you *not* encourage from housing residents?

a. Get rid of containers which trap water.
b. Use indoor aerosols and fly swatters.
c. Apply larvicides in water-holding tree cavities.
d. Make sure screening is installed and in good repair.

25. (610) Which main categories of IPM are applicable to adult mosquito control programs?

a. Mechanical and biological.
b. Chemical and biological.
c. Cultural and chemical.
d. Mechanical and chemical.

26. (610) Which of the following is an example of biological control of mosquitoes?

a. Controlling aquatic vegetation to reduce breeding and resting sites.
b. Stocking a pond with fish that feed on mosquito larvae.
c. Disposing of containers that provide breeding sites.
d. Applying methoprene to breeding areas.

27. (611) Which listed disease is *not* transmitted by flies?

a. Typhoid.
b. Cholera.
c. Dysentery.
d. Plague.

28. (612) How many body regions does an adult fly have?

a. 2.
b. 3.
c. 4.
d. 5.

29. (612) How many stages are there in the life cycle of a fly?

a. 1.
b. 2.
c. 3.
d. 4.

30. (613) Which choice correctly describes the thorax and abdomen of a housefly?

a. Dull thorax, shiny abdomen.
b. Dull thorax, dull abdomen.
c. Shiny thorax, shiny abdomen.
d. Shiny thorax, dull abdomen.

31. (613) How do fly larvae regulate their temperature?

a. By leaving the breeding place.
b. By moving about in the breeding material.
c. By excreting a fluid which evaporates.
d. By a built-in temperature control system.

32. (613) Which listed food substance is required in order for houseflies to produce eggs?

a. Calcium.
b. Fiber.
c. Minerals.
d. Protein.

33. (614) Both males and females of which listed flies are vicious biters of people and animals?

a. Dump flies.
b. Stable flies.
c. False stable flies.
d. Little house flies.

34. (614) Which of the following fly species help to control other fly populations?

a. The tsetse fly and the stable fly.
b. The housefly and the dump fly.
c. The dump fly and the false stable fly.
d. The false stable fly and the housefly.

35. (615) Which choice states a unique characteristic of the flesh fly?

a. They breed in animal flesh.
b. The females deposit living larvae.
c. They eat animal flesh.
d. They deposit their eggs in animal flesh.

36. (615) Within buildings, where are flesh flies commonly found?

a. Around heating and air conditioning units.
b. Around animal bedding.
c. In kitchens and bathrooms.
d. In bathrooms and in babies' rooms.

37. (616) What happens to blowfly larvae after they leave the breeding material?

a. They burrow into the ground.
b. They are ready to breed.
c. They bore deeper into the material.
d. They leave to start their own colony.

38. (616) Which one of the following fly species is active on warm winter days in the South, while it overwinters in the North as full-grown larvae?

a. The bluebottle fly.
b. The bronzebottle fly.
c. The green blowfly.
d. The black blowfly.

39. (616) Select the fly species that is a parasite of earthworms.

a. The black blowfly.
b. The screwworm fly.
c. The green blowfly.
d. The cluster fly.

40. (617) Why are eye gnats so difficult to control?

a. Effective insecticides are harmful to desirable plants and animals.
b. They breed in remote areas and are hard to reach.
c. They are parasites of desirable animals.
d. They breed in loose soil over vast areas of land.

41. (617) Where do filter flies create a very serious problem?

a. Around swimming pools.
b. In large eating facilities.
c. Around sewage treatment plants.
d. In water treatment facilities.

42. (617) Which of these flies is often called a "giant mosquito," even though it can't bite people?

a. Crane fly.
b. Black fly.
c. Hover fly.
d. Eye gnat.

43. (618) Which type of trap takes advantage of the habit of flies to rise vertically when they take off?

a. Light traps.
b. Sticky traps.
c. Fly grills.
d. Bait traps.

44. (618) How may different species of flies be attracted to a bait trap?

a. By using a variety of baits.
b. By isolating the trap.
c. By lighting the trap.
d. By hanging the trap off the ground.

45. (619) All of the following conditions naturally affect fly populations *except*

a. reproduction.
b. mortality.
c. sterilization.
d. migration.

46. (619) Which one of the following would have the greatest effect in limiting a fly population?

a. The chemical controls used.
b. The physical and biological environment.
c. The long-range weather conditions.
d. Parasites and predators.

47. (620) Which one of the following procedures is *not* considered a cultural method of domestic fly control?

a. Refuse disposal.
b. Spraying and fogging.
c. Refuse collection.
d. Weed control.

48. (621) Why is it necessary to identify fly species *before* applying chemical control measures?

a. To know how much chemical to use.
b. To avoid killing desirable flies.
c. To determine whether or not to use a residual spray.
d. To know what to use, as some flies become resistant to certain chemicals.

49. (622) If an environmental sanitation program was *not* sufficient, which of the following would be useful in reducing fly population at horse stables?

a. Fly cords.
b. Attractants.
c. Repellents.
d. Space sprays.

50. (622) What should be your *first* control measure in reducing a large scale fly problem in a base housing area?

a. Contact local health authorities.
b. Educate residents to get their support.
c. Perform a detailed survey of the area.
d. Begin applying space sprays on a daily basis.

51. (623) What is the *main* objection to fleas?

a. They annoy domestic animals.
b. They contribute to the breeding of other pests.
c. They are vectors of serious diseases.
d. They annoy humans.

52. (623) What is required by a female flea before she can produce eggs?

a. A blood meal.
b. A temperature above 72° F.
c. Plenty of organic food.
d. The absence of sunligh

53. (624) Which of these fleas has a vertical rodlike thickening in the mesopluron and no genal or pronotal comb?

a. Human fl a.
b. Chigue flea.
c. Sticktight flea.
d. Oriental rat flea.

54. (624) What flea would you expect to find causing dermatitis and allergies in its victims at a western U.S. base?

a. Dog flea.
b. Cat flea.
c. Human flea.
d. Sticktight flea.

55. (625) The *first* step in performing a pest flea survey is to

a. locate flea "hot spots."
b. locate all possible hosts.
c. lay a white cloth on the floor.
d. hand pick fleas for later identification.

56. (625) Which of the following is *not* a primary step in accomplishing a pest flea survey?

a. Locate all possible hosts in the area.
b. Check for flea "hot spots."
c. Walk through the area wearing white socks.
d. Determine the habits of host animals.

57. (626) In a fleaborne disease prevention program, the primary emphasis should be

a. general sanitation.
b. flea control.
c. rodent control.
d. personal immunization.

58. (626) Insecticidal dust patches around rodent burrows should be how thick i a fleaborne disease control program?

a. 1/8 to 1/4".
b. 1/4 to 3/8".
c. 3/8 to 1/2".
d. 1/2 to 3/4".

59. (627) Which one of the following pesticide formulations is most effective for outdoor treatment for fleas?

a. Dusts.
b. Solutions.
c. Emulsions.
d. Sprays.

60. (628) What type of metamorphosis, if any, do lice go through?

a. Complete.
b. Incomplete.
c. Gradual.
d. None.

61. (628) Most lice spend most of their lives on

a. birds.
b. mammals.
c. reptiles.
d. amphibians.

62. (629) Head and body lice are primarily dependent upon

a. dog blood.
b. bird blood.
c. skunk blood.
d. human blood.

63. (629) The total life cycle of head and body lice is usually completed in about

a. 6 days.
b. 12 days.
c. 18 days.
d. 24 days.

64. (630) Which statement presents a characteristic of crab lice?

a. They lay eggs along thick clothing seams.
b. They are often found on dogs and cats.
c. They survive briefly away from the host.
d. They hibernate during the winter months.

65. (630) Crab and body lice are chiefly spread by

a. humans.
b. rodents.
c. birds.
d. dogs and cats.

66. (631) In a louse control program, what is your primary responsibility?

a. Educate the people involved.
b. Take corrective sanitary actions.
c. Send infested people to a doctor.
d. Treat mattresses, baseboards, and toilets.

67. (631) What is the best treatment for lice in rugs and furniture?

a. Residual sprays and dusts.
b. Thoroughly vacuum these items.
c. Use an upholstery shampoo with lindane.
d. Reduce room temperature to 55° F for 8 hours.

68. (632) For a tick to transmit spotted fever, it must remain attached for more than

a. one hour.
b. two hours.
c. three hours.
d. four hours.

69. (632) What treatment is required for tick bite paralysis?

a. Remove the tick and administer suitable antibiotics.
b. Immediate medical attention by a doctor.
c. Remove the tick and apply a suitable antiseptic.
d. Remove the tick and apply suction to remove venom.

70. (633) Which one of the following locations is *least* likely to contain large numbers of hard ticks?

a. The ground around small vegetation.
b. Shrubby areas.
c. Areas along paths.
d. Deep woodlands.

71. (633) What is meant by infection through interrupted feeding?

a. Biological transmission from infected ticks to healthy animals.
b. Mechanical transmission of disease by a tick feeding on an infected animal and then feeding on a healthy animal.
c. Biological transmission of disease by a tick feeding on an infected animal and then a healthy animal.
d. Mechanical transmission from an infected tick to a healthy animal.

72. (634) Which choice correctly states the developmental stages of ticks?

a. Egg, larva, pupa, adult.
b. Egg, larva, nymph, adult.
c. Egg, pupa, adult.
d. Egg, nymph, adult.

73. (634) How many legs does the seed tick have?

a. 2.
b. 4.
c. 6.
d. 8.

74. (635) Which of the following adult ticks cling to low vegetation waiting for a host to come along?

a. American dog ticks.
b. Rocky Mountain wood ticks.
c. Relapsing fever ticks.
d. Gulf Coast ticks.

75. (635) Which listed tick has a roughened, warty appearance and a hypostome with well-developed teeth?

a. American dog tick.
b. Rocky Mountain wood tick.
c. Relapsing fever tick.
d. Gulf Coast tick.

76. (636) For a tick survey, a tick drag should be dragged for a distance of about

a. 25 feet.
b. 50 feet.
c. 75 feet.
d. 100 feet.

77. (636) One method of determining the degree of tick infestation is to

a. check with the hospital.
b. spray and collect the dead ticks.
c. use a tick-attracting trap.
d. pick the ticks from the host animal.

78. (636) How much tick repellent is needed to wet a complete uniform?

a. 1 pint.
b. 2 pints.
c. 3 pints.
d. 4 pints.

79. (636) What categories of IPM lend themselves to controlling ticks in outdoor situations?

a. Cultural and chemical.
b. Cultural and mechanical.
c. Cultural, chemical, and mechanical.
d. Cultural, chemical, and biological.

80. (637) Select the intermediate host(s) of certain tapeworms.

a. Beetle mite.
b. House dust mite.
c. Bird and chicken mites.
d. Grain and cheese mites.

81. (637) Which mite(s) transmit(s) rickettsialpox to humans?

a. Bird and chicken mites.
b. House mouse mite.
c. Grain and cheese mites.
d. Straw-itch mite.

82. (637) Which mite does *not* bite man, transmit diseas. , or damage foodstuffs?

a. House mouse mite.
b. Bird and chicken mites.
c. Straw-itch mite.
d. Clover mite.

83. (638) Which choice correctly presents the stages of mite development?

a. Egg, larva, nymph, adult.
b. Egg, larva, pupa, adult.
c. Egg, nymph, adult.
d. Larva, pupa, adult.

84. (638) Chiggers, follicle mites, and spider mites are examples of mites in which suborder?

a. *Mesostigmata.*
b. *Trombidiformes.*
c. *Sarcoptiformes.*
d. *Ornithoformes.*

85. (639) Which of the following mites can be identified by large dorsal and anal plates, short sternal plate, and needlelike chelicerae?

a. Chicken mites.
b. Straw-itch mites.
c. Grain and flour mites.
d. Tropical rat mites.

86. (639) Which mites are tiny, pale gray or yellowish-white, and have conspicious, long hairs?

a. Grain and flour mites.
b. House mouse mites.
c. Itch mites.
d. Northern fowl mites.

87. (640) Black glass plates or cardboard rectangles are used in surveying areas infested with

a. house mouse mites.
b. bird mites.
c. chiggers.
d. flour and grain mites.

88. (640) Burlese funnels car be used to survey for all of these mites *except*

a. chigger mites.
b. grain mites.
c. flour mites.
d. bird mites.

89. (641) Which of the following measures would be *least* likely used to reduce the chigger population in your yard?

a. Spraying with ethyl hexanediol.
b. Eliminating tall weeds.
c. Trapping rodents.
d. Keeping lawns closely cut.

90. (641) The most frequently used chemical control method used to reduce mite populations in buildings is

a. fogging.
b. fumigation.
c. spot treatment.
d. spraying entry points.

END OF EXERCISE

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012 and EO 9397. PRINCIPAL PURPOSES: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package. It is utilized by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's need. Failure to provide all information would result in slower action or inability to provide assistance to the student.

SECTION I: CORRECTED OR LATEST ENROLLMENT DATA: *(Mail to: ECI, Gunter AFS AL 36118)*

1. THIS REQUEST CONCERNS COURSE (1 - 6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7 - 15)	6. GRADE/RANK	7. NAME *(First initial, second initial, last name)* (17) (18) (19-32)
– –		

8. ADDRESS *(OJT Enrollees -- Address of unit training office with zip code. All others -- current mailing address with zip code.)*	(33-53)
	(54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33 - 39)

SECTION II: REQUEST FOR MATERIALS, RECORDS, OR SERVICE

(Place an 'X' through number in box to left of service requested)

FOR ECI USE ONLY

1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction (Provide Old or Incorrect data)
4	Request Grade/Rank change/correction.
5	Correct SSAN. (List incorrect SSAN here) (Correct SSAN should be shown in Section I)
6	Extend course completion date. (Justify in REMARKS)
7	Request enrollment cancellation. (Justify in REMARKS)
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 Originals were: ☐ Not received ☐ Lost ☐ Misused
9	Send course materials. (Specify in REMARKS) ☐ Not received ☐ Lost ☐ Damaged
10	Course exam not yet received. Final VRE submitted for grading on ________________(date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 not yet received. Answer sheet(s) submitted ________________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on ________________ (date).
13	Previous inquiry (☐ ECI Fm 17, ☐ Ltr, ☐ Msg) sent to ECI on ________________ (date).
14	Give instructional assistance as requested on reverse.
15	Other (Explain fully in REMARKS)

16 G	33	
K	Vol 33 - 35	GR 36 - 38
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N	33 - 35	
P	Vol 33 - 35	
	TC 36 - 37	38
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REMARKS *(Continue on Reverse)*

OJT STUDENTS must have their OJT Administrator certify this request.	I certify that the information on this form is accurate and that this request cannot be answered at this station. *(Signature)*
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NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

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Has VRE Answer Sheet been submitted for grading?

☐ Yes ☐ No

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(Textual reference for the answer I chose can be found as shown below)

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In ☐ left ☐ right column

Lines _____ Through ______

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REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

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CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 5

Economic Pests

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Air University

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Preface

THIS FIFTH VOLUME of CDC 56650 will teach you about many of the pests which have a primarily economic impact on the Air Force.

Chapter 1 discusses stored-product pests such as those which attack stored foods and fabrics. These pests are grouped according to the types of products they attack; so, instead of beetles and moths separately, you'll see that both are mingled together throughout the chapter.

In Chapter 2, you'll study economic pests which attack structures. This includes subterranean and nonsubterranean termites, wood-destroying fungi, and wood-boring insects.

Ornamental and turf pests are discussed in Chapter 3. Many of these pests are arranged according to how they attack various types of vegetation (e.g., skeletonizing defoliators, mining defoliators, or pests which attack grass and stems). You may want to prepare an outline of the subject headings to help you categorize each pest according to the way it works. Included in this chapter are mostly fungal plant diseases; these fungi will be very different from those you study as wood-destroying pests.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in this publication is for information purposes only and does not imply indorsement by the Air Force.

This volume is rated at 39 hours (13 points).

Material in this volume is technically accurate, adequate, and current as of May 1984.

Acknowledgement

PREPARATION of this volume was aided through the cooperation and courtesy of Harcourt Brace Jovanovich Publications, publishers of the *Scientific Guide to Pest Control Operations*, 3rd edition; *Pest Control* magazine, and the *Turf Managers' Handbook*. Information from these sources helped in developing text on several different pests and turf diseases.

Course development was further enhanced through the cooperation and courtesy of Gie, Inc. Publishers, whose *Pest Control Technology* magazine assisted greatly in developing control information on stored-food pests. Permission to use materials by these publishers is gratefully acknowledged.

Contents

Pests of Stored Products

THERE ARE MANY insects important as stored-product pests to the civilian community and to the Air Force. The majority of them are in either the order Coleoptera, the beetles, or the order Lepidoptera, the moths. These pests fall into two groups according to the type of product they generally infest: pests that infest fabrics and those that infest foods.

Insects steal our food, infest our dwellings, and damage our property. Through the centuries, an increasing number of insects have adapted to indoor life, preferring buildings because of the moderate temperature, plentiful food and water, and abundant harborage. Economically, the second most costly pests at military installations are the stored-product pests. These pests destroy a variety of products composed of, or derived from, materials of plant or animal origin. Damage may occur at the point of origin, in transit, or in storage. This chapter covers the more important pests within each group with physical descriptions and important information about their habits and life cycles. It also gives the survey and control procedures.

1-1. Pests of Stored Foods

Stored food pests rob U.S. citizens of about $1 billion worth of stored food each year, and this cost doesn't even count their damage to crops in the field or the human and domestic animal diseases they cause. Stored food pests fall into five groups based on their feeding habits: those that attack whole grains, attack broken grains, attack beans and peas, attack meats and cheese, and are general feeders. You will learn about the habits, habitats, and control of these pests in this section.

800. Verify or correct given statements about the physical descriptions and habits of whole grain pests.

Whole Grain Pests. The pests discussed this lesson are those that principally infest whole grain. The *rice weevil (Sitophilus oryza)* is worldwide in distribution and is probably the most important grain pest. This small, reddish-brown-to-black snout beetle (fig. 1-1) is from 3.1 to 4.2 mm long and has small, round pits on the thorax and two reddish or yellowish spots on each wing cover. The larva is short, fat, and whitish. The adult is a strong flier. The larva and pupa develop within a single grain of rice or kernel of corn, from which the adult weevil emerges about 30 days after the egg is laid. The adult female lives 4 to 5 months, depositing 300 to 400 eggs in small openings bored into grain. The rice weevil feeds on corn, rice, wheat, barley, and other grains. This weevil is a major pest in the South.

The granary weevil (Sitophilus granarius) is similar to the rice weevil in appearance, but it has oval pits on the thorax and the wing covers are uniformly dark brown. This insect has become thoroughly domesticated, losing its power of flight and forsaking wild and cultivated grain fields for grain storehouses. This snout beetle is slightly larger than the rice weevil and lives 7 to 8 months. The granary weevil is mainly a pest in the North.

The *cadelle (Tenebroides Mauritanicus)* is a black beetle, 8.3 to 12.5 mm long, with the head and pronotum distinctly separated from the forewings by a loose joint (fig. 1-1). The large, whitish, fleshy larva is about 19 mm long when fully grown, and you can recognize it by it's prominent black head, the paired black spots on the three segments of the thorax, and two short, dark hooks at the posterior end. Larvae burrow into the woodwork of grain bins. A seemingly clean bin may harbor thousands of larvae, pupae, and adults. The life cycle takes 2 to 14 months, with many adults living more than a year. The females lay about 1,000 eggs in protected situations, such as in cracks near food. Cadelles feed on grain and grain products and are especially injurious in unclean mills.

The *lessser grain borer (Rhyzopertha dominica)* is a brown or black, slender, cylindrical beetle with numerous coarse elevations on the pronotum (fig. 1-1). It's about 3 mm long and is most common in the Gulf States, but it may occur anywhere in the country. Both larvae and adults attack and destroy wheat kernels. The females lay up to 500 eggs each, dropping them in the loose grain. In warm weather, the life cycle takes about 1 month.

The *Angoumois grain moth (Sitotreoga cerealella)* is a light-grayish-brown or straw-colored moth with a satiny luster and wing expanse of 12.5 to 16.6 mm. The hind wings are fringed with long, dark setae and have a point at the tip like a finger (fig. 1-2). This feature distinguishes the insect from the clothes moth. The larva is white with a brown head. It is only 5 mm long and lives within the individual grain of wheat, corn, or other grain. It passes the winter in stored grain. The adult emerges and infests cereal crops either in the field or in storage and deposits about 40 eggs. The entire life cycle may be passed in 5 weeks. The Angoumois grain moth is second in importance to the rice and granary weevils as a

BEETLES: PICTORIAL KEY TO SOME SPECIES COMMONLY ASSOCIATED WITH STORED FOODS

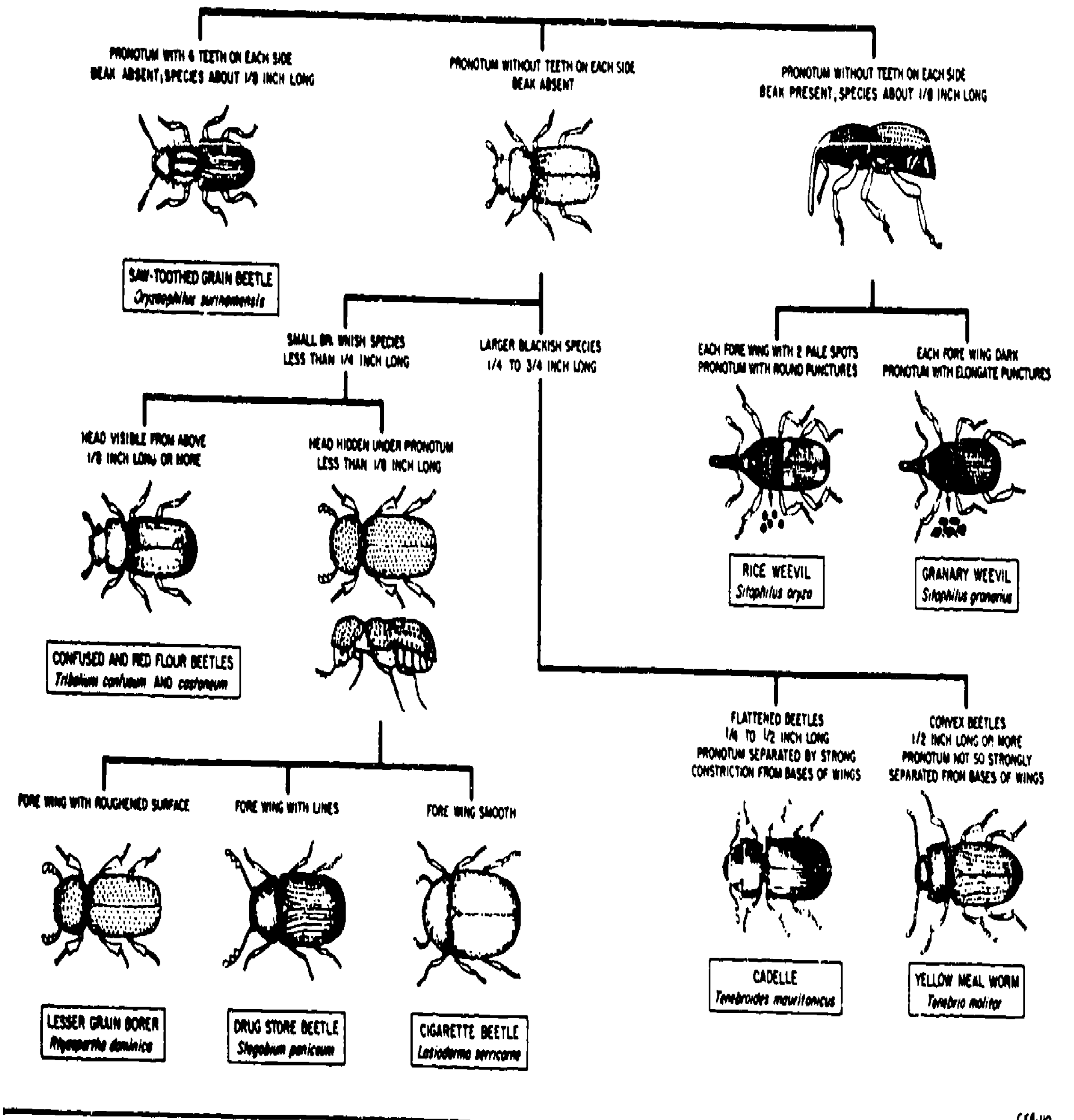

Figure 1-2. Wing patterns of some common moth pests of stored products. Right: the Indian meal moth; Center: the Mediterranean flour moth. Left: the Angoumois grain moth.

pest of stored grain. It is of greatest importance in the South and in the soft, red, winter wheat region of the Eastern and Central States.

Exercises (800):

Mark each statement true (T) or false (F), and correct any that are false.

____ 1. The rice weevil is a small, reddish-brown-to-black snout beetle with small, round pits on the thorax and two reddish or yellowish spots on each wing cover.

____ 2. The adult rice weevil emerges about 30 days after the egg is laid.

____ 3. The granary weevil is similar to the rice weevil in appearance, but it has oval pits on the thorax and the wing covers are uniformly dark brown.

____ 4. The granary weevil often frequents the Southern States.

____ 5. The cadelle is a black beetle with its head and pronotum distinctly separated from its forewings by a loose joint.

____ 6. The lesser grain borer is a white or grey, slender, cylindrical beetle with numerous coarse elevations on the pronotum.

____ 7. In warm weather, the lesser grain borer life cycle is completed in about 1 month.

____ 8. The Angoumois grain moth is a light-grayish-brown or straw-colored moth with a satiny luster.

____ 9. The larvae of the Angoumois grain moth is black with a brown head and lives within the individual grain of wheat, corn, or other grain.

801. Verify or correct statements about the physical appearance, importance, and development of important broken grain pests.

Broken Grain Pests. These pests we discuss here principally infest processed grains, such as cereal, flour, and corn meal. The *confused flour beetle (Tribolium confusum)* is the worst insect pest of prepared cereals. It is a shiny, reddish-brown beetle, 3.5 mm long with a flattened, oval body. The head and the thorax are densely covered with minute punctures, and the wing covers are ridged lengthwise and are sparsely punctured between the ridges. Each antenna gradually enlarges from head to tip. This beetle isn't known to fly even though it has wings. The female lays her eggs on the food surface with a sticky substance so that it becomes covered with the product. They will hatch in 5 to 12 days.

The larva is somewhat cylindrical in shape and is about 1/4 inch long (fig. 1-3). It's a yellowish-white color except for the darker mandibles and the pair of projections arising from the last abdominal segment. The head is flattened so that the mouth opening is forward.

The *red flour beetle (Tribolium casteneum)* is very similar to the confused flour beetle in its life history, habits, and appearance. This similarity probably accounts for the naming of the confused flour beetle. Even though they are very similar, there are some morphological differences between the two. For example, the last three segments of the red flour beetle's antennae are abruptly enlarged, and the sides of its thorax are curved instead of being somewhat straightened, as with the confused flour beetle. In addition to these differences, the red flour beetle *does* fly.

The *Mediterranean flour moth (Anagasta kuhniella)* prefers cereal products, but it will attack a wide variety of foods, including whole grain, bran, nuts, and dried fruits. With this species, adults are quite difficult to distinguish from a number of similar species. It has a wingspread of less than 25 mm. The forewings are pale gray with transverse, wavy, black markings (fig. 1-2). The hindwings are a dirty-white color. The whitish larva (fig. 1-3) is about 12.5 mm long with a brown head. It lives in a silken tube, and its silk clogs machinery and tangles flour, nuts, chocolate, dried fruit, and other foods.

The *Indian meal moth (Plodia interpuctella)* prefers coarse grades of flour and milled products, but it will attack a wide variety of dry food products. This moth has a wingspread of about 19 mm and is easily recognized by the

A pictorial key to the larval stages of some of the more common insect pests of stored grain and other food products.

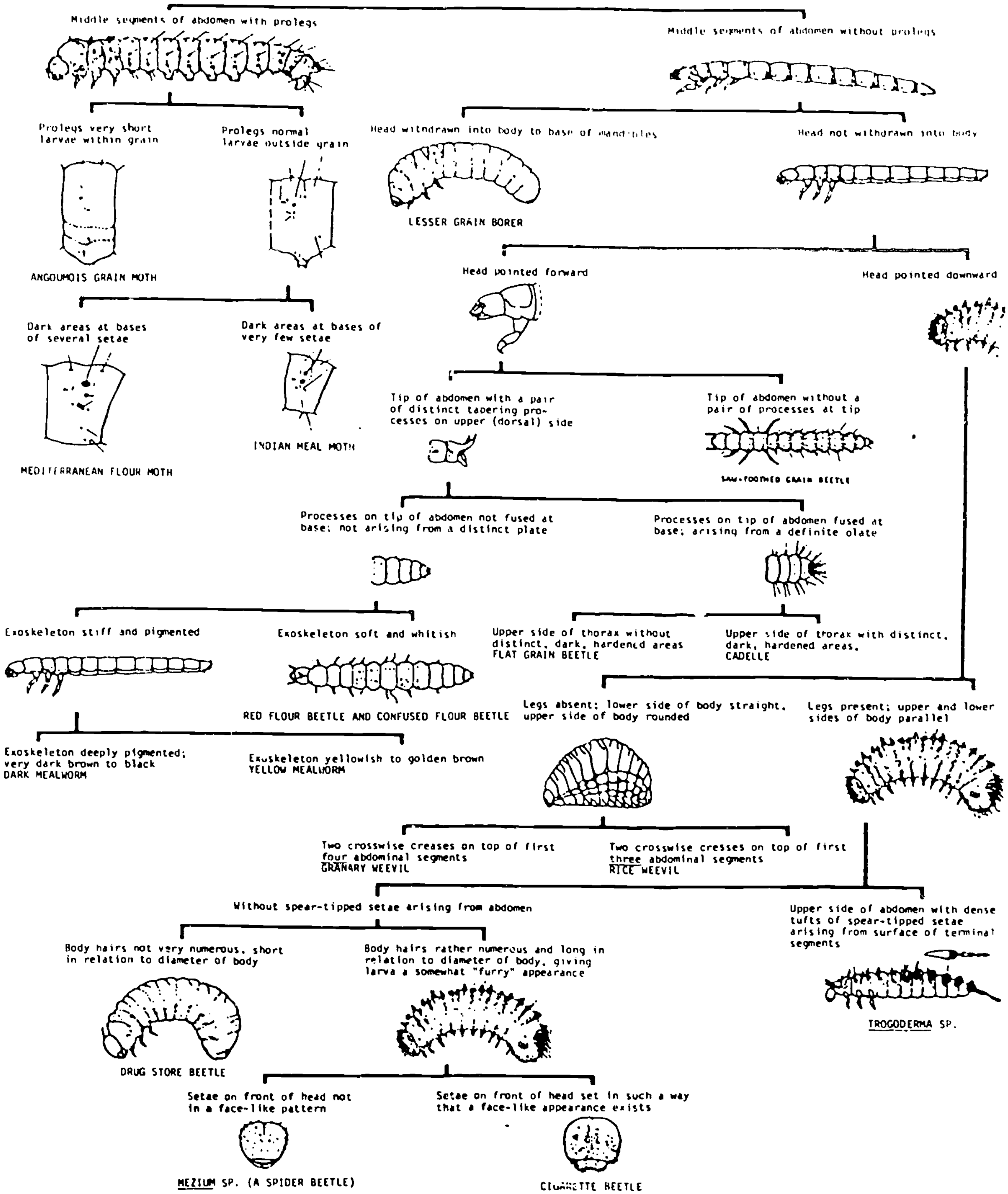

Figure 1-3. Larval stages of common insect pests of stored foods.

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distinctive markings on the forewings. These wings are reddish brown with a coppery luster on the outer two-thirds and whitish gray on the upper third (see fig. 1-2). The tiny, white, brown-headed larvae spin a silken thread that forms a loose webbing you can readily detect in a heavy infestation.

The *flat grain beetle (Cryptolestes pusillus)* is the smallest of the grain-infesting insects. Adults are flattened, oblong, reddish brown, and about 1/16 inch long. The antennae are slender and are about two-thirds as long as the body. The larva is a little less than 1/8 inch long. The abdominal segments are about 1½ times as wide as the thorax, and the last segment of the abdomen bears a pair of distinctly sclerotized, hooklike structures that are joined at the base. These processes and the head are brown, while the rest of the body is nearly white. The flat grain beetle is widespread and is one of the most common pests of stored grain, but it can't attack sound, uninjured kernels. For this reason, it is often found in combination with other grain pests.

Exercises (801):

Mark each statement true (T) or false (F), and correct any false ones.

____ 1. The confused flour beetle attacks cereal products and is the worst insect pest of prepared cereals.

____ 2. The confused flour beetle is shiny and reddish brown, with a flattened, oval body.

____ 3. Apparently, the confused flour beetle does not fly, even though it has wings.

____ 4. The last three segments of the red flour beetle's antennae are much smaller.

____ 5. Apparently, the red flour beetle does not fly, even though it has wings.

____ 6. The Mediterranean flour moth prefers cereal products, including whole grain, bran, nuts, and dried fruit.

____ 7. Mediterranean flour moths are pale grey, with transverse, wavy, black markings. The hindwings are a dirty-white color.

____ 8. Indian meal moths prefer fine grades of flour and milled products.

____ 9. The forewings of the Indian meal moth are reddish brown with a coppery luster on the outer two-thirds and whitish gray on the upper third.

____ 10. Flat grain beetles can only attack previously-damaged grains, so are found mostly with other grain pests.

802. Give details of the identification, life cycle, and feeding habits of the bean weevil and the pea weevil.

Pests of Beans and Peas. Although several arthropods attack beans and peas, only two are significant to you. Both are weevils that are actually beetles (order Coleoptera) with snouts. The *bean weevil (Acanthoscelides obtectus)* has a short snout and feeds on stored beans and peas. The adult is about 3 mm long with reddish legs and a light olive-brown color, mottled with darker brown and gray. The body narrows evenly toward the head. The tiny, legless larva and pupa live within the bean, whereas the adult emerges from the bean and feeds on other materials. The female deposits eggs in beans, both in the field and in storage. Six or seven generations may be completed in a year. As many as 28 weevils have been known to develop in one bean. The use of tight sacks has been found to afford considerable protection. Bean vines and other refuse should be burned in the field or plowed under to prevent propagation of this insect. The adults hibernate in fields and warehouses.

The *pea weevil (Bruchus pisorum)* is similar to the bean weevil but is larger (5 mm long), brownish flecked with white, and it has black-to-gray patches of scales. There is one generation per year, the adults overwintering in peas in the field or in storage. Egg deposition occurs only in the field. House mice eat pea weevils by cracking open the infested pea, eating the weevil, and discarding the pea.

Exercises (802)

1. What are the identifying characteristics of the bean weevil?

2. Compare the feeding habits of adult and larval bean weevils.

3. How many generations of bean weevils can be produced in a year, and how many can develop within a bean?

4. List the identifying characteristics of th 'a weevil.

5. Where does the female pea weevil deposit her eggs?

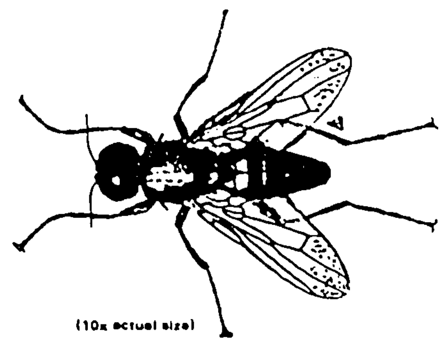

Figure 1-5. Cheese maggot.

803. Identify meat and cheese pests by physical description, significance, and feeding habits.

Pests of Meat and Cheese. These pests principally infest the products of animal origin. The *larder beetle (Dermestes lardarius)* is about 8 mm long, dark brown, with a wide yellow band across the front part of the wing cover. The larva is brown, very hairy, tapering towards the ends of the body. This insect is worldwide in distribution. The eggs are laid on or near animal products, such as feathers, horns, skins, hair, ham, bacon, dried beef, and like products. The life cycle requires 40 to 50 days. This insect may be found in dog biscuits, cheese, museum specimens, dried fish, and stored tobacco. It is also known to penetrate lead.

The *red-legged ham beetle (Necrobia rafipes)* is a shiny-blue-to-green beetle, 3.5 to 6.2 mm long, with reddish legs (fig. 1-4). It is especially troublesome in the Middle Atlantic States. The adults usually disperse by rapid running, but they can fly. The mature larva is about 10 mm long, purplish, with six short legs, and it tapers toward the head. The life cycle usually takes 36 to 150 days. The female lays 400 to 1,000 eggs on exposed meat. Thus, hams must be wrapped immediately after smoking. The larva can perforate grease-soaked paper wrappings. This pest lives primarily on dead and decaying animal matter, but it is sometimes reported in groceries and warehouses in smoked ham, bacon, garlic, bone meal, and other materials.

The *cheese maggot* is a fly *(Piophila casei)* about the size of a housefly and is often called a cheese skipper (fig. 1-5). The adult is black with a bronze tint on the thorax. It has reddish-brown eyes and iridescent wings that lie flat over the body. The larva is a slender maggot, pointed toward the head end. The larva can skip as far as 10 inches horizontally and 6 inches vertically by curving its body into a ring, fastening its mouth hooks onto the end of its abdomen, suddenly releasing its hold, and throwing itself into the air. The life cycle of the insect is completed in 12 days under favorable conditions. The adult deposits 140 to 500 eggs over a period of 3 to 4 days. This insect infests ham and cheeses. The adults can transmit enteric diseases to man by contamination, and the maggots cause intestinal irritation when ingested with cheese The recognized common name ''cheese skipper'' is a misnomer for this pest, since true skippers are mothlike Lepidoptera.

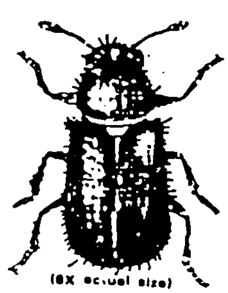

Figure 1-4. Red-legged ham beetle.

Exercises (803):

Indicate whether each statement applies to the larder beetle, the red-legged ham beetle, or the cheese maggot.

_____________ 1. The adult is shiny blue with reddish legs.

_____________ 2. The larva is brown, very hairy, and tapers towards the end of the body.

_____________ 3. The adult is black with a bronze tint on the thorax, reddish-brown eyes, and iridescent wings that lie flat over the body.

_____________ 4. 8 mm long, dark brown, with yellow band across the front part of the wing cover.

_____________ 5. The larva has six short legs and tapers toward the head.

_____________ 6. The larva is a slender maggot, pointed toward the head end.

804. Verify or correct statements about general feeder pests.

General Feeder Pests. Even though many of the stored-product pests we've covered may infest a variety of products, they are considered to be specific in food choice. This preference is not the case with the general feeders. The *saw-toothed grain beetle (Oryzaephilus surinamensis)* is an important pest known throughout most of the world. The adult is a small, active, brown beetle, 2.5 mm long, with a flattened body and six saw-toothed projections on each side of the thorax (fig. 1-1). The larva is yellowish white, about

3 mm long, with a brown head and an abdomen tapering toward the tip (fig. 1-3). The female lives for 6 to 10 months, depositing 45 to 285 eggs in foodstuff. Several generations may occur each year, as the life cycle requires only 3 to 4 weeks during the summer. The saw-toothed grain beetle is an important pest in food stores, warehouses, and grain storage. It readily penetrates packaged cereals, dried fruits, and candies. It also attacks flour, meal, sugar, drugs, dried meat, and tobacco.

The *cigarette beetle (Lasioderma serricorne)* is principally a pest of tobacco, but it will feed on many other products as was evidenced by its presence in the tomb of Tutankhamen in Egypt. This small, oval, light-brown beetle is 2.5 mm long with smooth wing covers (fig. 1-1). The head is retracted beneath the thorax. This beetle readily flies. The larva is yellowish white, curved, very hairy, with a light brown head, and is about 4.2 mm long (fig. 1-3). The life cycle takes 6 to 12 weeks, and there may be 5 to 6 overlapping generations per year in warm areas, but only one in cooler regions. The female deposits as many as 100 eggs in tobacco, grain, milled cereals, and other products. This insect infests upholstered furniture, feeds, dried plants, drugs, black and red pepper, pyrethrum powder, raisins, rice, and many other commodities.

The *drug store beetle (Stegobium paniceum)* (fig. 1-1) is similar to the cigarette beetle in appearance, but it is slightly larger (2.5-3 mm long), and its wing covers are distinctly straited (grooved). The last three antennae segments are sawlike. Its food is even more varied than that of the cigarette beetle, and it is said to feed upon "almost anything except cast iron." Its peculiar diet includes such odd materials as strychnine, belladonna, books, mummies, and lead. (Have you met any active-duty mummies lately?)

The *khapra beetle (Trogoderma granarium)* is pale red to brown or black, from 1.7 to 3 mm long. Females are much larger than males. The female lays up to 126 eggs, which hatch yellowish-brown larvae with long setae. The larva develops into a pupa and the pupa into an adult. The life cycle requires about 6 weeks during warm weather. The larvae may live for years without food. Khapra beetles feed on dried vegetable or animal matter of all kinds. Only limited parts of the United States are known to be infested at this time. If you suspect any of these beetles in your area (they're very hard to identify), you must report it immediately to the U.S. Department of Agriculture.

Exercises (804):

Correct any statements that are false.

____ 1. The adult saw-toothed grain beetle is a small, active, brown beetle with a flattened body and four saw-toothed projections on each side of the thorax.

____ 2. Its larva is yellowish white with a brown head and an abdomen tapered towards the tip.

____ 3. The cigarette beetle is a small, oval, light-green beetle with smooth wing covers.

____ 4. Its larva is yellowish white, curved, very hairy, with a light-brown head.

____ 5. The drug store beetle is similar to the khapra beetle in appearance.

____ 6. The drug store beetle diet includes strychnine, belledonna, books, and lead.

____ 7. The female khapra beetle is much larger than the male.

____ 8. The khapra beetle larva may live for years without food.

805. State survey and inspection principles for stored-food pests.

Surveys and Inspection Techniques. The dry stores area is probably the most overlooked food service area from a pest management point of view. The insects that infest dry stores may not be easy to spot in light infestations, but heavy infestations can be nauseating. The monetary loss of foods due to insect infestations can run into hundreds of dollars and deprive people of certain food items until replacements are available.

Surveys are a vital part of any pest management program. A good survey program not only helps you control a current infestation, but helps you prevent future infestations. Work with base veterinarian inspectors to inspect (visually) all incoming goods susceptible to insects. If a heavy infestation is present at time of receipt, the load should be rejected. A light infestation detected at this time would indicate a need for treatment before these items are stored.

These guidelines for determining the fitness of insect-infested subsistence items for human consumption have been approved by the Surgeon Generals of the military services:

- When an infestation includes larval stages of an insect species of genus *Trogoderma* or other dermestids, one insect within the product is justification for condemnation.
- For the genus *Tribolium*, three insects per pound within the product container justifies condemnation.

- For insects other than these two genera, a maximum of six insects per pound of product is permissible.
- For all resale subsistence to be sold at military commissary or exchange outlets, any insect within a subsistence product container justifies condemnation.

Spot inspections. Virtually all items of subsistence, except canned or bottled foods, are susceptible to infestation or damage by insects, rodents, and other pests. A spot inspection of any commodity to determine degree of infestation should rarely exceed 10 percent of the lot. Normally a 5 percent inspection will indicate the condition of the lot you're inspecting. In either event, temporarily stop your inspections when you first detect stored food pests and fumigate the lot or otherwise treat it appropriately, then make a followup survey to find out whether or not the stock is suitable for issue.

You can't put too much emphasis on the importance of detecting insect infestation in the early stages, especially when climatic and other environmental conditions are conducive to incubation and migration. Certain insects are attracted to light, and you can spot infestations by scanning windows and other light sources. Anticipate insect activity when the product temperature is above 50° F. or the air temperature is above 60° F. and the relative humidity is more than 35 percent. Generally, insect activity will increase as the temperature and relative humidity rise, so increase the frequency of inspections from monthly to biweekly surveys during prolonged hot, humid weather. Many stored-food pests have a high reproductive potential and a short life cycle, which means that under suitable conditions, a minor infestation can become a major problem within a short time. A "grain thief" (fig. 1-6) can be used to sample bagged products such as flour, rice, and corn. This device is a tube within a tube, the tubes having a series of matching openings. You stick it into a sack and when you reach the right depth, you turn the inner tube to close the sampler, then you withdraw it.

Inspection while in storage. Inspect storage facilities and exteriors of infestible material at regular intervals. The infestible contents of food products are inspected by veterinary, food, or qualified subsistence quality assurance inspectors. Your section and the veterinarian inspection specialists should also make a joint monthly inspection of vulnerable stocks and storage areas and prepare a report to show the results and recommendations. In your inspection, use equipment such as a flashlight, magnifying glass, hand sifter, and grain thief. You'll make visual and spot inspections at the storage stack, and there should be a central inspection area for more thorough and extensive examinations.

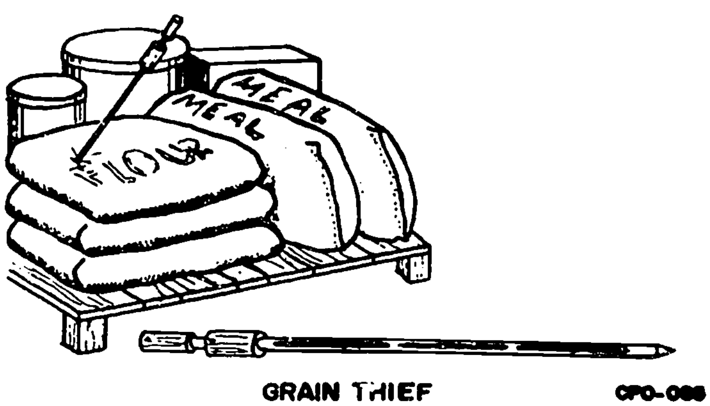

Figure 1-6. Grain thief.

Subsistence Inspection. Usually, you can readily detect advanced infestations in bagged, domestic-pack subsistence with a visual inspection. To find infestation in an earlier stage, or to any degree within a multiwall bag, you must open the bag and sift sample lots of the contents. You'll need a hand sieve with a catch pan such as sieve, sifting, 8-inch or 12-inch diameter, No. 10 mesh; or locally made sieves that use an 8XX bolting cloth as the screening material for flours. Use a No. 8 mesh sieve or locally made sieves with normal window screen for such bulk items as macaroni or beans. You can even get mechanical sifting equipment when the workload warrants.

- Carefully examine the seams and ears of the bags for evidence of insect infestation.
- Randomly select containers of spices, pepper, dried milk, and other finely divided subsistence stocks; then empty and sift them.
- Visually inspect and sieve spaghetti, macaroni, and cereal products for signs of insect and rodent infestations.
- Check all paperboard and other nonmetal containers for areas damaged by rodents, and inspect the contents for evidence of insects. Under some circumstances you may want to incubate a sample of the commodity to check for immature stages of insects.

Inspect all other infestible subsistence by visual or open container examination as prescribed by the material manager.

Exercises (805):

1. If you find two *Tribolium* larvae in 5 pounds of subsistence sold at a commissary, what must you do?

2. In spot inspections of subsistence items, how much of each lot should you normally inspect?

3. How often should you inspect warehouses for stored-food pests during prolonged hot, humid weather?

4. How often should you make joint inspections with qualified veterinary, food, or other subsistence inspectors?

5. Why should you *not* limit your surveys to visual inspections?

6. How do you survey each of these?
   a. Dried milk containers.

   b. Cereal products.

   c. Foods in other nonmetal containers.

806. State what preventive stored-product pest management is suitable for non-pest-management personnel.

Preventive Control Measures. Some people's custom of storing food for later consumption gives insects easy living. Some pests live in the fields and fly into storehouses or are transported in with infested food. Others live only in stored foods and invade fresh material that is brought in. If the storehouse provides favorable moisture, temperature, and harborage, not only may tremendous economic loss result, but people are exposed to insect-borne disease. Stored-product pest control should be conducted by warehouse workers and others on a year round basis. Prevention is the best way to control stored-product pests. A few of the more common ways you can prevent these pests are sanitation, palletizing, rotation, isolation, ventilation, packaging, and insectproof construction.

Sanitation. Cleanliness is an important factor in preventing insect damage to stored products. Many warehouses have become highly infested because flour, rice, or other foods have been spilled on the floors and left for a long time. Good sanitation helps keep insects and other pests from becoming established. As a corrective measure, it can force them to migrate or (combined with other techniques) starve them. You *must* repair all torn bags immediately, keep floors clean, and direct your efforts toward preventing contamination of stored-food products.

Palletizing. Don't let workers place cartons, bags, and other containers of goods directly on the floor. Warehouses should use oak or pine pallets to store these items, each pallet holding a load that can be moved from place to place by hydraulic lift. Cartons or bags should be placed upon the pallets by hand labor, but after that, machinery transports the palletized stocks from place to place. There is a trend toward shipping material on pallets so that the merchandise can be loaded and unloaded by machinery. Cereal products or other foods must not be stacked against warehouse walls or ceilings; this prevents adequate inspection, creates a fire hazard; and increases the amount of rodent harborage. Stacks shouldn't be high enough to crush cartons and bags, increasing the probability of an infestation.

Rotation. Stock rotation is an important factor in preventing losses due to insects. If old stocks stay in storage for a long time, the insects may complete one or more life cycles, and light infestations may become damaging ones. Old stocks left on hand may infest stocks received later. The accumulation of dirt and filth, rodent urine or feces, and moisture may result in the eventual loss of valuable foodstuffs. Food stored under such conditions is especially subject to insect attack, and mold formation may impart an off-flavor.

Isolation. It is important to isolate new stocks of susceptible items from the old supply. Often a carload of feed or flour is stacked on or near a few remaining sacks of old, infested materials. This placement results in the immediate infestation of the new shipment. Susceptible items must be stored as far as possible from old stocks, whether the infestation is heavy or light—even if you think the material is uninfested.

Ventilation. Adequate ventilation is important in storing dry foods. A high moisture content is conducive to attack by insects and mites and the formation of mold. Ventilation may be provided by 3-foot access aisles between stacks and the walls, and 2 feet between the stacks and the ceiling. Ventilators and doors should be opened during dry weather and closed during periods of high humidity. In the winter, let cool air circulate in warehouses unless this air may cause damage to products subject to freezing. Grains may be subjected to extremely low temperatures without damage. Cold is a useful factor in deterring insect infestations, as most species develop slowly at low temperatures and many individual insects are killed by freezing temperatures.

Packaging. Careful packaging of subsistence items can greatly limit insect infestations in stored food. Generally, it is best not to reuse packaging. If packaging is to be reused, it must be sterilized by heat or fumigation.

Insectproof construction. Grain stored in poorly constructed buildings may get infested by insects that fly in from nearby fields or warehouses. Poor construction encourages rapid buildup of large populations. Carefully planned and constructed warehouses can minimize this hazard. Make the building as insectproof as possible.

Exercises (806):

1. What seven preventive control techniques are applicable by non-pest-management personnel?

2. What are the pest control benefits of sanitation in a food warehouse?

3. List three effects of improper stock rotation.

4. Why is ventilation important in efforts to keep pests from attacking dry foods?

807. State why and how we use various corrective control measures.

Corrective Control Measures. Once stored foods have become infested with insects, you must act to prevent these insects from spreading and causing further damage. The corrective methods you can use include residual and nonresidual sprays, fumigation, and pheromones.

Residual spraying in subsistence warehouses should be restricted to walls and floors only. Be sure to follow all label instructions, as each pesticide is registered with Environmental Protection Agency (EPA) only for the uses listed on the label. The label is the law.

Nonresidual, or space, sprays of approved insecticides may be applied with ultra-low-volume dispersal equipment. This equipment fills the air with tiny droplets of insecticide that kill insects in flight or on exposed surfaces. Space sprays help kill pests between pallets, bags, and such locations, but they *don't* constitute fumigation, and they aren't feasible for destroying insects that have penetrated bags and cartons. Space sprays are regarded as preventive maintenance, rather than as a way to eliminate existing infestations.

Fumigation of stored products is the traditional means for destroying all insects infesting bins, elevators, warehouses and storerooms. It is dangerous and should be done only by qualified personnel. We'll talk about it in detail in the next learning objective.

The use of *pheromones* in a pest management program is a chemical behavioral insect control method. Stored-product insects are among the most expensive pests to feed, since they feast on products that have been grown, harvested, stored, and often processed. These pests may soon be their own worst enemies, now that scientists have learned to isolate the pheromones of the insects. The sex-attractant pheromones, now being commercially produced for several common pests, can be used in pest management for monitoring insect activity, for mass trapping, and as a form of birth control to reduce populations. Using pheromones in place of insecticides has several advantages:

- Only small amounts are needed; male insects can detect as little as several molecules floating around in the air.
- Pheromones are not poisonous; they are organic compounds that decompose in the environment.
- They are species specific; a butterfly pheromone will not attract a moth. This allows for careful control of harmful insects without threatening helpful ones or humans.
- There is no insect resistance. Through evolution, insects develop tolerances to some pesticides, but because pheromones are produced naturally by insects, resistance is not anticipated.

Pheromones are already commercially available for the Indian meal, tobacco, raisin, and almond moths and for the Angoumois and khapra beetles. In time, you can expect to see pheromones commercially available for the cigarette beetle, red and confused flour beetles, lesser grain borer, and rice weevil.

Methodology for applied chemical controls. You can use products that are registered for crack-and-crevice treatment in food area (and don't have specific instructions to the contrary) while the establishments are open and in operation. Of course you must take due care to avoid any contamination of food. You may use contact sprays and space sprays of synergized pyrethrins and resmethrin to control flying adults, and you can make crack-and-crevice treatments with residuals such as diazinon, Dursban and malathion.

In nonfood areas (loading docks, storage areas, locker rooms, offices, etc.) of food establishments, the EPA allows more liberal use of residual insecticides. In each case, the label of the product you use should describe the pests to be controlled, the places that can be treated, and the concentration to use. You can use such residuals as 1 percent diazinon, 0.5 percent Dursban and 2 percent malathion as sprays to treat surfaces in nonfood areas, as long as they don't come in contact with food containers.

In warehouses, the first step is to make sure the sanitation is acceptable. Then you must locate the infested material and identify the insects in it. For the best control, remove the infested material from the premises since, without fumigation, you can't kill insects inside stored materials. Insects on the outside of packaged materials can be killed by a contact spray of relatively low toxicity to man, such as pyrethrins or resmethrin. After warehouse workers have cleaned up any debris and the infested material has been removed, spray the storage areas thoroughly, spraying the walls, floors, posts, and any other areas that could harbor insects. Give particular attention to cracks and crevices, where debris is hard to remove. Again, *residual sprays must not come in direct contact with food containers.*

If there is a light infestation in returned goods that must be held in the warehouse for a time, you can use a modification of this procedure. The infested material must be stored off the floor on pallets, and the area should then be treated at regular intervals with one of the low-toxicity materials. Apply the chemical with a mist applicator, fog machine, or ULV machine to get the best penetration through the space between the containers in the stack. Along with this treatment, make a residual application to the floors and walls up to the maximum height of storage using a residual pesticide. If food products are exposed, you can only use crack-and-crevice treatment. The need to repeat this application depends on the type of surface you sprayed and the length of residual for the chemical you're using. Timing may be on a monthly, bimonthly, or even a quarterly basis. Check conditions carefully so you have a continuously effective residual working at all times. This type treatment will be effective only where the storage area has been cleaned out to start with and where no heavy infestation is introduced after the program starts. During this program the building must also be kept clean so that untreated dust and debris do not accumulate. As a standard method of warehouse maintenance, this system is excellent.

In commissaries or food stores, control depends on prompt removal of infested material. You don't have much hope of controlling storage pests until this is done and the premises are cleaned of as much debris as possible. After this, make a thorough application of a low-toxicity contact spray to kill any exposed adults or larvae. Use a mist blower or ULV generator to apply pyrethrins, resmethrin, etc. to as many surfaces in the area of infestation as possible, taking extreme care not to contaminate food items in the store. If other items aren't in tight containers, be sure they are completely covered with a protective material such as a plastic sheet before spraying. In nonfood areas, use residual sprays.

Some special problems exist in the home. Since many of the stored-product insects are strong fliers and their larvae may crawl considerable distances from a source of infestation, you must show the occupants that these wanderers don't necessarily indicate either the source of infestation or the areas you need to treat.

The source of infestation in a home is usually a very limited area, such as the kitchen, or even a single cabinet or a single box of material in the kitchen. Before you try any control, find this source and eliminate it. This is not always easy to do, but it is essential. Look very carefully, not only into cracks and crevices, but also inside containers of such things as cereals, beans, peas, flour, dried fruits and spices, and any other material where they may live and complete their life cycle. Don't overlook the possibility that a sealed container may be infested on the inside and be loose enough to allow the insects to escape from it.

After removing infested material, remove the contents of drawers and cupboards in the area and spray all shelves, drawer bottoms, cracks, and crevices with any of the standard residual emulsions or oil-base formulations. After the chemical has dried, cover all drawer bottoms and shelves with paper to keep food or containers from direct contact with the residual. It may take several days for insects not actually contacted during the treatment to contact the residual and be killed. Tell occupants about this fact so you won't be making unnecessary return trips immediately after completing the job.

Chemical applications to control stored-product pests in all situations take considerable care on your part. It is essential that insecticide, whether a residual or a space spray, be kept from direct contact with food products. *No insecticide is to be considered as nontoxic or suitable for direct use on any food product.* When shelves are treated, food products should not be replaced on them until the insecticide is completely dry, and shelf paper should then be placed on the shelf to protect the food from direct contact. Application made directly to bags or other packages should be very light and should not be sufficient to wet the container.

You can also be of value to housing occupants by giving advice on how to inspect for infestations, how to clean storage areas where food particles tend to sift out and collect in cracks, and how properly to store food products, especially those in which the original container has been opened (store in clean metal, glass, or plastic containers with tight-fitting lids).

Commercial food-handling facilities may have special sanitation problems. It is absolutely essential that the premises be cleaned of any loose food materials that might be lodged on the floor, the walls, and on the ceiling, because this food will provide harborage for the insects even though you've removed the principal infestation.

The use of pesticides in and around food-handling establishments was greatly restricted by the 1972 amendment of the Federal Insecticide, Fungicide, and Rodenticide Act. This is especially true in food areas of food-handling establishments, where application of residual insecticides is limited to the crack-and-crevice method. Food areas include places where food is exposed during receiving, storage, preparation, and serving. It does not include dining areas where food is under the control of the person eating it. EPA's official definition of crack-and-crevice treatment is ". . . the application of small amounts of insecticides into cracks and crevices in which insects hide or through which they may enter the building." Such openings commonly occur at expansion joints, between different elements of construction, and between equipment and floors. These openings may lead to voids such as hollow walls, equipment legs and bases, conduits, motor housings, junctions, and switch boxes. The crack-and-crevice treatment uses sprays, dusts, or baits only in cracks and crevices; doesn't treat surfaces. Insecticides must be applied under low pressure and with great care to avoid splashing or runoff which might lead to contamination of the exposed surfaces of the building or equipment. When dusts or baits are applied into cracks or voids, take care to avoid leaving any of the material on exposed surfaces. If contact sprays or space sprays are used, again take care not to treat food areas when food is exposed, and you should avoid leaving any of the material on exposed surfaces that may come in direct contact with food or food products.

Exercises (807):

1. What purpose does nonresidual space spraying serve in controlling stored food pests?

2. In what three ways can pheromones be used in a stored-food pest management program?

3. What four advantages are there in using pheromones rather than insecticides in a stored-food pest management program?

4. Before you treat a warehouse for stored-food pests, what must you insure?

5. Where should you apply residual sprays in a food warehouse?

6. What equipment can you use to apply contact pesticides in food warehouses?

7. In homes, what should you do before you try to control stored-food pests?

8. In what areas are you limited to crack-and-crevice applications of residual pesticides?

9. List the areas where crack-and-crevice treatments are advised.

10. What should be your major safety concern in applying residual pesticides?

808. State the sequence of given steps for in-place fumigation with aluminum phosphide and name the phase to which each step belongs.

In-Place Fumigation. In this lesson, you'll learn about the procedures for in-place (stack) fumigation of stored foods using aluminum phosphide. Take note that you are authorized to work with this fumigant *only* if you're certified in EPA category 7, Industrial, Institutional, Structural, and Health-Related Pest Control.

Aluminum phosphide is highly effective for fumigating products with stored-food pests either indoors or outdoors under polyethylene tarpaulins, but there are some safety restrictions. Hydrogen phosphide gas released from aluminum phosphide pellets or tablets is explosive under vacuum conditions. As a result, you can use it only in airtight enclosures at normal atmospheric pressure, normally under a tarpaulin. Under some atmospheric conditions, especially when moisture may condense, the gas will corrode gold, silver, copper, copper alloys such as brass and bronze, and other products containing copper. You must not let the pellets, tablets, or residual ash contact any processed food. Cloth, canvas, or vinyl-coated tarpaulins are not suitable for fumigation with aluminum phosphide.

Fumigation phases. There are four phases in aluminum phosphide fumigation: preparation, application, evaluation, and clearance. Before you start, though, make sure you have all the equipment you need. You may want to stop at this point and review the list of fumigation equipment in Volume 3, Chapter 3 before you continue.

Preparation. You can do in-place fumigation without necessarily moving infested material already in storage, but if slightly infested goods come into a warehouse frequently, it's advisable to set up an area where you can fumigate them conveniently. For outdoor fumigation, avoid using bare ground; but first, place a plastic ground cover under stocks being fumigated.

Gather your materials, using a form similar to the one in table 1-1 to make sure you have everything you'll need.

Next, check the stack's dimensions with a tape measure to find out how much polyethylene film and fumigant you'll need. Now cover the stack with the film. Make sure you allow at least 18 inches of floor lap on each side of the stack.

Seal the film to the floor with sand snakes or a suitable substitute. Make sure you overlap the sand snakes at least six inches, and place extra sand snakes at each corner of the stack to insure a tight seal. Then check the tarpaulin for holes. If you find any, close them with the masking tape. Also, you should reinforce any pressure points on the tarpaulin by putting masking tape on them.

At this point, you're almost ready to put the fumigant in the stack. First, however, check the temperature of the material you're fumigating. If it's less than 59° F., consult your command pest management professional before you continue.

Applying the fumigant. Now you're ready to place fumigant tablets or pellets in the stack. With the stack measurements you got earlier, refer to table 1-2 to see how much fumigant to use, or use:

100 pellets or 30 tablets per 1000 cubic feet indoors or 165 pellets or 45 tablets per 1000 cubic feet outdoors.

Make sure you record the amount of fumigant you apply (table 1-3, part 6).

When you take the aluminum phosphide out of the container, you don't need to wear a gas mask; the hydrogen phosphide gas evolves slowly upon contact with moisture in the air. (Just make sure you work quickly and efficiently; don't take any coffee breaks before you place the fumigant in the stack.) You *must,* however, have approved gas [illegible]ks and canisters in your possession when you're ha[illegible]g the fumigant. Keep the fumigant container closed [illegible]pt when you're actually measuring or applying the fum[illegible]ant.

Place the fumigant pellets or tablets in a single layer on a pan or tray and immediately slide it under the tarpaulin. Take care not to expose the tray to condensed water that has accumulated under the tarpaulin, and reseal the tarpaulin to the floor or ground. It doesn't matter where you position the fumigant in the stack, since the gas will penetrate until the concentration levels equalize throughout the stack.

Once you've removed the fumigant from the container, hydrogen phosphide will start being released in 15-30 minutes. You may notice a garliclike odor, and the pellets or tablets will start changing from a green-grey to a white-grey color as the gas is freed. The most intense gas development is between the 4th and 12th hours, and complete breakdown of the pellets or tablets may take up to 72 hours.

Your last step in this phase is to set up a safety barrier at least 5 feet from each side of the stack. Place warning signs (fig. 1-7) on each side of the stack where people may approach it and on the safety barriers. If it's a particularly large stack, you may want to put more than one warning sign on each side.

Evaluation. Most pest management efforts are evaluated after you've finished the job, but you take readings while the fumigation is in progress to be sure the gas is reaching a level high enough to kill all pests. You use the Drager bellows or Auer bulb and gas detection tubes to find how many parts-per-million (ppm) of fumigant are in the stack 24, 48, and 72 hours after fumigation began. These readings will vary according to the temperature, but you want to make sure you get either 300 ppm after 48 hours or 200 ppm after 60 hours. Keep in mind, even though you get one or both of these readings, you still need an exposure time of at least 72 hours to get 100 percent control of all the pests.

As with setting up the stack, there are some safety precautions you must follow. First, *do not work alone.* This

Table 1-1
Aluminum Phosphide Fumigation Preparation Checklist

ALUMINUM PHOSPHIDE FUMIGATION-PREPARATION CHECKLIST

1. FACILITY: ____________ 2. DATE: ____________

3. ASSIGNMENT OF FUMIGATION TEAM (MINIMUM OF 2)

a. ______________________

b. ______________________

4. LOCATION:

a. Indoors, Bldg. # ________ Section ________

b. Outdoors, Nearest Bldg. # ____________

Hardstand or Ground *

c. Freight car, located at ____________

For in-transit fumigation (ITF), Destination

For in-place funigation

5. NOTIFICATION:

	Person Notified	Phone Number	Time/Date Notified
a. Fire			
b. Security			
c. Medical			
d. Safety			
e. OIC			

Installation Engr. Public Works Officer

Base Civil Engr.

* AVOID USING BARE GROUND WHEN POSSIBLE. IF NECESSARY TO USE GROUND, IT WILL BE NECESSARY TO USE A PLASTIC GROUND COVER UNDER STOCKS BEING FUMIGATED.

EQUIPMENT (ARE THE FOLLOWING ITEMS ON HAND?)

a. _2.0_4.0_6.0 Polyethylene __ __

b. 4 mil plastic and 4" tapes __ __

c. Measuring tape __ __

d. Thermometer __ __

e. Two approved gas masks __ __

f. Two unexpired gas mask canisters __ __

g. Aluminum pan or tray (in-place stacks) __ __

h. Envelopes (freight cars) __ __

i. Phostrays (freight cars) __ __

j. Warning signs __ __

k. Measuring device (cup w/premeasured volume for tablets/ pellets) __ __

l. Auer test tubes with sampling bulb __ __

m. Drager test tubes with bellows pump __ __

n. MSA test tubes with MSA sampler __ __

o. Sand snakes or loose sand __ __

p. Bucket __ __

q. Paddle __ __

r. Liquid detergent __ __

s. Surgical gloves __ __

t. Flashlight __ __

u. Aluminum Phosphide __ __

__ Tablets

__ Pellets

__ Bags (if authorized)

7. SAFETY

a. Has the fumigation team been briefed on the emergency procedures for:

(1) Deactivating a live stack? __ __

(2) Providing first aid in case of PH_3 poisoning? __ __

b. Have all warehouse personnel been briefed on:

(1) Odor of gas? __ __

(2) What to do in case it is detected? __ __

(3) Providing emergency first aid in case of PH_3 poisoning? __ __

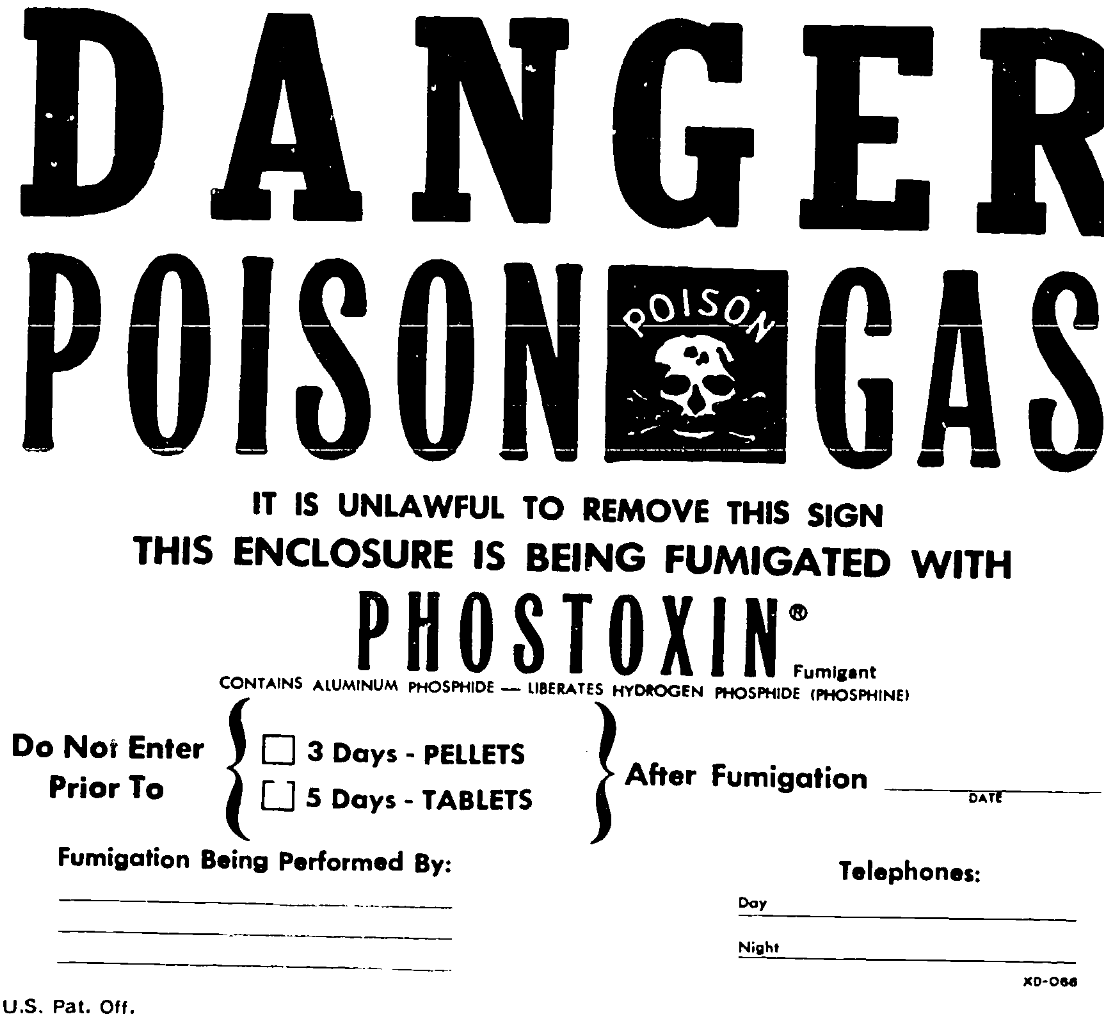

Figure 1-7. Aluminum phosphide warning sign for in-place fumigation.

applies to *all* phases of working with aluminum phosphide. Also, make sure you have the right gas masks and cartridges with you *at all times.* (Refer to table 1-3 as you continue.)

Clearance. This is the last phase of your operation, but there's more involved than just pulling away the tarpaulin, gathering your materials, and heading for the club. First, you must make sure the hydrogen phosphide concentrations are below 0.3 ppm. To do this, use "low range" gas detection tubes with the Drager bellows or Auer bulb. These tubes have a range of 0.1-40.0 ppm compared to 50.0-1000 ppm for the high range tubes (Drager bellows). For the Auer bulb, these ranges are 0.1-100.0 ppm and 50-2000 ppm respectively. Take three separate readings and average the results to be as accurate as possible.

Once you've gotten these readings, you're ready to clear the stack. If your ppm reading was 0.3 or higher, you and your coworker will need to put on gas masks before you pull back the tarpaulin. Below 0.3 ppm, don't worry about it. Just pull back the tarpaulin and make sure everybody stays away from the stack for at least 1 hour. When you get back, sample the air around the stack; you should get a 0.0 reading. If you had to wear gas masks when you pulled back the tarpaulin, wear them now until you're sure fumigant levels are below 0.3 ppm.

At this point, you must dispose of the ash residue of the pellets or tablets. Take this material outside and *slowly* pour it into a bucket of soapy water. When the ash contacts the water, there will be spontaneous heating (and possibly, combustion). You must *never* add alcohol to the water, since this increases the chances for spontaneous combustion. For this same reason, have somebody stir the water while you pour in the ash. When you're finished with this, you can bury the solution or pour it directly into the influent of a sewage treatment facility.

As with other fumigants, hydrogen phosphide gas offers no residual protection against any new infestations by stored-food pests. Therefore, if the treated goods were infested while they were in the warehouse, do whatever you can to reduce the need for fumigation. Push for higher sanitation standards, use contact and residual insecticides as needed, and try to get warehouse managers to segregate highly infestible commodities such as dog food and cereal products to control insects, limit reinfestation, and reduce the need for fumigation.

Table 1-2

Dosage Rates for In-Place Fumigation

Cubic Footage of Stack to be Fumigated	PELLETS APPLICATION		TABLET APPLICATION	
	No. Required Indoors	No. Required Outdoors	No. Required Indoors	No. Required Outdoors
100	10	17	3	5
110	11	18	3	5
120	12	20	3	6
130	13	22	3	6
140	14	24	4	7
150	15	25	4	7
160	16	27	4	8
170	17	29	5	8
180	18	30	5	9
190	19	32	5	9
200	20	33	6	9
300	30	50	9	14
400	40	66	12	18
500	50	83	15	23
600	60	99	18	27
700	70	116	21	32
800	80	132	24	36
900	90	149	27	41
1000	100	165	30	45
2000	200	330	60	90
3000	300	495	90	135
4000	400	660	120	180
5000	500	825	150	225
6000	600	990	180	270
7000	700	1155	210	315
8000	800	1320	240	360
9000	900	1,485	270	405
10,000	1,000	1,650	300	450
20,000	2,000	3,300	600	900
30,000	3,000	4,950	900	1,350
40,000	4,000	6,600	1,200	1,800
50,000	5,000	8,250	1,500	2,250
60,000	6,000	9,900	1,800	1,700
70,000	7,000	11,550	2,100	3,150
80,000	8,000	13,200	2,400	3,600
90,000	9,000	14,850	[illegible],700	4,050
100,000	10,000	16,500	3,000	4,500

CPL-187

Exercises (808):

To which phase of fumigation does each of these steps apply? Number the steps in the sequence you should do them.

	Phase	Order
1. Use sand snakes to seal the tarpaulin to the floor.		
2. Place fumigant tablets or pellets in a single layer on a pan or tray, and put it under the tarpaulin.		
3. Pull back the tarpaulin and leave the area for 1 hour.		
4. Gather all necessary materials.		
5. Set up a safety barrier at least 5 feet from the stack and post warning signs.		
6. Bury the solution or pour it into the influent of a sewage treatment facility.		
7. Take 3 readings to insure 0.3 ppm or less within the stack.		
8. Apply 100 pellets or 30 tablets per 1000 cubic feet.		
9. If fumigation is conducted on the ground, cover the ground with a plastic cover.		
10. Reseal the tarpaulin to the ground or floor.		
11. Add the ash from the pellets or tablets to soapy water.		
12. Take ppm readings at 24-hour intervals.		
13. Record the amount of fumigant applied.		
14. Check the temperature of the stack.		

Table 1-3
Clearance Checklist

1. FACILITY: ________________ 2. DATE CLEARED: __________

3. CLEARANCE TEAM

a. ______________________________

b. ______________________________

4. COMMODITY FUMIGATED

a. Nomenclature ______________

b. FSN (if applicable) ______________

c. Contract Number ______________

d. Contract Item Number ______________

e. Manufacturer or Assembler ______________

f. Lot Number and Date of Pack ______________

g. Quantity

(1) Weight________lbs.

(2) Cubic Feet

(a) of stack________

(b) of freight car ______

5. DATE FUMIGATED ______________________

6. FUMIGANT INFORMATION

a. Name of fumigant used________________

b. Form used: ___ tablets ___ pellets ___ bags (powder)

c. Number of tablets, pellets or bags used: ___

7. CLEARANCE INFORMATION

	YES	NO
a. Warning signs are posted and properly completed.	__	__
b. A minimum of 72 hours has elapsed since fumigation was initiated.	__	__
c. Stack Fumigation:		
(1) Gas concentration checked while wearing an approved mask.	__	__
(2) After lifting edge of the tarp, gas concentration in the area of stack was less than 50 ppm.	__	__
(3) Gas masks were required to complete the lifting of tarp on all sides.	__	__
(4) Area vacated and ventililated for one hour before tarp was removed.	__	__
(5) Gas concentration after one hour of ventilation = ________	__	__
(6) Additional ventilation was required. If yes, ventilation accomplished for________ additional hours.	__	__

10. RESIDUE DISPOSAL:

a. Clay residue mixed w/liquid detergent in bucket of water.	__	__
b. Residue emulsion, all gloves, and empty primary containers (following deactivation w/detergent and water) were buried in an approved manner.	__	__

11. REMARKS:

____
____
____
____
____
____
____

12. CERTIFICATION:

I CERTIFY THAT THE ABOVE INFORMATION IS CORRECT, WAS ACTUALLY PERFORMED, AND BOTH A PREPARATION AND FUMIGATION CHECKLIST WERE COMPLETED IF FUMIGATION WAS INITAITED AT THIS INSTALLATION.

____
CERTIFIED PEST MANAGEMENT SUPERVISOR

____
CERTIFIED PEST MANAGEMENT OPERATOR

Phase *Order*

15. Make sure there are at least 18 inches of floor lap on each side of the stack.
16. Reinforce pressure points with tape.

1-2. Fabric Pests

Fabric-destroying insects cause great damage each year. In addition to large losses to fabrics in the process of manufacture and storage, the many small damages caused in households add up to a significant figure. A hole in a $125 suit usually means a new one will be bought; a patch of carpet eaten out under a sofa may require purchase of new carpeting the next time furniture is rearranged. Other materials that are readily infested include upholstery, piano felt, blankets, and any other woolen products as well as fur, hair, feathers, horns, insect and animal collections, and such stored foods as meat, fish, meal, and milk products. Synthetic fibers and cellulose materials are damaged only incidentally.

Just as some pests create problems because they attack and use cellulose, the fabric pests are troublesome because they attack and use keratin. Although its name is not very common, keratin is a most important material to people, being the chief constituent of such structures as the hair of humans and other mammals, horns, hoofs, and feathers. It is a protein that is quite stable chemically and is very resistant to most means of digestion. The only animals that can digest keratin are a relatively small number of insects. This peculiar ability of keratin digestion, coupled with the widespread use of wool and other animal hair, is the basis of the fabric pest problem.

Any number of other insects can damage fabrics by chewing or shredding, but they can't digest keratin. Silverfish, cockroaches, crickets, earwigs, etc. fall into this category, but they aren't considered true fabric pests and won't be included here.

The main group of fabric-destroying insects in the United States is made up of three moths and five carpet beetles, although many other insects may cause some damage occasionally or may cause important damage locally.

809. Associate statements about the development, characteristics, and habits of clothes moths with the particular moth to which they refer.

Clothes Moths. The term "clothes moth" is properly used in connection with the webbing clothes moth, the casemaking clothes moth, and the tapestry, or carpet, moth. The first two are most common; tapestry moths occur rarely. These are all small moths; adults have a wingspread of less than 1/2 inch. Their habits are different from most moths, because we rarely see them flying around lights at night. Rather, they prefer the dark and tend to live in dark corners, or in folds of fabric. They will fly occasionally, but normally only on the edges of a lighted area, usually remaining quite inconspicuous.

Clothes moths have a complete metamorphosis. Adults cannot feed, and it is the larval stage that damages fabrics. In houses, they are most frequently pests of clothing, carpets, rugs, upholstery fabrics, piano felt, brush bristles, blankets, hair from pets, furs, lint from woolens, and any stored wool products. These products all contain the protein keratin.

Clothes moth larvae will, at times, damage other products such as cotton, linen, silk, synthetic fibers, and paper. Such damage, however, is usually incidental, resulting from the larva damaging such fibers while eating its natural food. Clothes moth larvae are particularly damaging to fabrics stained with such materials as oil from human hair, human sweat, urine, beer, tomato juice, milk, and soft drinks. These developing insects' nutrition requires balance in their diet, and they especially need vitamin B. As a matter of fact, first instar larvae can't survive on "clean" wool; but it must have the nutritional supplements found in soilage. You can identify common clothes moth adults with the key in fig. 1-8. Larvae are hard to identify morphologically but can easily be separated by their habits.

Webbing clothes moth. This moth *(Tineola bisselliella)* is the most numerous clothes moth in the United States, being found commonly in all states. The body and wings of the adult are uniformly buff colored, and its head has light-reddish hairs on top. The wings are silvery brown, without spots, and measure less than 1/2 inch across when they're extended. Adult males can fly as far as 100 yards but seldom do. Females, on the other hand, are rather weak fliers, although they can fly for short distances. Adult females can mate and lay eggs the same day they emerge from the cocoon. Normally, adults live about 15 to 30 days, but colder weather may extend this time somewhat.

The eggs are oval, ivory white, and about 1/24 inch long. They are laid either singly or in small groups among the threads or in cracks of a suitable food material and are usually attached to this food material with a gelatinous substance. Each female lays an average of 40 to 50 eggs, but a few may lay as many as 200. In the summer these eggs will hatch in 4 to 10 days, but in winter it may take a month or more. Be careful not to confuse eggs with the fine, hard, characteristically bun-shaped particles of excrement which are left scattered about wherever the larvae live. These excrement particles are frequently of the same color as the fabric on which the larvae are feeding.

Larvae are shiny, creamy white, and not more than 1/2 inch long. They usually spin feeding tunnels of silk, but they may produce somewhat randomly placed patches of silk as they move about. Some particles of the material on which they are feeding and bits of their own excrement are often entangled in the silk. These feeding tubes and silken patches together make up the webbing which is a characteristic of this moth. In fur, webbing is sparse. In its growth, each larva molts from 5 to 45 times. The time necessary to complete larval development may vary greatly with such things as availability of food, relative humidity, and temperature. This variation may be anywhere from 35 days to as long as 2½ years.

The larva spins a silken pupal case and attaches bits of fiber and excrement to the outside of it. This case is usually well hidden in the fabric. Length of the pupal stage varies from about 8 to 40 days. You may find adult webbing clothes moths at any time of the year, but they're more abundant in warm summer months. They can also develop quite well in

A pictorial key to the adults of some common insect pests of fabrics.

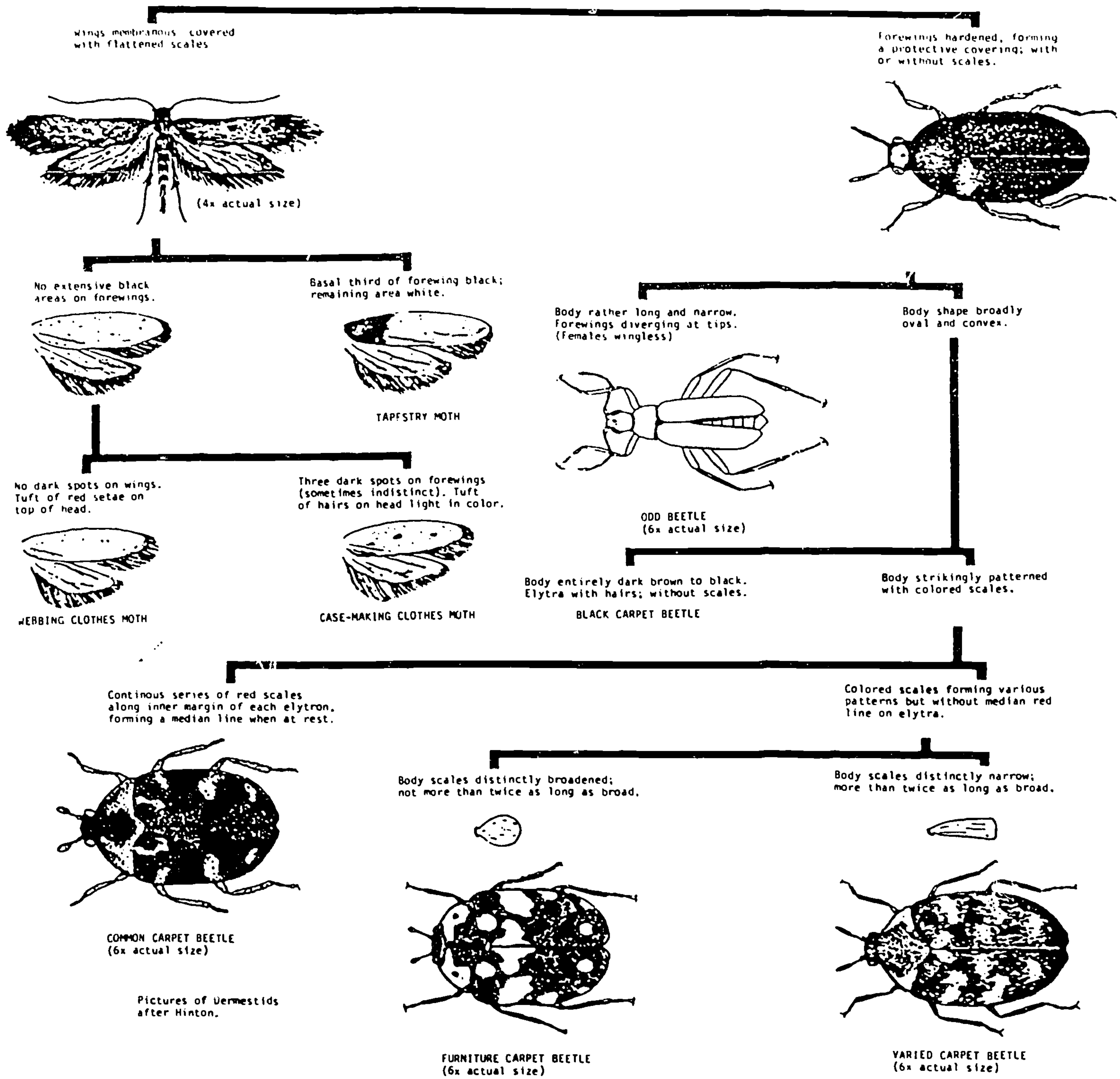

Figure 1-8. Adult fabric pests.

heated buildings in the winter. The entire length of their life cycle may vary from 55 days to 4 years. Normally, the cycle will be from 65 to 90 days. This moth seldom occurs in the dry areas of the country.

Casemaking clothes moth. This moth *(Tinea pellionella)* is not as common as the webbing clothes moth. It is most numerous in the Southern States, although it is rather generally distributed in the U.S. This moth is more brown in color than the webbing clothes moth, and 3 dark spots on the wings help to identify it. Don't rely on this characteristic, though, since the spots are often indistinct and the scales of the wings may have worn off, leaving no spots. The adult has a somewhat smaller wingspread than the webbing clothes moth.

The larva spins a small silken cell around itself and carries it while it feeds (fig. 1-9). The head and first segment of the thorax are exposed at the anterior end of the case. Note the darkened, platelike areas on top of the thorax. It moves about by extending its head and legs from the front end of the case. There is rarely any webbing spun on the material upon which larvae feed. Larvae wander about on food material feeding a little here and a little there, but they rarely do any great damage at any one spot.

When it's ready to pupate, the larva draws itself completely within its case, seals both ends of the case and pupates in this cocoon. In Northern States, the pupal stage is usually the only one found during the winter months, but in the South all stages are found the year around. This moth is a particular pest of feathers and down, although it feeds readily on almost any material used as food by webbing clothes moths.

Carpet moth. This moth *(Trichophaga tapetzella)* is not found very often but can cause considerable damage in a severe infestation. It is most common in old woolens, horsehair, furs, and feathers. The wingspread of the adult is somewhat greater than that of either webbing or casemaking clothes moths. It can be distinguished from them by the fact that the front third of the wing is black and the rest of the wing is white with a few black or gray spots (fig. 1-1). Its head is white. The larva makes a silk tube, or burrow, through the material and feeds inside this tube. Its entire life cycle is similar to that of the casemaking clothes moth.

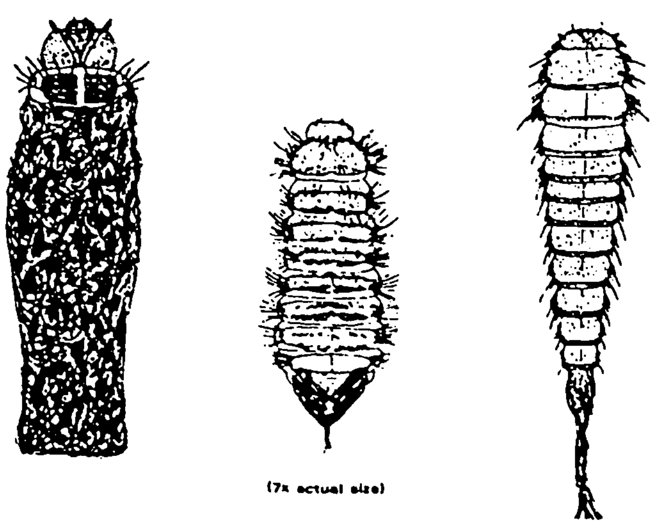

Figure 1-9. Representative larvae of common fabric pests. Left: dorsal view of the casemaking clothes moth. Center: varied carpet beetle. Right: black carpet beetle.

Exercises (809):

To which clothes moth does each statement refer (the webbing clothes moth, the casemaking clothes moth, or the carpet moth)?

_______________ 1. Larvae wander around on the food material causing spotty damage, but rarely cause any great damage in one spot.

_______________ 2. Three dark spots on the wings are poor identifiers because they are frequently indistinct or rub off easily.

_______________ 3. Of the three moths discussed, this one has the greatest wingspread.

_______________ 4. Larvae spin a cocoon and then attach particles of fiber and excrement to it.

_______________ 5. Eggs are laid singly or in small groups among the threads or in cracks in the food material.

_______________ 6. The front third of each wing is black and the rest is white with a few black or grey spots. The head is white.

_______________ 7. Adults live 15-30 days and females can mate and lay eggs on the same day they emerge from the cocoon.

_______________ 8. The larvae of this moth spins a small silken cell around it and carries the cell as it feeds.

_______________ 9. The body and wings are buff colored and the head has light-reddish hairs on top.

_______________ 10. Larvae of this moth make a silk tube, or burrow, in the material and feed inside this tube.

810. Match carpet beetle characteristics and habits with the beetles they describe.

Carpet Beetles. Several species of beetles may at one time or another damage fabrics. The four most common species are the black, varied, common, and furniture carpet beetles. Together, this group can usually be considered more important economically than the clothes moth. They all have a complete metamorphosis, with the larva being the only stage that causes damage to fabrics. All of the adults are small and inconspicuous and are not frequently seen by building occupants. Adults may be found indoors or outdoors and often are found on flowers around a house.

The *black carpet beetle (Attagenus megatoma)* is the most abundant and widespread of the carpet beetles and is the species that causes the greatest damage in most of the United

States. Adults are shiny black with brownish legs and grow to a length of 1/8 to 3/16 inch (fig. 1-8). They are frequently found outdoors in flowers and are most numerous in the spring and early summer. The adult lays its eggs indoors and outdoors starting 4 to 8 days after it emerges. Each female lays approximately 50 eggs over a period of about 3 weeks, after which she dies. These eggs are deposited in accumulations of lint, in air ducts, underneath baseboards, and other similar places. In warm weather, they hatch in 6 to 11 days.

Larvae are quite tiny when they hatch but have the same distinctive elongated carrot or cigar shape and the long brush of tail bristles of the larger larvae. Body color varies from a light brown to almost black. They can develop under a wide range of temperature and humidity conditions and are much less susceptible to normal changes than are the clothes moths. Over a series of 5 to 11 molts, the larvae may become as long as 1/2 inch. They tend to stay away from light and thus are found most frequently in the lower parts of clothes closets, rolled up or wrapped in woolen materials, at the edge of carpeting under baseboards, or inside upholstered furniture. Mature larvae are great wanderers and may be found anywhere in a building. It is not at all unusual to find them in a bathtub, kitchen sink, or even crawling on walls and ceilings.

Many other common beetles resemble adult and larval carpet beetles. The hide beetles, museum beetles, birdnest carpet beetles, and cabinet beetles all have a somewhat similar appearance. Although both adults and larvae may be mistaken for carpet beetles, close attention to the descriptions of the carpet beetles, together with the habits of the larvae, will usually be enough for proper identification.

Black carpet beetle larvae are general feeders, feeding on dead animal materials, hair, fur, hides, and horns as well as the usual woolen products and many plant materials such as cereals and stored grain and nuts. On wool, they tend to be surface feeders, usually eating the nap from fabric and leaving the base threads alone. They are, however, quite capable of eating large, irregular holes through any suitable food material. In fur, hairs are cut at the base with no injury to the hide; the hair then drops out readily leaving the hide bare. Frequently they burrow through containers to get food and leave small openings through which other insects may enter and cause additional damage. Cast skins and frass in the form of minute, irregular pellets are often left in the fabric. The black carpet beetle may live as a larva from as few as 9 months to as many as 3 years, depending on environmental conditions. Larvae pupate in the last larval skin, with the pupal state lasting from 6 to 24 days.

Varied carpet beetle. Varied carpet beetles *(Anthrenus verbasci)* are widely distributed in the United States. Adults are much smaller than the black carpet beetle, are rounded and have a varied pattern of white, brown, and yellow scales on the back. Eggs are laid in various locations, where they hatch in 17 to 18 days. Each larva molts, on the average, 7 or 8 times over a period of from 7 to 11 months. Mature larvae are rarely more than 1/4 inch long and bear 3 clumps of hairs on the back end of the abdomen. The larva is rather wide in proportion to its length and has a "hippy" appearance since it is usually broader at the back than at the front.

The larva of this beetle is a scavenger; it is quite common in nests of birds and spiders, on dead animals, and in insect collections. It feeds on a variety of animal products such as woolens, carpets, hides, feathers, horns, bone, and insect pupae as well as on plant products such as rye meal, corn, red pepper, and similar materials. It has also been found in drywood termite workings after fumigation has removed the termites. Pupae are formed in the last larval skin and take about 10 to 13 days to develop into the adult.

Common carpet beetle. Adult common carpet beetles *(Anthrenus scophulariae)* are small, rounded, and gray to black with a varied pattern of white and orange scales on the back. (See fig. 1-8.) There is an orange-red band of scales down the middle of the back. They feed on nectar and pollen in flowers. Each female deposits 30 to 40 small, white eggs which hatch in 10 to 20 days.

Larvae are active, frequently moving about rapidly. They are elongated, oval, rarely more than ¼ inch long, reddish-brown and covered with numerous black or brown hairs. There is an average of 6 molts over an average period of 60 to 70 days, after which pupation occurs in the last larval skin. The pupal stage lasts for 12 to 15 days before emergence of the adult. The adult beetle remains in the old larval skin for approximately 18 days before becoming active. Larvae often attack carpets, but they also eat other woolens, furs, feathers, silk, museum specimens, and similar materials.

Furniture carpet beetle. This beetle *(Anthrenus flavipes)* often attacks upholstered furniture. Adults are small, rounded, and blackish with a mottling of yellow and white scales on the back and a heavy coating of yellow scales on the femur of the legs (fig. 1-8). The color pattern varies considerably. In some specimens the yellow scales are darker and more numerous, while in others the white scales predominate. Females lay a total of 35 to 100 eggs in 1 to 3 batches which hatch, at room temperature, in about 3 weeks. Larvae have 6 to 12 molts over a period of 3 to 6 months. They are oval, somewhat elongated, and thickly covered with brownish hairs. The pupa is white and develops in the last larval skin. At room temperature, the pupal stage lasts 14 to 19 days. The adult rests in the pupal skin from 1 to 10 weeks before becoming active.

While furniture carpet beetles are often found on furniture (where they feed on hair, padding, feathers, and woolen upholstering), they are common feeders on other woolens, carpets, fur, bristles, horns, silk, and other such materials. They will also feed on such fibers as linen, cotton, rayon, and jute that are stained with animal excreta.

Odd beetle. This insect *(Thylodrias contractus)* has been called the "tissue paper bug," but this is an unfortunate misnomer. It is rather closely related to the carpet beetles, but the general appearance of the adult would hardly suggest such a relationship. Adult males have a long, narrow body with long legs and antennae (fig. 1-10). These characteristics contrast quite sharply with the rather oval body and compact appendages of the typical carpet beetle. The male is yellowish brown with a moderately dense covering of hair on the body. The elytra, when at rest over the body, touch each other on the inner margin for only a short distance and then separate noticeably toward the wing tip. This characteristic, plus the presence of a single median ocellus between the compound eyes, should serve to identify this beetle.

Adult females do not even look like a beetle in general body form. The body is broader and stouter than the male, and there are no wings. The antennae are thin and about twice

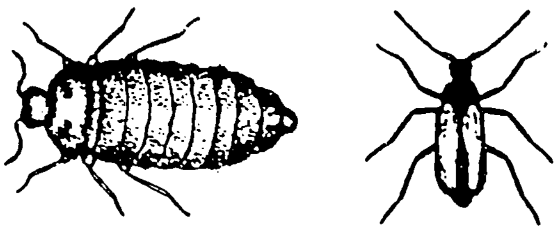
(7x actual size) (3x actual size)

Figure 1-10. Female (left) and male (right) odd beetles.

as long as the head is wide. There is a median ocellus between the rather small, compound eyes.

Larvae are rather similar to those of the carpet beetles, but do not have dorsal elongate hairs at the tip of the abdomen nor long hairs on the dorsal surface of the body. There is a dorsal row of large stout bristles across the rear edge of each body segment, and those on the rear edge of the prothorax are distinctly club shaped. The larva tends to roll up in a ball when it's disturbed, another aid in identification. These insects attack dry animal matter and will feed readily on woolen cloth. They have also been known to damage silk.

This beetle is an introduced species which seems to be increasing gradually in importance as a household pest. The wingless condition of the adult female suggests that dispersal of the species will depend primarily upon its being carried from place to place. This insect has been found in situations that seem to be remote from its normal food.

Exercises (810):

To which carpet beetle does each statement refer (black, varied, common, furniture, or odd)?

__________ 1. These adults are small, rounded, and grey-to-black with a varied pattern of white and orange scales on the back.

__________ 2. Adult males have a long, narrow body with long legs and antennae.

__________ 3. Mature larvae wander greatly and may be found in many parts of a building.

__________ 4. Adults have pattern of white, brown, and yellow scales on the back.

__________ 5. Larvae are oval, somewhat elongated, and are thickly covered with brownish hairs.

__________ 6. Larvae are frequently active and move about rapidly.

__________ 7. These larvae tend to roll up in a ball when they're disturbed.

__________ 8. Mature larvae are generally less than 1/4 inch long and have three clumps of hairs on the posterior end.

__________ 9. This species causes the most damage in most parts of the U.S.

811. State how to make surveys for fabric pests.

Recognizing Damage and Surveying for Fabric Pests. In most cases the presence of fabric pests goes undetected until someone sees that furnishings or clothes have been damaged. You may be called on to find out whether or not the damages were caused by fabric pests. Since pest damage may often resemble damage caused by such mechanical means as scissors, snags, punctures, cigarette burns, rodents, or termites, you must be able to tell the difference. The descriptions of damages and the probable cause of the damages in table 1-4 should help you. Keep in mind that the damage may be old and may have happened somewhere else.

Fabric pest detection requires a thorough knowledge of pest biology and behavior. Building occupants can also be a useful source of information. They will know where pet foods, mounted animal specimens, insect collections, skins, furs, woolens, seeds, fertilizers, and other items likely to be infested are located or stored. They may also know if there are bird nests under eaves or in the attic or if there are any wasp nests around. By asking these questions, the specialist may certainly save a great deal of time and trouble.

You'll need to make a thorough inspection of infested premises to find the source of infestation before making any attempt at control. It is important to remember that adults of these insects don't feed on woolens or on any of the other materials that might be attacked by the larvae. The presence of visible adults in an area does not necessarily mean that larvae are in the same area, since the adults may have already laid their eggs in some other room of a house and may be just moving around at random.

Larvae of both clothes moths and carpet beetles prefer to feed in secluded and protected places. When you search for them, a good flashlight and a knife, nail file, or small spatula are essential tools. Larvae will usually be found in dark clothes closets, in furs, woolens, bits of carpeting, and other such materials in storage. They are also found in lint, especially under baseboards and around door casings, in and under upholstered furniture, in collections of animal hair, in air ducts, occasionally in cereals in the kitchen, and anywhere else where suitable food material is available. As you look for carpet beetle larvae, be especially careful to examine under baseboards and around the bottoms of door casings. Use the knife blade or nail file to bring out bits of lint. Examine these closely for live larvae or their cast skins. Cast skins are sometimes more numerous than are live larvae, but they are such exact duplicates of larvae that they can be used for identification purposes. Use the flashlight to examine dark closets and other such places.

You must also consider certain natural sources of infestation. Always look for articles of woolen clothing that have been stored and neglected, and check for old furniture and rugs, which may be a source of continuing trouble. Less often considered reservoirs that are equally important are the *natural* habitat of these insects. Such places as nests built by sparrows, starlings, or other birds on or inside the building are often sources of infestations. Wasp nests, found quite commonly under eaves and in attics, are also common sources of carpet beetles and moths, whose larvae feed on the cast larval skins and sometimes on the living wasp larvae.

Table I-4

DAMAGE ASSESSMENT FOR FABRIC PESTS

Probable Cause	Damage Description
1. Webbing Clothes Moth	Usually fixed silk tubes sometimes bearing frass, this frass often showing the color of the cloth. Nap of wool eaten away in spots if lightly damaged; holes completely through fabric if infestation is extensive. Larvae may be present in the tubes. If fur, hairs are cut at base causing loose fur and exposing the hide with some webbing present. Fecal pellets are bun-shaped.
2. Casemaking Clothes Moth	Cigar-shaped cases 1/16" to 3/8" (size depending on larval age) usually attached to the fabric at one end. Cases white or bearing slight colors of the infested fabric. Cases appear to move about if larvae are inside and are stationary if they contain pupae or if empty. If cases are absent, damage is recognized as surface feeding in irregular furrows or when damage is severe, by holes through the fabric. Webbing essentially absent.
3. Mechanical Damage	Fabric actually cut; threads pulled, broken, torn, or looped; and exposed ends frayed. No loss of threads unless section of fabric torn out. Damage to neighboring area not expected. In rugs, loops pulled out.
4. Rodents	Damage is very similar to mechanical damage but the damaged area may be soiled and hairs may be present.
5. Burns	Irregular or round holes in wool that may or may not penetrate fabric. Tips of exposed threads usually curled and charred. In fur curling of damaged hairs; leather scorched.
6. Black Carpet Beetle	Fabric damaged with no traces of silk-like threads. Much surface damage with various penetrating holes. If infestation light, damage may be limited to scattered holes with surrounding surface damage. A few or many cast larval skins may be present. Frass in the form of minute irregular pellets often the color of the fabric. In fur, hairs cut at base with no injury to hide; hair drops out readily and hide may be bare in severe infestations. Cast skins; no webbing.
7. Furniture and Common Carpet Beetles	Fabric damaged with no traces of silk-like threads. Much surface damage with various penetrating holes. If infestation light, damage may be limited to scattered holes with surrounding surface damage. A few or many cast larval skins may be present. Frass in the form of minute irregular pellets often the color of the fabric. In fur and brushes, principal damage to tips of hair leaving numerous uneven areas.
8. Hide Beetles	Hide rather badly damaged on exposed side (not fabrication scars). If on fur, damage is on the inner surface; holes and loss of hair result from complete larval penetration of hide.
9. Termites	Cotton or hemp binding of wool rug eaten leaving the wool untouched. Hard mastic substance present.

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Another important reservoir of food material is accumulations of animal hair in homes with pets. Shed hair may accumulate in heating ducts, beneath furniture, or in hard-to-clean corners. These loose tangles of hair may sustain a small population of fabric pests for a long period of time in places where all wool products have been treated.

Exercises (811):

1. In a fabric pest survey, why do you inspect mainly for larvae?

2. What survey tools do you need?

3. List five indoor areas where you should check for fabric pests.

4. List two outdoor areas that are often pest reservoirs.

812. Verify or correct statements about fabric pest controls.

Controlling Fabric Pests. Prevention and correction of fabric pest infestations require special skills, an extensive knowledge of the problem, and careful workmanship. Preventive measures, in general, must be the key to fabric insect control because once a ''hole'' is made, the damage is done. Three areas of preventive procedures are preventive sanitation and related chemical measures, actual protection by mothproofing, and control of existing infestations.

Much can be done to prevent trouble by household cleanliness—thorough and frequent cleaning with a vacuum cleaner, brushing, airing, and drycleaning susceptible clothing—and by avoiding locations predisposed to infestation such as wall-to-wall carpeting and prolonged storage of discarded garments, bedding, and old rugs. Remember that a clean environment is not conducive to fabric-destroying insect activity. In all moth and carpet beetle control work, it is essential to eliminate as many breeding places as possible. Old pieces of woolen fabric, cutoff pieces of carpeting, old feather pillows, and other such sources of food should be destroyed and the areas under baseboards, behind door casings, under heat radiators, and inside furnace registers should be thoroughly cleaned with a vacuum cleaner to remove as much lint as possible. A professional, strong-suction vacuum cleaner is a good piece of special equipment for such an operation.

Several approaches can be made to the use of insecticides as preventive treatment in close association with sanitation. The most common is the use of Paradichlorobenzene (PDB) as a repellent and continuous fumigant in storage. Woolens to be stored should be interspaced with crystals of this material placed in clean paper as the fabrics are packed into tightly sealed trucks or boxes. Napthalene (mothballs), although less desirable to use, is effective at the same rate. Cedar closets and most cedar chests are ineffective. Fur storage in cold vaults is a worthwhile preventive measure.

Mothproofing. Mothproofing and moth control are two different things. Mothproofing implies prevention to avoid infestation. Moth control is the correction of an existing infestation. Mothproofing is often done by a special treatment during the manufacture of woolen fabric. Sometimes it is a service of the drycleaning industry. You will most often engage in mothproofing in connection with rugs, furniture, and carpets.

Various mothproofers give semipermanent protection from moth to carpet beetle damage. These chemicals depend either on poisoning the fabric so the larvae will be killed by very light feeding or on leaving a residual film that will kill larvae that contact it, or a combination of both.

Many fabrics treated with mothproofing solution at the time of manufacture are safe from damage until the chemicals are removed, either by washing or by drycleaning. You should never try to mothproof clothing. When the householder wants to have clothing treated, recommend that the treatment be done during drycleaning. Such mothproofing is usually quite effective for the time between cleanings or for storage over summer months.

Suitable chemicals for mothproofing are 2 percent malathion or 0.5 percent lindane used as spot treatment for the critical areas. In carpets, this would be around baseboard areas and under furniture. In furniture, this would be around seams, buttons, cracks, crevices, and padding areas. Observe the concentrations indicated because high quantities of some will result in ''blooming'' of insecticide on the surface of fabric. These chemicals are removed to some extent by washing and drycleaning; always follow the manufacturer's recommendations as to length of control.

Mothproofers may be applied as either oil-base or water-base chemicals. Where there are rubber pads or rubber fabric backing, a water base is always preferable—the oil will distort and damage the rubber. With either type, you should first apply some of the chemical to a small, inconspicuous part of the fabric or to some scraps to be sure the dyes won't be affected.

To apply mothproofers, a 1 gallon, compressed-air sprayer is usually preferable to power-operated or atomizing equipment. Mothproofing solutions should be applied only as a wet spray directly to the material. Use a hollow-cone, fan, or solid-cone nozzle that delivers about 0.1 gallon per minute.

Make applications to upholstery fabrics lightly and rapidly. Don't soak the fabric, because you'll almost certainly stain it. Give special attention to the padding of upholstered furniture; it's often feathers or horsehair, and it's susceptible to insect damage.

When you treat carpets, be careful to prevent staining or soiling. If possible, the carpet should be cleaned before you treat it. You can treat with water-base chemicals immediately after cleaning, but if your mothproofer is in an oil base, the carpet must be dry. Be very careful not to soil the treated carpet with dirt from your shoes. Use either polyethylene or flannel slip-on covers, such as those used by window trimmers, to cover your shoes or carry a clean pair of shoes to be used only inside the house.

It is best to remove all furniture from a room before you treat it. This is not always possible due either to the size and weight of the furniture involved or to a lack of space to put it elsewhere in the house. You can move the furniture, treat the carpet, and return the furniture if you place some kind of temporary pad under the casters or skids on the bottom, as well as entirely underneath wood or metal which may touch the carpet. If you don't do this, you'll end with rust marks on the carpet from metal parts or stain marks from the wooden parts of furniture. Both types of stain are almost impossible to remove and may result in damage claims. Corrugated cardboard cut into strips or squares makes good pads for this purpose, as do folded paper towels and small paper or aluminum pie plates. These pads should not be removed until the carpet is thoroughly dry, usually a matter of 2 or 3 days. Be very careful to tell the occupant to keep small children and pets out until the furniture and rugs are thoroughly dry, since any mothproofing chemicals are poisonous to some degree while they're wet.

Controlling existing infestations. Corrective measures to get rid of an existing moth or carpet beetle infestation is the phase of this work most commonly engaged in by pest managers. It consists of thoroughly evaluating the infestation, instituting sanitation measures, and then (and only then) applying chemicals where they're needed.

When infestations are not heavy, application of a good contact spray will kill both adults and larvae that are exposed to it. Synergized pyrethrins, DDVP, and resmethrin will be effective. Apply these sprays closely to cracks and crevices with as much force as possible to drive in the spray deeply. In closets, an aerosol spray is frequently effective. With all such applications, take care to avoid staining clothes, walls, or furniture. You might get good results by using a mist or ULV machine to treat a room or even a whole house—but be sure to cover all food, food containers and fish tanks and to remove any plants that might be damaged.

For heavier infestations and for building areas that need longtime protection, use residual insecticides. You can spot treat with liquid formulations of the insecticides listed for mothproofing. You can spray nonfabric areas with 0.5 percent Dursban, 1 percent diazinon, or 2 percent malathion. Make dust application of 2 percent diazinon or 5 percent malathion for such hard-to-reach places as wall voids or false floors. Use the same methods of application and general handling of fabrics and fabric products as for mothproofing.

If furniture is infested, you may have to open cushions or remove the covering from the bottom of sofas and chairs to expose the padding for treatment with sprays that won't hurt it. You can also dust it thoroughly with a suitable dust. Generally, a dust application is better, as there is no drying time involved and the results are long lasting.

Exercises (812):

Identify the following statements as being true (T) or false (F). Correct any false statements.

____ 1. Household sanitation plays a minor part at best in preventing fabric pests, since they feed on such a wide variety of materials.

____ 2. Repellent chemicals such as PDB are useful for keeping fabric pests from attacking stored materials.

____ 3. Cedar closets and most cedar chests are ineffective for preventing fabric pest infestations.

____ 4. Mothproofing carpets gives permanent control against fabric pests.

____ 5. You should never attempt to mothproof clothing.

____ 6. When you use residual sprays to mothproof a carpet, you should treat the entire carpet.

____ 7. Before spraying a carpet, you should apply the chemical to a sample or hidden part to make sure the chemical won't discolor or damage the carpet.

____ 8. In spraying upholstery, you need a heavy application to penetrate the thick fibers thoroughly.

____ 9. If a carpet is still wet from cleaning before chemical treatment, you should only use a water-base spray.

____ 10. When existing infestations aren't heavy, a good contact spray is effective for controlling all adults and larvae it contacts.

Structural Pests

STRUCTURAL pests are the most important pests, from an economic standpoint, on military installations. These pests include fungi, termites, powder-post beetles, carpenter bees, and carpenter ants. You must be very familiar with these pests because it is your responsibility to prevent pest damage to all base facilities. Your duties include making frequent inspections and taking preventive and corrective action to keep structures free from structural pests. This chapter will cover the importance, descriptions, and general characteristics of the more important structural pests and the preventive and corrective controls you can use to keep base structures free from destructive fungi, termites, powder-post beetles, carpenter bees, and carpenter ants.

2-1. Subterranean Termites

You will more than likely be spending a lot of time on the job inspecting base facilities for termites and then controlling them. It is part of your responsibility to prevent damage by termites whenever possible as well as to detect early infestations and take action.

813. Cite details of the importance and life history of subterranean termites.

Importance of Termites. Termites are the most destructive insect pests at military activities, and of all pests, they rank second only to wood-destroying fungi. They may damage a building enough for condemnation. They eat wood and other cellulose products, such as paper, cardboard, and fiberboard and will destroy structural timbers, pallets, crates, tool handles, furniture, books, and other wood products. Also, in their search for food, they will damage many materials that they don't normally eat. In tunneling through the ground, subterranean termites can penetrate lead-covered and plastic-covered electrical cable and thus short out electrical systems.

The order Isoptera consists entirely of termites, which are primitive insects closely related to cockroaches. In nature they help to convert deadwood and other materials containing cellulose to humus. From this standpoint, termites are very beneficial animals. Only when people started to build in the natural home of the termite did they start feeding on our buildings. Termites' digestive tracts harbor certain one-cell organisms that convert cellulose into simple substances the termites can digest. Termites are social insects, with division of labor between different types of individuals (castes). Nearly all termite species have reproductive and soldier castes. In many termite societies there is a distinct worker caste, but in many of the more primitive species, the typical duties of the workers (nest building, food gathering, and feeding of reproductives and soldiers) are handled entirely by the nymphs. Even in species with workers, the older nymphs usually do much of the work, earning the title of functional workers. The literature on subterranean termites has many references to the worker caste. Recent investigations of living colonies indicate that there may not be a true worker caste in our common North American species and that what we have long considered to be workers are actually late instar nymphs.

Workers and nymphs of subterranean termites do all the work of the colony, and they're the forms that do all of the structural damage that concerns pest managers. Soldiers serve only to defend the colony against its enemies and cannot eat wood. They, together with the reproductives, are fed by the workers. Both workers and soldiers are blind.

Winged adults are referred to as the primary reproductives. They leave the colonies on colonizing flights at certain seasons of the year. After these flights, they lose their wings and build a small cell in which they mate, reproduce, and rear the first group of workers. Where these primary forms are not present, supplemental or secondary reproductives without pigmentation or functional wings occur, often in large numbers. Each termite colony is self-supporting and essentially independent of other colonies.

Life History. The stages in the life history of subterranean termites are essentially the same for the various species of concern to you. Termites develop from eggs laid by the primary or secondary reproductives (fig. 2-1). Nymphs hatch from the eggs and undergo several molts, through which different individuals develop into various forms. Four different castes can develop from nymphs: workers, soldiers, primary (winged) reproductives, and supplementary reproductives. In new colonies, nymphs from the first small batch of eggs usually all become workers. Other forms normally are not produced until later egg laying.

In species that have workers, they are the most numerous caste, doing all the work of the colony—feeding the other forms, grooming the queen, excavating the nest, and making the tunnels. In the process of making nests and tunnels and ingesting food, they chew and eat cellulose, thus causing the destruction that gives them economic importance. Worker

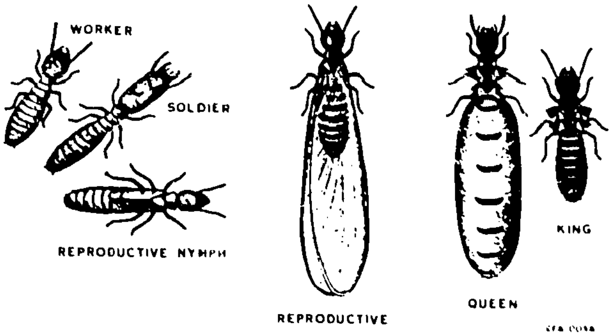

Figure 2-1. The termite.

termites are usually light colored and do not have wings or other specialized structures.

Soldier termites protect the colony from its enemies. Their heads are large and quite hard, and they have much larger jaws than the other forms. When openings are made into termite workings, the soldiers gather, with their large heads and strong mandibles facing outward, to protect the colony from invaders.

Secondary reproductives of both sexes are wingless or have only very short wings. These forms are developed as needed and quickly take the place of a queen who is injured or dies. They usually develop in addition to the regular queen and become the most important source of eggs in the colony. Others, with a group of males and workers, may become isolated from the colony and establish a new one, thus spreading the original infestation without being visible above ground at any time.

Primary reproductives (swarmer termites) are the forms most often seen by building occupants. The winged adults are usually much darker than the other members of the colony. All four wings are the same length and extend more than the length of the body beyond the tip of the abdomen. Both male and female reproductives leave the colony in great numbers, usually in the spring or fall, in swarms which are often the first visible indication that termites are present. Environmental conditions have to meet certain requirements before termites will swarm. The temperature, moisture (inside and outside the colony), light conditions, and even barometric pressure influence swarming. As a general rule, swarmers emerge on warm sunny days when the humidity is high.

After a brief flight, the wings break off and males and females pair and try to establish a new colony. They are particularly defenseless at this time, and many die or are killed by their natural enemies. Each surviving pair will make a small cell in which they will mate and lay eggs. Although this is the classical cycle of termite reproduction, there is an unfortunate tendency to overemphasize the importance of the primary queen. Secondary reproductives are responsible for the production of most of the eggs within a colony after it has become established. In a colony of one million individuals, the queen may have laid as few as 10,000 of the eggs from which individuals develop, with supplementary reproductives responsible for the remainder.

Swarmer termites are often confused with flying or swarmer ants. Since ants are often seen swarming around buildings, it is important to be able to distinguish the two so appropriate control recommendations can be made. Ants have a very thin waist between the thorax and the abdomen, while termites are broad waisted. Termite wings are all about the same size and shape, where the forewings of the ant are larger, longer, and of a different shape from the hindwings. A third difference involves the antennae; termite antennae are straight, and ant antennae are elbowed.

Exercises (813):

1. How do termites rank among the destructive pests at military activities?

2. List five substances termites eat.

3. How are termites beneficial?

4. Which members of a termite colony do all the work?

5. In colonies that have workers, what are their responsibilities?

6. What caste is the most important in terms of egg production?

7. Which termite form is most often seen by building occupants?

8. Compare swarming termites and ants in terms of body shape, wings, and antennae.

814. State how the environment affects termites.

The Termite and its Environment. Subterranean termites are very closely dependent upon a complex of environmental factors that normally restrict the colony to the soil. We mentioned contact with the soil as a source of moisture, and although this is the fundamental need, the simple statement that moisture is essential tends to make the relationship seem more simple than it really is.

The workers, soldiers, supplementary reproductives, and nymphs are soft-bodied insects which tend to lose water very rapidly upon exposure to dry air. This fact illustrates one of the important functions of an available moisture source, and it is reflected in the habit of construction of tubing when the termites pass over exposed areas. While these tubes serve as a means of concealment and also to some extent as a mechanical barrier against intrusion of ants, moisture retention and preservation of high humidity around the termite is probably the most important function. The termites' negative response to light is intimately involved with keeping the termite in a concealed environment, and it may have started as a response to the great problem of water loss.

The mere retention of moisture is not the only important facet of the termite's life that's associated with water. The warm, moist conditions within the closed system of the nest provide an ideal site for the growth of micro-organisms, particularly fungi, which apparently provide protein and vitamins that are essential to the termite. The accumulation of fecal material, in turn, adds to the material available to promote the growth of the fungi.

The most striking facet of this intricately interdependent system is the delicacy with which it is balanced. It is not rare to discover the remains of a termite colony that is slowly being crowded out by fungi that have grown too fast for the termites to "keep up with it." If sudden temperature shifts or other factors cause water to accumulate in the galleries, the termites may literally drown. Each autumn the termites in the temperate zone normally respond to more gradual temperature changes by moving downward in the soil where the necessary stable conditions of temperature and humidity can be maintained. In the following spring, the colony then seems to respond to increased temperatures and moisture in the soil above and again moves upward.

Colony Development. A relatively new colony of subterranean termites will normally consist of the original pair of reproductives, a few dwarf workers, and one dwarf soldier. During the second year, the young reproductives may be found. A full 2 years is required for the complete development of the reproductives. In older colonies, supplementary reproductives may help with colony development, producing thousands of eggs and a quarter of a million termites. In the colonies of subterranean termites, the worker caste predominates. The workers are small, cream colored, soft bodied, and sexless. The soldiers have large heads with specialized mouth parts and are normally incapable of feeding themselves.

During periods of favorable weather, mature colonies may produce new swarms of dark-bodied, winged reproductives. The time of emergence will depend on geographic area, climatic conditions, the species of termite involved, and other factors such as the temperature of the building or soil. In temperate areas, the emergence of termites may be expected in the spring, and depending on species, also at odd times during the summer and fall. If the emergence occurs within a building, the flying termites may constitute a considerable nuisance. Since the reproductives may be emerging as fast as the opening size permits, residual insecticides or contact insecticides used as sprays or mists will be of little value. Injecting contact insecticides into the emergence openings can provide some relief, but if nothing is done, the emergence will last for only a few hours.

Exercises (814):

1. Why do workers, soldiers, and secondary reproductives need to live in a high-humidity environment?

2. What other purpose does humidity serve in the colony?

3. What termites are generally included in a relatively new termite colony?

4. What factors govern the time of primary reproductives swarming from a termite colony?

815. Identify species of subterranean termites with their appearance and characteristics.

Subterranean Termites of North America. The large majority of termite damage in the United States is caused by subterranean termites although, in certain specific areas, others may be the principal problem. Several species of the genus *Reticulitermes* comprise our most important and widespread group of subterranean termites.

Subterranean termites differ from the dry-wood and damp-wood termites in that colonies usually need contact with the soil to get enough water to survive. In a few cases, where structural timbers are damp enough, colonies can survive without ground contact, but this is not common. The underground colony lives in a series of chambers and galleries, from which they build mud tubes to the wood they use as food.

Eastern subterranean termite. The eastern subterranean termite, *Reticulitermes flavipes*, is thought to be the most common and widely distributed termite in North America. It is found from Ontario, Canada, south to Florida and west to Arizona and Utah. This very destructive termite damages building timbers and contents, fence posts, utility poles, and occasionally, living plants. Swarming starts as early as February in the Southern States and as late as May or June in the colder areas. There may be late-fall swarming, from September to November. Swarms have occurred every month of the year where there are heated slabs.

Light southeastern subterranean termite. The light southeastern subterranean termite, *Reticulitermes hageni*, occurs from the District of Columbia south to Florida and west to Texas and Kansas. Swarming occurs from August to October in the northern part of its range and from October to February in Florida.

Southeastern subterranean termite. The southeastern subterranean termite, *Reticulitermes virginicus*, is found from Philadelphia south to Florida and west to eastern Texas and Oklahoma. Swarming flights occur in May or June with some fall flights in October and November.

Pacific Coast subterranean termite. The Pacific Coast subterranean termite, *Reticulitermes hesperus*, is the most destructive subterranean termite on the West Coast. This termite excavates galleries in wood similar to those of the eastern subterranean termite, spotting the wood with dirty, yellowish-brown fecal spots. It builds shelter tubes, but less commonly than the eastern termites. This termite is found from British Columbia south to western Mexico and east to Idaho and Nevada. It is a slow developing species with the flight of reproductives not usually occurring from new colonies until after the fourth year.

Formosan termite. Another subterranean termite that has been found in the continental United States as well as Hawaii is the Formosan subterranean termite, *Coptotermes formosanus.* Since 1965 this termite has been found in several cities along the coast lines. The number of infestations already located, the evidence of large, widely dispersed swarms, and the fact that some infestations appear to have been active for years suggest that this termite is now firmly established on this continent. It is one of the world's most aggressive and economically important species of termite, and it has been reported to cause more damage to structures in Hawaii than any other insect. They represent an extreme economic hazard in all areas where they become established. Although subterranean in nature, the termite is quite active without soil contact as long as there's enough moisture to support the colony. Although this termite is found mainly in tropical regions, it has moved into more temperate areas in shipments of infested wood and wood products. Figure 2-2 compares Formosan termites to other species.

Formosan termite nests are made of a combination of chewed wood, saliva, and excrement called carton. No other termite in the United States builds such nests. The primary nest is usually near a source of food in or on the soil. Foraging galleries lined with carton material are then built to the food source.

Auxiliary nests often are built in the walls of buildings or in the food source. When a nest or gallery is disturbed, the Formosan termite soldiers are usually present in larger numbers and are more aggressive than native termites.

Formosan termites are easily recognized as soldiers or as winged reproductives. Their characteristic carton nests also are easily identifiable. The Formosan termite soldier is characterized by an oval, or egg-shaped, head that is shorter than the heads of native termites. When you inspect an infested timber, soldiers are more abundant than with our native termites. Further, the soldiers are more aggressive and will attack anything used to probe the damage. When

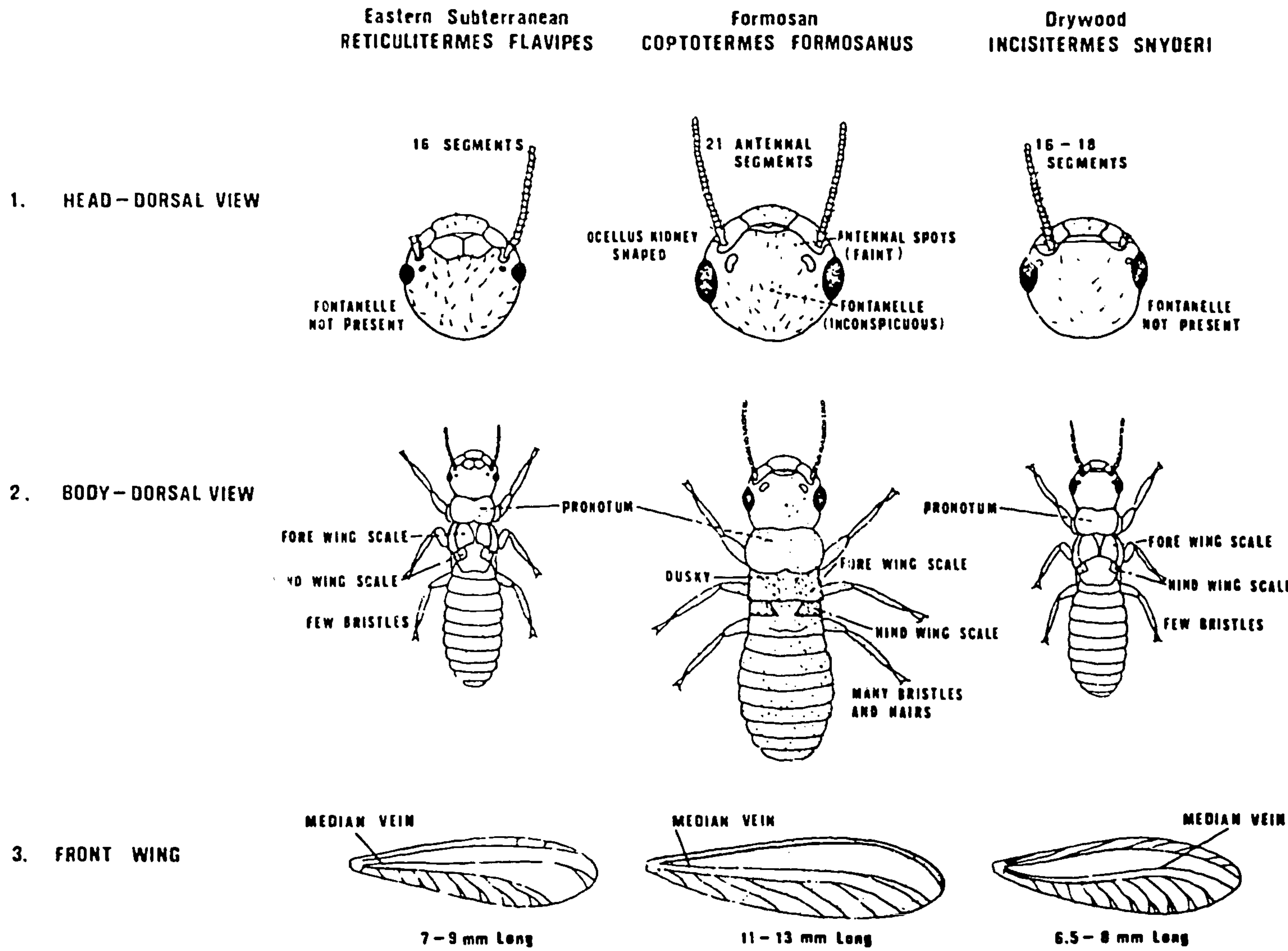

Figure 2-2. Winged reproductive comparison: The Formosan termite to *Incisitermes snyderi* (dry-wood) and *Reticulitermes flavipes* (eastern subterranean).

they're disturbed, the soldiers exude a white substance from the fontanelle, which is a tubelike gland readily seen on the top of the head. The fontanelle is small and barely visible on native termites.

The winged reproductives of the Formosan termite are yellowish brown and 12 to 15 mm long. Native subterranean termites are 10 mm long. The ocelli of the Formosan termite are large, whereas they are small on native termites. Tiny hairs not present on the wings of native termites can be seen on the wings of the Formosan termite under low magnification. The workers and nymphs of the Formosan termite are not easily distinguished from other termite species, so look at winged reproductives and soldiers when you try to identify the Formosan termite.

Desert termite. In addition to the members of the genera *Reticulitermes*, and *Coptotermes*, the soldierless, nasutiform, and desert termites are subterranean in habit. Of these, only the desert termite, *Amitermes wheeleri*, damages buildings. This species is distributed from southwestern Texas through Arizona and Nevada to California. In nature, they live in dead trees, stumps, and cactus plants. They are strong fliers and invade buildings built in arid areas.

Exercises (815):

To which species of subterranean, North American termite does each statement refer (eastern, light southeastern, southeastern, Pacific Coast, Formosan, or desert)?

______ 1. Relatively new to North America, this is one of the world's most aggressive and economically important termites.

______ 2. Although shelter tubes are built by this termite, they are less common than with the eastern subterranean termite.

______ 3. This species swarms from August to October in its northern range and from October to February in Florida.

______ 4. This is the most common and widely distributed termite in North America.

______ 5. The range of this termite is from the District of Columbia to Florida and as far west as Texas and Oklahoma.

______ 6. Colonies develop slowly with this species, with reproductive flights from a new colony not occurring until after the fourth year.

______ 7. Although subterranean in nature, these termites can be very active without soil contact if there's enough moisture available in the wood.

______ 8. This is the most destructive subterranean termite on the West Coast.

______ 9. These termites are strong fliers and invade buildings in arid areas.

______ 10. With this species, swarms have occurred in every month of the year where associated with heated slabs.

816. Verify or correct statements about termite damage patterns and surveys.

Damage Patterns. Depending on the design and building materials used, the quality of workmanship, and certain environmental factors, a given structure will be subject to attack by a given species of termites in a particular manner. Termite attacks in several similar buildings are so similar that you can find a predictable pattern.

In their blind probing for new sources of food, subterranean termites construct exploratory tunnels through the soil. These tunnels emerge above the ground level and are then usually cemented securely to solid objects, such as foundation walls and piers or pipes. These tunnels of earth and other materials can continue upward, when protected, until the termites find food. They often reach heights of several feet. If solid objects block their path, the termites will continue probing until they have found or created a passage. They can penetrate expansion joint fillers. They can also use natural cracks in foundation walls. Because the spaces between bricks or building blocks are rarely completely filled, termites may use these areas. Hollow-tile foundations can provide a nearly perfect approach to structural wood, as the termite tubes are well protected and are not detected during inspections.

Once gaining entry to the wood of a building, the termites may carry on their destruction for several years before they are found. The use of termite shields will, if the shields are properly installed and maintained, force the termites to extend their tubes out over the surface of the shields and thus will facilitate inspections. In buildings comprised primarily of concrete and masonry, damage may be limited to such wooden items as doors and window frames, baseboards, and insulating materials composed of wood fibers. In masonry and concrete buildings with wooden floors, damage may be most severe below the floor level. In frame buildings with solid-concrete decks, the damage may be evident first in door or window frames or baseboards, but more extensive hidden damage to studs, sheathing, and sole plates may exist. In wooden-frame buildings, the pattern varies, depending on the type of construction and environmental factors, but the damage may include all of these types.

Though it is unusual, a new building can be damaged severely during its first few years. This will happen when wood debris, usually tree stumps and roots, containing large, active colonies is left in the soil at the building site. Under such conditions, the extended pattern of damage is the same as that found in older buildings with well-established colonies. The emergence of termites at a point much above the first-floor level in a frame structure would normally indicate a large colony and considerable damage. An emergence of subterranean termites may occur in the attic of a two-story building. Subterranean termite tubes have been found at an elevation 62 feet above the ground level in a military building.

Survey Techniques. Inspect all structures built wholly or partly of wood at least annually for active termite infestations, regardless of preventive measures used in construction. Also give attention to those conditions conducive to future termite attack. Under some conditions, inspections should be made semiannually rather than annually. The subterranean nests of termite colonies or points of entry into buildings can often be found quickly if the emergence is observed. For this reason, you should give prompt attention to all complaints, such as those concerning "flying ants," which could indicate a termite emergence. Record all information available at the time you answer the complaint on the form used for recording the scheduled annual or semiannual inspections. The purpose of the annual or semiannual inspection includes onsite planning of control procedures as well as the detection of active or potential infestations. Thus, the inspections should be made by personnel trained in selecting and applying control techniques as well as in determining the need for control. All termite inspections and treatments must be recorded on the DD Form 1070, Termite and Wood Decay Inspection.

When you inspect a building for subterranean termite infestations, you must be able to tell whether or not there are termites. This often takes a great deal of effort, specialized techniques, and information. You must know which species live in your area. You must also know the habits of each of them to spot every sign of infestation. Recognizing the signs of damage helps you know whether or not termites are present and helps you evaluate the extent of an infestation.

Use a good, bright flashlight to check each potential trouble spot closely, and actually crawl into most spaces and other nonbasement areas. You usually can't get a good view from farther than a few feet. For this part of your inspection, wear coveralls to protect your usual clothing. Be prepared to measure the structure accurately and prepare a scale drawing to pinpoint your findings. A steel tape, a folding rule, and a rolling measuring device or an ordinary yardstick are essential parts of every inspector's equipment.

The presence of swarmers or their shed wings almost always indicates that there is a termite infestation. To do a good control job, though, you must not only find out where the swarmers came from, but you must also locate all exposed tubes and damaged wood.

The workings of subterranean termites differ from those of all other wood-destroying organisms. These termites remove only the soft layers of the annual rings in wood, penetrating the hard layers only to get from one soft layer to another. This often leaves a damaged piece of wood looking very much like the pages of a book. The most distinctive feature of subterranean termite damage is the presence of a brown masticlike material that lines the galleries in an irregular pattern.

Subterranean termites travel constantly from their nests in the ground to the wood, or other cellulose on which they feed. They make these trips only inside wood or in the mud tubes which they construct. Single tubes, when they are built in the open, are about the diameter of an ordinary lead pencil.

These termites, in common with other termites, may excavate the wood so that only a very thin shell is left on the surface between their cavities and the outside. When this shell is broken, they will cover the hole with the same pe material with which they make their tubes. This mud is also frequently used to cover the crack between two boards, or in a heavy timber, so the termites can move about in a protected situation.

As a general rule, subterranean termites are found at or near ground level. Only seldom do they occur above the level of first-floor windows, except in the warmer areas of the country. You must therefore examine thoroughly all of the underparts of a house such as the basement or crawl space walls, supporting piers, sill plates, floor joists, and subfloors. Pay particular attention to all places where concrete steps, porches, or concrete slabs join with the structure.

In wood, you can detect cavities that aren't visible from the surface by tapping on the wood and listening for the hollow sound given off by damaged wood. Occasionally you can detect a "ticking" sound made by the disturbed soldiers within the wood. This tapping does not take a heavy object; you can do it with a small hammer, or even by thumping the wood with your knuckles. Cavities can also be detected by probing the wood with a tool such as a screwdriver, awl, geologist's pick, or pocketknife. Some specialists prefer to probe deeply, thus making deep, visible marks in the wood. Just as thorough an inspection can be made leaving scarcely visible marks by using the small blade of a penknife to probe the wood. The sharp blade will penetrate deeply and will detect cavities in the wood just as easily as will the larger tools. In some types of construction, the use of heavier tools may be necessary.

The presence of live termites in the tubes or wood is, of course, certain evidence of their presence. Failure to find them, however, does not necessarily mean that they are not in the structure. You must be able to tell the difference between new workings and old. As a general rule, old mud is dry and brittle and breaks away easily. Fresh workings will be moist and stronger.

Additionally, inspections should show up any risk of contamination. Wells, springs, cisterns, etc., can be contaminated by improper insecticide applications, and so termite control takes special care. Alternate methods of control using limited amounts of insecticides, or no insecticide at all (mechanical alteration), generally require more labor and are more expensive, but you may have to use them to avoid a contamination problem.

Exercises (816):

Place the letter "T" before the true statements. Correct any false statements.

_____ 1. Termite attacks in similar buildings are not usually so similar that a predictable pattern may be found.

_____ 2. Subterranean termites will build tubes of earth up the foundation walls.

_____ 3. In buildings made primarily of concrete and masonry, damage may be limited to wood doors and window frames.

_____ 4. In concrete and masonry buildings with wooden floors, the damage may be very severe above the floor level.

_____ 5. In frame buildings built on concrete slabs, the damage may be evident first in door or window frames or baseboards.

_____ 6. The emergence of termites at a point much above the first floor level in a frame structure would indicate a large colony and considerable damage.

_____ 7. All termite inspections and treatments must be recorded on DD Form 1070.

_____ 8. Pest control supervisors should not give prompt attention to all complaints.

_____ 9. The presence of termite wings in a building is almost never a good indication that termites are infesting the building.

_____ 10. Termites often excavate the wood so that only a thin shell is left on the surface.

817. Cite preventive controls for termites.

An effective and economically managed program of termite control will always include the three principal phases of inspection, preventive control, and such corrective control as may be required. The techniques used include *elimination of food* through proper design and construction and through the application of sanitation at the building sites; *moisture control* through adequate drainage and ventilation; *exposure of termite tubes* through the use of impenetrable barriers between the soil and the structure wood; and *use of chemicals* to poison directly, to create barriers by soil poisoning, and to preserve the wood.

Preventive Control. The best time to provide protection from subterranean termites is during the planning and construction of a building. Many common design and construction practices are favorable for infestation. Some preventive control measures can be applied after construction and during the use of the buildings.

Construction. Military buildings should be planned and constructed to provide protection against termites. Recommendations regarding design and construction and the use of wood preservatives should be followed without deviation regardless of the urgency to complete construction by a specified date. Some common errors of design and construction are burial of stumps, logs, boards, stakes, form lumber, and wood scraps beneath buildings or next to the foundations; improper grading and drainage; insufficient air circulation and cross-ventilation; and failure to use chemically preserved wood.

Site sanitation. All surplus wood, including stumps, tree roots, logs and other wood debris, should be removed from the building site before construction work is started. All form lumber, grade stakes, and wood scraps should be removed by the time construction work has been completed.

Foundation construction. It is important that building foundations be impervious to subterranean termites and that woodwork resting on the foundation be protected against attack. Foundation types may be rated by their relative resistance to penetration:

- Poured concrete, reinforced to prevent cracks, with the expansion joints properly filled.
- Masonry walls capped with at least 4 inches of reinforced concrete or its equivalent.
- Hollow blocks with all of the top rows and joints between blocks filled with concrete.
- Wood posts, piers, steps, or braces pressure treated with chemical preservative and capped, when recommended, with metal termite shields to keep the insects from gaining hidden access to the buildings or other structures.

Ventilation and drainage. It is necessary to provide adequate ventilation and drainage to prevent termite attack. The number and size of openings should be determined by the soil moisture, air movements, and humidity. Areas beneath buildings should be well drained. The soil next to foundation walls should be graded to permit the drainage of surface water away from the buildings.

Clearance beneath buildings. In order that periodic inspections can be made for subterranean termites, adequate crawl space should be provided beneath buildings. The minimum clearance for effective inspection is 18 inches from the ground to the bottom of lowest joist, beam, or girder.

Skirting. When skirting is used, a clearance of 3 to 6 inches between it and the ground is needed. If this space is closed in winter, it should be reestablished early each spring.

Miscellaneous appendages. All miscellaneous building appendages, including porches, steps, terraces, platforms, and fire-escape ladders, should be installed with an unbridged clearance or effective barrier to keep termites out. All wood used in contact with the soil should be pressure treated with approved wood preservatives. Only treated wood should be used for construction timbers placed on concrete or masonry foundations. Pipes and conduits often provide entrance points for termites. Plumbing, electrical conduits, and other piping should be installed clear of the ground and should not be supported by wood braces or other appendages that touch the ground. At the point where piping enters the floor or wall from below ground, a funnel shield caulked with a coal-tar mastic is an effective barrier.

Pretreating. In recent years, the treatment of buildings under construction has become a standard procedure in many parts of the country, especially for slab-on-ground and basement construction. The toxicant must be applied to the soil with such thoroughness and uniformity that it provides a barrier to all routes of termite entry.

Pretreatment should be carried out only when favorable conditions prevail. It is extremely unwise to treat soil that is very wet because there is likely to be considerable surface flow of the chemical from the site of application. If the treated areas won't be covered immediately, take precautions to keep people and animals from contact with the treated areas.

Wood preservatives. Lumber and other forest products that are exposed to excessive moisture, fungi, and wood-destroying insects such as termites should be treated with wood preservatives to prolong their useful life. The type of treatment and the preservatives to be applied depend on the type and severity of exposure and on the desired life of the material. Surface treatments and dip or soak treatments that provide shallow penetration protect wood against dry-wood termites, but we need the deeper penetration of pressure treatment to protect against subterranean termites. Only the wood actually treated is protected. Termites will "bridge over" treated wood with their shelter tubes just as they will bypass other nonedible structural materials.

Exterior surfaces. You can get further prevention of attack by dry-wood termites by keeping smooth exterior surfaces on buildings All exterior cracks, grooves, and joints should be well filled before painting. A good coat of paint, with careful application at points of vulnerability, will help ward off attack.

Exercises (817):

1. What are the three main phases of termite control?

2. When is the best time to provide protection for subterranean termite attack?

3. What is the pretreatment for a building?

4. During construction, how should lumber and other forest products be prepared?

818. Cite corrective termite control measures.

Corrective Measures for Subterranean Termites. It is obviously impossible to list every detail of treatment for subterranean termites. Widely varying types of construction, even within small regional areas, make it necessary for you to think in terms of the principles of control and adapt your method of control to fit the situation.

The one thing you're trying to do in subterranean termite control is to make it impossible for termites to move between their nests, usually in the ground, and their food which is the wood in a structure you want to protect. We just saw how this is done in buildings under construction by keeping wood out of contact with the ground and by pretreating to make a chemical barrier. In buildings already constructed, the barrier is made either with chemicals or by modifying the existing structure to make a mechanical barrier.

The basic steps of a complete treatment are mechanical alteration, soil treating, foundation treating, and wood treating. Any given termite control job may involve one, several, or all of these steps, depending primarily on the type of construction. In many situations a most adequate treatment may be applied without involving all 4 types of treatment.

Mechanical alteration includes such modification of the structure as introducing barriers of an impermeable material (concrete, metal, etc.); removing cellulose debris; eliminating moisture near or in the structure; establishing good ventilation in the infested area; providing for inspection of the entire structure; and breaking wood-to-soil contact (for example, siding below grade level).

Soil treating is applying chemicals to the soil under and near a building to create an impervious barrier. Points where barriers should be established include along the inside and outside of the foundation, under slabs, and around utility entrances. *Foundation treating* is applying chemicals to a foundation to make it impervious to termites. The purpose is to get chemical into any cracks at the footing and through cracks in the wall leading to the ground outside. *Wood treating* is applying chemicals to wood to eliminate existing termite infestations or to make the wood impervious or resistant to termites.

As a general rule, the first 3 methods are used in termite control practice, with wood treatment as a pretreat or supplemental measure. Pressure-treated wood gives most effective control when it is used for all wood construction, at least to the ceiling level of the first floor. Spraying chemicals on wood that's already in place gives only a surface treatment and only rarely penetrates to the center of the wood. In badly damaged wood, injecting chemicals into the cavities made by termites will give a much better treatment than brush or spray application. Pentachlorophenol in a paste emulsion form gives much greater penetration and thus greater protection both from termites and fungus attack.

As a typical construction you might face in termite control work, let's consider the wall of a brick veneer house in which the brick veneer extends below grade (fig. 2-3). This construction, with a few variations, occurs in a large proportion of the houses in this country. Points of probable infestation are through cracks in the brick mortar below grade on the outside and through tubes on the face of the foundation on the inside.

You can use mechanical alteration on the outside by removing the lower courses of brick to above the grade line, filling the void with mortar, and replacing the brick. You

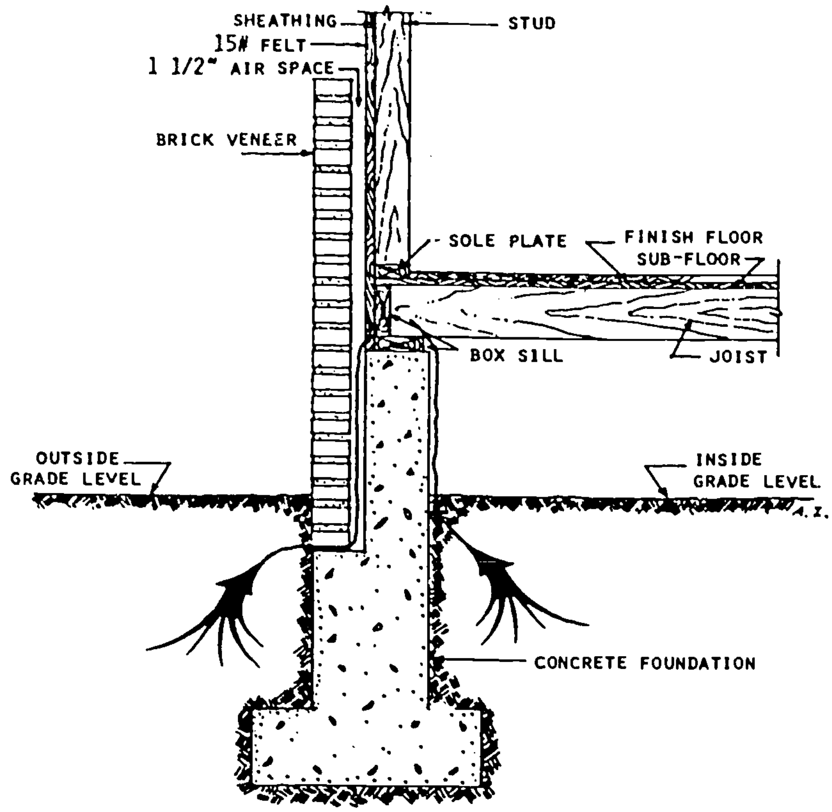

Figure 2-3. Construction with impervious veneer over wood sheathing, extending below the sheathing and below grade level.

could also lower the grade on the outside to below the brick, then either retain it with a wall built out from the building or build a gutter (fig. 2-4). A poured concrete flash wall barrier is often used in this situation on the West Coast.

In many parts of the country this area can be treated effectively through chemical means alone. Ideally, the soil adjacent to the foundation would be removed to within about 1 foot above the footing. As the soil is replaced, it should be treated with chemicals at the rate of 1 gallon per 5 linear feet for each foot of depth from grade level to footing. Allow 2 gallons per 5 linear feet for the first foot at ground level. In practice, a small trench is usually dug about 4 inches deep next to the foundation and treatment begun from here. The chemicals can be carried to the level of the footing by removing cores of dirt at 1-foot intervals, or by flooding the soil at the same intervals, injecting the chemicals through a long pipe. This procedure is called grouting and rodding. While these methods are desirable from the standpoint of less time and labor involved, they may not be quite as thorough as the trench method. Some pest managers use an earth auger to remove a core of earth next to the foundation at about 1-foot intervals. Others use a long pipe on the end of the treating hose and drive this deep along the foundation, saturating the soil as they go. In either case, flood the small trench at the top with enough chemicals to treat all the way along the foundation.

After mechanical alteration, you don't need to treat the void behind the brick veneer. After chemical treatment, though, this is an essential step. It can be done two ways. You can drill holes through the box sill between each pair of joists from the inside, or you can drill through the mortar joints of the bricks on the outside. Either way, you pump chemicals through these holes at a rate of 1 gallon per 5 linear feet. Holes drilled through the mortar joints should be plugged with mortar after treatment.

Since the foundation is made of poured concrete, it won't need any treatment unless it has been cracked. Cracks in the foundation should be drilled and injected with chemical under pressure, then the hole should be firmly and completely plugged with concrete.

The soil inside the foundation should be treated with chemicals the same way as the soil outside. Overall treatment of the soil under the structure is not recommended. Only soil next to walls and posts should be treated.

Concrete-block foundation. If the foundation wall shown in figure 2-4 were made of concrete block, you would need to treat the hollow voids in the center of the blocks. Holes are drilled, usually through the mortar joints and above grade level, at least every 8 inches and chemicals injected at a rate of 1 gallon per 5 linear feet.

In all of this treatment you will note that the work is designed to place either a mechanical or chemical barrier between the termites in the soil and the wood that they might use as food. This principle applies to all subterranean termite control, and the principles in this example can be used elsewhere.

Dirt-filled concrete porch on frame building. This is a common type of construction throughout the country, and the principles involved in treating also apply to situations such as concrete block foundations, rubble foundations, poured

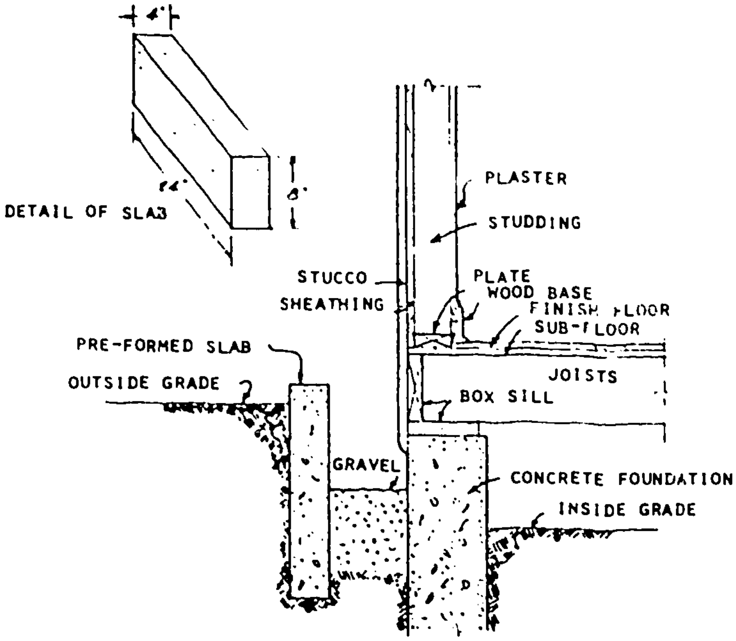

Figure 2-4. Remedial Construction with sheathing sealed off by a poured concrete foundation as a remedial measure.

outside slabs at ground level, and sidewalks and driveways poured adjacent to outside walls (fig. 2-5).

Treatment of the foundation wall in this type of construction is carried out as in the example of the brick veneer wall, but if the wall has voids, the treatment will be the same as for concrete block foundation.

Soil contact should be eliminated by tunneling along the wall and removing the dirt back to 1 foot from the wall in short porches and 2 feet in longer areas. This is usually done by removing part of the porch wall at either or both ends and installing an access door. It can be done by knocking out parts of the foundation wall from underneath, then digging out the necessary dirt fill. Where the tunneling leaves the porch poorly supported, you must install supplementary support, such as masonry piers. You treat this tunnel with 2 gallons of chemical per 5 lineal feet, and flood the rest of the accessible soil under the slab with 1 gallon of chemical per 10 square feet.

Some specialists think that the entire area under the porch should be flooded enough to treat all the soil under the porch, but many do not. If all of the soil is treated, chemical is applied by driving grouting rods horizontally under the slab, or by drilling vertically through the porch slab at intervals along the porch foundation and at enough other points to be sure it reaches all the soil under the porch. The soil on the inside grade level is treated the same as in the previous illustration. Critical areas under poured concrete slabs, sidewalks, and driveways can be treated with chemicals either by drilling down through the surface close to the building or by drilling horizontally through the inside wall immediately under the slab.

Slab-floor construction of frame building. This type of construction is used extensively throughout the country (fig. 2-6). Previous practice consisted of drilling the floor and flooding the fill underneath with chemicals in addition to the necessary foundation treatment and soil treatment outside the foundation. To keep from drilling through heat pipes, electrical conduits, and plumbing imbedded in the floor, it is safer to treat from the outside by drilling through the foundation wall. Mechanical alteration is not usually indicated in this type of construction.

Standard practice in many areas of the country consists of

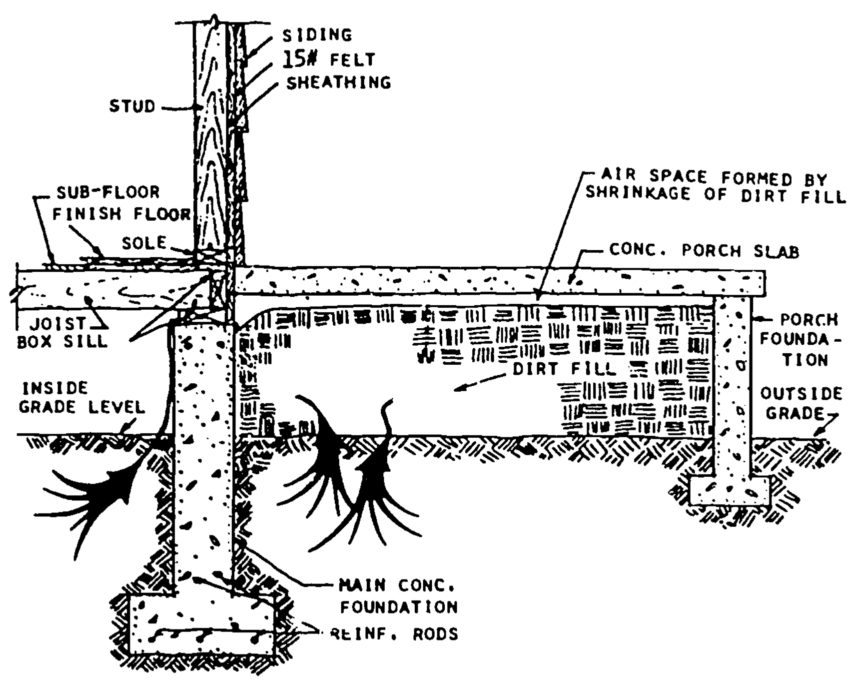

Figure 2-5. Common construction with dirt-filled concrete porch attached to frame house.

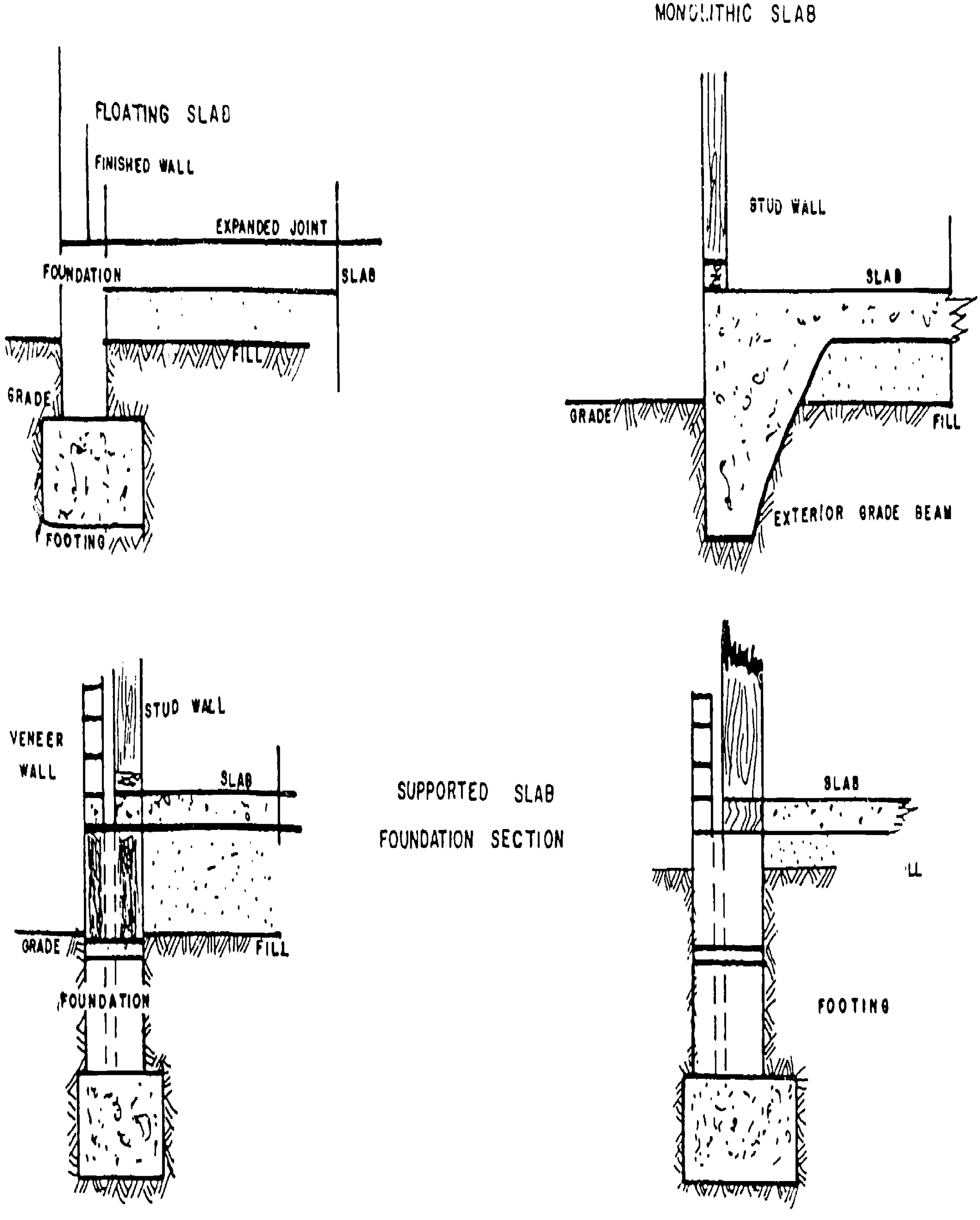

Figure 2-6. Slab-floor construction of frame houses (pretreated with chemicals during construction).

drilling holes through the outside foundation walls below the level of the slab floor, then pushing long rods through the holes and treating the entire area under the slab with 1 gallon chemical per 10 square feet. To do this, you may have to dig a trench outside the foundation to get room to work. You don't always have to drill all of the walls. If you can push the treatment rods all the way under the floor from one side, you can make a thorough treatment. We've already discussed the treatment for the foundation wall itself, the ground outside the foundation wall, porches, patios, driveways, or other outside slabs.

Miscellaneous situations. The same principles we have mentioned apply to treating many miscellaneous situations. One of the most common problems involves wooden members extending through the concrete in the basement floor. Supporting posts, stair risers, coalbins, and door frames are common examples. The best remedy is to cut the wooden member at least 4 inches above floor level, remove the part that extends through the floor. Saturate the soil underneath with chemicals. Then you can pour concrete into the hole and into a form that will leave you a concrete footing for the rest of the wood member. In the case of stairways, it is best to make the entire step of concrete if possible. It is generally unwise to use chemicals alone to treat wooden supports buried in soil.

Where termites are coming into a building through a cellar or basement floor, you may have to drill the floor and introduce chemicals into the soil underneath (fig. 2-7). This is usually done along cracks in the floor, around (not in) floor drains, by furnace pads, and around the edge of the floor. In the case of small cracks, the holes can be drilled directly through the crack. Next to walls and furnace pads, the holes should be drilled far enough from the wall to just miss any footing.

Concrete-block partition walls that extend down through the basement floor present a special problem. Ideally, they should be cut off above the floor and a concrete curb placed under them. In practice, this is both expensive and hard to do. Usual practice is to drill holes through the floor on both sides of the wall, treat the soil underneath and treat the wall's interior voids with chemicals the same as an exterior wall. These voids should be treated, whether or not they extend through the slabs (fig. 2-7).

Basement windows, with or without outside window wells, are another problem. Normally, the window sills are close to the ground, and when they're made of wood, they are a good source of food for termites as well as being subject to rot. It is a wise practice to replace basement window sills with concrete. Walls with voids in them should be treated with chemicals starting as close as possible beneath the window to insure thorough coverage. The ground outside the window should also be treated extra heavily.

Window wells are best treated by flooring them solidly with concrete, but they may be treated successfully by thoroughly flooding with chemicals and rodding or drilling immediately next to the foundation.

Wooden porches with outside ground contact should have all wood cut off above ground level and supporting concrete placed under it.

Houses in many parts of the country are built off the ground on supporting piers of brick, stone, concrete,

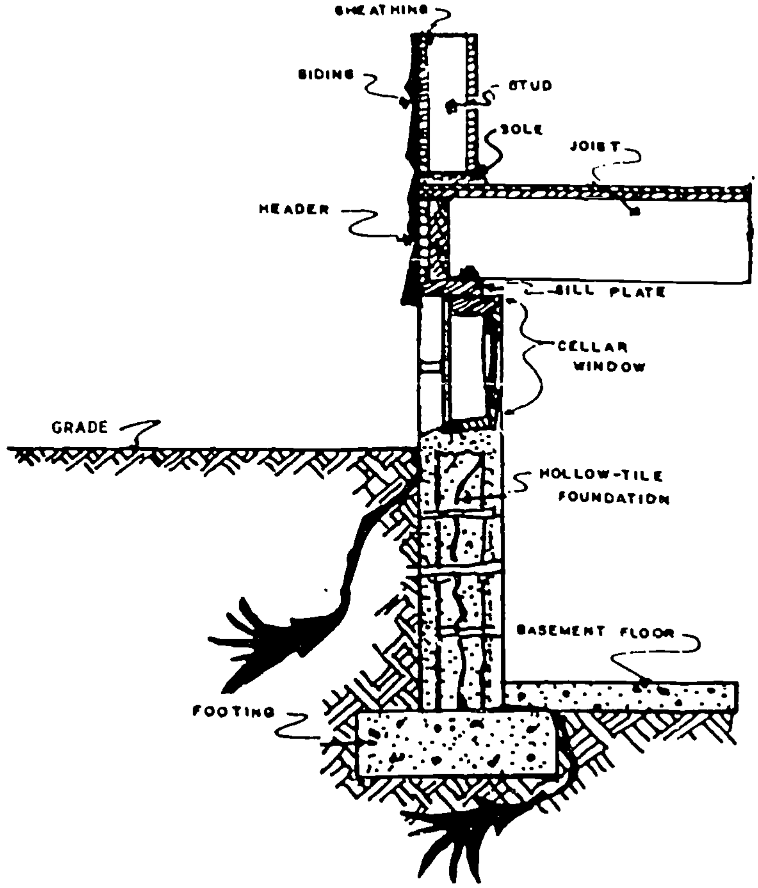

Figure 2-7. Concrete block foundation with basement window.

concrete block, or wood. Concrete piers create no particular hazard. Those of brick, stone, or concrete block, however, are usually hollow and provide an easy means of access to the wood above. Ideally, these would be filled solidly with concrete. In practice, it is usually more practical to drill into the hollow centers and thoroughly flood the voids with chemicals.

Wooden piers, wherever possible, should be removed and replaced with concrete or set on a concrete footing that extends at least 4 inches above grade level. Where this is not possible, holes should be drilled through to the bottom of the post so the ground underneath can be thoroughly saturated with chemicals, and the soil all around the base of the pier should also be thoroughly treated. In addition, pentachlorophenol should be used on the base of the pier to prevent rot.

With most of the chemicals now in general use, it is not necessary to take any particular precaution for the protection of plants on the outside of the house. Water emulsions generally will not harm plants.

The design of the structure and the nature of the materials that are susceptible to termite attack don't change the basic principle of subterranean termite control—the creation of a mechanical or chemical barrier that will keep termites living outside the structure from entering the building for food. The number of specific situations involved in construction is almost infinite, but as termite control specialists, we can get effective control if we always work on the basis of that principle.

Chemicals for subterranean termite control. Many different chemicals and combinations of chemicals have been used for termite control. Sodium arsenite and trichlorobenzene have both given control for several years, although not for so long as the newer chemicals now recommended. Both are more expensive than the newer chemicals, will kill plants, and will leach.

The five chemicals now recommended for subterranean termite control work are all used as water emulsions: 0.5 percent aldrin, 1 percent chlordane, 0.5 percent dieldrin, 0.5 percent heptachlor, and 1 percent chlorpyrifos. The percentages are important to remember and to use, because the gallonage recommendations are based on these concentrations. Remember that the main function of the volume of liquid placed into the ground or into wall voids is to distribute a given amount of toxicant properly. Recommended volumes of chemical are calculated to deliver the proper amount of toxicant to the treated areas.

You must consider the fact that some soils do not accept chemicals as readily as others and that the depth of foundation footings varies. In all instances, the important thing is to saturate the area being treated. One of the smaller costs on the average termite job is the direct cost of chemicals. It is poor economy to try to save on chemical costs and then have to pay for the far more expensive labor of re-treatment.

Exercises (818):

1. What are the four basic types of treatments for controlling termites in a structure?

2. Where should you set soil-treating barriers in a building?

3. What is the grouting and rodding method for applying termiticides?

4. How should you treat cracks in a poured-concrete foundation?

5. How should you treat a long, dirt-filled porch?

6. What is the safest method for treating along the foundation of a house on a concrete slab? Why?

7. How should wooden porches with outside ground contact be treated?

8. What chemicals and percentage rates of application are currently approved for termite control?

2-2. Nonsubterranean Termites

Termites other than subterranean termites are divided into three groups: dry-wood, damp-wood, and powder-post termites. Of these, dry-wood termites are the most common, although damp-wood termites may be found frequently in some limited areas.

819. Verify or correct stated characteristics and habits of dry-wood termites.

Dry-Wood Termites. Dry-wood termites (family Kalotermitidae) generally live in undecayed wood with a very low moisture content. They don't need any contact with the soil in order to live. In the United States, they are found in a narrow strip from Cape Henry, Virginia, on the Atlantic, south to Florida, along the Gulf of Mexico, and from Mexico to northern California on the Pacific Coast (fig. 2-8).

These termites bore directly into wood and make their nests in the wood itself. Because they don't need any contact with the ground, they can seriously damage movable wooden objects such as furniture.

A male and female pair work their way into the wood chosen for the nest. The opening through which they enter the wood is sealed with a plug of brown cement about 1/8 inch in diameter. Behind this plug they excavate a chamber where the queen lays the first eggs. The nymphs that hatch from these eggs do the work of the colony. Soldiers and reproductives develop from these nymphs. There is no worker caste.

During the swarming season, nymphs make round holes 1/16 to 1/8 inch in diameter through which the reproductive forms leave the wood. When swarming is completed, these holes are plugged in the same way as the entrance holes.

Damage done by dry-wood termites is entirely different from that caused by subterranean termites. These termites cut across the grain of wood, excavating large chambers connected by small tunnels (fig. 2-9). The chambers and tunnels used by the colony are kept clean, while excreta and other debris are stored in unused chambers or cast out through small openings in the wood.

Excretal pellets are a distinguishing characteristic of nonsubterranean termites. These pellets are hard and have six distinct concave surfaces on the sides; only the ends are rounded. Certain anobiid beetles also eject pellets from wood on which they feed. These can easily be distinguished from those of termites because they have rounded, convex surfaces.

Entrance into woo[illegible]lly made from a crack or crevice which the ter[illegible]n enter before boring into the wood. This may be a [illegible]k in the wood itself or may be the joist between two pieces of wood or even the space underneath the roofing paper or sheathing paper.

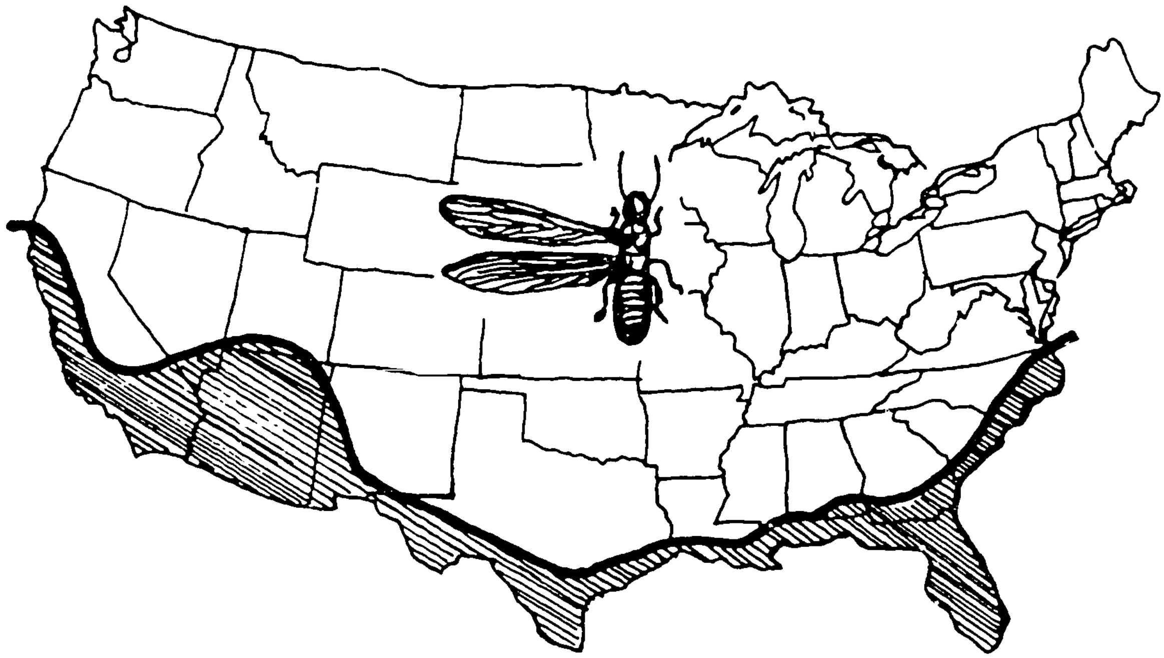

Figure 2-8. A winged adult dry-wood termite and its U.S. habitat (shaded).

Because of their ability to live in wood without contact with soil, nonsubterranean termites are frequently carried in infested furniture and other wooden objects into geographical areas where they are not normally found. Pest control specialists should be able to recognize them by their habits.

Dry-wood termites may attack wood products of all kinds. Structural timbers and woodwork in buildings, as well as furniture and other wooden objects, may be damaged. Although serious damage is done to buildings and other wood products in some areas of the U.S., these termites are usually less injurious than subterranean termites, simply because they are less widespread.

The dark, western dry-wood termite, *Incisitermes minor*, is found from California east to Arizona and Utah. In this area, it causes extensive damage to structures as well as to wooden derricks, piled lumber, furniture, and telephone poles. It may infest any dry-wood parts of a structure, from foundation plates to the roof, and it is the most destructive dry-wood termite in this country. Small flights occur from April through July, frequently after rains. Winged adults are dark brown and about 1/2 inch long. The white, soft-bodied nymphs remain in the galleries and are not seen unless the wood is broken open. The light, western dry-wood termite, *Marginitermes hubbardi*, is found from California to Arizona. Also called the southern dry-wood termite, it is very similar in habits to the western dry-wood termite, but it prefers drier conditions and higher temperatures.

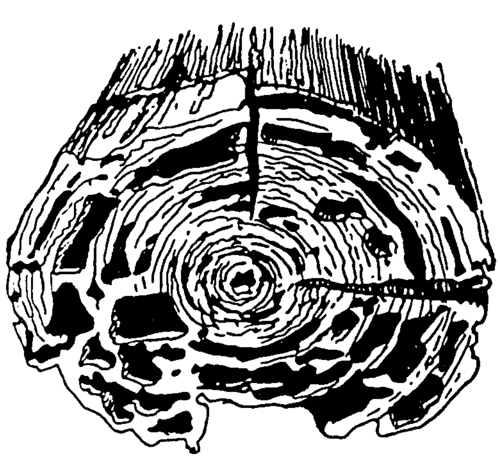

Figure 2-9. Typical dry-wood termite damage. (Note extensive galleries cutting across several annual rings.)

The light, southeastern dry-wood termite, *Incisitermes snyderi*, is the most injurious dry-wood termite from South Carolina to Florida and west to Texas. Another southern dry-wood termite, *Incisitermes schwartzi*, is a common species in southern Florida occurring as far north as Pensacola. The dark, southeastern dry-wood termite, *Kalotermes approximatus*, occurs along the Gulf Coast west to New Orleans and on the Atlantic Coast north to southern Virginia. It attacks both timbers in structures and in posts and utility poles.

Exercises (819):

Mark each statement true (T) or false (F) and correct any false statements.

____ 1. Dry-wood termites generally live in highly decayed wood with a low moisture content.

____ 2. Since they need no contact with the soil, dry-wood termites can seriously damage movable wood objects such as furniture.

____ 3. Dry-wood termite damage is very different from that of subterranean termites because dry-wood termites cut across the grain of the wood, excavating large tunnels.

____ 4. Since they are much more injurious to wood structures, nonsubterranean termites are much more damaging than subterranean species in the U.S.

____ 5. The dark. western dry-wood termite is the most destructive dry-wood termite in the U.S.

820. Verify or correct stated characteristics and habits of various nonsubterranean termites.

Rotten-Wood and Damp-Wood Termites. This group of termites in the families Kalotermitidae, Hodotermitidae, and Rhinotermitidae, contains some of our largest termites with bodies as much as 1 inch long and with wings of alates twice that length. Although damp-wood termites don't need contact with the soil to get moisture, they can't live in dry wood either; they need wood with a lot of moisture. They are also usually associated with wood decay.

They plug openings into the wood and excavate large galleries, much like dry-wood termites, but they don't keep the galleries clean. Their pellets can be found throughout their tunnels in infested wood, although many of the six-sided pellets are discarded from the galle[illegible] through small openings in the surface of the wood.

The rotten-wood termite, *Zootermopsis angusticollis,* is the largest of our native termites and is the most important termite of this group from an economic viewpoint. Since it attacks moist but sound wood, it should be called more properly a damp-wood termite. There is no worker caste. The work of the colony is carried on by the nymphs of the soldiers and reproductives. It occurs most commonly in the cool and humid coastal ranges of mountains. As one moves north along the West Coast, the frequency and severity of occurrence at lower elevations becomes more pronounced. The rotten-wood termite is a major problem at low altitudes along the coastal areas of Washington and Oregon. Although termed a rotten- or damp-wood termite, this species continues to live in dry, sound wood. Occasional colonies of this termite are carried to other parts of the country in shipments of lumber, but it has been unable to establish in these areas.

Winged forms are light brown with dark-brown leathery wings. Nymphs are white to cream-colored with a darker abdomen. These termites swarm in relatively small numbers, 50 to 60 from a single colony. Swarmers are attracted to light and are common about street lights at night.

The desert damp-wood termite, *Paraneotermes simplicicornis,* found in the Southwestern States from Texas to California, attacks only moist wood. It differs from other damp-wood termites in being subterranean in habit. It is of horticultural importance, since it frequently attacks the underground parts of shrubs and young trees and is particularly troublesome in residential areas and citrus groves. It is also found in fence posts and in baseboards and door frames of buildings. Flights occur in July and August after evening rains.

The Florida damp-wood termite, *Prorhinotermes simplex,* is found in the extreme southeastern counties of Florida and in the Keys. It lives naturally in damp but solid logs near salt water and is a common pest of buildings in the limited area where it is found. It is not earth inhabiting although it may enter logs beneath the soil.

Powder-Post Termites. Powder-post termites (family Kalotermitidae), live in dry wood, damaging structural timbers as well as furniture. They enter wood through tiny openings and excavate galleries as do dry-wood termites. The galleries are not kept clean but are frequently filled with the fine powder to which the wood is reduced by the termites.

Powder-post termites are easily distinguished from dry-wood termites by their much smaller size and small fecal pellets. The tiny fecal pellets are ejected from the galleries and are frequently the first sign that termites are working.

Only one species of powder-post termite, the tropical rough-headed powder-post termite, *Cryptotermes brevis,* is of commercial significance in the United States. It occurs only in the southern coastal areas from Florida to Louisiana where it is found only inside buildings. The head of the soldier is unusually shaped and serves as a good means of identification for this species (fig. 2-10). This termite is especially destructive to woodwork and to furniture because it destroys the interior of wood, leaving a paper-thin layer of wood or paint on the outside.

Figure 2-10. Head of soldier powder-post termite. (Note that the mandibles point downward rather than forward).

Exercises (820):

Mark each statement true (T) or false (F), and correct any false ones.

_____ 1. Some of our smallest termites are categorized as rotten-wood and damp-wood termites.

_____ 2. From an economic viewpoint, the rotten-wood termite is the most important member of this group.

_____ 3. Rotten-wood termites are most commonly found in cool and humid coastal areas.

_____ 4. The Florida damp-wood termite is of horticultural importance, since it frequently attacks the underground parts of shrubs and young trees.

_____ 5. Unlike dry-wood termites, powder-post termites do not keep galleries clean in the wood and furniture they attack.

821. Cite inspection and control techniques for nonsubterranean termites.

Inspecting for Nonsubterranean Termites. Nonsubterranean termites are found in almost any part of a structure and in wooden furnishings of all kinds. In inspecting for damp-wood and dry-wood termites, you must look not only for visible damage but also for the plugs in entrance and exit holes. Both kinds of termites can be found from cellar to attic—dry-wood termites in dry wood and damp-wood termites in wood with a lot of moisture.

Infestations of dry-wood termites are usually found around the perimeter of buildings and where wood is joined together. Large, well-established infestations often extend over large areas in central areas of structures. Look particularly for the characteristic fecal pellets pushed out from the termite galleries, which are often the first and most easily found sign of infestation. Make soundings of the wood, the same as for subterranean termites; a hollow sound warns you of internal galleries. Probe the wood with an ice pick, screwdriver, or the blade of a penknife to discover termite damage. Look for flights of adults, shed wings, and surface blisters where the galleries come close to the surface of the wood. Occasionally shelter tubes made of pellets cemented together bridge as a passageway from one piece of wood to another. Cementlike walls may partition off large chambers or close large openings to conserve humidity.

Since swarmers or shed wings from swarmers are sometimes the first evidence of an infestation, it is important to keep in mind a wing characteristic that quickly separates subterranean from nonsubterranean termites. Nonsubterranean termite wings have crossveins between the costal vein, which forms the anterior margin of the wing, and the subcostal vein, which is the second most anterior vein originating from the wing base. (See fig. 2-8.) These crossveins are lacking in subterranean (family Rhinotermitidae) termites.

In all inspections for nonsubterranean termites, make a scale diagram of the building, as you would for subterranean termites, indicating all places you find termites.

Treatment. Treatment for dry-wood termites consists of fumigating the entire structure with a toxic gas or introducing a toxic liquid or dust into the excavated chambers. Fumigate with sulfuryl fluoride (Vikane) or methyl bromide gas. Cover the whole building tightly with a plastic cover and pump in the gas. Standard dosage of methyl bromide is 2 pounds per 1,000 cubic feet. The dosage of sulfuryl fluoride (Vikane) varies with the manufacturer. Sulfuryl fluoride has the advantage of rapid and uniform dispersion within the temperature range for climates where dry-wood termites are found. Such fumigations should be done only by specialists thoroughly trained in the use of gasses. You can get detailed directions, as well as instruction, from the gas manufacturer.

To prepare for use of a liquid or dust, drill holes into the infested timbers through the termite galleries using a 1/2-inch drill in larger timbers and smaller drills elsewhere. Then force chemical through these holes to disperse through the galleries. Commonly used dust is sodium fluosilicate. The dessicant dust, silica gel, is also used, especially in attics, to reduce the rate of reinfestation.

This drilling and injecting method should only be used in the case of limited infestations. Extensive infestations should be controlled by fumigation. A recommended liquid insecticide for injection into galleries is 5 percent pentachlorophenol. There are certain disadvantages involved with the injection of liquid into the galleries. While there may be a fire hazard created when oil-base materials are used, the injection of water in a wooden beam may create a favorable site for decay fungi.

After liquids or dusts have been injected into wood, the openings should be plugged with wooden dowels.

Damp-wood termites are controlled by the same methods as dry-wood termites when they are in wood not in contact with the ground. Where there is ground contact, structural changes to eliminate moisture may be necessary, together with ground treatment as recommended for subterranean termites. However, control consists primarily of eliminating the moisture problem in the wood, and this often involves replacing damaged and moist wood.

Powder-post termites can be controlled by injecting the previously mentioned chemicals into their galleries and by fumigation. When dry-wood or powder-post termites are infesting furniture, chemicals can be injected into their galleries or the furniture can be fumigated. Some specialists control these termites in furniture by using a hypodermic syringe to inject a fumigant such as ethylene dibromide into their galleries. This method has the advantage of getting the chemicals inside the wood without making disfiguring holes on the surface of the furniture.

Powder-post and dry-wood termites infesting furniture can be killed by holding the furniture for 1½ hours in a chamber heated to 150° F., or for 4 hours in a chamber heated to 140° F. Kilns or special vaults equipped with heating units are used for this purpose. Cold may also be used to control these termites. In northern climates, infested furniture and crates may be moved outdoors, while refrigeration chambers can be used in warmer areas. Exposure at a temperature of 15° F. for 4 days will kill termites in wood.

There are a number of preventive measures you should consider to prevent nonsubterranean termite infestation. Inspect all lumber, especially secondhand lumber, carefully for evidence of infestation before being used for construction. Destroy infested lumber. Screen all doors, windows, especially attic windows, and other ventilation openings with 20-mesh noncorrodible metal wire cloth to keep winged termites out of areas where they can build colonies. Chemically treated wood will also prevent attack. You can buy lumber treated with wood preservatives in many areas. You can use termite resistant woods. Of construction timbers, certain kinds of redwood, cypress, and longleaf pine give the greatest protection. Protection of exterior wood surfaces with paint is also of value. An appropriate number of coats will fill many of the cracks and openings into wood used by termites to gain entrance. Larger cracks and joints can be filled with putty or plastic wood. Of course, the use of steel, concrete, brick, or stone in construction instead of wood offers the best protection against nonsubterranean termites, but it won't stop attack of wooden materials inside unless all entryways are properly sealed.

Exercises (821):

1. What two main signs should you look for in inspecting for nonsubterranean termites?

2. Where would you normally expect to find infestations of dry-wood termites?

3. What's the easiest way to check for damage caused by dry-wood termites?

4. When you look for shed wings as a sign of a termite infestation, how can you differentiate between subterranean and nonsubterranean termites?

5. What treatments are there for controlling nonsubterranean termites in a building?

6. What advantages does sulfuryl fluoride have in fumigating a building with nonsubterranean termites?

7. How should you prepare to use a liquid or dust in nonsubterranean termite control?

8. If damp-wood termite infestations contact the soil, what controls in addition to fumigation may be needed?

9. How can you treat for nonsubterranean termites in furniture?

10. List three ways to prevent infestations of nonsubterranean termites.

2-3. Wood-Destroying Fungi

Wood is an abundant, versatile, and relatively inexpensive material, but unprotected wood and wood products in use and in storage are subject to the destructive effects of fire, mechanical damage, insects, marine borers, moisture and weathering, and decay fungi. Of all of these, decay fungi cause the greatest losses. All of the "dry rot," "wet rot," and "natural deterioration" of wood is caused by living decay fungi. All can be prevented by recognizing the characteristics and biology of fungi, by knowing the conditions that are conducive to fungi growth, and by knowing how to control fungi. You have probably seen wood-rotting fungi as mycelial mats in the reproductive stages, as mushrooms, toadstools, and bracket fungi. However, by the time these surface growths are formed, extensive damage has been caused by the microscopic mycelial threads (hyphae), which have penetrated deep within the wood. For this reason, you must learn to recognize signs of early attack by fungi and to differentiate between the fungus damage and the destructive effects of moisture and weathering.

822. Cite classification, characteristics, and reproduction of fungi.

Recognition and Classification. Fungi belong to the division Thallophyta of the cryptogamic plants. There are five major classes of fungi. One of these, class Basidiomycetes, contains the order Hymenomycetales, which has five families. All five of these families have genera with wood-destroying species. Some 2,000 species of wood-rotting fungi are known, of which 200 to 300 are commonly involved in wood deterioration on a serious scale.

Since it usually takes laboratory procedures to identify specific wood-rotting fungi, it's a good thing that we don't have to know their genus and species to treat them. We can easily organize them into "artificial" classifications based on the destruction they do. This system depends on the metabolic processes of the fungi, on the composition of the materials on which or within which they grow, and on the rates and methods of growth. This system identifies all fungi on wood (in storage or in use) as mold fungi, stain fungi, or wood-rotting fungi.

Mold fungi. These may infect wood in storage or in use. Wood-inhabiting fungi require that the moisture and the air in the wood *each* be more than 20 percent of the wood's dry weight. The mold fungi enzymes break down and use only such wood materials as starches, sugars, gums, and oils; they have no direct effect on the cellulose and lignin. The hyphae of most molds penetrate the wood through existing pores and pits, and usually have no direct chemical or mechanical effects on the cell walls. In removing nonstructural elements of the wood, molds often reduce any natural water repellency and make the wood more subject to wetting and to decay. Mold fungi may be found on the surface of wood that is being attacked at depth by decay fungi.

Stain fungi. Stains of various types may be produced in wood by some of the deep mold fungi, ranging from nearly black through shades of blues, browns, reds, and yellows. Of all the wood stains, the blue stain, or sap stain, is probably the most common and the most serious. In the wood rays, in which the food substances are concentrated, the causal fungi can seriously damage the cell walls and weaken the wood mechanically.

Wood-rotting fungi. These normally start on the surface, or in checks or other openings, later penetrating deeper where they can cause considerable destruction. In the incipient stages, the hyphae spread in all directions through the wood. Unlike the hyphae of mold fungi, which pass from cell to cell through naturally existing holes, the hyphae of rot and decay fungi pass through "bore holes," which form at the cell walls at points of contact with the tips of growing hyphae. During the incipient stages there is no apparent dissolution of the wood other than at the microscopically small bore holes, nor are there visible changes in its characteristics other than the slight discolorations caused by some species. These discolorations may be easily overlooked, or may be mistaken for the color changes caused by mold fungi, chemical staining, or weathering. As decay progresses beyond the incipient stages, the appearance of the wood may alter more and more perceptibly. In the advanced stages of decay, the wood may become punky, spongy, stringy, ring shaped, pitted, or crumbly, depending on the species of wood and fungus, and on the extent of fungal development. The wood-rotting or decay fungi are usually thought of as belonging to three major groups: the white rots, the brown rots, and the water-conducting fungi.

White rots of wood and wood products are caused by those fungi whose enzymes can attack the ligno-cellulose complex of the cell walls and degrade the lignified material. Because of the slight color changes usually involved, the white rots may at times be difficult to see. Some have dark brown or black zone lines at the areas of incipient decay, which may be the only visual evidence of white-rot damage.

Brown rots of wood are caused by decay fungi that can attack the ligno-cellulose complex, but can't degrade the lignin. They destroy the cellulose, but leave the lignin and some other materials as a brownish residue, that crumbles easily into a powder when it's dry. Not infrequently the brown residue is found dry, rather than moist, leading to the widely used, though inappropriate, term "dry rot." Remember that rotting wood takes wood-rotting fungi and that they need a moisture content greater than 20 percent. After a period of initial growth, many of the brown-rotting fungi can develop structures highly resistant to desiccation. Some survive for several years in air-dry wood and severely damage wooden structures that are only intermittently exposed to moisture. For this reason, the use of infected wood for the construction or repair of buildings can be harmful or even dangerous.

Water-conducting fungi are brown-rot fungi that can conduct water from a single source to otherwise dry structural wood. The two most important water-conducting fungi are *Merulius lacrymans* and *Poria incrassata*. *Merulius lacrymans* is the most common building decay fungus in northern Europe, and is occasionally found in the northern United States. *Poria incrassata*, commonly called building poria, is more tolerant of high temperatures and is consequently the more common of the two. The initial growth may take place in cellulose material in most soil under structures. The building poria's ability to extend its growth over the surface of inorganic materials lets it bridge foundation walls and reach the wood above them. Its tendency to attack unexposed surfaces first and its ability to conduct moisture to heights of more than 20 feet are responsible for the extent of the damage that may be done before any destruction is readily evident.

Life and History of Destructive Fungi. You should not forget that fungi are living organisms. They are plants that have lost their ability to use sunlight to produce food.

Spore distribution. Fungi don't produce true seeds with many-celled embryonic plants; they produce single-celled spores from which new individual plants develop. Most fungus spores are microscopic, lightweight, resistant to extremes of temperature and humidity, and readily dispersed by wind and water. Fungus spores and even the fungus hyphae are easily carried from the ground and from infested wood to sound wood by wood-inhabiting insects.

Germination and growth. Under the right environmental conditions of humidity and temperature, a fungus spore germinates, developing a hyphal tube or filament. If only water and inorganic materials are present, the growth will stop after the organic materials concentrated in the spore have been used up. The right nutrients (such as the cellulose in wood) permit the further growth and branching of the hyphae and the formation of the mycelial thallus and the spore-bearing structures, such as bracket fungi, toadstools, mushrooms, and puffballs.

Physiology and metabolism. The physiology of the fungi differs from the physiology of green plants; lacking chlorophyll, fungi can't synthesize organic nutrients from dissolved inorganic materials. In the parasitic fungi, the mycelium penetrates living cells or the spaces between them and absorbs the intracellular or intercellular fluids of the host organisms. Most saprophytic fungi (such as those that decay wood) secrete substances that dissolve some or all of the solid organic materials on which the fungi are growing. All or some of these dissolved or "digested" materials are then absorbed by the hyphae and used for growth and development. Most of the wood-rotting fungi produce an acid reaction in various types of culture media; pH values as low as 2-3 are not uncommon. In the failure of structural concrete at points of contact with rotting wood, the effect of fungus-produced acids should be considered. Other metabolic products are also formed, and with the acids, destroy wood and other materials. To a lesser extent, the purely physical effects of fungal growth may also destroy useful materials. Mildew and mold fungi are found on a great variety of both living and dead organic materials.

Exercises (822):

1. Place the letter "T" before each true statement.
   ____a. One of the classes of fungi is Basidiomycetes.
   ____b. Wood-inhabiting fungi need both moisture and air within the wood and each is at least 40 percent of the dry weight of the wood.
   ____c. In removing nonstructural elements of wood, molds often reduce any natural water repelling and make the wood more subject to wetting and decay.
   ____d. Mold fungi may be found on the surface of the wood which is being attacked at depth by decay fungi.
   ____e. Of all the wood stains, the blue stain, or sap stain, is probably the most common and the least serious.
   ____f. The ability of the building poria to extend its growth over the surface of inorganic materials permits it to bridge foundation walls and to reach the wood above it.
   ____g. Fungi produce true seeds, with many-celled embryonic plants.
   ____h. The physiology of the fungi differs from the physiology of green plants in that fungi, lacking chlorophyll, are incapable of synthesizing organic nutrients from inorganic materials.
   ____i. Most of the wood-rotting fungi produce an alkaline reaction in various types of cultural media.
   ____j. Mildew and mold fungi are found on a great variety of both living and dead organic materials.
2. Correct any false statements.

3. In the artificial system of classification, all fungi on wood in storage or in use are identified how?

4. Mold fungi in wood enzymatically break down what materials and can't break down what materials?

5. Stains of various types may be produced in wood by some of the deep mold fungi in what color range?

6. The wood-rotting or decay fungi are usually thought of as belonging to what three major groups?

7. White rots of wood and wood products are caused by fungi whose enzymes can attack the ________ complex of the cell walls and degrade the ________ material.

8. Brown rots of wood are caused by decay fungi that can attack the ________ complex, but can't degrade the ________.

9. The brown rot fungi destroy the ________ but leave the ________ and some other materials as a ________ residue, which, when dry, may be easily crumbled into a powder.

10. Water-conducting fungi are ________ fungi that can conduct water from a single source to otherwise dry structural wood.

11. When the correct environmental condition of ________ and ________ exist, a fungus spore will germinate with the development of a hyphal ________ or ________.

12. How do saprophytic fungi decay wood?

823. Verify or correct statements about how to control wood-destroying fungi.

Wood-destroying fungi can be controlled effectively through (1) frequent inspections to detect the fungi or conditions that favor their growth, (2) preventive measures to deter their growth, and (3) corrective action to stop their growth.

Inspection. Inspect the [illegible] buildings at military activities at least annually (semiannually when possible and warranted) for the presence and extent of insect and fungus infestations and the type of control required. This inspection is often made in conjunction with the inspection for termite attack. Pay particular attention to locations where occasional moisture from condensation or precipitation supports wood-rotting fungi. Crawl spaces under basementless buildings give access to inspect structural timbers below the floor level. Wood in contact with masonry or metal subject to moisture condensation presents special hazards. Check carefully the window and door frames and porch columns and railings, as heavy coatings of paint may hide conditions for rot. It's a good practice to use a sharp-pointed probe to make these inspections. When you inspect wood in use, don't neglect the pallets used to store supply items.

Preventive Control. Preventive control of wood-destroying fungi falls into two categories from the standpoint of base pest control personnel: wood in storage and wood in use.

Protection of wood in storage. Lumber in storage can be protected from fungus damage and the destructive effects of moisture changes through proper storage management and dip-treating untreated lumber.

Lumber should be stored off the ground or flooring and under a protective overhead shelter. It should be stacked with a slight space between boards and elevated slightly at one end for ventilation and water runoff. These storage methods are discussed in considerable detail in AFM 67-3, *Storage and Materials Handling*.

[illegible] treatment of stored lumber with water-repellent pentachlorophenol will provide protection during a long storage life where the wood must be exposed to the weather. Before it is dip treated, the lumber should be stickered and baled ready for storage, and it should be dried to a moisture content of no more than 20 percent.

Protection of wood in use. Structural wood in use often requires protection from destructive fungi. The theories of planning control are based on the growth requirements and physiology of the fungi, and they are thus like those involved in the protection of lumber in storage. The actual practices that prevent decay, however, are different. Preventive control is based on the use of preservatives and on controlling moisture (condensation, rain water, and capillary, or seepage water). Preventive control should begin with the structure's planning and design. Since most of the buildings we treat are already built, it is too late to change the designs. It's not too late, though, to make some structural modifications to prolong their useful life. This is particularly true when we make repairs as the result of fungus damage. If we note that a design feature of several buildings has been responsible in part for fungus damage, we should consider minor modifications of the others before they, too, need expensive repairs. Proper design starts at or below the ground level, draining water away from the structure. If rainwater collects under buildings, *we must correct the drainage problem to save the buildings*. Even with adequate drainage, condensation on the sills, joists, and subflooring of basementless buildings may be so severe as to result in rapid deterioration.

a. Ventilation. Ventilation is critical in the crawl spaces under basementless buildings (and in those with incomplete basements). The [illegible] ventilation (with no pockets of stationary [illegible] interior foundation walls) is ca[illegible] formula. The crawl space vent must have a net unobstructed area of 2 square feet for each 100 lineal feet of outside wall, plus 1/3 square foot for each 100 square feet of crawl space area. Obstructions call for larger openings. If the vents are covered with louvers or 1/16-inch mesh insect screen, double the size. If they are covered with both, triple the size. If the gross area is partially covered by bars, grills, or grids, adjust the size for an adequate net area. The ill-advised practice of closing the vents during cold weather does lower the fuel bill, but it also increases the maintenance costs and shortens the useful life of the structures.

b. Ground cover. When it's too expensive to heat occupied buildings and keep adequate ventilation of the crawl spaces, we can use other condensation-prevention techniques to help. One successful method uses a soil cover of asphalt roll roofing (the grade that weighs 55 pounds per roll of 108 square feet). No lapping, fastening, cementing, or preliminary careful leveling is required. Plastic films are effective and are easier to handle, but they must be weighted at the corners.

c. Protection from water. Most cases of serious decay in siding and exterior trim are found on buildings with little or no roof overhang or with faulty eaves, gutters, or downspouts. Excessive amounts of water run down the sides and seep into joints, particularly butted joints between siding pieces and between siding and trim. It is nearly impossible to keep the joints tight enough to keep out seepage water during severe rain washings. Paint can't seal joints. In many areas, siding and trim that have much sapwood need protection by: (1) good projection of eaves and rake of gables to prevent all but occasional rain washing; (2) tight joints plus well-maintained paint films to minimize rain seepage during occasional wettings; (3) lightweight, vapor-permeable (breathing) building papers under siding to speed the drying of any seepage water; (4) good flashing of exposed doors, windows or other openings, and any horizontal projections; and (5) good gutters and downspouts. When you can't stop rain washing, use preservatives.

d. Building appendages. Wooden porches and exterior steps, even those of the best design and construction, are decay hazards; any feature promoting seepage will greatly hasten decay. Step and stoop rails that are protected by well-maintained paint still show marked differences in susceptibility to decay, depending on the type of construction. Considerable protection is afforded by extending the rail over the top of the newel rather than abutting the end of the rail to the side of the post. Any rail splice occurring over a post will greatly increase the decay hazard. These design features should be considered during inspections and during replacement. The common practice of placing trim over the ends of drop siding normally creates no decay hazard, but instead allows less water seepage than the common butt joints of siding to trim. With bevel siding, the placement of trim over the siding ends tends to reduce wetting, but not to any great degree. The bevel results in a long vertical opening and allows easy water-flow back under the siding. With bevel siding, metal corners are the only structural means of reducing water seepage; all other types of corner joints leak badly.

Wood preservatives. [illegible]nce no design modifications can prevent all decay [illegible] poor roof overhang and ventilation we should [illegible] preservatives. Badly rotted wood should, of course, be replaced. We should always use preservatives, and in some cases, we should use preservation to depth. Because of the seepage and the probable incipient rot, we should saturate the adjacent wood as thoroughly as possible by brushing or spraying on a water-repellent 5-percent pentachlorophenol solution in mineral spirits. This may take three or more brushings. Apply each treatment before the preceding treatment's solvent has dried and sealed the wood against further absorption. Building sidings may be easily treated with a preservative before the paint is applied, the water-repellent material in the preservative acting as a prepaint wood primer. It's a good idea to brush on all the preservative a window frame and sash can absorb before you renew the paint. Power sprayers provide a ready means of treating susceptible areas under basementless buildings. Heavy application of a water-repellent 5-percent pentachlorophenol solution can make the structural timber joints almost completely impervious to water and, therefore, safe from decay fungi. Pay particular attention to all joints and to wood in contact with concrete, brick, metal, stone, and other surfaces on which moisture condenses readily. The application will be most effective when the wood is dry, so save the job for a dry day if you can. Preservative emulsions and greases are suitable for many locations, but they may affect the paintability of wooden siding and trim.

Corrective Control. Corrective control of wood-destroying fungi can also be considered in terms of wood in storage and wood in use. Stored wood that is fungus infested should be removed from the clean lumber and given preventive treatment. It should never be left untreated in a lumber yard.

Seriously rotted wood can only weaken the structure it's in; it should be replaced. We can partially protect lightly damaged wood with preservatives, but trying to pressure-treat wood in place with fungicides or insecticides under pressure will consistently produce poor results. We can get deep penetration, though, by surface application of grease or emulsion formulations. For water-conducting fungi, give special attention to the moisture source. The use of water-soluble fungicides may be advisable at such points. Though it may be desirable in some cases, it will rarely be necessary to use wood preservatives at the points to which these specialized fungi have conducted moisture, provided the rhizomorphs are completely destroyed and their lower part poisoned with fungicides.

Exercise (823):

1. Place the letter "T" before the true statements and correct the false ones.

____ a. Wooden buildings at military activities should be inspected at least annually (semiannually when possible and warranted) to determine the presence and extent of insect and fungus infestation and the type of control needed.

____ b. Lumb[illegible] should be stored off the ground fl[illegible] and under a protective overhead shelter.

____ c. A quick-dip treatment of stored lumber with water-repellent pentachlorophenol will provide protection during a long storage life where the wood must be exposed to the weather.

____ d. Preventive control is based on using preservatives and controlling moisture.

____ e. Closing vents under basementless buildings in cold weather will lower the fuel bill, decrease the maintenance cost, and extend the useful life of structures.

____ f. A condensation-prevention technique under buildings is to use a soil cover if you can't get adequate ventilation.

____ g. Most serious decay in siding and exterior trim is found in buildings with little or no roof overhang or faulty eaves, gutters, or downspouts.

____ h. Wood porches and exterior steps are decay hazards.

____ i. A 5-percent pentachlorophenol solution in mineral spirits may be used as a wood preservative.

____ j. Preservative emulsions and greases are suitable for use as wood preservatives.

2-4. Wood-Boring Insects

Wood-boring insects are separated into three groups: the powder-post beetles, the powder-post borers, and the carpenter ants and bees. This section covers the characteristics (descriptions, habits, and habitats) of these insects as well as the controls for them.

824. [illegible]riminate among the general characteristics of thre[illegible] [illegible]der-post beetle families.

Powder-Post Beetles. Powder-post beetles are so named because of the powdery substance (frass) they leave on wood surfaces or in piles on the floor near chair and table legs. There are three families of powder-post beetles: Lyctidae, Anobiidae, and Bostrychidae. Powder-post beetles belong to the order Coleoptera. The larvae are responsible for most damages. They are the second most important insect pest of wood articles and timbers.

Lyctidae. This family is the true powder-post beetle. The larvae are whitish with dark-brown heads and manidibles. The anterior part of their bodies is larger than the posterior part. The larvae have three minute pairs of legs. The last pair of spiracles are much larger than the other. The very young larvae bore into the wood source. Once they mature, they bore almost completely out in order to pupate.

Once pupation is complete, the adults bore completely out, pushing a fine powdery wood dust out of the wood as they emerge. The adults are reddish brown to black and are from 2.4 to 5.6 mm long. The antennae terminate in two-segmented club. The tibiae bear spur The l abdominal segment is as long econd and third segments combined.

True powder-post beetles only attack seasoned wood and will not attack a live tree or freshly cut wood. The adults will usually deposit eggs into the surface pores of lumber while it is stored and while it is curing. After development is complete (3 months to a year), the adults will emerge from finished wood and furniture products. These beetles prefer the sapwood of hardwoods such as oak, hickory, and ash and are commonly found in tool handles, pallets, furniture, picture frames, and in interior woodwork of buildings. The exit holes, which run parallel with the wood grain, are filled with frass (absent of fecal pellets) and are approximately 1.2 mm in diameter.

Anobiidae. The larvae of this family attack the sapwood of hardwoods and softwoods, such as pine, oak, beech, alder, and willow. Anobiidae larvae prefer old wood and are commonly found in girders, beams, foundation timbers, and antique furniture.

The larvae are whitish, slightly curved, and wrinkled with tiny hairs on the body. They have three pairs of short legs and toothed mandibles. They range in size from 6.3 to 12.5 mm long. The young larvae bore into the wood, where they may live for a year or two. Just before they pupate, they bore toward the surface but not completely out. When the adults emerge, they leave small holes about 2.4 mm in diameter. The tunnels, or galleries, may run across the wood grain, and they're loosely filled with frass and distinct elongate or bun-shaped fecal pellets. These adults are reddish to blackish brown and are usually less than 8 mm long. The thoracic region is usually margined at the sides, and the head is barely visible from a dorsal view. They not have spurs the tibiae. They deposit eggs s of ood or in the mouth of old exit hole.

Bostrychidae mily of powder-post beetles is commonly referred to as the false powder-post beetle. The two species we meet most commonly are the bamboo borer and the lead-cable borer. The Bamboo borer adult is brown, cylindrical, and 3 to 4 mm long. As the common name implies, it prefers bamboo woods and will often be found in furniture, ornaments, and poles constructed from bamboo. The lead-cable borer is also known as the short-circuit beetle, because it actually causes shorts in telephone and other electrical circuits by feeding upon its preferred food source (lead) in underground cables. This beetle is also often found in wine casks. The adults are reddish brown, cylindrical. and 5 to 6 mm long.

Bostrychidae larvae are whitish, curved, wrinkled, and robust. They have small heads and greatly enlarged thoracic regions that bear three pairs of well-developed legs. Their mandibles are not toothed. Larval tunnels generally run parallel with the wood grain and are tightly packed with frass. The adults bore into the wood to deposit their eggs and may at times insert the eggs into the cells of the wood. Once the eggs hatch, the larvae bore toward the surface and pupate. After pupation, the new adults emerge from the wood. The adults have an enlarged, roughened thorax that gi beetle a humpbacked appearance. They have spurred and their entrance and exit holes average 6.3 mm in diameter.

Exercises (824):

State whether each description refers to Lyctidae (L), Anobiidae (A), or Bostrychidae (B).

____ 1. The very young larvae bore into the wood source, and once mature, they bore almost completely out to pupate.

____ 2. The emerging adults leave small holes about 2.4 mm in diameter.

____ 3. The adult bores into the wood to deposit eggs and may at times insert eggs into the cells of the wood.

____ 4. The adults have a roughened thorax that is enlarged, giving the beetle a humpbacked appearance, and they have spurred tibiae.

____ 5. The tunnels, or galleries, may run across the wood grain and are loosely filled with frass and distinct, elongated or bun-shaped fecal pellets.

____ 6. A true powder-post beetle.

____ 7. False powder-post beetle.

____ 8. The larvae attack the sapwood of hardwoods and softwoods.

____ 9. These adults are reddish to blackish brown in color and are less than 8 mm long.

____ 10. The larvae have three minute pairs of legs, and the last pair of spiracles are much larger than the others.

____ 11. The antennae end in a two-segmented club and the tibiae bear spurs.

____ 12. The larvae have three pairs of sho nd tooth mandibles.

____ 13. The larvae are whitish, slightly curved, and wrinkled, with tiny hairs the body.

____ 14. The larvae have small heads and greatly enlarged thoracic regions that bear three pairs of well-developed legs.

____ 15. The larvae prefer old wood and are commonly found in girders, beams, and foundation timber.

____ 16. The larvae are whitish with dark brown heads and mandibles.

____ 17. The basal abdominal segments are as long as the second and third segment combined.

____ 18. The adult's thoracic region is usually margined at the sides, and the head is barely visible from a dorsal view. They don't have spurs on the tibiae.

____ 19. Adults are reddish brown to black.

____ 20. Larval tunnels generally run parallel with the wood grain and are tightly packed with frass.

____ 21. The larvae anterior part of the body is larger than the posterior part.
____ 22. Their mandibles are not toothed.
____ 23. They only attack seasoned wood; not live trees.
____ 24. The larvae range from 6.3 to 12.5 mm long.
____ 25. Prefer the sapwoods of hardwoods, such as oak, hickory, and ash.
____ 26. The larvae may live in the wood for a year or two before boring towards the surface.
____ 27. Exit holes run parallel with the wood grain, are filled with frass, and are 1.2 mm in diameter.
____ 28. The larvae are whitish, curved, wrinkled, and robust.

825. Identify powder-post borers with their habits, habitat, descriptions, and treatment.

Powder-Post Borers. Powder-post borers belong to the order Coleoptera, specifically to the families Cerambycidae and Buprestidae. These beetles are primarily feeders on dry woods. Under natural forest conditions, they play an important role in reducing dead trees to permit new growth. Their destructiveness in structural woods, however, can result in considerable economic losses.

Cerambycidae. These are often referred to as long-horned wood borers or roundheaded wood borers. The family has some of the largest species of wood borers. Since cerambycids will attack living or dead wood, they are generally considered to be pests of such ornamental plants as shade trees and fruit trees, but the old-house borer is one species that is very important as a structural pest. It attacks sapwood of softwoods, such as pine and spruce, and is commonly found in floor joists, sills, beams, studs, and subflooring.

The old-house borer deposits eggs in tight crevices, such as cracks and natural checks in boards. Upon hatching, the larvae bore into the wood. They may stay in this stage for 2 to 3 years. The tunnels excavated are round because the head and thoracic region of the larvae are round. These tunnels are loosely filled with frass. Before the larvae pupate, they bore toward the surface. After pupation, the adults emerge at the surface and leave oval holes. The larvae are flesh colored, straight bodied, wedge shaped, and may be up to 25.6 mm long. The adults are brownish black in color and have many gray hairs on the head and anterior portion of the body. Each wing cover has two patches of gray, and when fused, they will form either two transverse bands or two downy white spots.

Buprestidae. This family of wood borers is often referred to as flatheaded wood borers because of the enlargement of the thorax immediately behind the relatively small head. Like the family Cerambycidae, the buprestids attack living and dead wood and are considered to be more important as pests of ornamental plants than as structural pests. Buprestids are attracted to smoke. This attraction leads them to forest fires, where they deposit eggs in bark cavities of scorched trees. Once the eggs hatch, the elongated, whitish, legless larvae bore into the sapwood and leave tunnels that are tightly packed with frass. The adults can usually be recognized by their bright metallic colors. Because there are many species of buprestids, their coloration and size vary. Most are iridescent blues and bronzes. These beetles range in size from small to medium and may be either flat bodied or cylindrical.

Exercises (825):
Does each of these statements refer to Cerambycidae (C), Buprestidae (B), or both?
____ 1. Primary feeders on dry wood.
____ 2. Will attack living or dead wood.
____ 3. Pests of ornamental plants, such as shade trees and fruit trees.
____ 4. Long-horned wood borers or roundheaded wood borers.
____ 5. Flatheated wood borers.
____ 6. Destructiveness in structural woods can result in considerable economic loss.
____ 7. Old-house borers attack sapwoods of soft woods and are commonly found in floor joists, subflooring, sills, beams, and studs.
____ 8. Adults have bright metallic colors; most are iridescent blues and bronzes.
____ 9. The adults are brownish black and have many gray hairs on the anterior part of the body.
____ 10. The tunnels are round because the head and thorax region of the larvae are round.

826. Verify or correct statements about control of powder-post beetles and borers.

Control of Powder-Post Beetles and Borers. Powder-post beetles and borers can be controlled effectively by preventive and corrective measures.

Preventive control. Wood susceptible to powder-post beetle attack and intended for prolonged or indefinite storage may be protected economically by a preventive treatment. Oil solutions containing chlorinated hydrocarbons, applied as 3-minute dips, have proven effective in preventing beetle attacks for 10 years or more. Emulsions and suspensions are less effective. Satisfactory solutions may be prepared from fuel oil, trichlorobenzene, or other recommended solvents. An effective general-purpose protective dipping solution should contain 5 percent of a water repellent, one of the approved chlorinated hydrocarbons, and a penetrating solvent. The pentachlorophenol will prevent fungus damage, and the chlorinated hydrocarbons will prevent insect attack. When wood so treated is cut or refinished, the cut surfaces should be covered with preservatives by dipping or brushing. An excellent wood preservative, without the insecticide, is pentachlorophenol. The pentachlorophenol is not needed unless the wood is to be stored or used where it would get wet and be subjected to attack by decay. If the wood won't be subject to decay, an oil solution of a recommended insecticide will protect it from beetle attack. Tool handles, gunstocks, and other items may be protected against lyctus attack if all surfaces are coated with a heavy linseed oil or paint that fills the wood pores and prevents oviposition (depositing of eggs).

Corrective control. Active infestations can be controlled with 3-minute dip treatments in oil solutions of the chlorinated hydrocarbons. Thorough brush and spray applications are effective on small-dimension stock, such as tool handles. For control in buildings, good penetration of the insecticide is important. Paint, varnish, or enamel should be removed before the insecticide is applied. In treating laid flooring in buildings, you can get deeper penetration by thoroughly brushing the oil solution into existing beetle emergence holes and the crevices between the boards. Merely spraying the oil solution onto the exposed surface of the flooring often does not give enough penetration for control. Heavy-dimension stock may take two or more applications. Heavy timbers may need vat dipping or drilling and injection of the oil solution under pressure. Fumigation with methyl bromide in vacuum chambers is effective, but it provides no residual protection.

Exercise (826):

1. Place the letter "T" before true statements and correct false ones.

____ a. Oil solutions containing chlorinated hydrocarbons, applied as 3-minute dips, have been effective in preventing beetle attack for 10 years or more.

____ b. Emulsions and suspensions are more effective than oil solutions.

____ c. An effective general-purpose protective dipping solution should contain 5 percent pentachlorophenol, approximately 5 percent of a water repellent, one of the approved chlorinated hydrocarbons, and a penetrating solvent.

____ d. The pentachlorophenol will prevent insect attack, and the chlorinated hydrocarbons will prevent fungus damage.

____ e. Active infestations can be controlled with a 3-minute dip treatment in oil solutions of the chlorinated hydrocarbons.

____ f. Paint, varnish, or enamel can be left in place when the insecticide is applied.

____ g. Spraying the oil solution onto the exposed surface of the flooring frequently does not give sufficient penetration to give satisfactory control.

827. Cite characteristics of and controls for carpenter ants and bees.

Carpenter Ants and Bees. These insects belong to the order Hymenoptera. Even though they are venomous, they have been reserved for this section because they are more important as structural pests.

Carpenter ants. Carpenter ants are so named because they tunnel into wood and excavate the galleries that form a home for the colony. Although they are general feeders and will not eat the wood, they can sometimes do serious damage. Common black carpenter ants are large ants, sometimes 12.5 mm long. They build their nests in such places as the dead heartwood of living trees, logs, house timbers, poles, and almost any wood material. They are most destructive in soft woods. Most of their tunnels are approximately parallel and run lengthwise with the grain of the wood. Other shorter tunnels that cut across the grain connect the longer parallel tunnels within the wood and open to the outside. Where wood is seriously damaged by carpenter ants, it should be replaced. For the most satisfactory control, short of removal of the infested wood, the nest must be located. Insecticidal formulations of chlorinated hydrocarbons are effective if they're injected into the nests. In some cases, it is hard to find the nest, but the ants may be seen coming from cracks or joints in the building. In such cases, we can get good control with insecticidal dusts that are carried to the nest by ants walking through them, or with poisoned baits.

Carpenter bees. Carpenter bees belonging to genus Xylocopa are large bees, sometimes an inch long. Most of them are found in the southern part of the United States and in the Tropics. Carpenter bees, like carpenter ants, don't eat wood but excavate tunnels for nesting sites. Unlike ants and some other bees, carpenter bees are not social insects developing large colonies. Tunnel openings are usually perfectly round, or nearly so. The tunnels, which may extend as much as a foot, are divided into brood cells. The occasional tunneling of structural timbers by carpenter bees should cause no alarm to building occupants, but repeated attacks in the same area may result in significant damage. Dusting partly completed tunnels with insecticide powder will kill the adult bees. Insecticides may be used as preventive sprays or may be packed into the tunnels, which are then sealed with putty. The most effective preventive treatment for use in structures is a heavy protective coating of paint.

Exercises (827):

1. Carpenter ants are so named because they ________ ________ into wood and ________ to provide the galleries that form a home for the colony.

2. Carpenter ants are most destructive in what kind of wood?

3. Insecticidal formulations containing ________ ________ hydrocarbons are effective if ________ into the nests.

4. We can often get good control using insecticidal ________ that are ________ into the nests by ants walking through them.

5. Most carpenter bees are found in what part of the United States?

6. Carpenter bees do not ________ wood but ________ tunnels for nesting sites.

7. Partly completed ________ can be ________ with insecticide ________ to kill the adult bees.

8. The most effective preventive treatment for use in structures is a heavy protective ________ of ________.

Ornamental and Turf Pests

ORNAMENTAL TREES AND shrubs represent an important part of the wealth and beauty of this country. They make up our forests and beautify residential grounds, city streets, highways, and the countryside in general. On many of our military installations, cultivated plantings and forest areas are the most attractive features. In addition, they provide protection against dust, erosion, and flooding.

Trees and shrubs on military installations may be attacked and progressively damaged by insects and other pests in many ways. For example, a colony of caterpillars may strip the foliage from twigs and branches; aphids may suck the sap from new shoots and leaves, causing them to wilt or to grow abnormally; tiny scale may encrust branches and twigs, withdrawing enough food to kill plants outright; and borers of many kinds may invade the bark and wood, seriously injuring or killing plants. More subtle and often more serious is the damage caused by those insects that carry bacterial, fungal, or viral disease.

Turf is subject to attack from insects and insectlike pests that cause it to turn brown and die. The extensively grassed areas at military installations represent important investments in land management (dust and erosion control) and in the morale benefits of lawns, golf courses, and recreation areas. The many pests that destroy lawns and other grassed areas are grouped by their methods of attack and types of damage. Some live in the sod and chew the grass roots. Others live above ground and chew the leaves and stems. Still others suck the juice from the plants.

3-1. Ornamental Pests

Ornamental pests discussed in this section include insects that feed on trees and shrubs (by eating entire leaves, eating parts of leaves, or boring into the bark and sucking the sap from leaves and stems). We'll cover the characteristics and controls for common, webbing, and miscellaneous lepidoptera defoliators; skeletonizing and mining defoliators; bark beetles and engravers; sapsuckers; and gall formers.

828. Associate three common Lepidoptera defoliators with their descriptions.

Common Lepidoptera Defoliators. Many of the insects that defoliate shade trees and shrubs are general feeders that attack a wide variety of hosts. The more important and abundant ones are typical caterpillars, such as the fall cankerworm, white-marked tussock moth, and gypsy moth.

Fall cankerworm. The fall cankerworm is found in nearly all parts of the northern United States and as far west as Montana and south to the Carolinas and Missouri. It has been reported in Colorado and California. The adult male has a wing spread of approximately 31 mm. The wings are light gray with pale markings. The female is light gray and wingless. Eggs are deposited in clusters on twigs in late fall and hatch in the spring. Pupation is in a silken cocoon in the ground just a few inches below the surface.

White-marked tussock moth. This moth is found along the entire Atlantic Coast and westward to Colorado. It feeds chiefly on shade trees, such as sycamores. The adult has a wingspread of about 25 mm. The wings are gray with wavy dark bands and pale markings. The female is robust, light gray in color, and is wingless. Eggs are deposited in the fall on silken cocoons in which pupation occurs. They are covered with a white, liquid substance that hardens to form a crust that is very noticeable against the bark of trees. These eggs hatch in early spring, and the larvae start to feed immediately. The larvae are about 3.8 cm long, with a bright-red head and two raised, red humps on top near the posterior end.

Gypsy moth. The gypsy moth is found primarily in the New England States and parts of New York and Pennsylvania. It feeds mainly upon such trees as apple, alder, birch, oak, and willow. The adult male has a wingspread of about 3.8 cm and the the wings are brown with yellowish markings. The wings of the female are almost entirely white with a few dark markings and are approximately 5 cm across. The female has a thick heavy body and does not fly.

Exercises (828):

______ 1. Which pest feeds mainly on such trees as apple, alder, birch, oak, and willow?

______ 2. Which feeds chiefly on shade trees, such as sycamores?

______ 3. Which adult male has a wingspread of about 3.8 cm and wings that are brown with yellowish markings?

______ 4. Which adult male has a wing spread of approximately 31 mm and light gray wings with pale markings?

______ 5. Which adult has a wingspread of about 25 mm and gray wings with wavy dark bands and pale markings?

829. Associate three webbing Lepidoptera defoliators with their descriptions.

Webbing Lepidoptera Defoliators. Many important pests of ornamentals construct webbed tents on limbs and branches of host trees. Others enclose themselves in rolled leaves or leaves tied and webbed together. The large ugly webs, or rolled and tied leaves, combined with the stripping of foliage by the caterpillars, adds to the unsightly appearance of damaged trees.

Fall webworm. The fall webworm is a moth belonging to the order Lepidoptera. It is only important as an ornamental pest in its larval stage, as is the case of all Lepidopteras. It feeds on shade and fruit trees and is most abundant in the western region of the United States, but is also found westward to the Rocky Mountains. An unusual characteristic of fall webworms is the forming of a thin white web that encloses the tips of branches on which the worm is feeding. As they grow and eat the foliage within the web, they extend the web to cover more leaves. Remember this characteristic especially, because you must detect the presence of fall webworms when you make surveys.

The larvae are about 28 mm long and pale yellowish or greenish. They have a longitudinal greyish stripe down the center of their backs, a yellow strip along each side, and are black and orange spotted. The adults have pure white wings that may be spotted with black at times. The wingspread of these adults is approximately 25 mm.

Fall webworms spend the winter as pupae in a thin cocoon on the ground. They emerge as adults in late spring and lay their eggs in masses of up to 500 on the bottom of leaves. The eggs hatch in about 10 days and the larvae start to feed, eating the entire leaves.

Eastern tent caterpillar. The eastern tent caterpillar is a moth that eats entire leaves of shade and fruit trees. Found from the Rocky Mountains eastward, these insects build webs in the forks of main branches in a tree. Unlike the fall webworms, these webs don't enclose leaves; they serve only as protective living areas. The larvae must leave the web to feed. The caterpillar is about 5 cm long and black with a white longitudinal stripe on its back. On each side of the stripe is a row of alternating pale blue and velvety black spots. It is sparsely covered with light-brown hairs.

The adult is robust and has a reddish-brown body and wings. The forewings have two whitish lines crossing them. The male's wingspread is about 3.2 cm, while the female's is only about 12.5 mm. The adults appear in early summer and lay as many as 300 eggs in wide bands around small twigs of trees. A sticky substance deposited over the eggs hardens and attaches them to the twig. The larvae hatch and overwinter within the case, emerging in early spring. At first, the larvae feed on the eggs' covering material, and then they spin the web.

Spruce bud worm. This moth larva is probably the most destructive leaf roller and tier in the United States. It is a serious pest of spruce, balsam fir, and ponderosa pine. The larvae feed first by boring within old needles and then tunnels into opening buds. They later tie the tips of twigs together, forming a nest, and when they are full grown, they spin loose cocoons in the nest or on a twig, where pupation occurs. The adults are active in the summer and lay their eggs on foliage. The eggs hatch and the young larvae spin protective coverings under the bark scales to overwinter. The larvae then become active in the spring, feeding on opening buds. The adults are attractively striped or spotted in brown or grays. Resting, they appear to be bell shaped because of the way the wings are folded across their backs. The moths seldom exceed 25 mm in wingspread. The larvae are greenish and have sparse hairs protruding from tiny raised areas on their bodies.

Exercises (829):

To which pest does each description refer?

1. It eats entire leaves of shade and fruit trees. These insects construct webs in the forks of main branches in a tree. The web does not enclose leaves and serves only as a protective living area.

2. Is only important as an ornamental pest in its larval stage. It feeds upon shade and fruit trees. The white web encloses the tips of branches that are being fed upon.

3. It is a serious pest of spruce, balsam fir, and ponderosa pine. The larvae feed first by boring within old needles and then tunneling into the opening bud. The adults are active in the summer and lay their eggs on foliage.

830. Confirm or correct statements about bagworm and cutworm characteristics, habits, and habitat.

Miscellaneous Lepidoptera Defoliators. The most common of the other arthropods that eat leaves and needles of ornamentals are the bagworms and cutworms.

Bagworms. The bagworm caterpillar lives in a silken cocoonlike bag, approximately 5 cm long, attached to the stems and twigs of the host plant. It is principally a pest of shade trees, shrubs, and hedges, although it attacks evergreens of all kinds, especially junipers, cedars, and arborvitae. Affected plants may be partially-to-totally defoliated. The bag is usually recognizable by the bits of leaves and debris stuck to it.

Cutworms. Cutworms are smooth, plump caterpillars, gray or brownish, and 2.5 to 5.0 cm long when full grown. They are seldom seen because they usually remain hidden under clods of earth or in the topsoil by day. In the evening, cutworms emerge to feed on foliage, buds, green fruits, and succulent growth of ornamentals. Heavy infestations cause severe damage, and at times, young plants may be killed.

Exercises (830):

Mark each statement true (T) or false (F) and correct the false ones.

____ 1. Other than "common" and "webbing" types, the most common Lepidoptera defoliators are bagworms and cutworms.

____ 2. The cutworm is a caterpillar that lives in a silken cocoonlike bag with bits of leaves and twigs stuck to it.

____ 3. The bagworm is principally a pest of shade trees, shrubs, and hedges although it attacks evergreens of all kinds.

____ 4. Bagworms are smooth, plump caterpillars, gray or brownish, and full-grown ones are 2.5 to 5.0 cm long.

____ 5. Cutworms are seldom seen because they usually remain hidden under clods of earth or in the topsoil by day.

831. Identify descriptive statements with the elm leaf beetle, Japanese beetle, or both.

Skeletonizing Defoliators. Leaf beetles, as the name implies, feed on the leaves of plants as adults or larvae or both. The adults are characterized by a great variation in coloration and markings; they are spotted, striped, or patterned in brightly contrasting colors. The larvae are usually soft bodied and sometimes highly pigmented. The feeding pattern of the adults often "skeletonizes" the leaves. The larvae and adults eat the upper and lower epidermal layers of the leaf, leaving only the veins and cross veins untouched. Heavy feeding by either adults or larvae causes a distinct brown or gray appearance of the trees attacked.

Elm leaf beetle. This beetle can be found in almost every region of the United States, but it's most commonly found in the New England and Mid-Atlantic States. As its name indicates, its preferred food is the elm tree. Both the adult and larval stages feed on the leaves. The adults eat irregularly shaped holes in the leaves in early spring, while the larvae feed on the leaves' undersurface, leaving the upper epidermis unbroken in the summer. The adult beetle is about 6 mm long, dull yellow with black spots on the head and pronotum. It has a black band near the outside of each elytron (wing cover) and a short streak at the base of each elytron.

Japanese beetle. This beetle is distributed from Maine to Florida and eastward to the Mississippi River, although it is most abundant in Connecticut, New York, New Jersey, Delaware, Pennsyl[illegible]a, and Maryland. It feeds on the foliage of many types of plants as an adult. It also feeds on the roots of many plants in the larval stage. The adults appear in June and lay their eggs in the ground. Upon hatching, the larvae (grubs) feed on decaying vegetation and living plant roots. As the weather gets cooler, the larvae burrow deeper into the ground and overwinter. As the weather warms, they begin to work themselves closer to the surface to pupate in May. The adults are about 12.5 mm long and bronzy green. The elytra are brown. There are six white spots along each side of the abdomen.

Exercises (831):

To which skeletonizing defoliator beetle does each statement refer (elm leaf, Japanese, or both)?

____________ 1. Their preferred food is the elm tree.

____________ 2. Both the adult and larval stage feed on the leaves.

____________ 3. The adult is about 6 mm long, dull yellow, and has black spots on the head and pronotum.

____________ 4. Heavy feeding by either the adults or larvae causes a distinct brown or gray appearance of the trees attacked.

____________ 5. The adult feeds on foliage of many plants, and larvae feed on the roots of many plants.

____________ 6. The adults appear in June and lay their eggs in the ground.

____________ 7. The adults are about 12.5 mm long and bronzy green.

832. Associate four mining defoliators with their physical descriptions, habits, and food.

Mining Defoliators. Leaf-mining insects eat the tissues between the upper and lower surfaces of leaves and needles. On deciduous trees, miners make blotchlike or irregular serpentine mines, thus producing brown patches or blotches on leaves. When they're numerous, they kill the leaves and thus disfigure the plant or tree. On conifers, the needles are hollowed out, and the dried, mined needles have a scorched, sickly appearance. When leaf miners are numerous, growth of plants and trees is retarded, and at times, the plants and trees may be killed.

Holly leaf miner. Holly leaf miners are the larval stage of a small dark or yellowish fly. The maggots are less than 4.7 mm long, with whitish, cylindrical, soft, legless bodies. The head is indistinct and is located at the pointed end of the body. The mouthparts consist of a single, toothed hooker one or two parallel, toothed hooks. The pupae hibernate over the winter in the leaf mines.

Arborvitae leaf miner. The arborvitae leaf miner is the larval stage of a small, gray moth with a wingspread of only 8.3 mm. The larvae are 5 mm long, green with a reddish tinge and black head and short bristles across the black head, and short bristles across the back of each segment. The larvae mine the terminal leaves by eating out the inside. The mined tips turn yellow or whitish, and finally, brown, and they stand out prominently against the normal green foliage. In severe cases, all the foliage is mined, and the shrubs turn brown all over. The moths emerge in May and June and lay their eggs in late June.

Basswood leaf miner. The basswood leaf miner is the larval stage of a small, reddish-yellow, wedgeshaped beetle that spends the winter under leaves and trash of the tree. It becomes active in May, skeletonizing the foliage. Eggs are laid singly in feeding areas and covered with excrement. The larvae start feeding into the leaves in single mines; then several join together in a common mine. Spiny pupae appear in the mines in August. The beetles emerge to do more feeding before hibernation for winter begins.

Birch leaf miner. The birch leaf miner is an important sawfly. It was first discovered in Connecticut in 1923. It is now a major pest of birch in New England, New York, New Jersey, Pennsylvania, and recently, Oregon. Infested trees look as if they had been blighted by disease. The mature larva is 6.2 to 12.5 mm long, rather flat, and whitish with black spots on the underwide of the thorax and first abdominal segments. This miner passes the winter in a cell in the soil. The adult is a 1.5-mm black sawfly that emerges in the spring about the time leaves are half open and lays its eggs in the new leaves. The larvae first make small, gray, kidney-shaped blotch mines in the leaf. Gradually, half of the leaf turns brown. There are several generations, with the female sawflies laying eggs always in the newly developing leaves. Hence, the first brood is the worst, when all the leaves are new. The later broods infest mostly ends of branches of water sprouts.

Exercises (832):

To which mining defoliator does each statement refer (holly, arborvitae, basswood, or birch)?

_______________ 1. This is the larval stage of a small, reddish-yellow wedge-shaped beetle that spends the winter under leaves and trash of the tree.

_______________ 2. This is the larval stage of a small, dark or yellowish fly. The maggots are less than 4.7 mm long, with whitish, cylindrical, soft, legless bodies.

_______________ 3. This makes infested trees look as if they had been blighted by disease. The mature larva is 6.2 to 12.5 mm long, rather flat, and whitish, with black spots on the underside of the thorax and first abdominal segments.

_______________ 4. This is the larval stage of a small, gray moth with a wingspread of only 8.3 mm.

833. Cite measures you can take to control ornamental defoliators.

Control of Ornamental Defoliators. Common Lepidoptera defoliators and skeletonizing defoliators are easily controlled with insecticidal sprays and dusts. When you are controlling these pests with insecticides, always make sure that the insecticide is approved for your intended use.

Leaf and needle miners often are hard to control because they are between the layers of the leaf. Insecticidal sprays are effective, but it takes thorough coverage and you must repeat the treatment. You can control light infestations by handpicking the infested needles or twigs.

Insects in webbed tents and in rolled and tied leaves usually can be controlled by the insecticidal sprays recommended for general defoliators. Mechanical methods also are useful when infestations are confined to individual trees or single limbs or branches. Destruction of wild cherry trees, a preferred host of the eastern tent caterpillar, is helpful in reducing the populations of this pest. Tents on other trees can be pruned off and destroyed or, on occasion, burned in place. Removal and destruction of rolled and tied leaves is also effective in controlling light infestations on individual ornamentals. Bagworms are readily controlled by handpicking bags from affected hosts. If handpicking is not feasible, you can control them with insecticidal sprays, but only in the spring and early summer months, when they are feeding.

Exercises (833):

1. What insecticidal formulations are most suitable for controlling defoliators?

2. Why are leaf and needle miners often hard to control?

3. What is the easiest control for bagworms?

834. Confirm or correct statements about the importance, description, and control of bark beetles.

Bark Beetles. Bark beetles and engravers are major pests of coniferous trees in forested areas. Forest trees serve as the breeding place for most species. Ornamentals that are usually forest trees but are growing under unnatural conditions often are attacked and killed. For the most part, both adults and larvae live in the bark or wood of trees. Many species confine their attack to pines, although other conifers and hardwoods often are affected.

Bark beetles and engravers are small, black or dark brown, cylindrical beetles. They are usually less than 6.2

mm long. The larvae are small, soft, white or yellowish-white, legless, and strongly curved grubs. Most species are found between the bark and the wood along the stem of the trees. Some bark beetles, however, feed entirely in the corky layer of outer bark. You can recognize all of the bark beetles and engravers by the characteristic pattern of winding galleries constructed by adults or larvae in the cambium tissues beneath the bark. The engravers, as the name implies, etch the wood beneath the bark in the construction of their galleries. Bark beetles don't score the wood. Attacked trees are quickly killed and foliage soon turns a sickly yellow, red, and brown and finally the needles fall to the ground.

Control of bark beetles and engravers is primarily prevention because attacked trees usually are quickly killed and cannot be saved. Individual trees can be protected against attack by spraying bark surface of stems with an approved insecticidal emulsion. Trees damaged through neglect and carelessness are highly attractive to bark beetles and engravers. Measures taken to avoid this damage will decrease the probability of attack by bark beetles and engravers. Cutting and destroying trees previously killed by bark beetles will also lessen the possibility of attack of surrounding shade trees.

Exercises (834):

Mark each statement true (T) or false (F) and correct any false ones.

____ 1. Bark beetles and engravers are major pests of coniferous trees in forested areas.

____ 2. Bark beetles and engravers are small, black or brown, cylindrical beetles, usually less than 2.6 mm long.

____ 3. Bark beetles score the wood.

____ 4. The engravers etch the wood beneath the bark in the construction of their galleries.

____ 5. Individual trees can be protected against attack by spraying bark surface of stems with an approved insecticidal emulsion.

____ 6. Attacked trees are quickly killed.

835. State what damage borers do and how we control them.

Ornamental Borer Damage. The larvae of some beetles and moths are borers in the woody tissue of ornamentals. They are a constant and serious threat to a wide variety of ornamentals and shade trees, especially dogwood, lilac, apple, ash, birch, rhododendron, pine, locust, maple, sweetgum, and oaks. Since infestations usually start in weakened trees, their damage often goes unnoticed until serious injury develops. Injury is caused by larvae tunneling under bark and into the wood. Some confine their attack to the sapwood of the trunks, decreasing the vigor of the host plant and causing foliage to wilt. Others bore into the heartwood. Still others bore into hollow branches and twigs. Wilting leaves on individual branches or twigs are suggestive of their work. The twigs or branches eventually die and are broken by the wind. Dangling dead branches become conspicuous. Close examination of trees attacked by borers usually reveals fine boring dust being pushed from the holes by the larvae as they extend their tunnels. Severe infestations may result in the girdling and eventual death of the tree.

Control. Since the larvae are well protected within the bark and wood, control of borers is very difficult. There are, however, a number of remedial measures that you can take. Since infestations usually start in weakened trees, cultural methods of control are often effective. Application of fertilizers monthly and frequent watering of weakened or newly transplanted trees will increase plant vigor and help them to overcome attacks to some extent. Wrapping the trunks of newly transplanted trees with paper or burlap will lessen the chance of attack. In the early spring, pruning and burning the dying or unthrifty twigs or branches containing borers will reduce infestations. Preventing careless damage to the bark will help lessen the chance of attack by borers.

Borers in the wood or bark can be killed by injecting carbon disulfide, paradichlorobenzene, or benzene hexachloride paste into the tunnels and sealing the openings with putty. Overwintering borers living just beneath the bark of infested trees can be killed by applying such an insecticidal residual as a bark wash in the spring.

Exercises (835):

1. The larvae of some beetles and moths are ________ in the woody tissue of ornamentals.
2. Injury is caused by larvae ________ ________ ________ and into the ________.
3. Close examination of trees attacked by borers usually reveals ________ ________ ________ being pushed from the holes by the ________ as they extend their ________.
4. Wrapping the trunks of newly transplanted trees with ________ or ________ will lessen the chance of ________.
5. Borers within the wood or bark can be killed by injecting ________ ________, ________, or ________ ________ paste into the ________ and sealing the openings with ________.

836. Identify damage, descriptive characteristics, and control measures for ornamental sapsuckers.

Ornamental Sapsuckers. Many insects and some other arthropods feed only on plant sap. Spotting, discoloration, malformation, and general devitalization of the foliage, twigs, or other plant parts are caused by insects and mites that have mouthparts adapted for piercing plants and extracting sap. Solid parts of the plants are never eaten. The injury consists of enlarged growth (galls): foliage disturbances, such as bleaching or yellowing: or deformations, such as curling. All parts of all plant species are subject to attack by these pests, but usually a given species infests only a particular plant part. Most sapsucking insects belong to the orders Hemiptera and Homoptera, but some are mites (class Arachnida) and many of the gall formers are wasps (Hymenoptera) and flies (Diptera).

Aphids. Aphids are sapsucking insects that cause a general devitalization of the part of the plant. When feeding is intense and continuous, branch killing and even tree killing results. Aphids commonly produce large quantities of honeydew; sometimes during heavy infestations, the excreted liquid may appear as mist falling from the tree. This honeydew often spots or forms a glistening coat on the leaves and on cars and other objects located below. Various insects use honeydew for food. Some species of ants also care for and protect the aphids, even moving them to new feeding areas in a mutually beneficial relationship.

The adult aphids are small insects, 0.8 to 6.2 mm long, with delicate, soft, globular- to pear-shaped bodies that are yellow, red, green, gray, blue, or black. The adults have both winged and wingless forms; the winged forms have two pairs of delicate membranous wings that are usually held rooflike over the body. There are three pairs of long, slender, thoracic legs with two-segmented tarsi. The antennae are prominent and threadlike, with three to six segments. The beak appears to arise from between the front legs. The nymphs resemble adults in most characteristics except that they are smaller in size, always lack wings, and are sexually immature.

The life cycle of some aphids is simple, while others have a complex development. They pass the winter as eggs on the primary host plant. The eggs hatch in the spring to produce nymphs, which all mature as wingless females. They reproduce without mating (parthenogenesis), and some (Aphididae) give birth to living young (viviparous), whereas others (Adelgidae) always lay eggs (oviparous). Several additional, similarly produced, asexual, wingless generations may be produced on the primary host before a winged asexual generation develops. These migrate to the secondary host plant, where wingless females are produced again for a number of generations. A second, winged, migrating generation, consisting solely of females, develops later in the year, and these return to the primary host plant. A bisexual generation then develops. These mate, and each female lays one overwintering egg. You can use pesticides such as malathion and dimethoate to control aphids.

Scale insects. Scale insects are so called because many species secrete a scalelike wax coating over their backs, and others resemble bark scales. These insects cause general devitalization and death of the infested parts by extracting plant sap and by injecting toxic saliva into the host plant tissue. Different species attack different parts of the hosts, but most infest the twigs and smaller branches. The soft scales frequently produce large amounts of honeydew, which attracts nectar-feeding insects. The honeydew that is not used falls on the leaves, twigs, and branches below, where it forms a medium for black sooty molds. Only a few species are troublesome forest pests, but many injure shrubs and shade and ornamental trees. A few species produce useful products, such as shellac; and in past times, some scale insects were the sole source of certain brilliant dyes.

The adult female body may be flattened, globular, hemispherical, saclike, elongated, or circular. Sometimes it is covered with wax in the form of powder, cottony masses, or a continuous scalelike layer. The females are always wingless, and the legs, antennae, and compound eyes are reduced or absent. Most species are sedentary and cannot move from the place where they settle after the crawler stage. The males, though seldom observed, usually have a pair of membranous wings. The legs are well developed, the antennae are long, with 6 to 13 segments, and the beak is absent. The nymphs of the first instar (crawlers) of both sexes have legs, antennae, and functional mouthparts, and they are mobile; other nymphal instars of both sexes are scalelike, with male scales being smaller and often more elongated. Most species lay eggs, but a few are viviparous. The crawlers disperse to new places on the same host plant or get carried to new host plants by wind, birds, or other animals. There may be one to three additional instars and one to six generations per year, depending on the species and the length of the summer season. Insecticides are seldom used for protecting forest trees but commonly are used on shrubs and shade trees. Mineral oils (3 percent emulsions) can be used as dormant sprays on most decidous trees except walnut, beech, and sugar maple, which are injured by oils. Since the heavy, dormant oil sprays also may injure evergreens, we use only the lighter, milder, summer oil emulsions. Apply dormant oils in the early spring, before the buds begin to expand, but be sure the temperature won't drop below freezing for at least 24 hours.

Mealybugs. Mealybugs are closely related to the scale insects. They are small and are covered with a soft, fine, white, granular material that forms long, cottony threads over the body. Mealybugs damage hosts by sucking juices from plants much as scale insects do. They can be controlled effectively with malathion the same way you treat for aphids.

Spider mites. Spider mites are minute, reddish or yellowish spiderlike arthropods barely visible to the naked eye. Their bodies are rounded, shiny, and covered with fine hairs. Spider mites infest most ornamental plants and many shade trees. They feed by sucking juices from the underside of leaves and tender parts of plants. The result of their feeding is a stippled appearance of the foliage, which later discolors and dies. The lower surfaces of leaves on infested plants have a residue of cast skins, eggs, and webbings. Spider mites can be controlled to some extent by destroying weeds and brush adjacent to ornamental plants. Chemical controls would be the same as for aphids and mealybugs.

Leafhoppers. Leafhoppers are very small, slender, delicate insects. The adults are colored variously and hold their wings over the back like a tent. They are very active and hop a considerable distance when they're disturbed. Leafhoppers attack a wide variety of grasses, shrubs, and shade trees in various ways. Sucking the plant juices withers and curls the leaves, kills tender tips, and turns the leaf edges brown. Some species transmit plant diseases, more so to cultivated crops than to ornamental and shade trees. Controlling leafhoppers involves the same measures as for aphids.

Spittlebugs. Adult spittlebugs resemble leafhoppers in appearance, but they are heavier bodied. The name is commonly applied to the nymphs, which secrete a frothy protective foam around themselves. Spittlebugs are pests of ornamentals and conifers. Some species have alternate hosts in nymphal and adult forms. They suck large quantities of sap from plants and leave numerous small pinholes in phloem and bark tissues. Needles of heavily infested trees turn brown, and twigs and branches are killed. In severe infestations, hosts may be killed in 2 to 3 years. You can control spittlebugs effectively with malathion. Make sure you cover the foliage thoroughly, including the undersides.

Lacebugs. Lacebugs are small, rectangular insects with an expanded prothorax extended and rounded, resembling a hood. The outer pair of wings are strongly veined and lacelike and are held flat over the back. The nymphs are frequently covered with spines. Lacebugs attack many shrubs and shade trees. The adults and nymphs feed by sucking juices from their hosts, usually from the undersurface of leaves. Damaged leaves have a spotted, grayish appearance on top and a black, shiny, varnishlike excrement and cast skins on the undersides. Severe infestations cause leaves to turn brown and finally to drop. Lacebugs can be controlled effectively the same way we control aphids.

Thrips. Thrips are very small insects varying in size from less than 1.0 to 1.6 mm in length. They are slender and usually are blackish, brownish, or yellowish. Most flowering plants and shrubs are subject to attack by thrips. They feed on the tissue of the foliage, buds, flowers, and bulbs by puncturing the surface and sucking juices from the part attacked. Buds may fail to open. Flowers may be deformed, blotched, or streaked. Foliage loses its rich colors and develops a characteristic yellowish or silvery appearance, and since it doesn't drop prematurely, the off-color appearance generally lasts until the end of the season. Some thrip species also carry virus diseases of flowering plants. Thrip control is difficult because the tiny insects hide in the sheaths of leaves and flower stems as well as within the flowers themselves. It is hard to reach them with sprays, often taking several applications.

Exercises (836):

1. What general types of plant damage are caused by insects and mites that act as ornamental sapsuckers?

2. What size, shape, and color are aphids?

3. What pesticides can you use to control aphids?

4. How do scale insects damage infested plants?

5. Give the identifying characteristics of scale insects in terms of:
   a. Body shape.

   b. Outer covering.

   c. Female characteristics.

   d. Male characteristics.

6. When should you apply dormant oils to plants for controlling scale insects?

7. What are the physical characteristics of mealybugs?

8. What physical characteristics do spider mites have?

9. How do spider mites damage plants as they feed?

10. What types of vegetation are attacked by leafhoppers?

11. How do spittlebugs damage ornamentals and conifers?

12. How should you insure effective chemical control of spittlebugs?

13. What damage to leaves is caused by lacebugs?

14. Spider mites, leafhoppers, and lacebugs are controlled in the same ways as for ________.

15. What are thrips' identifying characteristics, and what kinds of plants do they attack?

16. Why are several pesticide applications often needed to control thrips?

837. Cite survey and control methods for ornamental pests.

Ornamental Pest Survey and Control. The first essential for effective insect pest control is vigilance and an interest in looking for insects and signs of their damage. To detect insects before they seriously damage valuable trees and shrubs, you should carefully examine the plants at least once a week during the growing season. Examine deciduous trees in winter also, when you can see scale insects more easily. You must identify the pests and the host plants, then select your insecticides, prepare the right dosages, decide on the proper application, and select your equipment. Insecticide selection usually follows three basic rules. Use a stomach insecticide for pests with chewing mouthparts; use a contact insecticide for those with sucking mouthparts; and use a fumigant for larvae, such as wood borers. To simplify instructions and avoid complicated storage problems, select the lowest feasible number consistent with effective results.

Insecticides that destroy pests effectively are, with few exceptions, toxic to humans. This is also true of most of the solvents used to prepare them. No serious effects will normally result to control operators or to human and animal populations in the treated environment if you follow the mixing and application instructions on the product labels and apply insecticides only under the direct supervision of trained and certified personnel as required by Department of Defense directives. Since injury may occur when plants are sprayed under improper conditions, apply dormant oil sprays only from January 1 until buds swell in the spring—*never* in the fall. Don't apply them during sudden drops of temperature to below freezing. It's a good rule to apply them only when the temperature is above 40° F. Don't apply them on maples, beeches, walnuts, or Japanese flowering cherry trees of the varieties Yoshino, Akebono, and Benihigan; all are sensitive to oil injury. Don't spray summer oils when the temperature is above 86° F, particularly under high humidity and drought conditions.

Spraying and dusting equipment varies in size and type from the small dusters and sprayers suitable for a few small shrubs to large mechanical dusters, hydraulic sprayers, mist blowers, airplanes, and helicopters that are used on large shade trees and forested areas. Dusting insecticides in some cases may be less troublesome, but it is effective against fewer insect pests. Sprays and mists have a distinct advantage over dusts in that the loss from drift is less because they stick to plants.

Hydraulic sprayers and mist blowers, in most cases, complement rather than replace each other. Each has its particular advantages in applying spray materials. For example, the spray hose gives the hydraulic sprayer much more maneuverability for spraying in congested areas, around plantings, or in areas inaccessible to heavy equipment. The mist blower, however, has the advantage in spraying along streets, parkways, and open areas where there's room to maneuver. If there's room, the mist blower can spray large trees more rapidly and at lower cost than the hydraulic sprayer, but wind is more of a hindrance. It can only spray the tops of tall trees satisfactorily if there is not much wind. You need more skill to get good spray coverage with the mist blower, because of the wind factor and the relatively low volume and higher concentration of spray material it uses. Separate and mark all spraying equipment that you use to apply herbicides, including hoses and nozzles. *Do not use this equipment* for spraying insecticides on trees and shrubs.

When you must spray where cars are parked, put an announcement in the official bulletin or other station publication and post proper warning signs at least 1 day before the spray operation. These notices should give the car owners ample time to park their cars elsewhere during the period of spraying.

Trees and shrubs that are kept healthy are less likely to be seriously damaged by insect pests than those that suffer from improper pruning, mowing, cultivation, lack of water, low soil fertility, or poor soil condition. To help keep trees and shrubs healthy, we must take preventive measures to protect them from harmful insect pests. In the forest, these losses are usually offset by the growth of new plants, but under cultivated conditions, that means costly replanting. Careful selection of plant materials that are healthy, vigorous, and resistant to insect attack, as well as sanitation through pruning and burning infested wood, are essential preventive measures. It is important to develop a preventive control program for the area.

Exercises (837):

Mark each statement true (T) or false (F) and correct any errors.

____ 1. The first essential for effective control of insect pests is vigilance and an interest in looking for insects and signs of their damage.

____ 2. Use a contact insecticide for pests with sucking mouthparts.

____ 3. Use a stomach insecticide for those with sucking mouthparts.

____ 4. Use a fumigant for larvae, such as wood borers.

____ 5. Do not apply dormant oil sprays in the fall.

____ 6. Hydraulic sprayers and mist blowers, in most cases, complement rather than replace each other.

____ 7. When it is necessary to spray in areas where cars are parked, an announcement in the official bulletin or other station publication should be made and proper warning signs posted at least 1 day before the spray operation.

____ 8. Do not spray summer oils when the temperature is above 80° F, particularly under high humidity and drought conditions.

3-2. Turf Pests

The pests in this section include various insects, snails, and slugs. The grounds on Air Force installations must be kept pleasing to the eye and in shape to prevent rain and wind erosion. You must be able to recognize the effects of pests on turf and grasses. You must also know what controls will keep turf and grass free from these pests.

838. Relate given soil and root infesting insects with their descriptions.

Soil and Root Infesting Insects. Soil and root infesting insects include grubs (larvae) of many beetles, mole crickets, wireworms, billbugs, and ants. This lesson will describe these pests to enable you in recognizing them so that you can implement the proper controls.

Grubs. There are numerous species of beetles whose larvae, or grubs, attack the roots of grasses during underground development. They are whitish to grayish and, except for the larvae of the green June beetle, lie curled.

May or June beetle adults are 12.5 to 18.8 mm long, blackish-brown beetles. They are most abundant between April and mid-July, depending on which of more than 200 species they may be. Grubs of some species stay in the soil 2 or 3 years. They remain inactive well below the sod during the winters, but come up again to feed upon grass roots during warm weather. May beetles are found throughout the country.

Japanese beetle grubs are about 25 mm long when they mature. They feed on roots of grasses and of various other plants from August through October and again in April. Beetles appear in May or June and stay for 6 weeks or so. They're well known for their destructive mass attacks on berries, orchard fruits, truck and garden crops, ornamentals, and shade trees. They occur in varying numbers from southern Maine southward into South Carolina and westward into Ohio and West Virginia, with isolated colonies in several other states westward to the Mississippi River. The spread of the Japanese beetle has been retarded by a cooperative Federal-State regulatory program in which 5 percent of the area of the United States is under quarantine.

The body of the *green June beetle* is almost an inch long, slightly flattened, and grey/green with yellow edges. It is active from June through August. The larva is distinctive; it is not curled and it crawls on its back while searching for decaying organic matter on which it lives. Harmful holes in turf and little mounds of earth result from this exploration. There is only one generation per year. Green June beetles are found mostly in the Southern States, but frequently as far north as Long Island.

The *masked chafer beetle* is 12.5 mm long, brown, and often observed around lights on warm, humid evenings from June to September. Larvae are sometimes called annual white grubs because the life cycle is completed in 1 year. They attack the roots of grass. The northern masked chafer is found from Connecticut south to Alabama and west to California. The southern masked chafer is common in the Southeastern States and is found in Iowa and Illinois.

The adult *rose chafer* is 12.5 mm long, yellowish brown, and has long, spiny legs. It is found in late spring or early summer. The grub is about 18.8 mm long and slightly narrower than most other grubs discussed here. There is one generation per year. Turf damage by this species is generally less severe than that done by other grubs, but it may be bad in sandy areas. Rose chafers are found in the Eastern United States and west to Colorado and Texas.

European chafers are tan to chocolate-brown beetles, 12.5 mm long, that appear in June and July. Their larvae, which are generally similar to other chafer grubs, complete their development in 1 year and are serious turf pests in New York State. Isolated infestations have been found in Connecticut and West Virginia.

Oriental beetles are broadbodied, spiny-legged beetles, 15.6 mm long, varied in color pattern, but usually straw colored with some dark markings on the body. They appear in late June through August. These larvae are hard to tell from several of the other grubs. The life cycle is usually completed in 1 year, but the grubs may pass two winters in the soil. They kill lawn grass by eating off the roots close to the soil surface. They are found in Connecticut, southeastern New York, and northern New Jersey.

Adult *Asiatic garden beetles* are only 9.4 mm long, cinnamon brown, and look velvety. The underside of the body is covered with short yellow hairs. They are active only at night, and are troublesome prevalent from mid-July to mid-August. The larvae have more slender bodies than most of the other related grubs. They usually damage the roots of grass in association with weeds that afford some shade.

White-fringed beetles are dark grey snout beetles, slightly less than 12.5 mm long, with pale white margins on the wing covers extending along the prothorax. The beetles are found from early May to October. The full-grown larvae are about 12.5mm long, yellowish white, and almost hairless. They chew away the lower part of the stem and taproot of many kinds of plants and may sometimes become troublesome in turf. There is one generation per year, and the distribution is currently confined to the Southeastern States.

The *rhinoceros beetle* is 5 cm long. Its larva is 7.6 cm long. It is a pest of lawns in Florida, where it is found during the summer and fall.

Mole Crickets. These peculiar looking creatures are brownish, sometimes almost olive colored insects 3.8 cm long with powerful forelegs adapted for digging. They make burrows that resemble tiny mole tunnels in the soil, disturbing grass seedlings and cutting off established grass roots. There is one generation per year. They are most numerous in the South Atlantic and Gulf Coast States from North Carolina to Texas.

Wireworms. The adults of wireworms are slender brown "click beetles". The larvae, or wireworms themselves, may be 12.5 mm to 3.8 cm long at maturity and are usually hard, yellowish brown, smooth, and wormlike, They bore into the underground parts of numerous farm crops and other plants. This boring into and feeding in grass roots and stems causes withering and death. Wireworms remain in the soil for 2 to 6 years while developing, moving only a few yards during this time. Their distribution is cosmopolitan, but they are most serious in areas of high rainfall or where irrigation is practiced.

Billbugs. Adult billbugs are various colored beetles, 5.0 to 18.7 mm long, with long snouts or bills at the tip of which are strong jaws. With these jaws, adults burrow into grass stems for food and for the deposition of their eggs. They also eat leaves. The larvae have soft, white bodies; hard, yellow-to-brown heads; and are rather small. They feed on fibrous grass roots of turf and small grains throughtout the grasslands and cultivated areas of the United States.

Ants. Numerous species of ants have become associated with humans and their property. Most are small, 2.5 to 6.3 mm long, ranging from yellow to black. Several of these, such as the cornfield and little black ant, are frequent inhabitants of established lawns throughout the country. The Argentine and pavement ants are found in lawns in the Southeast and Atlantic Coast States, respectively. Their ant hills and underground nests smother or destroy the roots of surrounding turf. The southern fire ant is spreading northward from the Gulf Coast States, where it forms loose mounds or numerous scattered craters in grassed areas. Texas leaf-cutting ants damage turf and establish unusually deep nests, which they provision with cut leaves of plants (to grow fungus) and grass seed. This ant is found in Texas and Louisiana.

Exercise (838):

1. Match the statements in column B with the pests in column A.

Column A

____ (1) Grubs.
____ (2) May or June beetles.
____ (3) Japanese beetles.
____ (4) Green June beetles.
____ (5) Masked chafer.
____ (6) Rose chafer.
____ (7) European chafer.
____ (8) Oriental beetle.
____ (9) Asiatic garden beetle.
____(10) White-fringed beetle.
____(11) Rhinoceros beetle.
____(12) Mole cricket.
____(13) Wireworm.
____(14) Billbug.
____(15) Ant.

Column B

a. Well known for attacks on berries, orchard fruits, truck and garden crops, ornamentals, and shade trees.
b. 12.5 mm long, brown, and is often observed around lights on warm, humid evenings from June to September.
c. This snout beetle is dark grey, slightly less than 12.5 mm long, with pale white margins on the wing covers extending along the prothorax.
d. Small, 2.5. to 6.3 mm long, ranging in color from yellow to black. Its underground nests smother or destroy the roots of surrounding turf.

Column B

e. Attacks the roots of grasses during its underground development—Whitish to grayish and, except for one instance, larva lies in a curled position.
f. Its body is almost an inch long, slightly fattened, and grayish green with yellow edges.
g. Is a broadbodiea, spiny-legged beetles, 15.6 mm long, varied in color pattern, but usually straw colored with some dark markings on the body.
h. The adult is a slender, brown "click beetle." Its larva may be 12.5 mm to 3.8 cm long at maturity, usually hard, yellowish brown, smooth,and wormlike.
i. Adult is 12.5 to 18.8 mm long, blackish brown. Most abundant between April and Mid-July.
j. Varies in color, is 5.0 to 18.7 mm long, with a long snout or bill tipped with strong jaws.
k. The adult is 12.5 mm long, yellowish brown, and has long spiny legs. It is brown and has long, spiny legs. It is found in late spring or early summer.
l. Brownish, sometimes almost olive colored, insect 3.8 cm long, with powerful forelegs adapted for digging.
m. Tan-to-chocolate-brown beetle, 12.5 mm long. that appears in June and July.
n. Adult beetle is only 9.4 mm long, cinnamon brown, and looks velvety. The underside of the body is covered with short, yellow hairs.
o. It is 5 cm long, and its larva is 7.6 cm long. It is pest of lawns in Florida.

839. Associate leaf- and stem-damaging insects with their damaging characteristics and general descriptions.

Insects Infesting, Grass, Leaves and Stems. Insects in this category include the sod webworm, cutworm, lucerne moth, fiery skipper, and grasshopper. Adult *sod webworm moths* are 12.5 to 25 mm long and yellowish brown to dirty gray. They hide in the grass during the day, coming out in late afternoon or evening. The webworms themselves are about 18.8 mm long, light brown, and covered with fine hairs. They build short, silk-lined tunnels in the ground at the base of the grass plants. From these they emerge at night to feed on the grass, often dragging bits of the blades into their burrows. Sod webworms prefer new lawns. Ragged patches in the turf are the first signs of damage, but heavy infestations can kill large areas of turf. Most of the important species have several generations per year. Webworms occur throughout the United States.

Two *armyworms* are important to turf: the armyworm and the fall armyworm. The armyworm adult is a pale brown moth with a single white dot in the center of each forewing. The forewing of the fall armyworm adult is dark grey and mottled, while the hindwing is grayish white. Both have a

3.8 cm wingspread. The caterpillars resemble each other more closely—tan to green, with three yellowish-white hairlines down the back from end to end. Armyworms hide in the soil by day and feed first on the stems and then on the leaves of grasses at night. Fall armyworms don't leave the grass plants to hide. When these species are numerous, they may eat plants to the ground, causing more or less circular, bare areas in turf.

Some *cutworm* species stay in the soil and feed on roots and underground parts of stems; others cut off grass at the soil line, and still others devour the blades. Damage is done at night, leaving small, elongated, or irregular, closely cropped brown spots in the turf. Cutworms are of worldwide distribution, but some species are primarily in southern climates and others in the north.

The adult *Lucerne moth* is grayish brown, with two pairs of dark spots on each forewing. Its larvae may occasionally attack turf, particularly in California.

Adult *fiery skippers* are small, yellowish-brown butterflies. Early larval attack results in isolated, round, bare spots 1 to 2 inches in diameter. The spots may become numerous enough to destroy much of a grassed area. This insect is an occasional pest of lawns in California.

More than 100 species of *grasshoppers* feed on range vegetation or grassed areas. Most of these are 2.5 to 5.0 cm long and vary widely in coloration from mottled tones of tan to degrees of green and yellow, with or without spots and stripes. The migratory grasshopper and two other species that have the typical migratory habit are highly destructive during outbreaks. These adults fly in swarms and, as a group, lay their eggs in well-defined beds. There are one or two generations per year. These grasshoppers have occasionally destroyed grass and other vegetation cover over wide areas. They cut stems and blades close to the ground, often eating only part of what they have selected. While grasshoppers are found throughout the world, most extensive damage in this country has occurred primarily in the Central and Western States.

Exercise (839):

1. Match the statements in column B with the insects in column A.

Column A

____(1) Sod webworm.
____(2) Armyworm.
____(3) Cutworm.
____(4) Lucerne moth.
____(5) Fiery skipper.
____(6) Grasshopper.

Column B

a. The adult is grayish brown with two pairs of dark spots on each forewing. The larvae may occasionally attack turf, particularly in California.
b. Most are 2.5 to 5.0 cm long, and they may vary widely in coloration from mottled tones of tan to degrees of green and yellow, with or without spots and stripes. They cut stems and blades close to the ground, often eating only part of what they have selected.
c. The caterpillars resemble each other closely, having a basic tan-to-green color with three yellowish-white hairlines down the back from end to end. They hide in the soil by day and feed first on the stems and then on the leaves of grasses at night.
d. Adults are small yellowish-brown butterflies. Early larval attack results in isolated, round, bare spots 1 to 2 inches in diameter.
e. Some species stay in the soil and feed on roots and underground parts of stems; others cut grass at the soil line; still others devour the blades.
f. Moths of this insect are 12/5 to 25 mm long and are yellowish brown to dirty gray in color. They feed at night, often dragging bits of blades into their burrows.

840. Certify or correct four generalizations about sucking insects.

Sucking Insects of Turf and Grasses. This group of insects includes the leafbugs, chinchbugs, leafhoppers, and scale insects. *Leafbugs* feed on certain lawn grasses, killing the grass in spots. Found throughout the United States, it is best known in California lawns. An adult *chinch bug* is about 4.2 mm long and black with white markings; but the immature, nymphal, forms cause most of the injury. At birth they are half the size of a pinhead and bright red with a white band across the back. They increase in size and darkness with each of four molts. There are normally two generations, with the adults overwintering in clumps of perennial grasses or similar shelter. There may be There may be a partial third generation in the southernmost states. They attack cultivated and wild grasses, causing yellowish spots at first, which then turn brown as the turf dies. The chinch bug has been found throughout the United States and is one of the most destructive of the turf-attacking insects.

There are several species of *leafhopper* that feed upon and injure turf. They are less than 5.0 mm long and may be greenish yellow or light tan. Adults hold their wings over their backs, tentlike, but they fly short distances readily when disturbed. Both nymphs and adults suck plant juices, and in dry hot weather, they may cause extensive off-color of lawns (gray to a light brownish yellow in spots). This effect may be mistaken for damage due to dry weather or disease. Leafhoppers are found worldwide.

Several species of scale insects injure turf, primarily in the Southern States. Being tiny and inconspicuous, these true bugs are frequently overlooked. They are usually round or oval with a waxy covering. Eggs develop into active crawlers or nymphs. These soon insert their beaks into plant tissue and suck out plant juices. The adult *rhodegrass scale* is 3.1 mm in diameter, globular, and dark purplish brown. It is covered with a white cottony secretion. Both the adults and nymphs cause turf browning by attacking chiefly the plant crowns of Bermuda grass and St. Augustine grass. There may be five generations a year. This scale is found in southern Texas, Louisiana, Florida, and California.

Bermuda grass scale adults are 1.6 mm long, oval, and covered with a white, hard secretion. Nymphs and adults damage Bermuda grass where, with heavy infestations, they kill the grass and leave brown patches. Bermuda grass scale is most prevalent in Florida.

Ground pearls are scale insects, measuring 1.6 mm across, that have a hard, cream-colored covering over their bodies so that they look like small, round pearls. They feed on the roots of Bermuda grass, in the South and Southwest, and centipede grass in the South, causing turf to turn brown and eventually die.

Exercises (840):

Mark each statement true (T) or false (F) and correct any errors.

_____ 1. The leafbug feeds on certain lawn grasses and kills the grass in spots.

_____ 2. At birth, the chinch bug is half the size of a pinhead and is black with a white band across the back.

_____ 3. The leafhoppers are less than 5 mm long and may be greenish yellow or light tan. Both nymphs and adults suck plant juices, especially in dry, hot weather.

_____ 4. The common scale insects of cultivated turf are the Rhodegrass scale, Bermuda grass scale, and ground pearls.

841. State how to survey and control turf- and lawn-damaging insects.

Survey and Control of Turf Insects. Blotchy and dying grassed areas may be the result of disease, nutritional unbalance, drought, or insect damage. Check first for insects. Extensive injury to turf by many insects may be largely prevented through initial surveillance and a few simple inspection techniques.

Grub populations are best evaluated in the fall before cold weather or after the soil has been warmed by the sun in the spring. Cut three sides of a strip of sod 1 foot square by 2 or 3 inches deep and lay it back, using the uncut side as a hinge. Knock grubs from the exposed grass roots and soil with a trowel or blade. Make several such samples at random in an average-sized lawn. A half dozen or more grubs per square foot indicates need for control.

You can find *chinch bugs* by using a tin can with both ends removed. Push one end of this cylinder into the ground in a yellowed part of the damaged turf. Fill the cylinder with water. Chinch bugs will float to the surface within several minutes. You can bring *sod webworms, armyworms,* and *cutworms* to the surface by applying 1 tablespoonful of pryethrum extract in 1 gallon of water to 1 square yard of turf. If you see 12 to 16 of them per square foot, apply insecticide.

You can spot *wireworms* by passing broken-up sod through a hand sifter made of a piece of four-mesh hardware screen attached to a frame. Let the soil fall on a second sifter of standard window screen, and you can see the shiny, yellow wireworms. To control them, follow the recommendations on the pesticide labels.

Exercises (841):

1. When should you check grub populations?

2. How should you do it?

3. What population density calls for control?

4. How do you check for wireworms?

5. How do you check for chinch bugs?

842. Cite random facts about snail and slug habits and habitat.

Importance of Terrestrial Snails and Slugs. In some parts of the world, snails are grown as food for people. In many other places, they are very serious economic pests. A third economic impact is not quite so obvious. Some of the ones that are pests in the United States serve to maintain a balance of nature in their native areas. While most species native to the United States are solitary in habit and do very little damage, some introduced species require control. Many species are kept out by Federal quarantine. Military (and civilian) equipment returning from overseas areas must pass quarantine inspection for living snails. If live snails are found, there must be further inspection and fumigation, saltwater washdown, or steam cleaning. These tasks take time and money wherever they're done, but they cost a lot more at U.S. entry ports than at overseas ports before shipment.

Human food. Some helicine snails have served as food since early times. They are highly nutritious and are considered to be delicacies. For a number of years, over a million pounds of European snails per year were imported into the United States. The giant African land snail, *Achatina fulica,* is an important food source in its native areas, and in some locations it is the largest single item of animal protein in the human diet. It is not considered a delicacy as are the European helicines, and many people consider it inedible. In Africa, *Achatina* is highly beneficial, but in the areas to which it has been exported, it is a serious economic pest.

Natural controls. Snails and slugs in their native habitats are members of natural communities in which their populations are controlled by ecological forces. These natural population controls include natural enemies (predators and parasites), unfavorable climate, and an inability to overcome competition for food and shelter. Snails are an integral part of this ecological balance.

Economic pests. When a snail or slug species is introduced into a new area, it usually leaves its predators and parasites behind. Without these important checks and with favorable environmental factors, the species can realize its full population potential. If this potential is high, only a short period of unchecked reproduction will cause the population to erupt. The invaders eat certain plants in great quantity, destroying food and shelter of other native organisms and reducing their number. This quickly affects *their* predators and parasites, and the whole organization of a community may be completely disrupted. This can make beneficial plants and animals disappear permanently from the area. When the new species has exhausted its food supply, it may emigrate to other communities. Thus, the indirect economic import of introduced species actually may be far greater than the more obvious economic importance.

Of the roughly 725 species of terrestrial snails and 40 species of slugs now recognized in the continental United States, 44 snails and 11 slugs have been introduced. *Helix asperta* and *Otala Lactea* are now well established in California, in spite of considerable time, energy, and expense in fighting them. The distribution for any species tends to be spotty. Population densities are influenced by depths and types of soils, by climatic conditions, by availability of food, and by the intensity with which land is cultivated. *Achatina* has become established in Hawaii. Though it has been found on quarantine inspections at California ports *Achatina* hasn't gotten established there. *Achatina fulica* feeds on a wide variety of plants; only the grasses seem nearly immune to its attack. Even the larger "grasses," such as rice, sugar cane, and corn are fed upon only when no other foods are available, but many weeds are eaten. Food preferences seem to vary from place to place, but it attacks most fruits and vegetables, and such economically important plants as tobacco, cotton, and rubber. It eats young teak trees and many ornamental plants. We can only guess at the extent of damage that would be done if this snail were introduced into the continental United States.

Of the several economically important Mediterranean snails, *Theba pisana* is considered the most destructive. It entered California in the early 1920's, and it was well established before extensive control programs eradicated it. It entered South Carolina in 1956 in military cargo returned from North Africa but was eradicated before it became firmly established. It has a voracious appetite. When it's young, it will consume three to five times its own weight of vegetation each day, doubling its size in the first week and again in the second. Some of the Mediterranean snails are stem feeders, but *Theba pisana*, though it eats stems of some legumes, feeds primarily on leaves. Many snails eat straw, manure, and dead plants and animals, but *Theba pisana* will eat these only if foliage is not available. It feeds on weeds, particularly on thistle and other composites. It destroys alfalfa and a wide variety of legumes and has a strong propensity for citrus. It has demonstrated its ability to become a serious economic pest wherever it's introduced, as have its near relatives.

Exercises (842):

1. Mark each statement true (T) or false (F), and correct the errors.

____ a. In some parts of the world, snails are cultivated as food for humans.

____ b. When snails are introduced into new areas, they may become serious economic pests.

____ c. For many years over a million pounds of snails per year were imported into the United States.

____ d. The giant African land snail is an important food source in its native area.

____ e. The number of native snails is controlled, to a large extent, by natural enemies and climate.

____ f. Many snails eat straw, manure, and dead plants and animals, but *Theba pisana* will eat these only if foliage is not available.

____ g. *Achatina* have become established in California.

843. Associate terrestrial snail and slug families with physical descriptions, and cite random facts about snails found in military cargoes.

Terrestrial snails and slugs are gastropod mollusks. Almost all of those of economic importance belong to the order Pulmonata. The shell, if present, is basically a simple spiral or helix and is composed primarily of calcium carbonate. There are no gills, but rather an air-breathing lung opening by a contractile pore.

Slug Families. There are four families of slugs found in the United States. Families Veronicellidae, Arionidae, and Limacidae are all either completely without shells or have only internal vestigial shells. Some of the more important genera are *Veronicella, Arion, Milax, Deroceras,* and *Limax*. Slugs in family Testacelliadae have small, rudimentary shells near the posterior ends of their bodies. A single introduced species, *testacella haliotidea* spends considerable time in the ground, where it feeds chiefly on earthworms.

Snail Families. There are five families of snails found in the United States. *Family Zonitidae* is almost worldwide in distribution. The shell is usually umbilicate, and has a low spire that gives it a rather discoidal outline. The lip is thin and not reflected (not turned back). Some of the species native to

North America are of little economic importance, but three introduced species of the genus *Oxychilus* are pests. Some of these not only feed on young plants but are predatory and carnivorous and feed on other snails.

Family Bradybaenidae shells are wider than they are high; thin, narrowly umbilicate, with a rather depressed spire. The lip is reflected. The species *Bradybaena similaris* is a pest of horticulture and floriculture whenever introduced in areas of suitable climate, such as Hawaii.

Family Achatinidae shells vary in shape from oval to long and thin. All are longer than wide. These snails are distributed widely, and many are quite destructive. Two species of *Cecilioides* have been introduced into the United States. They usually stay in the soil and are moved with roots of plants. Two species of *Opeas* have been introduced from the Orient and tropical America. Four species of Lamellaxis have been introduced into the United States from tropical areas of both the old and new world. *Subulina octona* has been introduced from the Tropics and *Rumina decollata* from the Mediterranean. We've already discussed the most destructive, *Achatina fulica*, which has spread widely throughout the Central and Southwestern Pacific. This snail can reach an overall length of nearly 1 foot. As we said, it has been intercepted at United States ports but has not become established in North America.

Family Helicellidae shells are all either umbilicate or perforate, with shapes that vary from long and narrow to broad and flat. This is a large family, with snails of several species introduced into North America from Europe, Western Asia, and North Africa. Some of these are not only very destructive, but are readily transported because they leave the ground in hot weather and crawl onto surfaces where they seal the shell against drying. Several species of *Cochlicella Helicella*, *Monacha*, and *Hygromia* have been introduced into the United States.

Family Helicidae shells usually are banded, wider than high, loosely coiled, with the central column hollow or umbilicate. Adults often have the umbilicus closed over by an extension of the lip. This family is of European origin. It contains the edible snails. Two species of Otala are cultivated as food. Various species of economic importance in the genera *Helix*, *Cepaea*, *Otala*, and *Theba* have been introduced into the United States, and *Helicigona* elsewhere into North America.

Snails in Military Cargoes. The land snails that quarantine officials find most commonly on military cargoes belong to three genera: *Theba*, *Helicella*, and *Cochlicella*. The habits of these snails are typified by *Theba pisana*, the white garden snail. In the autumn and winter rainy season of plant growth, the snails actively feed and reproduce. They are reported to reproduce by self-fertilization, although mating has been observed. Prior to egg-laying, the snail prepares a nest by loosening the soil with its mouthparts and moving it to the rear by undulating movements of the foot. After the egg mass is deposited about an inch deep, the burrow is filled with soil. After about a week in the soil, the eggs hatch, and the small snails move to the undersides of leaves to feed. With the onset of the hot, dry, summer months, they cease to feed and seek surfaces above the hot ground to aestivate (pass the summer in a dormant state). In search of suitable sites, they often follow the slime trails of other snails. Hundreds of aestivating snails may be found covering a small thornbush or a signpost. The secreted mucous not only seals the shell and prevents drying, but also glues the snail to the surface on which it aestivates. In this condition, the snails can withstand long periods of dryness, and are unharmed by temperatures of up to 130° F, for short periods. In seeking sites for aestivation, the snails invade crates of military supplies, and in their dormant state, they can be shipped considerable distances before rain, fog, or other moisture reactivates them.

Exercises (843):

To which family does each statement refer (Veronicellidae, Testacelliadae, Zonitidae, Bradybaenidae, Achatinidae, Helicellidae, or Helicidae)?

1. ______________ 1. Snails of this family vary in shape from oval to long and thin.
______________ 2. The shell of this snail is usually umbilicate and has a low spire that gives it a rather discoidal outline.
______________ 3. These slugs are all either completely without shells or have only internal vestigial shells.
______________ 4. Shells of these snails are all either umbilicate or perforated, with shapes that vary from long and narrow to broad and flat.
______________ 5. Slugs in this family have small, rudimentary shells near the posterior end of their bodies.
______________ 6. A snail in this family will have a shell wider than high, thin, narrowly umbilicate, with a rather depressed spire.
______________ 7. The shells are banded, wider than high, loosely coiled, with the central column hollow or umbilicate.

2. In hot months, snails seek surfaces ________ the ground.
3. Most snails pass the summer in a dormant state called ________.
4. The *Theba pisana* is reported to reproduce by ________.

844. State how to inspect for snails and slugs.

Inspection for Snails and Slugs. Inspections for terrestrial snails and slugs have two purposes: horticultural and quarantine. To inspect for snails and slugs in gardens, greenhouses, and other horticultural areas, you must actually search for the pests. Where you find plant damage but do not see slugs or snails, you should inspect at night or early in the morning after a rain. You can use attractants, such as metaldehyde, diced apples, or other fruit to draw out the snails and slugs. When you can't inspect at night or early in the morning, place baits on sheets of wrapping paper so that you can see the slime trails.

Basically, a quarantine inspection for terrestrial snails is a search for the snails on materials shipped, on containers, and on tracked and wheeled vehicles. It is important to inspect small and obscure spaces where only very small snails may have been able to find space. Thorough inspection of cargo and cargo spaces on arrival at a United States port generally is more difficult and more time consuming than inspection at the cargo's point of origin.

Make a thorough inspection of all military material and personal household effects of military and civilian personnel before they leave a known snail area. Because of the tendency of snails to hide in crevices or to crawl into holes or other openings, you must inspect inside and outside of containers when you see likely entry holes. The smaller snails resemble ordinary pebbles in color markings and size, so it's easy to overlook a significant infestation on a superficial inspection. CONEX boxes, particularly when they have been in contact with the soil, offer such havens as the bottom runners (some of which are hollow), the lift hook slots, and the occasional rust holes in the more weathered boxes. Examine all sides of each likely item. Note in particular any cracks, crevices, or other areas not readily observable. You'll need a forklift to inspect the bottoms of boxes, crates, and the heavier articles. Sometimes the first sign of snails is a faint slime trail. Steel cylinders make good hiding places for snails aestivating under their screwscaps, or sticking to their pallets. Pipes of all types are especially attractive to snails, since caps or plugs are seldom feasible. In the case of halftracks, cranes, and other heavy equipment, steam or water-jet cleaning is recommended in lieu of or in addition to examination. When you examine the ships before they are loaded, give attention ot the bottom of holds and around the sides of ledges. Hold bulkheads near the engine room, being warmer, are favored snail sites. Snail-free cargo should never be loaded until holds have been inspected thoroughly and found or made snail-free.

Exercises (844):

1. The two purposes of snail and slug inspections are ________ and ________.

2. To find slime trails, where might you put baits?

3. What are the two best times to inspect for snails in a garden?

4. Where is cargo inspection easiest?

5. What is often the first sign of snails?

845. Certify or correct statements about how to control snails and slugs.

Physical Control. You can search actively for the pests and handpick or crush them as you find them, but physcial control may include easier ways to prevent military supplies, engineering equipment, and transportation equipment from becoming infested with snails and slugs. Incoming supplies should be stored in warehouses. Land snails normally do not enter buildings to aestivate; therefore, enclosed structures provide the greatest protection against infestation. If warehouses are not available, use paved storage areas, but protect them by sound, aggressive, and continuous chemical and cultural control programs. Only snail-free supplies should be stored in either area. Infested cargo should never be mixed with snail-free cargo in storage or in transit.

Equipment and materials (forklifts, tractor trailers, railcars, pallets, dunnage, and tarpaulins) used to store or transport noninfested supplies must be snail-free. Equipment not in use should be returned to snail-free areas. Equipment used to handle or transport snail-infested supplies should not be used to transport snail-free cargo unless the equipment has been fumigated. Snail-free storage areas should be established at those installations where large quantities of supplies are stored in open areas. To prevent the contamination of commercial or military carriers during the movement of supplies from one installation to another, only snail-free cargo should be shipped.

Adequate procedures must be established to prevent snail "stowaways" in personal household effects of military and civilian personnel. Lawn furniture, sporting goods (boats, motors, etc.), bicycles, motor scooters, utility trailers, and other personal effects that are allowed to remain outdoors must be fumigated before they are packed for shipment. Equipment used in grounds maintenance work should not be stored or left idle in snail-infested areas. It should be cleaned and returned to the equipment storage area at the end of each day. CONEX transporters should be stored in warehouses or in snail-free areas when they're not in use. They should not be stored or allowed to stay on the ground. Snail- infested supplies or household effects should never be packed in CONEX transporters for shipment.

Cultural Control. Cultural control involves destroying habitats or hiding places by clearing underbrush and by eliminating refuse piles, loose boards. and stones. Mowing grass and weeds will help keep some species from increasing in population. Cultivating the soil during the period of snail activity and breeding season will destroy many snails and their eggs. Plowing or turning the soil is preferred, but discing and cultipacking is helpful in areas where plowing is not practical, such as ammunition storage areas, golf courses, fence rows, and airfields. Plowing and seeding small grain to reduce erosion is recommended every 12 months. Burning heavily infested areas has been successful in eliminating aestivating land snails in California and North Africa.

Biological Control. Biological snail control is based on the natural balance between mollusks and their enemies. This balance is shifted in favor of the introduced species when they become pests, but it can be shifted in the opposite direction by importing their foreign predators or by conserving and augmenting natural, established predators. In introducing predators, extreme caution must be observed because of the possibility that they may become more serious pests than their prey. Any introduction of foreign species can be made only after careful study and approval by the U.S. Department of Agriculture. Many mammals, birds, reptiles, amphibians, rodents, and insects have been recorded as occasional predators of snails and slugs. In the continental United States, however, none offer effective and practical means of control of introduced species of snails and slugs, except for the limited use of turkeys, ducks, and chickens. Carnivorous snails attack some economically important pest snails and can greatly reduce the pest population at times. Depending on predators means we must accept a large enough pest population to feed the predators.

Chemical Control. Chemical snail control uses contact sprays and paints, irritating powders, poison baits, and deterrents. Since land snails must have lime to consolidate their shells and must actively search for it if it is not readily available a 1-percent solution of calcium arsenate mixed with lime water serves as a lure and as a poison. Sprays of Bordeaux mixture, kerosene emulsion, chlordane, lindane, pyrethrum, DDT, soap solutions, and lime sulfurs are good repellents, but they are not effective in eliminating the snails or slugs.

Sodium pentachlorophenate is a contact poison that effectively controls land snails and slugs from several days to several weeks. Use it as a barrier to protect materials from snail contamination. Apply 40 pounds per acre as often as required by soil conditions, rainfall, and the density of the snail population. Protective barrier rings of coal tar, soot, ash, lime, salt, and other substances often are used to keep snails and slugs from valuable plants, gardens, and other areas where they could cause damage. Since some of these materials can kill vegetation or injure the soil, you must use them with caution. Lime, salt, soot, ash, and similar substances act as dehydrators, causing slugs and snails to secrete slime so copiously that they dry out and die. These materials have limited effectiveness during the wet seasons of the year and must not be relied on as "cure-all" materials. Metaldehyde is one of the most important chemical weapons against land snails and slugs, but it's not always completely effective against all species.

Baits containing metaldehyde have been used successfully in reducing most snail and slug populations. The success of poison baits in snail control depends on the timing of the application. Apply baits when the snails are active and feeding. You can get baits commercially in meal or pellet form with or without calcium arsenate and containing metaldehyde. Mix 10 ounces of metaldehyde, 20 ounces of calcium arsenate or sodium fluosilicate and 20 pounds of wheat bran or cornmeal. Add enough water to moisten the bait and apply 1 pound per 1,000 square feet (40-50 pounds per acre). In general, baits are more effective where vegetation is scant. Metaldehyde sprays are not recommended, but handled properly they can be used safely. When you use them in combination with an arsenical, you must also follow the restrictions and precautions for arsenic.

Decontamination. High-pressure washdown is used to remove snails and encrusted dirt from military vehicles. Tracked ramps raise the vehicles enough for hose handlers to clean the undersides thoroughly. Cleaned and reinspected vehicles are parked only on snail-free hardstands to await ship loading. When washdown is needed at points of arrival after shipment, sea water is used and is drained only into bodies of salt water. Snail-infested materials that can't be decontaminated by washdown are fumigated.

Exercise (845):

1. Mark each statement true (T) or false (F) and correct any errors.

____ a. Land snails normally enter buildings to aestivate.

____ b. CONEX transporters should be stored in warehouses or in snail-free areas.

____ c. Infested cargo should never be mixed with snail-free cargo in storage.

____ c. Mowing grass and weeds will keep some species of snails from increasing in population.

____ e. Using predators is a biological method of controlling snails.

____ f. Sodium pentachlorophenate is a good repellent for snails.

____ g. Protective barrier rings of coal tar, soot, ash, lime, and salt are used to keep snails and slugs from valuable plants.

____ h. Snail-infested materials that can't be decontaminated by washdowns are fumigated.

3-3. Ornamental and Turf Diseases

Many pests of turf and ornamentals aren't insects; diseases that have a major impact on plants include such micro-organisms as fungi, bacteria, viruses, parasitic higher plants, and nematodes. The most common (and thus the most damaging) plant diseases are the fungi. These are small, generally microscopic, plants lacking chlorophyll and conductive tissues. Most of the 100,000 fungus species known are strictly saprophytic (living on dead organic matter, which they help decompose). Only about 50 species cause diseases in humans and animals, but more than 8000 species can cause diseases in plants.

Fungi can enter plant tissues through wounds, through natural openings, or directly through the cuticle and the epidermis. Once inside the plant, the fungi remove nutrients from the plant and use them for their own growth and production. The mere removal of nutrients that the plant cells would normally use for their own processes can sometimes cause an unhealthy condition in the host cells, leading to localized or generalized disease symptoms in the plant. In this final section of Chapter 3, you'll learn about various plant diseases roughly categorized as turf diseases, ornamental diseases, and nematodes. They can attack all parts of some plant species.

846. Associate various turf diseases with their characteristics and damage patterns.

Turf Diseases. As you know, a disease is a disorder caused by a fungus, bacterium, virus, or other agent. Some disease is normally expected on most turfgrasses, but there must be a susceptible host plant, a pathogen, and a proper environment for the disease to develop. Some diseases only weaken the plants; others kill them. Some diseases disappear with a change in the weather. Many disease problems can be ignored, but others can totally destroy a turfgrass area.

Brown patch. All of the major varieties of turfgrasses may be affected by the soil-borne fungus, *Rhizoctonia solani*. High temperatures (64°-90° F), prolonged humidity (more than 80 percent), dew, dense turfgrass, rain showers, wet soils, and excessive nitrogen availability increase the turfgrass susceptibility. As the pathogen develops, it tends to spread gradually in circles along the ground level. When conditions permit, it grows up onto the leaves and creates the characteristic "smoke ring" circles up to 2 feet in diameter. Within an hour the "smoke ring" of blue-grey tufts of activity can be evident. Leaves and leaf sheaths turn olive green, wilt, become light brown, and quickly die. With cooler temperatures and lower humidity, diseased turfgrass may recover rapidly. Small patches of St. Augustine with brown patch may spread slowly into 10-foot circles of infected turf. There is a cool-weather (40°-60° F) form of this disease that occurs infrequently and grows slowly. Excessive available nitrogen, low potassium, and long periods of excessive wetness favor this form also.

Dollar spot. Dollar spot, *Sclerotinia homoecarpa*, is characterized by small, yellow-green blotches on the blades of turfgrass. Within 24 hours a turfgrass leaf can be bleached to a light tan or straw color. As the disease progresses, the damaged area on the grass blade enlarges and forms a white cross-section with a dark-brown border. The area of damaged turf becomes white and gradually enlarges to "silver dollar" size. Small spots tend to grow together, forming large patches. The grayish, cobweblike mycelia can be seen easily in early morning while dew is present. Adjacent leaves become infected, and high-cut turfgrass may have larger areas of disease than low cut.

The disease seems to be worldwide and is reported as a persistent turfgrass problem in most areas of the USA, Canada, British Isles, and Australia. Temperatures from 60°-86° F favor infection when coupled with heavy dew and low nitrogen supply. Ample available nitrogen, to encourage fast growth, reduces severity and may, on some species, prevent evidence of infestation. Early summer and midfall are the peak times of dollar-spot activity in the midwest.

Copper spot. Beginning as small reddish spots, this disease enlarges rapidly to form irregular salmon-pink or copper patches up to 3 inches across. Masses of the pink spores can be seen on leaves when they are wet with dew. The fungus, *Gloeoceropora sorghi*, develops in bentgrass in early to midsummer. Copper spot and dollar spot look similar, and it is not unusual for them to appear together or in the same area. Recommended controls are similar to those for dollar spot.

Fusarium blight. This may be the most serious disease in bluegrass today. The relative tolerance of new bluegrass cultivars now on the market will be known only after they're grown for 3 or more years under stress conditions. In 1959, a severe blight epidemic was reported in Pennsylvania. Within a year, six other states reported similar damage. *Fusarium roseum* is known as a root and crown pathogen of turfgrass. The name, *Fusarium* blight, indicates that the leaf is also affected.

During the leaf-blight stage, stunted, light-green patches of turfgrass, from 2-6 inches across, change within 48 hours to a dull reddish brown, then to tan, and finally to a straw color. In time, more or less circular patches from 6-24 inches across develop a reddish outer circle, which indicates slow, continued activity. A few tufts of green tillers may show in the center of the affected area indicating that, while the disease progressed outward, a few new rhizomes and tillers escaped damage and were able to emerge and produce new leaves. Extension of the circles, or coalescence, occurs when weather favors the disease.

High soil temperature is the key contributor. Where sunny areas were more than 50 percent affected, turfgrass in the afternoon shade patterns of trees and in excessively irrigated spots, such as around poorly adjusted sprinklers, did not show any disease. Reduced air circulation and high humidity contribute to high soil temperatures. Thatch serves as a blanket, holding heat and moisture and keeping the cooling evaporation from the soil. Slopes facing south are first affected because of more direct exposure to the sun. Soils low in moisture content do not have the cooling advantage of evaporation.

High levels of available nitrogen favor drouth by causing increased water use by the turfgrass and excessive growth of the thin-walled cells which then require frequent mowing. This enhances the chance of infection through cut leaf tips. Drouth signs show quickly when the plant has only short roots near the surface.

Nematodes favor ***Fusarium*** blight by feeding on the roots. These feeding sites serve as points for infection as well as to shorten the roots and increase drought stress.

Damping-off (seed rot). Spotty turfgrass seedling stands are produced when the seed decays and turns black within the soil. Damping-off can cause new grass seedlings, initially uniform, to appear stunted, water soaked, and yellow before they wilt and collapse. With high humidity, "cottony" mycelia cover the affected plants. Shoots of some plants decay at the soil line. Damage can develop within a few hours under favorable conditions.

Low light intensity heightens the degree of damage, as does a shortage of calcium (thin cell walls). Excessive available nitrogen contributes most to susceptibility. Active decay of thatch, in which mycelium is growing saprophytically, and continued surface soil wetness provide ideal conditions for the seed damage. Cooler, drier weather may abruptly stop damage. *Pythium*, *Fusarium*, and other pathogens may be active at the same time.

Damping-off is particularly a problem in Southern climates where fall overseeding into bermuda is practiced. Persistent periods of warm weather combined with frequent watering of the seedbed favors sudden seedling losses.

Mildew. White mycelia on the upper and lower surfaces of leaves may be powdery mildew, *Erysiphe graminis*. In the early stages, the powdery material may be scraped off and the green leaf will appear normal underneath. In time, the mass penetrates the leaf surface, and yellowish lesions develop. Entire leaves become yellow and gradually turn brown. Very minute, black structures develop in the cottony mass and give a peppered appearance. These spores and some mycelia may live over winter. The fungus is an obligate parasite; i.e., it lives on the live host.

Powdery mildew is enhanced by low light intensity, minimal air circulation, and cooler air temperatures. In the Midwest, Merion bluegrass lawns on the north side of houses are often severely damaged by the mildew. Changing grasses either from susceptible to resistant bluegrass strains, or to the fine-leaved red fescues or bentgrasses may be the best solution for such areas.

Spring dead spot. Spring dead spot is just what the name implies. Circular areas of dead bermuda grass are likely to recur each spring. The regrowth and rooting in the area is slow. We've been aware of the disease since 1936 and have done research on it since 1954, but we still don't know the specific causal organism.

Fairy rings. The disfigurement of turfgrass areas may be reduced by early recognition and understanding of fairy ring. It is caused primarily by *Marasmium oreades*, *Lipiota morgani*, and *Aquaricus campestris*. The circles created by fairy ring—at times green, at times brown, with or without mushrooms—recur in an ever-enlarging pattern. When the circles created by the disease meet, the pathogen activity seems to terminate, but odd configurations are formed. The organisms causing fairy rings are fungi of the large group of basidiomycetes, some of which produce mushrooms and puffballs. As the mycelium spreads through the soil, it breaks down the organic matter, including thatch. The mass of mycelia densely permeating the soil depletes the moisture and reduces normal penetration of water until drought causes the brown rings of dead turfgrass.

Exercise (846):

Does each statement below refer to brown patch, dollar spot, copper spot, Fusarium blight, damping-off, mildew, spring dead spot, or fairy dead rings?

__________ 1. Heavy dew, low nitrogen, and temperatures of 60°-80° F favor this disease.

__________ 2. This is potentially the most serious disease of bluegrass today, attacking both the plant root and leaf.

__________ 3. This disease spreads gradually in circles along the ground, developing a characteristic "smoke ring" when conditions permit.

__________ 4. As this disease spreads through the ground, it breaks down organic matter, including thatch, depleting moisture and reducing normal water penetration.

__________ 5. In early stages of this disease, a powdery material can be scraped off and the plant will appear normal underneath.

__________ 6. This disease causes circular areas of dead bermuda grass to reappear each spring.

__________ 7. This disease can cause new grass seedlings to appear stunted, water-soaked, and yellow before they wilt and collapse.

__________ 8. High temperatures, dew, and dense turfgrass growth favor this disease.

__________ 9. This disease is characterized by small yellow-green blotches on turfgrass blades; small spots tend to grow together.

__________ 10. As this disease progresses, very small cottony masses and a peppered appearance develop.

__________ 11. High soil temperature contributes greatly to the spread of the disease, as well as high available levels of nitrogen.

__________ 12. This disease begins as small, reddish spots and enlarges rapidly to form irregular salmon- or copper-colored patches.

847. Cite factors in turfgrass disease control.

The endless variety and complexity of the many fungus diseases of plants have led to the development of a correspondingly larger number of approaches to their control. The particular characteristics in the life cycle of each fungus, its habitat preferences, and its performance under certain enviromental conditions are some of the most important points to consider in trying to control a plant disease caused by a fungus. The use of treated seeds is always recommended and, for control of certain diseases, it is mandatory. Destruction of plant parts or refuse harboring the fungus spores, use of clean tools and containers, proper drainage of lawns and fields, and proper aeration of soil and plants are all very important practices in the control of most plant diseases caused by fungi. Most fungicides are used to prevent diseases on the aboveground parts of the plants and are applied on the foliage as sprays or dusts. Many of these are protectants, since they can only prevent fungi from causing infection but cannot stop an infection once it has started.

Identifying Turfgrass Diseases. Identifying turf diseases alone is not an easy task. You may need to ask a county agent or other authority to make a final determination as to what turf disease(s) exist in a given area. Here are some general principles you should keep in mind when you're confronted with a possible turf disease situation.

a. The part of a turfgrass plant that is visibly damaged cannot be saved.

b. The disease-producing pathogens attack individual leaves, sheaths, tillers, and roots of the plant.

c. Each pathogen operates within a range of environmental conditions in which it produces visible turfgrass disease symptoms.

d. Two or more diseases are often active at the same time in the same area, adding to the difficulty of identification.

e. Most fungicides serve to coat the leaf surface, protecting it from infection by killing or inhibiting the growth of the mycelia or germ spores before the leaf tissue is penetrated.

f. Fungicides are normally effective on the plant from 3-21 days, but when they're diluted by rainfall, dew, biodegradation, ultraviolet (UV) light, and new growth, the protection may be inadequate.

g. A preventive program of disease control is preferred for important turfgrass areas.

h. After the disease shows curative programs help the damaged area recover. You may need two treatments, 5 to 10 days apart, to break the disease cycle (because of different stages of disease development).

i. Many turf management practices are attempts to favor plant survival in spite of disease.

j. Chemical misuse is costly, may be potentially hazardous, and often leads to disappointing results.

Factors Affecting Turf Diseases. Climate is a major factor in the prevalence of turfgrass diseases and their control. In areas where high humidity and other stresses favor diseases, 20 applications of fungicides may be needed in 1 year, but where the humidity is low and the weather is dry, the same turfgrass used in the same way may do well for years without a single fungicide treatment.

A change in weather usually alters the severity of the disease pattern. Mycelial growth is drastically reduced as the humidity drops, the wind increases, and the sun dries the surface of the turfgrass areas. Rapid leaf replacement favored by good nutrition, irrigation, and mowing at favorable heights can be effective in reducing turf diseases. Rain, dew, and humidity vary daily. The desert climate favors minimal disease activity. Hot, humid periods in the midwest can assure danger, sometimes disaster to turfgrasses. However, turf managers generally can minimize the damage created by disease by being aware of the needs and responses of the turfgrass plant. Some precautionary measures are:

a. Remove dew early in the day by poling, hose dragging, syringing, or mowing in an effort to dilute dew and dry the leaf before air temperatures become optimal for many of the diseases.

b. Irrigate the turfgrass when the leaf is already wet with dew instead of in later afternoon.

c. In stress periods avoid night watering. Midday watering cools the plant and allows the leaf to dry soon after the cooling.

d. Delay work on an area that shows signs of a disease. It may be helpful to mow a green showing stress only during the dry afternoon, only half as often, and only portions near the cup. Young turfgrass seedlings are easily damaged during the mowing process.

e. If an area shows indications of weakness, topdressing may be helpful. This, in effect, raises the height of cut.

Controlling Turf Diseases. As you will recall from Volume 3, Chapter 2, there are a number of fungicides you may use to control various turf diseases. However, most of these products will give optimum results only when they're coupled with other efforts designed to reduce opportunities for disease-causing organisms. Here are some guidelines for managing various turf diseases.

***Fusarium* blight control.** In turfgrass areas subject to the disease, use a pre-emergent crabgrass control to reduce infestation and competition. It can permit faster fall recovery of the existing grasses.

Early summer cultivation and improved ventilation by intense coring (several passes of the machine in one day) will open the thatch, let the heat escape, and insure water penetration. This special management may help avoid damage in "near" normal cool seasons.

Use moisture to help air condition the soil. As hot, humid, stress periods continue, apply water midday until the weather changes. This cools the soil and the plant. On an Ohio golf course, the men's tees were free of disease but adjacent and less watered women's tees were more than 60 percent damaged with *Fusarium* blight. The turf under the cooling effect of shade trees and wet areas was undamaged while other open, sunny turfgrass areas were severely damaged.

Fungicides for control of *Fusarium* blight include systemics, such as benomyl, mancozeb, and thiabendazole. There are limitations, however. One application made on an obviously diseased bluegrass plot resulted in an 8[illegible] percent survival of bluegrass while the check plot, untreated, had only 52 percent bluegrass survival. The standard recommended rate is 4-8 oz/1,000 sq. ft. of a 50 percent wettable powder (WP) formulation. Immediately after application, water the chemical into the root zone so that the fungicide can enter the roots and then move into the plant. Watering dry soils the day before treatment and applying fungicide while dew is present aids in distribution into the root zones.

Only two treatments per year are suggested since new races of *Fusarium* with resistance to the systemics may develop. The first protective application should be made 2 weeks before symptoms normally appear. Some turf managers recommend curative rate applications of the fungicide when the damage first becomes visible.

Damping off control. Recommended control may include chemical seed treatment with thiram before planting. Additional protection for stress periods may include an application of foliage spray to the emerging seedlings plus successive treatments every 3-5 days until the seedlings are well established. The soil pH should be nearly neutral, and drainage should be good.

Fairy ring control. There are fumigation measures you can take to control fairy rings, but even so, eradication is difficult. The most practical approaches to fairy rir ;s are aeration, overwatering, and wetting agents. Keeping the soil moist reduces or prevents the browning stage. Coring can assure uniform water penetration in spite of mycelium. Spiking and dethatching as well as the use of spot treatments of wetting agents can be helpful. Injection of water by pressurized root feeding attachments may be helpful. Deliberate overwatering to saturation tends to reduce mycelium activity and to modify the soil temperature which may reduce the severity of the damage.

Brown patch control. Recommended treatment for brown patch includes reducing the available nitrogen and frequency of watering and maintenance of a dry turfgrass surface by watering only at midday. Numerous fungicides are available, including benomyl, bayleton, and maneb. Vapor formed from the mercurial fungicides inhibits the spread of brown patch in turfgrasses.

Dollar spot control. Most fungicides are effective in reducing dollar spot. Cadmium was an effective antidote until the mid-1960's, when tolerance was developed by some strains of the fungus. In 1971, the benzimidazole systemics were widely acclaimed, but in the early 1970's, certain strains developed resistance. A current recommendation is to apply systemics alternately with contact foliar protectants. Cultural control measures include keeping thatch to a minimum, increasing nitrogen levels in the soil, and watering deeply when necessary.

Spring dead spot control. A series of fungicides used throughout the prior season, April through September, can eliminate any spring damage, but after one year without fungicides the disease tends to reappear. In areas known for spring dead spot, use more intense summer and early fall renovation along with reducing thatch and cultivating and aerating soils to increase bermuda grass vigor.

Exercise (847):

1. How long are turf fungicides normally effective?

2. List three factors that may reduce the effectiveness of turf fungicides.

3. What impact will a weather change often have on disease growth?

4. What fungicides are suitable for controlling *Fusarium* blight?

5. How may thiram be used to control damping-off?

6. What are the most practical ways to control fairy ring?

7. What are the nonchemical controls for brown patch?

8. What cultural controls are suitable for helping treat dollar spot?

848. Cite characteristics of various ornamental diseases.

Diseases of Ornamentals. Some diseases are categorized by the part of the plant they attack. Here, we'll cover those that attack leaves, stems, and roots. We'll also cover Dutch elm disease, a fungal disease that attacks the vascular system of an infested tree.

Leaf diseases. A wide variety of disorders affect the leaves of shade trees. Perhaps no other part of a tree has been given more attention by ornamental tree researchers than the leaves. Leaf condition is often thought to be a primary indicator of the health of a tree. Although leaves sometimes accurately show tree health, in other cases a spectacular abnormality of the leaves may be of little importance to the health of the tree. The importance of a leaf disease on a shade tree depends upon the type of tree infected and its previous health history, as well as the type and severity of the disease.

Since many species of fungi can cause leaf diseases and because there are many species of hardwoods, there are very many diseases. Hardwood leaf diseases are grouped into these six categories (Fig. 3-1):

(1) Leaf spot—Dead area that is well defined from healthy tissue.

(2) Leaf blotch—Dead area that often diffuses into the healthy tissues.

(3) Anthracnose—Irregular dead areas on leaf margin, between and across or along veins, often moving onto the shoots and small twigs; sometimes whole leaves are engulfed.

(4) Powdery mildew—Superficial growth of white to gray-white fungus material on leaves and shoots.

(5) Leaf-blister—Leaf spot or blotch that is swollen or raised, so that the area appears blisterlike on the upper surface of the leaf.

(6) Shot-hole—Loss of dead areas inside spots that result in a series of holes in the leaf.

The fungi that attack each tree species usually are different but often have similar life cycles on hardwood leaves. Most fungal pathogens of hardwood leaves are dormant in the dead leaves on the ground or attached to the tree during the winter. Some pathogens survive in the buds or on dead twigs and branches. In the spring during wet weather the pathogens become active and discharge spores that are carried by wind and rainsplash and land on the young

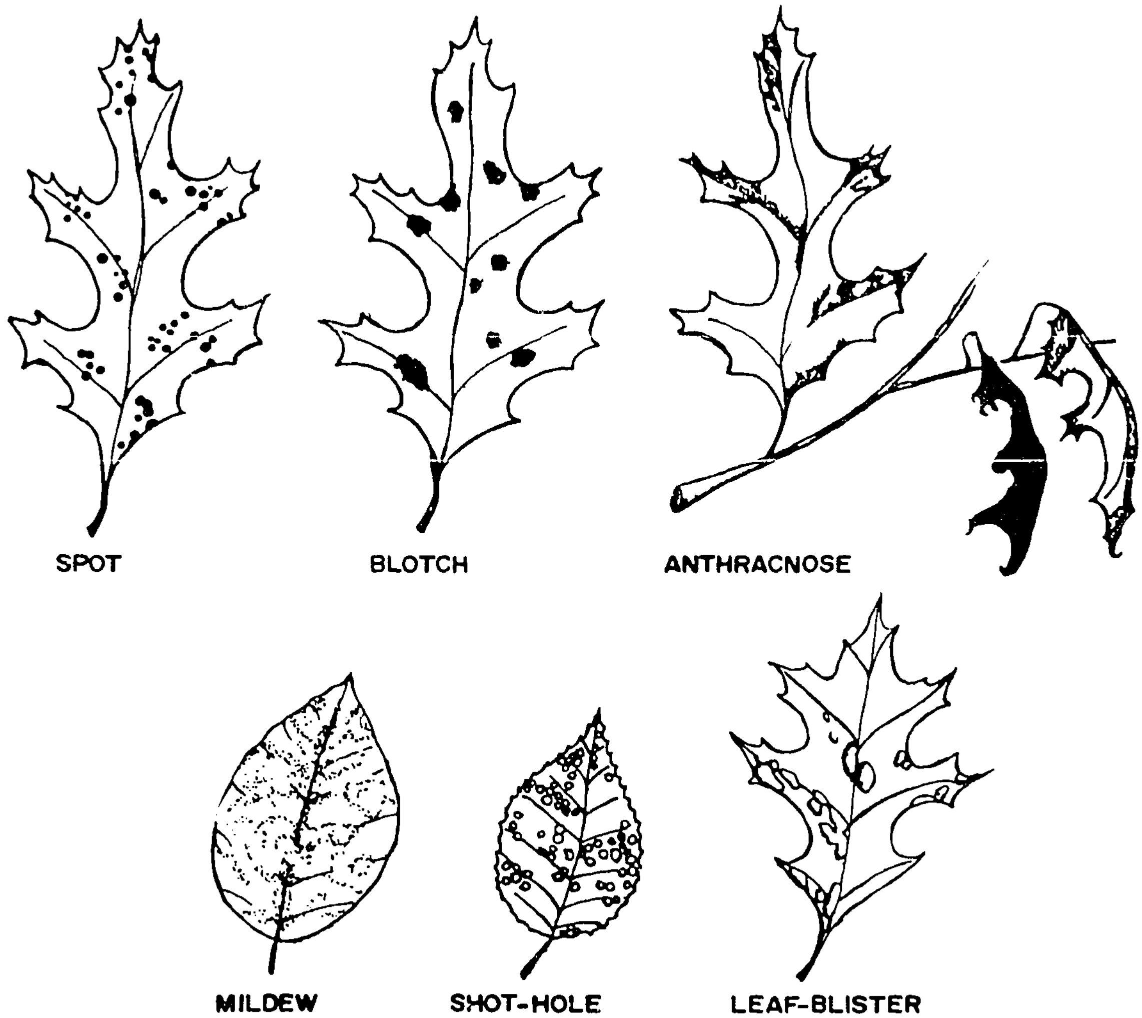

Figure 3-1. Symptom categories of hardwood leaf disease.

expanding leaves. The spores quickly germinate and penetrate the leaves. By summer this infection produces symptoms similar to one of the other categories. During summer more spores are produced in these infected areas, which can cause leaf infections during wet weather. These secondary spores are also spread by wind and rainsplash. Thus during wet growing seasons a considerable buildup of infections on a tree can occur.

Stem diseases. Stem diseases are caused by the formation of lesions (dead areas) on the bark-cambium tissues. The death of these tissues is usually associated with a mechanical injury, such as a broken branch, and it extends radially from the wound. This localized lesion, called a canker, may form on the trunk, the branches, or the twigs.

Cankers vary considerably in size and shape. A canker on a woody plant indicates a host-parasite interaction that may last for several years. A typical sequence for canker development is: (1) the pathogen enters the host through a wound and invades and kills healthy bark, usually during a dormant period; (2) the host trys to limit pathogen invasion by forming a layer of callus (a mass of thin-walled cells) over the edge of the infected tissue; (3) the pathogen invades the callus tissue during the next dormant period; and (4) the host forms new callus. Steps 3 and 4 may be repeated each year throughout the life of the host. The form of the resulting canker will be determined by the rate of pathogen movement and the amount of callus formation.

Most cankers can be placed into three groups; target cankers, diffuse cankers, and canker blights. Cankers that are roughly circular, with abundant callus throughout the canker face and at the margin are called target cankers. The pathogen spread in target cankers is relatively slow and in most cases the tree's radial increase in growth is about the same as the radial growth of the canker. Diffuse cankers are elongated ovals, with little callus at the margin. The pathogen spread in diffuse cankers is faster than in target cankers, so little callus forms ahead of the canker. Diffuse cankers enlarge faster than the radial growth of the tree and often girdle trees after several years' infection. Cankers which are circular to elliptical, but contain little or no callus, and increase rapidly during a single season are termed canker blights. The pathogen spread in canker blights is extremely rapid; therefore, branches and even whole trees are often girdled in a single season.

Most canker fungi are restricted to invasion of bark tissues, but some can attack both the bark and the underlying xylem. Stem diseases that come from a simultaneous canker and woody decay are called canker rots.

Root diseases. The health of the root system is probably the most important factor in the total health of a tree, but most people look first at the leaves, then the stem, and last, if at all, the roots. The trunk, branches, and leaves can only grow at the rate permitted by the condition and growth of the root system. The initial symptoms of most root diseases are similar; slow-to-rapid decline, and death of the tree, usually beginning in the upper branches. Since a large part of the root system is often killed before obvious symptoms appear, it is very hard to control root diseases after decline symptoms appear. Root diseases seem even more mysterious because of the lag between our knowledge of roots and our knowledge of other parts of the tree. Let's look first at the growth and function of roots before we move on to specific root diseases.

Careful examination of roots around standing trees shows that most roots stay in the top 18 inches of soil and that most of the small roots are in the top few inches of soil. It is easy to see why the tree's roots are so easily injured by even minor disturbances of the soil around them and also why trees are so sensitive to the condition of the upper soil layers.

We once thought that roots absorbed soil nutrients and water directly through the root hairs on the feeder roots, but most absorption takes place through structures formed with the feeder roots by beneficial fungi. These structures formed by the feeder roots and the fungi are called mycorrhizae. Practically all forest trees and most other plants are now known to form mycorrhizae.

The tree, therefore, is actually a dual organism that is part plant and part root-inhabiting fungus. The cortical tissues of the young roots are invaded by these specialized beneficial fungi in a relationship that benefits both organisms. The formation of mycorrhizae aids water and mineral absorption for the tree, and the fungus in turn gets needed organic compounds from its association with the tree.

Many fungi that cause root diseases are facultative parasites commonly found growing in the soil on organic matter such as dead roots or stumps. From this base living trees are continually attacked. Trees of low vigor are most easily infected, but some fungi can infect vigorous trees. Some root disease fungi penetrate directly into healthy roots, but most gain entrance through wounds in the lower trunk, buttress, and roots. They also enter at root contacts and grafts, where healthy and infected roots are in contact or are fused. These points are common when trees of the same species ar growing next to each other and their root systems are intermeshed. Once they're established, these fungi progressively kill the roots by girdling, eventually moving into the buttress area and sometimes into the lower trunk. The underlying wood may or may not be decayed, depending on the fungus involved. Infected trees are killed most often by girdling of the lower truck or buttress, but they may also fall victim to "wind throw" from extensive decay in the root system.

Most root disease fungi produce specialized structures for survival or movement in the soil. These may be reproductive structures, such as thick-walled or motile spores, or vegetative structures that enable translocation or storage of materials. Some fungi produce windblown spores that are important for long-range disease spread. Since most fungus pathogens of tree roots are widespread, the local movement of the pathogen in the soil and its movement from one shade tree to an adjacent one are of most concern.

Dutch elm disease. Dutch elm disease, caused by *Ceratocystis ulmi*, is the most devastating disease of elm trees in the United States. It has been recorded in most states east of the Mississippi and as far as Idaho in the Northwest and Texas in the Southwest. All of the native elm species are susceptible, while many of the ornamental Asiatic species are highly resistant.

Trees suffering from Dutch elm disease may show a variety of symptoms (fig. 3-2). Leaves become yellow, wilt, and turn brown. Premature defoliation and death of branches usually makes the crown seem thin and sparse. Internally, a brown discoloration appears in the outer sapwood. C. ulmi is transmitted from diseased to healthy elms by elm bark beetles, mainly the small European elm bark beetle and the native elm bark beetle. These beetles make characteristic galleries under the bark of dead and dying elms. Adult beetles pick up the sticky fungus spores from under the bark and then feed on the young tender elm twigs of healthy trees, inadvertently inoculating the healthy tree with the fungus. The fungus may also spread from diseased elms to adjacent healthy elms through root grafts.

Exercise (848):

1. Match the condition in column B with its identification in column A.

Column A

____ (1) This series of holes in a leaf is a result of the loss of dead areas inside spots.
____ (2) These diseases can move through the soil from one tree to another.
____ (3) This dead area on a leaf often diffuses into the healthy tissues.
____ (4) This disease causes a superficial growth of white to grey-white fungus material on leaves and shoots.
____ (5) This is a dead area on the leaf that's well defined from healthy tissue.
____ (6) These cankers are elongated ovals with little callus at the margin.
____ (7) This stem disease has cankers that are roughly circular with abundant callus throughout the canker face.
____ (8) On trees with this condition, leaves become yellow, wilt, and then turn brown.
____ (9) This disease causes irregular dead areas on the leaf margin in early stages; sometimes whole leaves are engulfed.
____ (10) These cankers are circular to elliptical, but contain little or no callus. They increase rapidly during a single season.
____ (11) This disease causes swollen or raised blotches causing the upper surface of the leaf to appear blisterlike.

Column B

a. Leaf spot.
b. Leaf blotch.
c. Anthracnose.
d. Powdery mildew.
e. Leaf-blister.
f. Shot-hole.
g. Target canker.
h. Diffuse cankers.
i. Canker blight.
j. Root disease fungi.
k. Dutch elm disease.

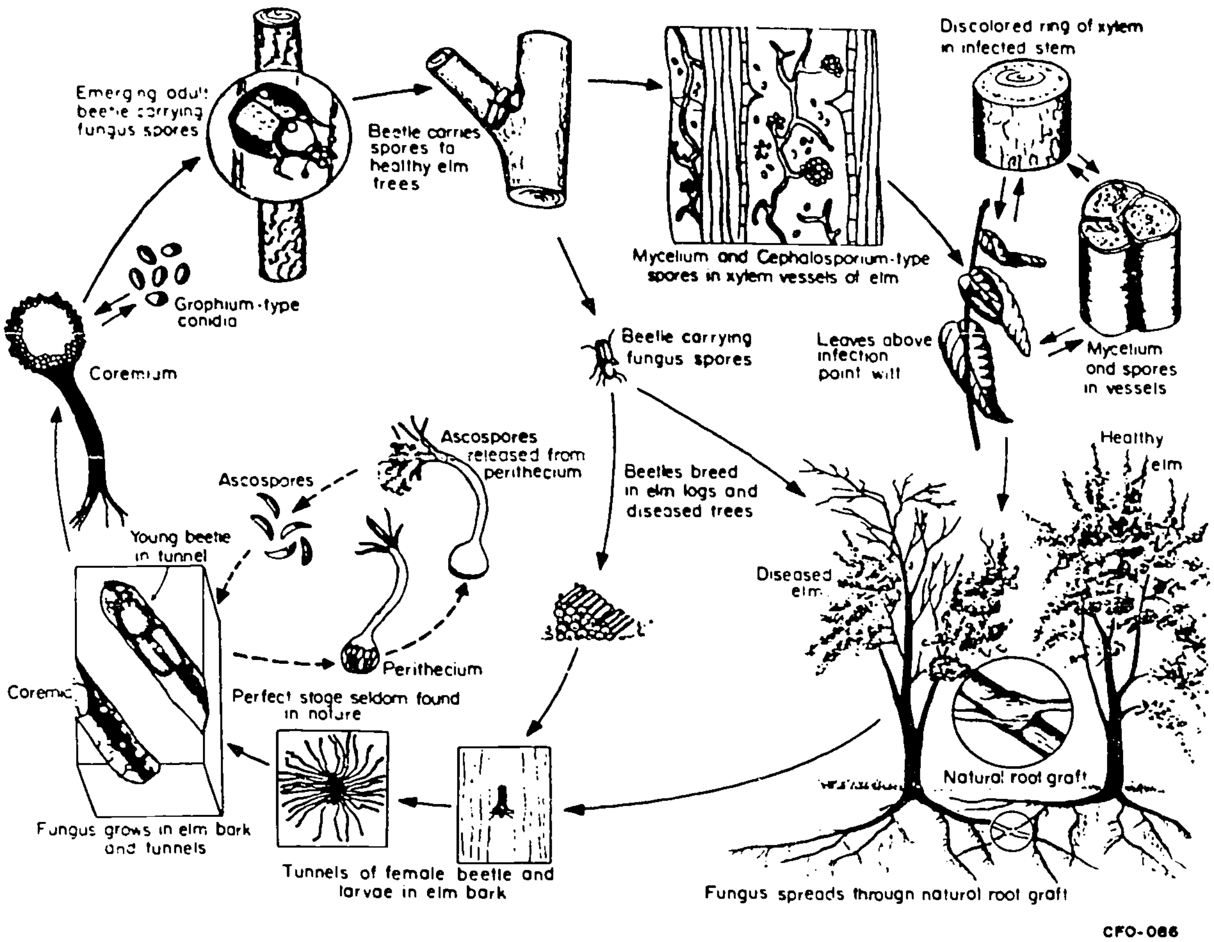

Figure 3-2. Disease cycle of Dutch elm disease.

849. Cite controls for ornamental diseases.

Controlling Diseases of Ornamentals. Controls for ornamental diseases are usually recommended only when the tree's health is poor or its aesthetic value would be lost from the disease. A severe infection on an already stressed tree could tip the balance in favor of invading micro-organisms and thus kill a valuable tree. In this case, control of diseases is not only desirable but essential to survival of the tree. Although a leaf disease might not threaten the health of a shade tree it could cause the tree to lose a great deal of its ability to cast shade and also change its aesthetic effect from positive to negative. On shade trees, therefore, control of a hardwood leaf disease can also be justified on aesthetic grounds.

Treating leaf diseases. Hardwood leaf diseases can be controlled by protecting against infection with fungicides or by using resistant varieties. Fungicides can be used effectively to protect the trees against infection from most leaf pathogens by spraying at or before bud break and then every 2 weeks until about mid-June, with additional sprays if there's prolonged wet weather in late spring. The key to fungicidal control of leaf diseases is to apply materials before infection starts and subsequent symptoms develop. Most residents don't recognize leaf diseases until the symptoms are extensive. They often request that sprays be applied to make the symptoms on the trees disappear. It is, of course, impossible to rid a tree of symptoms during the growing season, since the affected leaf tissues are already dead. Tell them that this year you can only prevent further infection by spraying, and the control efforts must start early the next year to keep the disease from recurring. Resistant varieties are available for many of the tree species that are attacked by particularly troublesome leaf diseases. When new trees are to be planted, encourage the people responsible to choose or recommend these resistant varieties to avoid the needless future expense of spraying. Use of resistant varieties is most warranted for street and park trees, because they are always highly visible.

Most people will burn infected leaves in the fall in an effort to remove potential sources of inoculum for the tree, but many leaf pathogens overwinter on the tree: in the buds, on the bark or on dead twigs. Besides, the spores that infect leaves may also travel great distances in the wind; so that the removal of local sources of inoculum, such as from around the base of the tree, may have no effect on reducing disease severity. Dry leaves break up during raking, and many pieces are left in the grass. Therefore, removal of fallen leaves gives little or no control of most leaf diseases.

Treating stem diseases. Stem diseases can be minimized by avoiding all unnecessary wounds and by promptly treating any wounds you make during pruning, cabling, or any other form of essential wounding. You can control a stem disease only by removing all infected tissues. You can easily remove cankers on small- to medium-sized branches by pruning, but you must remove cankers on the trunk or on large branches critical to the tree's value by surgical excision. Surgical excision is similar to wound treatment around trunk wounds, except that you may need to remove some healthy bark around fast growing cankers to be sure you've got all the infected tissue. Host vigor is a contributing factor in the susceptibility of trees to many stem diseases. In general, trees in poor vigor cannot heal wounds and prevent the invasion of canker fungi as well as trees with plenty of moisture and balanced soil nutrients, so prevention includes therapeutic treatments for stem diseases, regular watering, and application of balanced fertilizers.

Treating root diseases. Root diseases can be minimized by keeping trees vigorous and avoiding wounds in the root system and near the base of the tree. Once a tree is infected, the disease is hard to control. A thorough examination of the root system near the trunk can help you find the extent of the infection. In severe cases where most of the roots are dead or the trunk is almost girded, removal is recommended. If only a few roots are infected, therapy may delay the disease progression almost indefinitely. Since infected trees are often suffering from some previous stress, you must restore their vigor. Regular watering and fertilization will help, and pruning the crown will help balanc[illegible] ...ss. Excise any infected bark on the buttress roots an[illegible] k.

Before you replant in the same area where a tree has died from root disease, remove as much of the dead stump and roots as possible. Replace or fumigate soil that's infected with the pathogen. Newly planted trees, in general, are quite susceptible to root diseases. Use soil fumigation or trenching around an infected tree to protect susceptible woody plants from the spread of the pathogen in the soil.

Treating Dutch elm disease. Presently, control of Dutch elm disease in the United States is attempted primarily through sanitation and through chemical control of the insect vectors of the fungus. Sanitation involves the removing and destroying of weakened or dead elm trees and elm logs, thus destroying the larvae in them or denying the insect and the fungus their over-wintering habitat. Pruning out infected twigs and branches will sometimes eliminate the disease. Control of the insect vector by chemicals involves spraying the healthy elm trees while they're dormant and in the spring with a residual spray, such as malathion. A fungicide, Tebuthiuron, has been used recently against the disease. This is applied by injection into the tree trunk in varying amounts depending on the tree's size. Also, a soil fumigant, Vapam, can be used between elm trees to kill the roots and prevent spread by root grafts between adjacent trees.

Exercises (849):

1. Under what conditions are control measures usually recommended for diseases of trees?
2. What are the two principle methods of controlling hardwood leaf diseases?
3. When should you apply fungicides to treat leaf diseases?
4. List 3 reasons raking and burning leaves may *not* help reduce opportunities for leaf disease infections.
5. What is the only way stem diseases can be controlled?
6. How can root diseases be minimized?
7. What controls are generally recommended when a tree's roots are partially infected? When they're mostly dead?
8. List sanitation measures for Dutch elm disease.
9. What chemical controls help in treating Dutch elm disease?

850. Cite general characteristics of nematodes.

Nematodes. Nematodes are often serious plant pests that require control. Nematodes, or eelworms, belong to the class Nematoda of the phylum Nemathelminthes. Most mature nematodes are quite small, requiring magnification to be seen, but some parasitic roundworms grow almost a yard long. Nematodes are found nearly everywhere in nature, from arid deserts and hot springs to polar seas and ice caps, and from beach sands to the bottoms of lakes and rivers. Many are free living, while others are parasites of plants and animals. Over 50 species live in or on humans. It has been estimated that as many as 80,000 species prey on vertebrate animals, that a larger number of species infest invertebrate animals, and that a still greater number are parasites of plants or are free living in soil or water. The total number of individual nematodes is beyond human comprehension. A tablespoonful of ooze from the sea bottom may contain thousands, and the top acre-foot of cultivated soil may contain many billions. Most nematodes in the soil are harmless, and some are even beneficial to human purposes.

They are one of the most important biological and mechanical factors in soil building. The nematodes we're concerned with here are parasites of plants. Some damage the roots, some the stems, some the leaves, and some the seeds of agricultural and horticultural plants.

Recognition and biology. Nematodes are unsegmented roundworms quite different from all other forms of life. Plant parasites may be less than 0.4 mm long when they're fully grown, and few ever exceed 8 millimeters. In most, the body is very slender and is tapered at both ends.

There is a tough cuticle, secreted from underlying tissue, which may be smooth, striated, bossed, or ornamented with spines. The body has longitudinal muscle fibers only. These fibers produce flexing movement but no elongation or contraction. Under a microscope in clear water, the movements seem to produce only a useless thrashing about, but in the presence of plant debris or soil particles, the flexing can produce forward movement.

Both sexes exist in nematodes, though some females can produce eggs in the absence of males. The tiny larvae, which hatch from the eggs, are shaped like adults. They grow rapidly, shedding their cuticle several times before reaching maturity. Under favorable conditions, growth may require a few days to a few weeks, depending on the species. Some will repeat the reproductive cycles as long as temperature and moisture conditions are favorable and as long as the host plant lives. Some will leave dead host plants to enter the soil; some will stay in the dead plant tissue and may remain dormant for several years.

Feeding methods vary from one type of parasite to another. Some enter the plant cells and eat the cell contents. Some feed by means of stylets that puncture the cell walls and, like hypodermic needles, let the nematodes suck out the cell juices. The stylet punctures permit penetration by disease-causing bacteria. Parasitic fungi enter the plant through the holes made by the nematodes that feed within the cells.

A single root-knot nematode female may produce 500 to 1,000 eggs; yet few of the larvae will ever live to reach maturity and to reproduce. Nematode parasites of plants have many enemies in the soil. They are captured readily and devoured by other soil animals, such as insects and predatory, free-living nematodes. Even certain soil fungi can trap living plants, so nematodes must compete with fungi for food. Since nematode movement is more or less random, and since the nematodes are very small, they must be very close to a food source to find it. Those that penetrate some forms of "resistant" plants are effectively trapped, for their activity is limited and they are seldom able to reproduce.

Exercises (850):

1. Most mature nematodes are quite ________, requiring ________ to be seen.
2. Both sexes exist in nematodes, though some females can produce ________ in the absence of ________.
3. When nematodes are seen under microscopes in clear water, the movements seem to produce only a useless ________ ________.

851. Cite damages caused by the root- and top-growth-attacking nematodes.

The nematodes that parasitize plants are categorized arbitrarily by the part of the plant they attack and by the way they attack. Some of the individual species attack many types of plants, the common garden nematode *Heterodera schachtii* being found on over 1,000 varieties.

Root-Attacking Nematodes. We can divide these nematodes into four groups according to the part of the root they infest: sedentary parasites, endoparasitic, semiendoparasitic, and ectoparasitic.

Sedentary parasites. In this group, females become fixed in one position, where they feed until death. Unlike most others, these females do not retain their wormlike appearance but become swollen. The important types of sedentary parasite nematodes are the cyst nematodes and the root-knot nematodes. The females of the 12 to 15 cyst nematode species develop into brown, pear-shaped cysts that can protect viable eggs up to 10 years. Plants that they attack appear stunted, have yellow leaves, and have a very fine, hairy-looking root system. Hosts include some truck crops, clovers, and ornamentals and are subject to U.S. and foreign quarantines.

There are eight *root-knot nematodes* species, and the females become globular but don't form cysts. They're usually found in swollen knots in the root systems. These knots typify the group, which attacks 1,800 species of plants. Plants included are nursery stock, ornamentals, and grasses.

Endoparasitic nematodes. Eggs are deposited in lesions of the roots, where the larvae feed. All stages may be found free in the soil. One species of *burrowing nematode* parasitizes several hundred plant species, including woody ornamentals. It is a serious pest of citrus, causing tip dieback, sparse growth, and spreading decline. It is currently under quarantine in Florida. There are 20 species of *meadow, or lesion, nematodes* which are found in small lesions in roots or free in the soil. Hosts appear necrotic and unthrifty, and include fruit trees, trees, ornamentals, and nursery stock.

Semiendoparasitic nematodes. These nematodes feed both externally and within the roots of plants. There are about 12 described species of spiral nematodes, usually found free in the soil around roots. Attacked plants demonstrate chlorosis, stunting, and sometimes sparse growth. Spiral nematodes damage ornamentals, including roses and boxwoods, and lawn grasses. There are two species of *lance nematodes* whose damage looks like that caused by spiral nematodes on the same hosts, but these are also pests on some lawn grasses.

Migrant, or ectoparasitic nematodes. These nematodes feed at the tips and along the surface of roots. They sometimes insert part of their bodies into the root tissue. This damage results in chlorosis and stunting due to sparse root systems with short, stubby, lateral roots. Both of the two *sting nematodes* are parasites of ornamentals and lawn grasses. They normally are found in the light, sandy soils of the coastal plains. Only one of the 15 species of *stubby root nematodes* is known to be parasitic. It is of widespread distribution in the United States and affects a variety of plants, including a large number of grasses and truck crops. Two important species of *dagger and needle* *nematodes* are primarily parasites of perennials. One causes the general decline of boxwoods and roses. Dagger nematodes have worldwide distribution. Little is known about the prevalence of the needle nematodes, but they have been collected in Europe, the Pacific Northwest, and several species in the Southeast. *Stunt nematodes* include parasites of many plants. One species is an important pest of strawberries, tobacco, and ornamentals. Stunt nematodes have been found in the East, Southeast, and one Southwestern State. There are about 20 known species of *ring nematodes*, which are important parasites of trees and other woody perennials, but they also are found associated with the roots of grasses and many other plants. They live in many parts of the world.

Top-Growth-Attacking Nematodes. Nematodes attacking the top growth of vegetation may be separated into three groups, based upon the part of the plant that they attack. These groups are called the bud and leaf nematodes, stem and bulb nematodes, and seed gall nematodes.

Bud and leaf nematodes. A dozen or so species in this group are important pests, feeding on developing buds and very young leaves. They cause leaf crimping, deformation, and plant unproductivity. Strawberries, alfalfa, and rice may be hosts to these parasites. Several species attack primarily the leaf parenchyma, where progressively darkening, angular spots may lead to eventual defoliation. This occurs on chrysanthemum, aster, dahlia, zinnia, and other plants raised for their flowers. Distribution of this group is widespread. These nematodes that feed within the leaf will move from leaf to leaf in films of water from rain or dew.

Stem and bulb nematodes. A number of species of nematodes invade the stem and bulb parts of such hosts as alfalfa, clover, and certain grasses, as well as such ornamental bulbs as iris, tulips, and narcissus. They invade the parenchymatous tissue and injure the plant with their salivary secretions. Distortion, hypertrophy, necrosis, secondary infection, or general unthriftiness result. Members of the group are found throughout the world.

Seedgall nematodes. Two of 11 species of this group are important economically in the United States. They develop in the growing part of wheat, lawn grass, and grasses grown for commercial seed. They complete development within a resistant gall in the seed. Seeds are destroyed or contaminated. Animals feeding on the infested seeds are poisoned. The wheat nematode is found primarily in the Eastern States, while the bentgrass nematode is most common in the Northwestern States.

Exercises (851):

1. The four groups of root-attacking nematodes are ________ ________, ________, ________, and ________.
2. In the sedentary parasites group, the females become ________ in ________ position where they feed until ________.
3. Plants that cyst nematodes attack appear ________ ________, have ________ leaves, and have a very ________, hairy-looking ________ system.
4. Root-knot nematodes attack what kinds of plants?
5. Endoparasitic nematodes eggs are deposited in ________ of the ________ where the ________ feed.
6. Burrowing nematodes are a serious pest of ________, causing ________ ________, ________ growth, and ________ decline.
7. Meadow or lesion nematodes are found in small ________ in ________ or free in the ________.
8. Semiendoparasitic nematodes feed both ________ and within the ________ of ________.
9. Spiral nematodes are usually found ________ in the ________ around ________.
10. Lance nematode damage looks like that done by ________ nematodes on the same hosts.
11. Migrant or ectoparasitic nematodes feed at the ________ and along the surface of ________.
12. Bud and leaf nematodes feed in the developing ________ and, subsequently, in the very ________ leaves, causing leaf ________, ________ and plant ________.
13. Stem and bulb nematodes invade the ________ tissue and injure the ________ with their ________ secretions.
14. Seedgall nematodes complete development within a resistant ________ in the seed. Animals feeding on the infested seeds are ________.

852. State the survey and control procedures for nematodes.

Unthriftiness, stunting, malformation, chlorosis, or death of plants may be caused by nematodes, insects, nutritional deficiencies, drought, and other conditions. We must establish the presence of nematodes, identify them, and take corrective measures.

Survey. You must collect soil and root samples and send them to your command pest management professional (with approval of the local agricultural department). If the plant in question is small and is expandable, place its roots and most of the soil attached to them in a l-quart polyethylene bag or freeze bag. Attach a label with the names of the installation, collector, host plant, and locality in indelible pencil or ink. Close the bag with a rubber band and put the bag in a suitable mailing box. Wrap the box and place the agricultural permit label on the box. In the case of a large plant, get a sample of its roots and associated soil. Bag and label this similarly. If turf is affected, include a 2-inch square plug 6 inches deep from the margin of the infested area.

Preventive Control. Nematodes brought into installations in soil and plants will adversely affect plants to which they spread. It is, therefore, a must that everyone responsible for grounds maintenance take the few preventive measures necessary to avoid the spread of plant parasitic nematodes. All nursery stock for military installations must be certified free of plant parasitic nematodes or be certifiable under local restrictions.

Incoming and outgoing equipment or any other facility on which there may be soil attached should be thoroughly *steam cleaned* or at least washed off, and equipment allowed to dry. Cleaning off all soil and exposing the equipment to direct sunlight is enough in areas where cyst nematodes are not a problem. Severel Federal *quarantines* have been established to prevent the further spread of certain nematodes. Some states also have local restrictions. People who send plants, plant products, soil, tracked vehicles, or earth-moving equipment to or from military installations should learn what quarantines apply in their areas of operation.

Chemical Control. Since all nematocides are highly toxic to animals, you must avoid inhalation and skin contact. One of the most important considerations in selecting a nematocide is its phytotoxicity. A few important plant nematodes infest aboveground parts of plants, and you can use penetrating sprays of nonphytotoxic nematocides on them. Most of our important plant nematodes are inhabitants of the soil. You can use nematocides toxic to living plants in seedbed or field preplant sterilization. In order for chemicals to reach the nematodes in the soil, you must use either vaporized or water-dispersed nematocides.

Injected liquids that vaporize. The most successful control is soil fumigation with vapors from volatile liquids injected into the soil at closely spaced intervals. Diffusion through the soil, and subsequent effectiveness, depends largely on soil porosity, moisture, and temperature. Prepare and level the area as you would for planting, with soil moisture not unusually high or low, and the temperature betwen 60° and 80°F. Inject the fumigants 8 to 10 inches into the soil for proper vaporization and dispersal. You give this treatment in small plots with specialized hand equipment and in a 1-foot grid pattern. When you calibrate the application to the manufacturer's recommended dosage rate, you make the injections at the points of grid line intersection. Tamp the holes closed. With most nematodes, you should wait 2 to 3 weeks before you plant the plot.

Tractor-drawn application equipment is available for larger areas. Its principle is essentially the same, but the equipment digs furrows, treats them, and covers them.

Methyl bromide takes a different procedure and different equipment. The areas must be leveled, as prepared for planting, and irrigated to bring the moisture to about 60 percent of capacity. Distribute buckets or similar supports over the area. Also put out shallow pans to receive the plastic applicator hose from the methyl bromide container. Securely fasten a hose directly over each pan, the numbers of which depend upon the manufacturer's dosage recommendation. Lead the other ends of the hoses outside the area to be treated. Then, drape a plastic tarpaulin, free from holes, over the supports. Seal its edges thoroughly with a 6-inch border of soil. Attach containers of liquid methyl bromide under pressure to special couplings on the outer end of the plastic hoses. When you puncture these containers, the methyl bromide flows into the pans and becomes a very penetrating gas.

Water-dispersed drenches. The development of effective nematocides that are nontoxic to growing plants has stimulated increased use of water-dispersed drenches to control nematodes in turf and a wide variety of ornamentals. You water the area, but don't saturate it. Measure the diseased zone and a 6-foot strip of healthy looking turf around it. Calculate the dosage by the manufacturer's recommendations and dilute the emulsion concentrate with water. Disperse it by hand sprinklers or use power equipment after a test run with water to get the distribution right. After treatment, irrigate the area with 2 inches of water. Plantings or a single plant may be treated similarly. You can use a metal rod to open holes in the soil within the root area 15 to 25 inches deep. A small earth dam made around the base of the planting or plant will hold the water you apply after treatment.

Exercises (852):

1. List in sequence the steps that you should take to confirm suspicions of nematode damage to small and expendable plants.

2. What can you do to preclude the spread of plant parasitic nematodes?

3. State how you would control nematodes with hand equipment and phytotoxic nematocides.

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Answers for Exercises

CHAPTER 1

Reference:

800 - 1. T.
800 - 2. T.
800 - 3. T.
800 - 4. F; change "southern" to "northern."
800 - 5. T.
800 - 6. F; change "white and grey" to "brown and black."
800 - 7. T.
800 - 8. T.
800 - 9. F; change "black" to "white."

801 - 1. T.
801 - 2. T.
801 - 3. T.
801 - 4. Change "smaller" to "enlarged."
801 - 5. Remove "not."
801 - 6. T.
801 - 7. T.
801 - 8. Change "fine" to "coarse."
801 - 9. T.
801 - 10. T.

802 - 1. It has a short snout, is about 3 mm long, with reddish legs and a light olive-brown color mottled with darker brown and grey. The body narrows evenly toward the head.
802 - 2. The larva feeds within the bean, but when the adult emerges, it feeds on other materials.
802 - 3. There can be 6 or 7 generations per year with up to 28 weevils within one bean.
802 - 4. Larger than the bean weevil, it's about 5 mm long, brownish flecked with white, with black to grey patches of scales.
802 - 5. Only in the field.

803 - 1. Red-legged ham beetle.
803 - 2. Larder beetle.
803 - 3. Cheese maggot.
803 - 4. Larder beetle.
803 - 5. Red-legged ham beetle.
803 - 6. Cheese maggot.

804 - 1. F; change "four" to "six."
804 - 3. F; change "green" to "brown."
804 - 5. F; change "khapra" to "cigarette."

805 - 1. Have the food product condemned.
805 - 2. Five percent.
805 - 3. At least every 2 weeks.
805 - 4. Once a month.
805 - 5. Because visual surveys are only effective for the most advanced stages of an infestation.
805 - 6.
a. Select at random, empty, and sift.
b. Visually inspect, then sift for signs of insect and rodent damage.
c. Check for areas damaged by rodents and inspect contents for evidence of insects.

806 - 1. Sanitation, palletization, rotation, isolation, ventilation, packaging, insectproof construction, etc.
806 - 2. It will force them to migrate or will starve them out (combined with other control techniques).
806 - 3. Old stocks may let insects complete one or more life cycles, light infestations may become heavy ones, old contaminated stocks may infest new shipments, dirt, filth, and moisture may lead to loss of foodstuffs, etc.
806 - 4. It reduces moisture content.

807 - 1. It serves as a preventive measure to keep the insects from becoming established.
807 - 2. For monitoring insect activity, for mass trapping, and as a form of birth control.
807 - 3. Only small amounts are needed, pheromones aren't poisonous, they are species-specific, and there is no insect resistance.
807 - 4. That sanitation is adequate.
807 - 5. To walls, floors, posts, and any other areas that might harbor insects, particularly cracks and crevices.
807 - 6. A mist blower or ULV generator.
807 - 7. Locate the source of the pests and get rid of it.
807 - 8. Food-handling areas, including places where food is exposed during receiving, storage, preparation, and serving.
807 - 9. Expansion joints, between different elements of construction, between equipment and floors, and in voids such as hollow walls, equipment legs and bases, conduits, motor housings, junctions, and switch boxes.
807 - 10. Be careful not to treat food areas where food is exposed and avoid leaving any material on exposed surfaces.

	Phase	*Order*
808 - 1.	Preparation	4
808 - 2.	Application	8
808 - 3.	Clearance	14
808 - 4.	Preparation	1
808 - 5.	Application	11
808 - 6.	Clearance	16
808 - 7.	Clearance	13
808 - 8.	Application	7
808 - 9.	Preparation	2
808 -10.	Application	10
808 -11.	Clearance	15
808 -12.	Evaluation	12
808 -13.	Application	9
808 -14.	Preparation	6
808 -15.	Preparation	3
808 -16.	Preparation	5

809 - 1. Casemaking.
809 - 2. Casemaking.
809 - 3. Carpet.
809 - 4. Webbing.
809 - 5. Webbing.
809 - 6. Carpet.
809 - 7. Webbing.
809 - 8. Casemaking.
809 - 9. Webbing.

809 - 10. Carpet.

810 - 1. Common.
810 - 2. Odd.
810 - 3. Black.
810 - 4. Varied.
810 - 5. Furniture.
810 - 6. Common.
810 - 7. Odd.
810 - 8. Varied.
810 - 9. Black.

811 - 1. Because the adults don't feed on any of the materials attacked by larvae.
811 - 2. A flashlight and a knife, nail file, or small spatula.
811 - 3. Dark clothes closets, furs, woolens, bits of carpeting, lint around doors and under baseboards, in and under upholstered furniture, in collections of animal hair, air ducts, in cereal and other food products, etc.
811 - 4. Bird nests and wasp nests on or in the building.

812 - 1. F; proper household cleanliness is very important in keeping fabric pests from becoming established.
812 - 2. T.
812 - 3. T.
812 - 4. F; control is only semipermanent.
812 - 5. T.
812 - 6. F; you only should spot treat, focusing on critical areas such as around baseboards and under furniture.
812 - 7. T.
812 - 8. F; applications should be made lightly and quickly.
812 - 9. T.
812 - 10. T.

CHAPTER 2

813 - 1. They are the worst of the insect pests, and of all types of pests, they are second only to wood-destroying fungi.
813 - 2. Paper, cardboard, fiberboard, structural timbers, pallets, crates, tool handles, furniture, and other wood products.
813 - 3. In nature, they help convert deadwood and other materials containing cellulose to humus.
813 - 4. Workers and nymphs.
813 - 5. Feed the other forms, groom the queen, excavate the nest, and make the tunnels.
813 - 6. The secondary reproductives.
813 - 7. Primary reproductives.
813 - 8. Ants have a very thin waist between the thorax and abdomen; termites have thick waists. Termite wings are about the same size and shape, but the forewings of an ant are larger, longer, and shaped differently from the hindwings. Termite antennae are straight; ant antennae are elbowed.

814 - 1. Because their soft bodies lose water rapidly when they're exposed to dry air.
814 - 2. It promotes the growth of fungi the termites need as a food source.
814 - 3. The original pair of reproductives, a few dwarf workers, and one dwarf soldier.
814 - 4. The geographic area, climatic conditions, the species of termite involved, and other factors such as the temperature of the building or soil.

815 - 1. Formosan.
815 - 2. Pacific Coast.
815 - 3. Light southeastern.
815 - 4. Eastern.
815 - 5. Southeastern.
815 - 6. Pacific Coast.
815 - 7. Formosan.
815 - 8. Pacific Coast.
815 - 9. Desert.
815 - 10. Eastern.

816 - 1. False; delete the word "not."
816 - 2. True.
816 - 3. True.
816 - 4. False; change "above" to "below."
816 - 5. True.
816 - 6. True.
816 - 7. True.
816 - 8. False; delete the word "not."
816 - 9. False; change "never" to "always."
816 - 10. True.

817 - 1. Inspection, preventive controls, and corrective controls.
817 - 2. During planning and construction of a building.
817 - 3. During construction, treat the soil next to the foundation, walls, and piers, and under concrete slabs with a residual insecticide to give a long-lasting barrier against subterranean termites.
817 - 4. They should be treated with a wood preservative.

818 - 1. Mechanical alteration, soil treating, foundation treating, and wood treating.
818 - 2. Along the inside and outside of the foundation, under slabs, and around utility entrances.
818 - 3. Dig a small trench about 4" deep next to the foundation, then remove cores of earth at 1-foot intervals and flood the soil or use a long pipe to flood soil at the same intervals.
818 - 4. You should drill along the crack and inject chemical under pressure.
818 - 5. Eliminate soil contact by removing the dirt back to 2 feet and removing part of the porch wall at both ends and installing access doors. Then treat the tunnel at the rate of 2 gallons per 5 linear feet and the remainder of the soil at the rate of 1 gallon per 10 square feet.
818 - 6. Treat from the outside by drilling through the foundation wall. This lets you avoid the hazard of drilling through heat pipes, electrical conduits, and plumbing embedded in the floor.
818 - 7. All wood should be cut off above ground level, and supporting concrete placed under it.
818 - 8. 0.5 percent aldrin; 1.0 percent chlordane; 0.5 percent dieldrin; 0.5 percent heptachlor; 1.0 percent chlorpyrifos.

819 - 1. F; change "highly decayed" to "undecayed."
819 - 2. T.
819 - 3. T.
819 - 4. F; they are less damaging since their range is much more limited.
819 - 5. T.

820 - 1. F; change "smallest" to "largest."
820 - 2. T.
820 - 3. T.
820 - 4. F; this describes the desert damp-wood termite.
820 - 5. T.

821 - 1. Visible damage and plugs in entrance and exit holes.
821 - 2. Around the perimeter of buildings and where wood is joined together.
821 - 3. Look for the characteristic fecal pellets pushed out of termite galleries.
821 - 4. Nonsubterranean termites have crossveins between the costal and subcostal veins. These crossveins are lacking in subterranean termites.
821 - 5. Either fumigating the entire structure with a toxic gas or introducing a toxic liquid or dust into the excavated chambers.
821 - 6. It disperses rapidly and evenly within the temperature range for climates where nonsubterranean termites are found.
821 - 7. Drill holes into infested timbers and deposit the pesticides here. Drill one-half-inch holes for large timbers and smaller holes elsewhere.
821 - 8. Structural changes to eliminate moisture may be needed, and the same treatment as for subterranean termites may be necessary.
821 - 9. Inject chemicals into the galleries or fumigate the furniture items.

821 - 10. Carefully inspect lumber, especially used lumber, for evidence of an infestation; screen doors, windows, and attic windows; chemically treat wood to prevent attack; use termite-resistant wood; protect exterior wood sufaces with paint; etc.

822 - 1. a, c, d, f, h, and j are true.
822 - 2. b. Change "40" to "20."
e. Change "least" to "most."
g. Add "do not" before produce.
i. Change "alkaline" to "acid."
822 - 3. As mold, stain, or wood-rotting fungi.
822 - 4. They break down starches, sugars, gums, and oils; they don't break down cellulose or lignin.
822 - 5. From black through blues, browns, reds, and yellows.
822 - 6. White rots, brown rots, and water-conducting fungi.
822 - 7. Ligno-cellulose; lignified.
822 - 8. Ligno-cellulose; lignin.
822 - 9. Cellulose; lignin; brownish.
822 - 10. Brown-rot.
822 - 11. Humidity; temperature; tube; filament.
822 - 12. They secrete substances that dissolve organic material (wood).

823 - 1. a, b, c, d, f, g, h, i, and j are true; for e, change "decrease" to "increase" and "extend" to "shorten."

824 - 1. L.
824 - 2. A.
824 - 3. B.
824 - 4. B.
824 - 5. A.
824 - 6. L.
824 - 7. B.
824 - 8. A.
824 - 9. A.
824 - 10. L.
824 - 11. L.
824 - 12. A.
824 - 13. A.
824 - 14. B.
824 - 15. A.
824 - 16. L.
824 - 17. L.
824 - 18. A.
824 - 19. L.
824 - 20. B.
824 - 21. L.
824 - 22. B.
824 - 23. L.
824 - 24. A.
824 - 25. L.
824 - 26. A.
824 - 27. L.
824 - 28 B.

825 - 1. Both.
825 - 2. Both.
824 - 3. Both.
824 - 4. C.
825 - 5. B.
825 - 6. Both.
825 - 7. C.
825 - 8. B.
825 - 9. C.
825 - 10. C.

826 - 1. a, c, e, and g are true. In b, change "more" to "less." In d, reverse "insect" and "fungus." In f, change "can be left in place" to "should be removed."

827 - 1. Tunnel; excavate.
827 - 2. Soft.
827 - 3. Chlorinated; injected.
827 - 4. Dusts; carried.
827 - 5. Southern.
827 - 6. Eat; excavate.
827 - 7. Tunnels; dusted; powders.
827 - 8. Coat; paint.

CHAPTER 3

828 - 1. Gypsy moth.
828 - 2. White-marked tussock moth.
828 - 3. Gypsy moth.
828 - 4. Fall cankerworm.
828 - 5. White-marked tussock moth.

829 - 1. Eastern tent caterpillar.
829 - 2. Fall webworm.
829 - 3. Spruce bud worm.

830 - 1. T.
830 - 2. F; change "cutworm" to "bagworm."
830 - 3. T.
830 - 4. F; change "bagworms" to "cutworms."
830 - 5. T.

831 - 1. Elm leaf.
831 - 2. Elm leaf.
831 - 3. Elm leaf.
831 - 4. Both.
831 - 5. Japanese.
831 - 6. Japanese.
831 - 7. Japanese.

832 - 1. Basswood.
832 - 2. Holly.
832 - 3. Birch.
832 - 4. Arborvital.

833 - 1. Insecticidal sprays and dusts.
833 - 2 Because they are concealed between the layers of the leaf.
833 - 3. Pick them from the affected host.

834 - 1. T.
834 - 2. F; change "2.6" to "6.2."
834 - 3. F; change "bark beetles" to "engravers."
834 - 4. T.
834 - 5. T.
834 - 6. T.

835 - 1. Borers.
835 - 2. Tunneling under bark; wood.
835 - 3. Fine boring dust; larvae; tunnels.
835 - 4. Paper; burlap; attack.
835 - 5. Carbon disulfide; paradichlorobenzene; benzene hexachloride; tunnels; putty.

836 - 1. Spotting, discoloration, malformation, and general devitalization of the foliage, twigs, and other plant parts.
836 - 2. They are 0.8 to 6.2 mm long, with delicate, soft, globular-to-pear-shaped bodies that are yellow, green, red, grey, blue, or black.
836 - 3. Malathion and dimethoate.
836 - 4. They cause general devitalization and death by extracting plant sap and injecting toxic saliva. Also, unused honeydew falls on lower plant parts where it forms a medium for black sooty molds.
836 - 5. a. They may be flattened, globular, hemispherical, saclike, elongated, or circular.
b. They're sometimes covered with wax in the form of powder, cottony masses, or a continuous scalelike layer.
c. They are always wingless, and the legs, antennae, and compound eyes are reduced or absent.
d. They usually have a pair of membraneous wings, well-developed legs, long antennae, and no beak.
836 - 6. In the early spring before the buds start to expand, but when the temperature will stay above freezing for at least 24 hours.
836 - 7. Closely related to the scale insects, they're small and covered

with a soft, fine, white granular material that forms long, cottony threads over the body.

836 - 8. They are minute, reddish or yellowish spiderlike arthropods with tiny bodies that are rounded, shiny, and covered with fine hairs.

836 - 9. They suck juices from the undersides of leaves and tender parts of the plant. This causes a stippled appearance of the foliage, which later discolors and dies.

836 - 10. They attack a wide variety of grasses, shrubs, and shade trees.

836 - 11. They suck large amounts of sap from plants and cause numerous small pinholes in the phloem and bark tissues.

836 - 12. Make sure you cover the foliage thoroughly, including the undersides.

836 - 13. Damaged leaves have a spotted, greyish appearance on top and a black, shiny, varnishlike excrement and cast skins on the underside.

836 - 14. Aphids.

836 - 15. They're 1.0 to 1.6 mm long, slender, and usually blackish, brownish, or yellowish. They eat most flowering plants and shrubs.

836 - 16. Because these minute insects hide in the sheaths of leaves and flower stems as well as within the flowers themselves.

837 - 1. T.
837 - 2. T.
837 - 3. F; change "sucking" to "chewing."
837 - 4. T.
837 - 5. T.
837 - 6. T.
837 - 7. T
837 - 8. F; change "80°F" to "86°F."

838 - 1. (1) e.
(2) i.
(3) a.
(4) f.
(5) b.
(6) k.
(7) m.
(8) g.
(9) n.
(10) c.
(11) o.
(12) l.
(13) h.
(14) j.
(15) d.

839 - 1. (1) f.
(2) c.
(3) e.
(4) a.
(5) d.
(6) b.

840 - 1. T.
840 - 2. F; change "black" to "bright red."
840 - 3. T.
840 - 4. T.

841 - 1. In the fall or spring, when the soil is fairly warm.

841 - 2. Cut three sides of a 1-foot square, lay it back on its fourth side, count the grubs, and replace the sod.

841 - 3. At least a half dozen grubs per square foot.

841 - 4. Pass broken-up sod through a four-mesh screen and then through a window screen; the wireworms won't pass the second screen.

841 - 5. Cut both ends out of a tin can, shove it halfway into the sod, and fill it with water. The chinch bugs will float.

842 - 1. a, b, c, d, e, and f are true; in g, Achatina have *not* become established in California.

843 - 1. 1. Achatinidae.
2. Zonitidae.
3. Veronicellidae.
4. Helicellidae.
5. Testacellidae.
6. Bradybaenidae.
7. Helicidae.

843 - 2. Above.
843 - 3. Aestivation.
843 - 4. Self-fertilization.

844 - 1. Horticultural; quarantine.
844 - 2. On sheets of wrapping paper.
844 - 3. At night or early in the morning after a rain.
844 - 4. At the point of origin.
844 - 5. A slime trail.

845 - 1. b, c, d, e, g, and h are true. In a, after "normally" insert "do not." In f, replace "repellent" with "contact poison."

846 - 1. Dollar spot.
846 - 2. Fusarium blight.
846 - 3. Brown patch.
846 - 4. Fairy rings.
846 - 5. Mildew.
846 - 6. Spring dead spot.
846 - 7. Damping-off.
846 - 8. Brown patch.
846 - 9. Dollar spot.
846 - 10. Mildew.
846 - 11. Fusarium blight.
846 - 12. Copper spot.

847 - 1. 3 to 21 days.

847 - 2. Rainfall, dew, biodegradation, UV light, and new growth.

847 - 3. It may reduce the severity of the disease if the humidity drops, wind increases, or if the sun dries the turfgrass surface area.

847 - 4. Benomyl, mancozeb and thiabendazole.

847 - 5. As a chemical seed treatment applied before planting.

847 - 6. Aeration, overwatering, and applying wetting agents.

847 - 7. Reduce available nitrogen and the frequency of watering. Water only at midday to help maintain a dry turfgrass surface.

847 - 8. Keep thatch to a minimum, increase nitrogen levels in the soil, and water deeply when necessary.

848 - (1) f.
848 - (2) j.
848 - (3) b.
848 - (4) d.
848 - (5) a.
848 - (6) h.
848 - (7) g.
848 - (8) k.
848 - (9) c.
848 - (10) i.
848 - (11) e.

849 - 1. When the tree's health is poor or its aesthetic value would be lost from the disease.

849 - 2. Protection against infection with fungicides and use of resistant varieties.

849 - 3. Spray at or before bud break and every 2 weeks until about mid-June.

849 - 4. Many disease pathogens overwinter on the tree, in the buds, on the bark, or on dead twigs. Spores that infect leaves may travel great distances in the wind. Dry leaves break up during raking, and many pieces are left in the grass.

849 - 5. By removing all infected tissues.

849 - 6. By keeping trees vigorous and avoiding wounds in the root system and near the base of the tree.

849 - 7. Use therapy to delay the disease's progression in a partially infected system. When the roots are mostly dead, remove the tree.

849 - 8. Removal and destruction of weakened or dead elm trees and logs, and pruning out infected twigs and branches.

849 - 9. Control the insect vector with malathion spray, inject

Tebuthiuron into the tree trunk, and fumigate the soil between trees with Vapam to prevent further spread through root grafts.

850 - 1. Small; magnification.
850 - 2. Eggs; males.
850 - 3. Thrashing about.

851 - 1. Sedentary parasites; endoparasitic; semiendoparasitic; ectoparasitic.
851 - 2. Fixed; one; death.
851 - 3. Stunted; yellow; fine; root.
851 - 4. Nursery stock, ornamentals, and grasses.
851 - 5. Lesions; roots; larvae.
851 - 6. Citrus; tip dieback; sparse; spreading.
851 - 7. Lesions; roots; soil.
851 - 8. Externally; roots; plants.
851 - 9. Free; soil; roots.
851 - 10. Spiral.
851 - 11 Tips; roots.
851 - 12. Bud; young; crimping; deformation; unproductivity.
851 - 13. Parenchymatous; plant; salivary.
851 - 14 Gall; poisoned.

852 - 1. Collect soil and root samples; get shipment approval from the local agricultural department; put the plant roots and soil in a 1-quart polyethylene or freeze bag; include a label with the installation, collector, host plant, and locality; close the bag with a rubber band and put it in a mailing box; wrap the box and place the agricultural permit label on it, and send it to your command pest management professional.
852 - 2. Be familiar with quarantines within your area of operations; see that incoming and outgoing equipment or any other soiled facility is thoroughly steam cleaned or at least washed off and allowed to dry; and see that all nursery stock is certified free of plant parasitic nematodes.
852 - 3. For this preplant soil sterilization, you prepare the area by digging, leveling, and marking it off in a 1-foot grid pattern. Calibrate the equipment, and inject the recommended volatile liquids 8 to 10 inches deep at each intersecting gridline point.

1985-544-008/20374 AUGAFS,AL(854566)350

STOP- 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 05 22

ECONOMIC PESTS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet e sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the *best* answer to each question.

1. (800) What pest is considered the most important whole grain pest?
   a. Cadelle.
   b. Drugstore beetle.
   c. Granary weevil.
   d. Rice weevil.

2. (801) Which of the following insects is the worst pest of prepared cereals?
   a. Red flour beetle.
   b. Cadelle.
   c. Confused flour beetle.
   d. Indian meal moth

3. (801) What moth is easily recognized by pale gray forewings with transverse wavy black markings?
   a. Indian meal moth.
   b. Angoumois grain moth.
   c. Webbing clothes moth.
   d. Mediterranean flour moth.

4. (802) The statement "a pest with reddish legs and a light olive-brown color, mottled with darker brown and gray," describes the
   a. bean weevil.
   b. pea weevil.
   c. cadelle.
   d. red flour beetle.

5. (803) Which of the meat and cheese pests also infests dog biscuits, museum spec'mens, and dried tobacco?
   a. Larder beetle.
   b. Cheese maggot.
   c. Red-legged ham beetle.
   d. Cadelle beetle.

6. (804) Which of these general feeder beetles is an important pest in grocery stores, food warehouses, and grain storage?
   a. Saw-tooth grain beetle.
   b. Drug store beetle.
   c. Cigarette beetle.
   d. Khapra beetle.

7. (805) How often should you conduct joint surveys with other food quality inspectors for stored products pests?
   a. At least twice a month.
   b. At least once a month.
   c. At least every six weeks.
   d. At least every eight weeks.

8. (806) All of the following are forms of preventive control for stored products pests *except*
   a. palletizing.
   b. isolation.
   c. fumigation.
   d. rotation.

9. (807) Pheromones can be used in a stored-food pest management program in all these ways *except*
   a. to conduct mass trapping.
   b. to rapidly reduce larval population.
   c. to monitor insect activity.
   d. as a birth control method.

10. (807) In warehouses, insects on the outside of packaged materials can be killed with
    a. residual sprays.
    b. residual dusts.
    c. contact sprays.
    d. a vacuum cleaner.

11. (807) In areas where food is prepared, you may only use

a. crack and crevice treatment.
b. residual dusts.
c. pheromones.
d. insect traps.

12. (808) Before you clear a stack being fumigated with aluminum phosphide, you must make sure gas concentrations are below

a. 0.1 ppm.
b. 0.3 ppm.
c. 0.5 ppm.
d. 1.0 ppm.

13. (809) What pest spins and carries a silken case during its larval stage?

a. Black carpet beetle.
b. Furniture carpet beetle.
c. Casemaking clothes moth.
d. Webbing clothes moth.

14. (809) Which clothes moth has larvae which spin a cocoon and then attach particles of fiber and excrement to it?

a. Webbing clothes moth.
b. Casemaking clothes moth.
c. Carpet moth.
d. Upholstery moth.

15. (810) The larvae of which of these carpet beetles are great wanderers and may be found in a wide variety of locations?

a. Odd beetle.
b. Furniture carpet beetle.
c. Common carpet beetle.
d. Black carpet beetle.

16. (811) For what stage of fabric pests should you survey?

a. Eggs.
b. Larvae.
c. Pupae.
d. Adults.

17. (812) Which of the following is generally ineffective in preventing infestations of fabric pests?

a. Cedar chests.
b. Mothproofing.
c. Household sanitation.
d. Cold storage for clothing.

18. (812) Preventive controls for fabric pests include all of these *except*

a. Paradichlorobenzene (PDB).
b. naphthalene.
c. thorough, regular vacuuming.
d. cedar closets and chests.

19. (812) When fabric pest infestation is not heavy, what is a suitable chemical control method for adults and larvae?

a. Contact spray application.
b. Ultra low volume (ULV) treatment throughout the building.
c. Dusts applied to carpet pads.
d. Crack and crevice treatment with residual sprays.

20. (813) The insect pests most destructive to structures at military activities are

a. fungi.
b. termites.
c. carpenter ants.
d. carpenter bees.

21. (813) The worker caste of the subterranean termite is important to the colony as a whole because workers

a. protect the colony from invaders.
b. produce eggs to sustain the colony.
c. produce the food for the members of the colony
d. feed and care for all the other members.

22. (814) In temperate areas, the primary subterranean termite reproductive swarm in

a. late winter.
b. spring.
c. summer.
d. fall.

23. (815) What termite is relatively new to North America, but is highly aggressive and destructuve in world areas where it is found?

a. Desert termite.
b. Formosan termite.
c. Northern termite.
d. Eastern termite.

24. (815) Which termite is most aggressive when its nests or galleries are disturbed?

a. Light southeastern subterranean termite.
b. Southeastern subterranean termite.
c. Eastern subterranean termite.
d. Formosan termite.

25. (816) When inspecting structures, you should know in advance all of the following *except*:

a. what termite species are common in your area.
b. the signs of damage commonly caused locally.
c. the extent of an infestation when it occurs.
d. the relative age of any infestion found.

26. (816) Exploratory tunnels constructed by subterranean termites will usually emerge

a. in old logs and wood under the ground.
b. a little below ground level.
c. above ground level.
d. in windows and doors.

27. (817) The *best* time to provide protection against termites is

a. immediately after construction is completed.
b. during the final construction.
c. during planning and construction.
d. one year after construction is completed.

28. (817) To ease termite inspection in buildings with crawl spaces, how much clearance should there be between the ground and the lowest joist, beam, or girder?

a. 18 inches.
b. 24 inches.
c. 30 inches.
d. 36 inches.

29. (818) At what rate should termiticides be applied to a trench along a foundation?

a. 1 gallon per 10 linear feet.
b. 1 gallon per 5 linear feet.
c. 2 gallons per 10 linear feet.
d. 2 gallons per 5 linear feet.

30. (818) Which termiticide is available in paste form and gives good penetration to control both termites and fungi?

a. Paradichlorobenzene.
b. Pentachlorophenol.
c. Dichlorvos.
d. Chloroneb.

31. (818) Buildings with concrete block foundations must be treated for termites by

a. drilling holes every 6 inches and injecting chemical at the rate of 1 gallon per 10 linear feet.
b. drilling holes every 8 inches and injecting chemical at the rate of 1 gallon per 5 linear feet.
c. drilling holes every 12 inches and injecting 1/2 gallon per hole.
d. drilling holes every 18 inches and injecting 1 gallon per hole.

32. (819) Dry-wood termites generally live in wood which is

a. undecayed and low in moisture content.
b. undecayed and moderate in moisture content.
c. partly decayed and moderate in moisture content.
d. highly decayed and low in moisture content.

33. (820) Which termite is of horticultural importance, attacking underground parts of shrubs and small trees?

a. Rotten-wood termite.
b. Desert damp-wood termite.
c. Florida damp-wood termite.
d. Powder-post termite.

34. (821) The easiest way to survey for non-subterranean termites is to

a. probe wooden timbers with an awl.
b. use a moisture detection device in wood members.
c. look for fecal pellets pushed out of galleries.
d. look for unpainted or poorly painted wood being attacked by fungi.

35. (822) *Poria incrassata* is an example of which type of fungi?

a. White rot.
b. Water conducting.
c. Stain fungi.
d. Mold fungi.

36. (822) The term "dry-rot" suggests an attack on wood by

a. red-rot fungi.
b. yellow-rot fungi.
c. brown-rot fungi.
d. white-rot fungi.

37. (823) What percentage of pentachlorophenol is recommended to make wood almost completely impervious to water?

a. 1 percent.
b. 3 percent.
c. 5 percent.
d. 10 percent.

38. (823) The maximum permissible moisture content for safe storage of lumber before it is dip-treated is

a. 10 percent.
b. 20 percent.
c. 30 percent.
d. 40 percent.

39. (824) Which one of the powder post beetles is identified by larval tunnels tightly packed with frass and running parallel with the wood grain?

a. Lyctidae.
b. Anobiidae.
c. Bostrychidae.
d. Cerambycidae.

40. (824) The larvae of which powder post beetles attack the sapwood of pine, oak, beech, alder, and willow?

a. Anobiidae.
b. Lyctidae.
c. Bostrychidae.
d. Cerambycidae.

41. (825) Which of these insect pests is of particular importance because of its attacks on floor joists, sills, beams, studs, and subflooring?

a. Lesser house borer.
b. Greater house borer.
c. Old house borer.
d. Long-horned wood borer.

42. (826) What corrective control for powder post beetles is used to treat laid flooring in buildings?

a. Brushing with an oil solution.
b. Spraying with an oil solution.
c. Spraying with pentachlorophenol.
d. Brushing with pentachlorophenol.

43. (827) In structures, the most effective preventive treatment against carpenter bees is to

A. spray the surface with pentachlorophenol.
B. spray the surface with trichloromethane.
C. spray the surface with chlorinated hydrocarbons.
D. apply a heavy protective coating of paint.

44. (828) The common lepidoptera defoliators that feed mainly on trees such as apple, alder, birch, oak, and willow are the

a. white-marked tussock moths.
b. fall cankerworms.
c. gypsy moths.
d. fall webworms.

45. (829) Which very destructive webbing Ledidoptera defoliator spends its larval stage in protected coverings under bark scales?

a. Fall cankerworm.
b. Fall webworm.
c. Eastern tent caterpillar.
d. Spruce bud worm.

46. (830) Lepidoptera defoliators that are seldom seen because they usually remain hidden under clods of earth or in the topsoil during the day are the

a. bagworms.
b. Eastern tent caterpillars.
c. fall webworms.
d. cutworms.

47. (831) The larvae of which skeletonizing defoliators hatch in the ground and feed on decaying vegetation and plant roots?

a. Japanese beetles.
b. Fall cankerworms.
c. Elm leaf beetles.
d. Cutworms.

48. (832) The holly leaf miner is the larval stage of a

a. small dark or yellowish fly.
b. small gray moth.
c. wedge-shaped beetle.
d. white with blackspot fly.

49. (832) The larvae that eat out the inside of terminal leaves are

a. holly leaf miners.
b. basswood leaf miners.
c. arborvitae leaf miners.
d. birch leaf miners.

50. (833) Chemical control of bagworms is effective only in the

a. late summer.
b. fall.
c. winter.
d. spring and early summer.

51. (834) A method used to lessen the attack of bark beetles is to

a. spray the tree with a protective paint.
b. spray the surrounding foilage with herbicide.
c. cut and destroy the infested tree.
d. score around the base of the tree.

52. (835) To kill borers within wood or bark, you can use

a. carbon disulfide.
b. pentachlorophenol.
c. calcium carbonate.
d. fertilizer and water.

53. (836) Which pesticides are commonly used to control aphids and other pl[illegible] pests?

a. Dursban and malathion.
b. Malathion and dimethoate.
c. Baygon and carbaryl.
d. Carbaryl and diazinon.

54. (838) Which sapsuckers secrete large amounts of honeydew that often falls on plant parts and creates a medium for black sooty molds?

a. Lacebugs.
b. Spittlebugs.
c. Scale insects.
d. Leafhoppers.

55. (837) Summer oils should *not* be sprayed if the temperature is above

a. 52° F.
b. 64° F.
c. 78° F.
d. 86° F.

56. (838) Wireworms are most prevalent in

a. dry sandy soils.
b. gardens and orchards.
c. pastures and hay fields.
d. high rainfall areas.

57. (838) Normally, pavement ants are found in lawns in

a. the Atlantic Coast states.
b. Texas and Lousiana.
c. the West Coast states.
d. the New England states.

58. (839) The best way to distinguish between the armyworm and the fall armyworm is the

a. fall armyworm is more brilliantly colored.
b. armyworm has a white dot on each forewing.
c. armyworm feeds only during the day.
d. fall armyworm remains in the soil at night.

59. (840) One of the most destructive of the turf-attacking insects is the

a. leaf bug.
b. leafhopper.
c. chinch bug.
d. scale insect.

60. (841) Sifting broken-up sod through hand sifters is the recommended method for detecting the presence of

a. grubs.
b. chinch bugs.
c. cutworms.
d. wireworms.

61. (842) The Mediterranean snail that is considered to be the most destructive is the

a. *Theba pisana*.
b. *Achatina*.
c. *Otala lactea*.
d. *Helix asperta*.

62. (843) The aestivation of snails refers to the

a. ability to reproduce asexually.
b. preparation of a nest for eggs.
c. infestation of vegetation by snails.
d. period of dormancy during the summer.

63. (844) When inspecting wheeled and tracked equipment for snails, what is recommended in lieu of or in addition to examination?

a. Submersion in chemically treated water.
b. Spraying with diesel oil.
c. Steam or water-jet cleaning.
d. Treatment by infrared lighting.

64. (845) The best method of cultivating soil in order to destroy snails and snail eggs is

a. discing.
b. cultipacking.
c. turning.
d. harrowing.

65. (845) What predators may be used to control snails and slugs?

a. Hogs.
b. Chickens.
c. Snakes.
d. Lizards.

66. (846) Which turf disease spreads slowly and may leave a characteristic ``smoke ring'' in the infested area?

a. Damping off.
b. Dollarspot.
c. Copperspot.
d. Brown patch.

67. (846) Which turfgrass disease is indicated by the presence of greyish, cobweb-like mycelia in the early morning while dew is present?

a. Brown patch.
b. Copper spot.
c. Dollar spot.
d. Damping off.

68. (847) In controlling damping off, which of these fungicides may be used as a pre-planting seed treatment?

a. [illegible]
b. Mancozeb.
c. Benomyl.
d. Thiram.

69. (847) When using turf fungicides to control an existing fungus infestation, how should you generally schedule applications?

a. Conduct two treatments 5-10 days apart.
b. Conduct five treatments 3-5 days apart.
c. Conduct monthly treatments throughout the summer.
d. Conduct weekly treatments for a month.

70. (848) A stem disease that produces roughly circular bulbs and contains abundant callus is

a. Diffuse canker.
b. Target canker.
c. Anthracnose.
d. Fusarium blight.

71. (848) If there is a loss of dead areas inside spots on leaves, resulting in a series of holes, which ornamental disease is indicated?

a. Leaf blister.
b. Shot-hole.
c. Powdery mildew.
d. Leaf blotch.

72. (849) How often should fungicides be applied to control leaf diseases?

a. Once in the spring.
b. Every week.
c. Every 2 weeks.
d. Every 3 weeks.

73. (850) Nematodes are classified as

a. free-living.
b. plant parasites.
c. animal parasites.
d. all of the above.

74. (851) Which root-type nematode attacks fruit trees?

a. Root-knot.
b. Meadow.
c. Lance.
d. Stubby root.

75. (852) What has been the most successful method of controlling nematodes?

a. Quarantines
b. Soil fumigation.
c. Herbicides
d. Water-dispersal nematocides.

END OF EXERCISE

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012 and EO 9397. PRINCIPAL PURPOSES: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package. It is utilized by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's need. Failure to provide all information would result in slower action or inability to provide assistance to the student.

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1. THIS REQUEST CONCERNS COURSE (1 - 6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7 - 15)	6. GRADE/RANK	7. NAME *(First initial, second initial, last name)* (17) (18) (19-32)
_ _ _ – _ _ – _ _ _ _		

8. ADDRESS *(OJT Enrollees -- Address of unit training office with zip code. All others -- current mailing address with zip code.)* (33-53) (54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE

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FOR ECI USE ONLY

1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction (Provide Old or Incorrect data)
4	Request Grade/Rank change/correction.
5	Correct SSAN. (List incorrect SSAN here) (Correct SSAN should be shown in Section I)
6	Extend course completion date. (Justify in REMARKS)
7	Request enrollment cancellation. (Justify in REMARKS)
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 Originals were: ☐ Not received ☐ Lost ☐ Misused
9	Send course materials. (Specify in REMARKS) ☐ Not received ☐ Lost ☐ Damaged
10	Course exam not yet received. Final VRE submitted for grading on __________ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 not yet received. Answer sheet(s) submitted __________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on __________ (date).
13	Previous inquiry (☐ ECI Fm 17, ☐ Ltr, ☐ Msg) sent to ECI on __________ (date).
14	Give instructional assistance as requested on reverse.
15	Other (Explain fully in REMARKS)

16		
G	33	
K	Vol 33 - 35	GR 36 - 38
M	33 - 34	35 - 40
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P	Vol 33 - 35	
P	TC 36 - 37	38
P	DOE 39 - 45	
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REMARKS *(Continue on Reverse)*

OJT STUDENTS must have their OJT Administrator certify this request.

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I certify that the information on this form is accurate and that this request cannot be answered at this station. *(Signature)*

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VRE Item Questioned:	MY QUESTION IS:
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REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

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CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 6

Vertebrate Pests

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Preface

THIS SIXTH volume of CDC 56650 was written to teach you about the many vertebrate pests that have daily impact on Air Force installations and operations. As in Volumes 4 and 5, you'll be studying identification and biological characteristics, survey techniques, and control measures you can take to correct problems caused by these animals.

Chapter 1 discusses rodents and is divided into two parts. Part one is about domestic rodents—Norway rats, roof rats, and house mice; part two will discuss field rodents such as native mice and rats, squirrels, and pocket gophers.

In Chapter 2 you'll learn about birds and how they affect us as medical and economic pests and as hazardous pests on airfields. In the lessons on bird control, you'll see the influence of integrated pest management very clearly, since chemical control is always a very final resort compared to the many nonchemical control methods you have available in this area.

Chapter 3 will discuss a variety of vertebrate pests, some of them occasionally thought of as rodents, but in different families. You'll learn about rabbits and hares, bats, skunks, and moles—problems you'll meet on a less regular basis than other pests.

Vertebrate pest control offers you many interesting work opportunities as a pest management specialist. Whereas you can basically expect invertebrate pests to act instinctively in a given situation, vertebrate pests often exhibit a great ability to learn just as you do. This learning ability may often have an impact on what controls will work best for you. Keep these factors in mind both as you study this volume and as you manage these pests in the field.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in this publication is for information purposes only and does not imply indorsement by the Air Force.

This volume is rated at 27 hours (9 points).

Material in this volume is technically accurate, adequate, and current as of July 1984.

Acknowledgement

PREPARATION OF this volume was aided through the cooperation and courtesy of Harcourt Brace Jovanovich, publishers of the *Scientific Guide to Pest Control Operations*, 3rd edition, and *Pest Control* magazine. Information from these sources helped greatly in preparing information and illustrations on domestic rodents and pocket gophers. In accordance with the copyright agreement, distribution of this volume is limited to DOD personnel.

Gie, Inc., Publishers further enhanced development of this volume by their cooperation and courtesy in permitting the use of past issues of *Pest Control Technology* magazine. Past issues of this magazine assisted greatly in developing the discussions of domestic rodent control and skunk characteristics and controls.

Permission to use materials by both of these publishers is gratefully acknowledged.

Contents

Rodents

THE DOMESTIC RODENT is a major problem on military installations. One of your primary duties is to control these pests. Not only must you contend with the domestic rodent but you must control several field rodents including rabbits, hares, moles, shrews, and predatory animals. This chapter covers these pests, as well as bats and birds.

1-1. Domestic Rodents (Order Rodentia, Family Muridae)

Three species of murine rodents live in close association with humans: the Norway rat (*Rattus norvegicus*), the black or roof rat (*Rattus rattus*), and the house mouse (*Mus musculus*). These three imported murine rodents are far more important to humans and their property than are the rodents that are native to the United States. One or more of these three are found almost everywhere people live. Because these rodents live near humans, they are also known as the domestic rodents. This section deals with the importance, identification, life cycle, habits, habitats, and control of the murine rodents.

A01. State the importance of domestic rodents.

Murine rodents inhabit the buildings and destroy the food and property of humans. They also endanger human well-being by being the reservoir, or vector, for such diseases as plague, murine typhus, salmonellosis, leptospirois, and rickettsialpox. They are hosts for the ectoparasites that are the actual vectors of some of these diseases. We will divide this discussion of the importance of murine rodents into two parts: economic and medical.

Economic Importance. The murine rodents, especially the roof and Norway rats, cause tremendous financial losses each year by destroying and contaminating food, killing poultry and other domestic animals, and destroying property.

Destruction of food. Rats eat millions of bushels of grain each year. They eat it in the fields, grain elevators, processing mills, trucks and trains, stores, and homes. Because rats are omnivorous, this eating cycle can apply to various stages of many other products.

Contamination of food. Rats and mice commonly excrete wastes, both feces and urine, as they feed, so they contaminate and make unfit for human consumption about three times as much food as they eat. To give you an idea of the amount of damage that is possible, rats drop from 25 to 100 pellets a day and excrete 10 to 20 cc of urine each day. Another way rodents contaminate food is by shedding body hairs.

Destruction of poultry and other domestic animals. Rats may destroy hundreds of baby chicks in 1 night, and they have seriously injured young pigs, lambs, and calves. This type damage can become a major problem, because rats kill not only for food but also for the sake of killing.

Property destruction. Rats destroy by gnawing. They will gnaw through such items as concrete, brick, wood, and even metal. Such gnawing could cause a fire should a rodent gnaw through the insulation on electrical wiring. Fire could also occur through spontaneous combustion from flammable materials gathered as nesting materials. Burrowing rodents can also cause severe damage to structures or runways as they undermine and weaken these facilities. Rodents on aircraft are very dangerous because their consistent gnawing habit could damage electrical lines, pneumatic lines, or control cables.

Medical Importance. Although many diseases are transmitted by the rat, only the ones of importance to people will be discussed here.

Murine typhus fever. This disease is transmitted from rats (the reservoir) to humans by the rat flea. It is similar to epidemic typhus, which is transmitted by human lice. The rickettsial organisms cause the disease to enter the bloodstream when feces of infected fleas are rubbed or scratched into a fleabite wound or broken skin tissue.

Plague. A plague reservoir exists in wild rodents of the Western States and is transmitted from rodent to rodent and from rodent to humans by the bite of rodent fleas. There is always a danger that domestic rodents will become infected and carry the infection to people. This disease is usually fatal to rats, fleas, and humans.

Leptospirosis (Weil's disease). Human infections result from direct or indirect contact with the infected urine of rodents. The spirochetes living in water or on food may enter through mucous membranes, minute cuts, or skin abrasions. Therefore, Weil's disease is more often found in sailors, miners, sewer workers, fish or poultry dealers, and abattoir (slaughterhouse) workers.

Ratbite fever. The bacteria that cause this disease are found on the teeth and gums of many rats and are transmitted from a rat to a person by a ratbite. The most common ratbite fever in the United States is called Haverhill fever.

Salmonellosis. Salmonellosis is a food poisoning disease that causes diarrhea and dysentery. It is spread in several ways. One way is by contamination of edible materials with rat feces containing infective bacteria. Salmonellosis is a common disease found worldwide.

Rickettsialpox. The disease is transmitted from the house mouse to humans by the bite of a mite that the mouse harbors. Rickettsialpox is a mild, nonfatal disease which resembles chickenpox. Although these diseases may not be major problems in the United States at the present time, there is always the possibility of a major outbreak as long as rodents are living near humans. Also, as a member of the military, you may be sent to areas where epidemics of these diseases are frequent; therefore, you should be familiar with the vectors, hosts, and reservoirs of each of the diseases.

Exercises (A01):

1. Murine rodents inhabit the _____ and destroy the _____ and _____ of humans.

2. List several places where rats eat millions of bushels of grain a year.

3. Rats and mice commonly excrete wastes, both _____ and _____, as they _____, so they contaminate and make unfit for _____ _____ about three times as much _____ as they eat.

4. Why do rats kill?

5. Rats will gnaw through what kinds of items?

6. Fire could occur through _____ _____ from flammable materials gathered for _____ materials.

7. What transmits murine typhus fever to humans?

8. The bacteria that causes ratbite fever are found on the _____ and _____ of many rats and are transmitted from rats to humans by the _____ of the _____ .

9. Rickettsialpox is transmitted from the _____ _____ to humans by the _____ of a mite that the _____ harbors.

10. Where is salmonellosis commonly found?

A02. Distinguish among the roof rat, Norway rat, and house mouse, by their features and their droppings.

Field Identification of Domestic Rodents. Rodent control measures cannot be effective unless you know with which rodent you must deal. Thus, you must know how to identify the three most important species of murine rodents. Table 1-1 lists the physical characteristics of each. Identifying factors other than physical characteristics, such as droppings, gnawings, or trails, sometimes will be your only clues to a correct identification. See figure 1-1 for examples of the different types of rodent droppings.

Norway rat. The Norway rat (*Rattus norvegicus*), predominantly a burrowing rodent, is the most common and largest of the domestic rats. Numbers of this pest are generally distributed throughout the United States and the temperate regions of the world. In addition to the characteristics in table 1-1, the Norway rat's fur is coarse and reddish brown. Its droppings are large (up to three-fourths inch long) and capsule shaped. It is sexually mature in 3 to 5 months; its gestation period averages 22 days; and it can have 3 to 6 litters per year with 8 to 12 in each litter. It lives about 1 year, with harborage at ground level, and burrows in the ground, under building foundations, and in rubbish dumps. Its range is often 100 to 150 feet. It is omnivorous, daily eating 3/4 to 1 ounce of garbage, meat, fish, and cereal and drinking 1/2 to 1 ounce of water.

Roof rat. The roof rat (*Rattus rattus*), an agile climber, is a middle-sized rodent with a range confined largely to the South and to the Pacific coast in the United States. It is found most aboundantly in the tropical or temperate regions and is rare or absent in the colder portions of the world. Its fur has three color phases in the United States: the black rat (*Rattus* rattus) is black to slate gray; the Alexandrine rat (*Rattus rattus alexandrinus*) is tawny above and grayish white below; and the fruit rat (*Rattus rattus frugivorus*) is also tawny above with a white-to-lemon-colored belly. The droppings are medium sized (up to 1/2 inch long) and spindly shaped. It reaches sexual maturity in 3 to 5 months, with an average 22-day gestation period, and it has 4 to 6 litters per year with about 6 to 8 in each litter. The female actually weans about 20 per year. It lives about 1 year with harborage above ground level, indoors in attics, and between walls; outdoors in trees and dense vine growth. Its range and feeding habits are almost identical to the Norway rat.

House mouse. The house mouse (*Mus musculus*) the smallest of the domestic rodents, is widespread and abundant throughout the United States. It is found from the Tropics to the Arctic regions throughout the world. Its adult weight is about 1/2 ounce, its fur is dusky gray, and its droppings are small (1/8 inch long) and rod shaped. It reaches sexual maturity in 1½ months. Its gestation period averages 19 days, with as many as 8 litters per year,

TABLE 1–1
ADULT DOMESTIC RODENT CHARACTERISTICS

Species	Norway Rat (Rattus norvegicus)	Roof Rat (Rattus rattus)	House Mouse (Mus musculus)
Weight	10-17 oz (280-480 gm)	4-12 oz (110-340 gm)	1/2-3/4 oz (14-21 gm)
Total length (Nose to tip of tail	12 3/4-18 in (325-460 mm)	13 3/4-17 3/4 in (350-450 mm)	6-7 1/2 in (150-190 mm)
Head and Body	Blunt muzzle; heavy thick body 7-10 in (180-255 mm)	Pointed muzzle; slender body 6 1/2 - 8 in (165-205 mm)	Small 2 1/2-3 1/2 in (65-90 mm)
Tail	Shorter than head plus body, carried with much less movement, com paratively, than roof rat. Lighter-colored on under side at all ages. 6-8 1/2 in (150-215 mm)	Longer than head plus body generally moving whip-like, uniform coloring tip and bottom at all ages and for all subspecies. 7 1/2-10 in (190-255 mm)	Equal to or a little longer than body plus head. 3-4 in (75-10 mm)
Ears	Small, close set, appear half buried in fur. Rarely over 3/4 in (20 mm)	Large, prominent, stand well out from fur. Generally over 3/4 in (20 mm)	Prominent, large for size of animal. 1/2 in (15 mm) or less
Hind Foot	Usually over 1 1/2 in (40 mm) from heel to tip of longest toe.	Generally less than 1 1/2 in (40 mm) from heel to tip of longest toe.	Feet are shorter, darker, and broader than most wold mice. Generally less than 3/4 in (20 mm) from heel to tip of langest toe.

averaging 5 to 6 young per litter for an average of 30 to 35 weaned per year by each female. In comparing the house mouse to the young rat, you'll find that its feet and its head are much smaller than those of the young rat.

Exercises (A02):

1. Using figure 1-2 and table 1-1, place in the numbered spaces descriptive statements which distinguish these murine rodents from one another.

2. Droppings of these murine rodents are
   a. Small (1/8 inch long), rod shaped. The rodent is the ______ .

   b. Large (up to 3/4 inches long) capsule shaped. The rodent is the ______ .

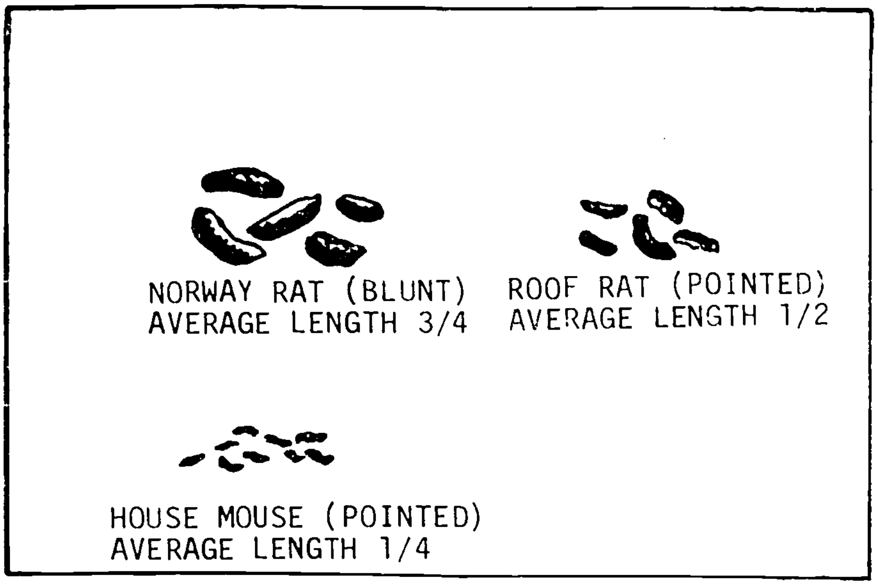


Figure 1-1. Comparison of domestic rodent droppings.

c. Medium size (up to 1/2 inch long), spindle shaped. The rodent is the ____ .

A03. Verify or correct statements that cite domestic rodent habits.

Habits of Domestic Rodents. To control domestic rodents effectively, you must know about their habits. This objective covers the general activity, reaction to strange objects, climbing, jumping, swimming, nesting, burrowing, and gnawing habits of murine rodents.

General activity. Young rats and mice gradually become familiar with their surroundings during a "training" period with their mother. Their first trips away from the nest are often by accident. Nursing young, clinging to their mother's nipples, are sometimes dragged from the nest as she leaves. Later they may follow her for a short distance when she leaves the nest. This habit of following increases until finally they regularly accompany her as she goes about her normal activities. During this period they learn their home area by associating with and imitating their mother. There is no evidence that she consciously tries to teach them. They learn by imitation and experience as they accompany her on forays. By the time the youngsters are 3 months old, they are very active and are completely independent. This level of activity remains high until they are about 9 months old, when old age overtakes them and they slow down.

When food is abundant, the rat shows the greatest activity during the first half of the night. The rat becomes most active at or shortly after dusk. This activity continues until about the middle of the night. The house mouse shows a similar pattern of nocturnal activity, and it shows a second, lesser activity peak starting well after midnight and lasting until dawn. Superimposed on this nocturnal activity are short periods of restlessness and activity periods that are related to periodic stomach contractions in the rat. The major pattern of noctural activity breaks down, however, when the rat is hungry.

Knowing where the rats and mice are likely to go is important in such control procedures as rat-proofing. They like to use regular paths or runways, especially along walls or objects that present a vertical plane. When a rat or mouse wants a piece of food, it will run under and behind things until it gets as close to the food as it can. Then, if the food is in the open, a short dash is the only exposure to danger. The farther away from runways that traps or baits are placed, the smaller the chance that they will be visited.

Reaction to strange objects. Rats and mice very often carefully avoid strange objects, even strange food. This habit contributes greatly to their ability to survive even in the most dangerous environments. Strange objects may be dangerous or even deadly. It is to the rodent's advantage to investigate them very cautiously. Interestingly, this "strange-object" reaction has led to many stories about the "wily" and "highly intelligent" rat. The answer to a great number of these stories is that the rat recognized the trap only as a strange object to be avoided, not specifically as a trap. Probably one of the reasons it's so hard to kill the last few rats or mice in a building is that these survivors have the strongest reaction to strange objects, so they avoid all new attempts to kill them. Rats may avoid new food for several days. This is an important fact in poisoning. When the rat or mouse first starts to take a new food, it may only take "token" amounts. If these amounts hold a sublethal dose of poison, they may make the animal sick and thus strengthen the avoidance reaction. This is the biologic basis for using unpoisoned bait, or prebaiting, before you add the poison. The feeding studies also indicate that hunger causes the avoidance of strange objects to break down more quickly.

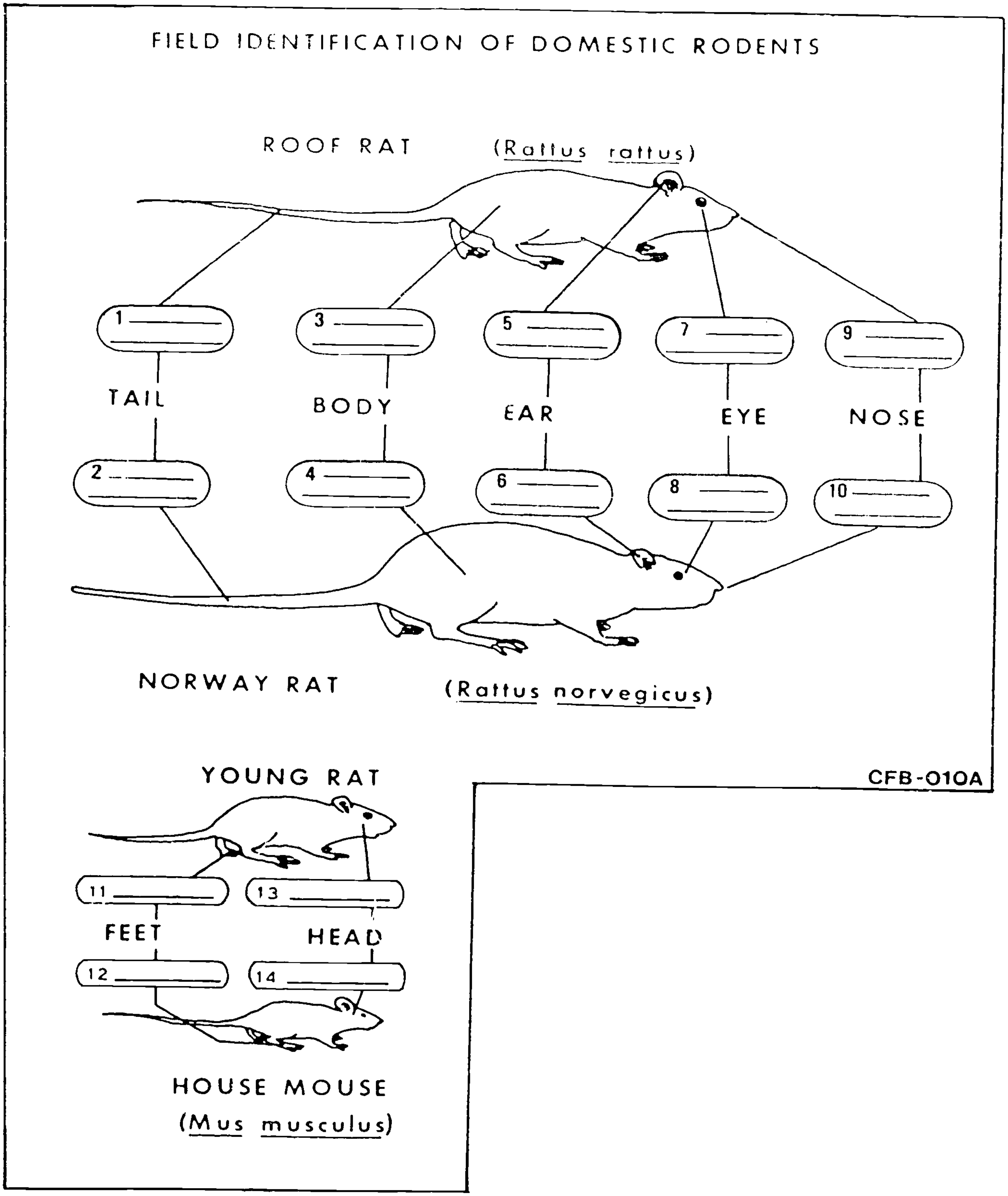


Figure 1–2. Comparison of rodent physical characteristics (objective A02, exercise 1).

In environments where "strange objects" appear regularly, rats and mice may show little or no evidence of the avoidance reaction. This is particularly true in such places as warehouses, where there is a constant turnover in harborage and food. Also, rats are less suspicious when they first enter a building, since everything is new and they must learn the new environment rapidly. They can be trapped or baited more easily at this time. Perimeter control programs work well because they intercept rats migrating into the area when they are more easily trapped or baited. Once the rat has explored it's new home and settled down, it becomes suspicious of changes.

Climbing ability. Roof rats and house mice are notoriously good climbers, and even the Norway rat can climb well if it has to. There are records of Norway rats having crossed wide city streets by walking telephone wires. This use of wires is common among roof rats and house mice.

Rats and mice can climb the vertical walls of most brick buildings. This is understandable for the smaller house mouse, but even the larger rats can climb any vertical surface where they can get a toenail hold. Run your fingernail over the surface of the average brick building, and you can see how easily a rodent could hang on. Even stucco is often rough enough for ready climbing. Vine-covered walls are perfect runways, and since the vines afford concealment they can be climbed if there is a pipe, a corner, or something else against which the rat or mouse can brace its back. Rats have been found using both the outside and inside of rusty 3-inch pipes placed against walls. Nailheads or screwheads placed too close together can serve as steps for rodents to climb. Rats have crossed sheet metal flashing by catching the top edge with the claws of their forefeet and swinging across overhand. Improperly installed sheet metal guards can't stop rats—not even the large rat guards used on ship mooring lines.

In rodent control work, however, we must draw a line between the possible and the probable in rodent climbing. For example, it is possible for rats to climb most types of vertical walls, but the chance of rats climbing these walls without supporting wires or pipes is quite remote. Remember that rats and mice aren't out to climb every wall they see. They work only as hard as is necessary, and only hunger or lack of shelter drives them to the acrobatics we've been talking about. This greatly simplifies the precautions against rat entry and reduces ratproofing costs.

Jumping ability. Because rats can reach as far as 13 inches along smooth vertical walls, a safety factor must be added to rat guards. The distance that should be completely clear of possible holding points is 18 inches. Rats can make a standing high jump of nearly 2 feet. With a running start and a bounce against the vertical surface two-thirds of the way up to give them a boost, some can jump a little more than 3 feet. Even the much smaller house mouse can jump more than 3 feet high. Jumping out and down from a height of 15 feet, a rat can cover a horizontal distance of 8 feet. It can do even better with a running start.

Swimming ability. All three of the domestic rodents are good swimmers, but rats have been known to swim as far as 1/2 mile in open water. There are reports that rats swim up through floor drains without hesitation. They probably come from a manhole or other break in the sewer lines, although rats may live in the sewer itself. On some bases, rats may use the older sewer systems as regular highways. If you are responsible for ratproofing inspection, be familiar with the layout of the major sewer lines in your area. Information is especially important on small lines that weren't removed when larger mains were laid.

Nesting. Rats and mice will nest wherever they can find safety close to food and water. They can use holes or burrows in the ground to hide and nest outdoors. In buildings, they use double walls, the space between walls and ceilings, closed-in spaces around counters, or any place hidden from view that enemies cannot reach. The more rubbish that is piled around, the more objects that are stacked in corners or closets, the greater the number of hiding and nesting places.

Generally, rats and mice build their nests in hiding places that are relatively quiet. They gather whatever soft material is nearby or tear up paper and cloth to line the nest. Rat nests generally are bowl shaped and about 8 inches in diameter. Occasionally, they are completely roofed over. In addition to cloth and paper, such materials as grasses, excelsior, small twigs, and other soft materials may be used.

Mouse nests are similar to rat nests but are smaller—about 5 inches in diameter. Normally, they are completely covered, and entrance is through a small hole in one side. Nest-building activity is greatest just before young are born and at the start of cold weather.

In addition to disclosing nesting sites, a careful search may reveal hidden resting and feeding stations somewhere between the food supply and the nest or burrow entrance. To these spots the mice and rats carry or drag food, and they leave behind feces, food wrappings, and scraps. The ideal condition, of course, is where harborage is such that runways, too, can be concealed. Too often this condition is found around homes and business places.

Burrowing. The three murine rodents differ considerably in their tendency to burrow. This habit is most highly developed in the Norway rat. As an adaptation to burrowing, the ears of this species are small, and the hairs in the ear openings keep dirt out. The roof rat is more adapted to a life of climbing. it burrows only in areas where Norway rats are absent. Its burrow system is seldom extensive. House mice burrow where other harborage is not available. In and around buildings mice seldom have trouble finding cover, but in open fields they burrow well and extensively.

Because of a peculiarity in rat burrowing habits, rodent-control workers have developed the L-shaped curtain wall to protect buildings from rat entry under the foundation walls (fig. 1-3). Rats and mice often start a short distance away and burrow at an angle toward the wall. Usually they reach it before they are 18 inches deep, and upon reaching it they may follow it downward. Most important, once they reach the wall they will not dig away from it to go around an obstruction.

Gnawing. Nature seldom has given an animal a more effective cutting tool than the rodent's front, or incisor,

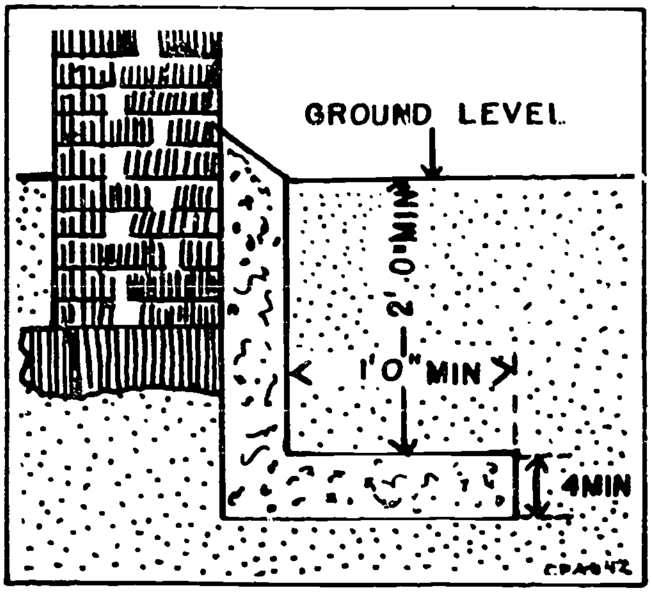


Figure 1–3. Concrete curtain wall.

teeth (fig. 1-4). Young rats and mice start to gnaw as early as the second week of life. Throughout their lives the teeth keep growing rapidly. In adult laboratory rats, the average growth for upper incisors is 4½ inches a year, and the lower incisors grow 5½ inches. The growth rate in wild rats probably is similar. This fast growth allows continuous gnawing without wearing out the cutting edge of the teeth. It may, however, cause trouble. Sometimes rodents are found with a front tooth broken and the one in the opposing jaw very long. This seems to indicate that the grinding action of the opposing teeth helps keep the teeth short, with the hard enamel on the front of the incisors wearing away the softer dentine on the back of the opposing tooth to help keep the tooth sharp. It is hard to see how gnawing, as such, could keep the teeth sharp, although this idea still persists. It would be like a chisel that grew sharper the more it was used. The tooth-shortening theory would explain why many holes are gnawed much larger than necessary. It might also explain random cutting of furniture legs and counter posts.

To get to food, rats and mice gnaw any material with a gnawing edge softer than their tooth enamel. This includes such things as wood, paperboard, cloth sacks, lead pipes, cinder block, asbestos, and aluminum. They have pierced concrete used for ratproofing before it had time to harden and have even gnawed through sun-dried adobe brick. Roof rats are even better at gnawing than are Norway rats.

Feeding habits. The feeding habits of rats and mice differ enough to require different controls. All three species have regular eating habits, determined by differences in the species, in the amount and kind of food, and in the dangers involved in securing it. Rats usually start searching for food a little after sunset each day; but mice are small and hard to see and come out during the day whenever possible. They all treat food much the same way, once they find it. Usually, they carry or drag it to a hiding place before eating it. Occasionally they eat small pieces on the spot, but they normally eat in the open only if they are starved, if no enemies are around, or if the pieces are too big to move to cover.

Rats are fairly steady eaters, but since mice are nibblers, taking a bit here and a bit there, we try to poison mice by putting out many baits quite close together. Norway rats feeding on mixed garbage prefer such foods as meats, grain, grain products (such as oatmeal), cooked eggs, and potatoes. On the other hand, they show very little desire for such foods as raw beets, peaches, onions, celery, cauliflower, and green peppers. There seems to be an aversion to highly spiced foods. The choice of food is determined largely by the environment of the rat or mouse. For example, citrus fruits are not preferred by rats and mice, but in Florida, the roof rat is considered a serious pest in citrus groves.

Exercises (A03):

Mark each statement true (T) or false (F) and correct any that are false.

____ 1. You must know the habits of rodents to control them effectively.

____ 2. Young rats and mice are trained by their father.

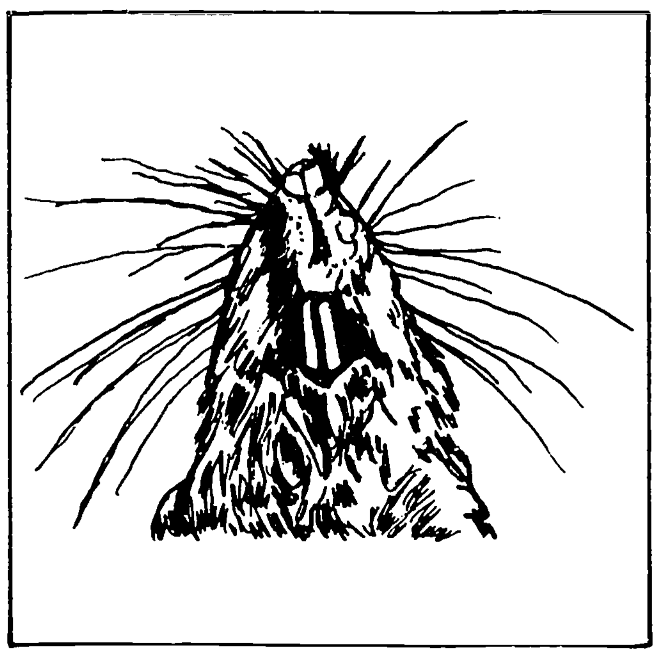


Figure 1–4. Incisor teeth.

___ 3. Rats become more active at dawn.

___ 4. Rats and mice avoid strange food.

___ 5. Rats and mice can climb vertical walls of brick buildings.

___ 6. Rats can make a standing high jump of 4 feet.

___ 7. Rats are good swimmers. They can even swim up through floor drains.

___ 8. Rats and mice generally build their nests in noisy places.

___ 9. The burrowing habit is most highly developed in the Norway rat.

___ 10. The teeth of rats and mice keep growing throughout their lives.

___ 11. Rats usually start searching for food in the early morning hours.

___ 12. A rodent's food choices are often determined largely by its environment.

A04. Verify or correct statements about signs of domestic rodents.

Survey and Inspection for Domestic Rodents. Often you must inspect an area to find the extent of rat or mouse infestation. The rodents leave characteristic signs of their activities that can often tell you the species present, the degree and location of the infestation, and the habits of the animals. You should always check as many signs as possible before you make a decision as to the presence and degree of any rodent infestation.

Sight. The most positive proof of infestation is to see a live rat or mouse, but since they're generally nocturnal and secretive in their habits, we seldom see them alive. As a rule, it is only in very heavy infestations that they show themselves around humans. They are especially secretive if there is much human activity in the area.

Dead animals may indicate either a current or a past infestation. If the carcass is dried or reduced to a skeleton, it may mean only a former infestation. If you find many recently dead animals, find out whether poisons have been used in the area. If not, there may be an epidemic disease, such as plague, among the rodents. For this reason (and as a basic sanitary precaution), you should never handle dead rodents with your bare hands. If possible, place them in cloth or paper bags to prevent the escape of fleas and other ectoparasites. Hold them for examination by specialists to find the cause of death.

Sound. The various noises made by rats and mice may give clues as to their presence and location. These noises are rarely heard unless the area is otherwise quiet. Upon entering an infested building, stand still to allow the sound of your own entry subside so that rat and mouse activity will resume. You may hear the sounds of running, gnawing, and scratching, especially from double walls and floors. Various squeaks and churring noises are also produced. The squeaking may accompany fighting and may occur intermittently for several minutes. Youngsters in the nest make faint squeaking noises.

Droppings. Presence of rat and mouse feces is one of the best indications of an infestation. All three animals commonly produce quantities of droppings. These droppings may be a key to the species and its relative abundance (fig. 1-1). It is important to be able to tell the age of rat and mouse droppings so you can decide whether the area is currently infested. Fresh droppings are soft enough to be pressed out of shape and often have a glistening, moist appearance. The color varies according to the kind of food eaten, but usually it is black or nearly black. Within a few days, depending on climatic conditions, droppings become dry and hard. Later the surface becomes dull, and with great age they assume a grayish dusty appearance and may crumble easily when pressed with a stick. The appearance of the surface alone, however, may be misleading. Droppings may be black and shiny and still be hard and crumbly. Old droppings dampened by rain or other moisture may look fresh, but when they're crushed they don't have the puttylike consistency of fresh droppings.

The quantity and sizes of fresh droppings in an area may give you an idea how many animals there are. Fresh droppings mean there's at least one rat or mouse. Since only rarely are Norway and roof rats found in the same area, presence of several sizes of fresh droppings means there are several ages of rats and they're probably reproducing. This often is the case in extensive infestations. Droppings are most numerous along runways, near harborage, in secluded corners, and near food supplies. In contrast, the burrows, and nests, especially, are usually very clean and have no droppings. Rats and mice have actually been seen carrying feces from nests and burrows.

The number of rodent droppings in any area depends not only on the amount of rodent activity but also on how often floors are swept and how rapidly stored goods are moved. The absence of droppings doesn't always mean there aren't any rodents, for droppings are irregular; sometimes they're abundant, sometimes scarce. On the other hand, the presence of old droppings, even in quantity, does not mean that the area is currently infested.

Runways and rub marks. Since rats and mice generally occupy only a limited area, they may use the same pathway many times. Out of doors or on earthen floors these runways may appear as clean-swept, well-packed earth paths 2 to 3 inches wide. In dusty areas, they may consist of tracks made in dust by passing rats or mice (fig. 1-5). Occasionally, you may even see the wavy line of a dragged tail. In many areas rats and mice leave dark smears or rub marks on large objects as the result of natural oils and dirt on their bodies.

Outdoors, runways are easily seen in dense vegetation, such as lawn grass, and they may even be conspicuous on bare earth. The location of runways usually reflects the rodent's generally secretive habits. Most often, they are found along walls, under boards, behind stored objects and accumulated litter, and in similar places. It is important to search such places carefully.

Rat and mouse runs in or on buildings are often marked by more or less extensive rub marks. You can find these marks around gnawed holes, along pipes and beams, on the edges of stairs, along walls, or anywhere else that the rodent is likely to travel. Swing marks made by rats passing under floor joists along a beam generally indicate the presence of roof rats. Norway rat runs are more often near the floor. House mouse runs, on the other hand, may be anywhere. They are the most difficult to locate because they are small and often very faint. It is especially important to search behind vertical pipes and columns, which are favorite means by which rats and mice change floors. You can often tell how old a rat or mouse run is. A fresh run over earth will generally be hard packed and free of dirt and litter. Heavy use may even make it look shiny. Dusty cobwebs across a run, of course, mean that it is no longer used. Fresh rub marks and smears are soft when you scratch them; old ones are brittle and may flake off. By tracing rat and mouse runs, you can find the harborage, the food and water supply, and the means of entry into buildings. This information will help you take the right control measures.

Tracks. You may find tracks anywhere along rat and mouse runs, both outdoors and inside. You can see tracks clearer with side illumination from a flashlight than with direct light from above (fig. 1-5). Especially good places to find tracks are in dust in little-used rooms and in mud around outdoor puddles. Rat tracks are fairly large. A hind foot of a walking Norway rat may leave a print 1½ inches long. Roof rat prints are about the same size. Mouse footprints are rarely even half and inch long, and they're much closer together, even in comparison to young rat tracks.

Tracks found outdoors generally are fresh because wind and rain would quickly erase them. The age of tracks indoors is more difficult to estimate; they may look fresh

Figure 1–5. Tracking domestic rodents.

long after they were made. If the dust is thin enough, you can determine their age by pressing a finger lightly into the dust near the track and observing the color. Fresh tracks should show about the same color as the finger mark, while old tracks will be different in color and have less sharply defined edges. Knowing the speed with which dust falls may be helpful. In a dusty flour mill where there is a heavy deposit every day, visible tracks are probably quite fresh. In the still air in the unexcavated area beneath a building, tracks last a long time.

It's helpful to use a fine dust for tracking. You can dust any fine powder, such as pyrophyllite or flour, on a suspected runway and inspect it later for footprints. Spread the powder smoothly to a depth of no more than 1/8 inch. Then when you inspect, look for prints of the 5-toed *hind* feet and the 4-toed *front* feet.

Gnawing. Recent gnawings through wood can be distinguished by the fresh, light-colored appearance of the gnawed surface and the presence of small, chewed pieces or cuttings in the vicinity. The edges of the gnawed area darken in a few days. and small cuttings are soon scattered or swept away. Another way to determine the age of gnawed openings is to notice the sharpness of the bitten edges. A freshly gnawed opening has sharp edges that scratch the animals as they pass through. They will stop and nibble at the offending edge so that as the openings become older, they acquire well-rounded edges. Evidence of recent gnawing is one of the most reliable signs for determining the presence of rats and mice.

The extent of damage to materials may be an indication of the degree of infestation. You must be careful to determine whether the gnawing was done by one or more species. A mixed infestation of rats and mice may be present, and damage done by mice may be attributed to the rats. When recently delivered materials are damaged, you can assume that the infestation is a current one. In this case, the extent of damage may be a very reliable index to the number of animals present.

Exercises (A04):

Mark each statement true (T) or false (F) and correct the false ones.

____ 1. The most positive proof of infestation is to see a live rat or mouse.

____ 2. If many recently dead animals are found, you should ask about the use of poisons in the area.

____ 3. The various noises made by rats and mice may give clues as to their presence and locations.

____ 4. The droppings are not usually a key to the species present and its relative abundance.

____ 5. The quantity and size of fresh droppings found in an area may indicate the number of animals present.

____ 6. Out of doors or on earthen floors, runways may appear as clean-swept, well-packed earth paths two to three inches wide.

____ 7. The hind feet of a walking Norway rat may leave a print 1½ inches long.

____ 8. A way to determine the age of gnawed openings is to check the sharpness of the bitten edges.

A05. State how to control domestic rodents with cultural and mechanical or physical technique.

Sanitation for Controlling Domestic Rodents. Sanitation is the backbone of a successful rat control program. the elimination of rodent shelter, food, and water can mean the difference between success or failure in controlling them, and it helps prevent successful reinfestations. The presence of rats generally indicates an inadequate sanitation program or lack of effective ratproofing.

Good housekeeping practices are an absolute must. This is true whether the structure is a residence, office building, or food-handling facility. In all facilities, a well-organized and supervised program of routine cleaning must be set up and followed rigidly. Such areas as obscure corners, shelves, under and in cabinets, worktables, lockers, and equipment must not be overlooked or neglected.

In all areas, rubbish piles must be eliminated. Where refuse must accumulate, keep it in rodentproof containers until it is removed from the premises. Careless handling of garbage and refuse is a prime source of food and shelter for rats, and it will attract them to any building. Improper garbage disposal will not only nullify control measures but will bring an increasing rat population.

Once rats have gained entry into any building, the first thing they must do is find a safe place to hide. Only by a thorough inspection of a building will you uncover potential harborages. These must be eliminated by building occupants or by other civil engineer (CE) sections, depending on the severity of the problem. Rodentproofing may be necessary within the building in such places as under stairways, cabinets, lockers, machinery, double walls, false ceilings and floors, hollow tile partitions, and boxed in pipes and conduits. These areas serve not only as shelter but as nesting and breeding sites.

Proper storage practices within any building are an absolute must in effective rodent control. Improper storage will result in the creation of ideal and inaccessible harborages, preventing thorough inspection and proper baiting or trapping. Rat damage to stored materials can easily be reduced to a minimum when good storage practices are followed. In storage areas, products should be on pallets 12 to 18 inches off the floor, 18 inches from adjacent walls, not stacked more than 6 feet wide, and separated by an aisle at least 12 inches wide. These practices reduce harborage areas, permit inspection and cleaning and allow you to apply appropriate control measures.

Outside harborages areas should also be given attention. Grass, weeds, and other vegetation near buildings should be kept closely cut. Lumber, rock piles, rubbish, old equipment, construction materials, etc. must be eliminated. Items must be kept 12 inches away from walls or fences. Spaces under loading docks, outside storage buildings or sheds, etc. must be blocked off so rats cannot gain entry. Also, old rat burrows and holes should be filled in with earth.

Mechanical and Physical Controls. In many buildings rat control is impossible because the construction of the building permits rats to get in faster than they can be killed. In such cases, you may have to accept a lesser degree of control than is normally desirable, or to have other shops ratproof the structure to allow adequate control. Ratproofing isn't always possible, but you should see that enough ratproofing is done for your trapping and baiting programs to have a chance to succeed.

Rodentproofing. Sheet metal of 26 gage or heavier, 1/4-inch mesh hardware cloth, and cement are suitable materials for use in rodentproofing. Openings more than 1/4 inch wide in the interior of building should be closed (fig. 1-6). Other openings, such as cracks around doorways, gratings, and windows less than 4 feet above the ground—through which rats may enter directly or by enlarging the opening—should be covered with hardware cloth or other suitable material. Openings around boxed-in piping and wire conduits should be closed (fig. 1-7). Conduits for wiring should be closed and limited, if possible, to sizes that will prevent passage of rats and mice. Fire stops in double walls and floors of wood construction should exclude potential rat runways along beams. Spaces between walls should be blocked (fig. 1-8) Doors should be self-closing and should fit tightly. Wood sills and doors at ground level may be sheathed in sheet metal to prevent gnawing.

When holes must be patched, keep in mind that rats will chew out a green concrete "plug" 4 or more hours after the hole is filled unless the hole has been tightly jammed with wire mesh and then cement placed in and over the wire ball. this system allows the rat 15 minutes or less to tear out the "plug."

Advise masonry personnel to start with No. 3 coarse steel wool and make a "ball" out of the steel wool. Fill the ball with a quick-setting cement mixed with water, not too thin. Stuff this ball tightly into the rat hole, leaving no holes for even a mouse to dig out. finally, fill the hole with a thinner consistency of quick-setting cement to finish off the surface.

Trapping. Many types of traps are used to control rodents. Included are common wooden-base snap traps, steel traps, wire live traps, and multiple-catch box traps. In certain situations, particularly where there is danger of contaminating food products or of harming pets or children, it may be necessary to trap for rats. The trap most commonly employed in rat control is the wood-base snap trap. You can use it with bait, or expand the trigger device and use it without bait (fig. 1-9). Steel traps used to catch small fur-bearing animals are less suitable for use in trapping rats. Such traps usually catch the rat by snapping shut on one leg, and the rat will often chew the leg off and escape.

Tie a suitable bait not larger than the end of your index finger to the trigger of the wood-base trap, and set it in a runway. Select the right-sized trap for the pest species involved and place it in the normal travel routes. Place snap traps so the long axis is perpendicular to the travel route with the baited pan directly across the path (fig. 1-10). Multi-catch traps (fig. 1-11) should be placed against walls or other objects so that entrance ways face the routes used by mice.

A number of traps should be used and should be spaced appropriately for the rodent involved. Traps should be placed within 20 feet of each other for controlling rats and within 10 feet of each other for mice. Check traps frequently, and remove trapped rodents. You may want to use multi-catch mouse traps inside and outside every entrance leading into the building. They catch mice and very small rats outside easier than inside.

It is usually recommended that a variety of baits be used in successive traps. Meat in one trap, vegetable in another, and cereal in another gives the rat a choice.

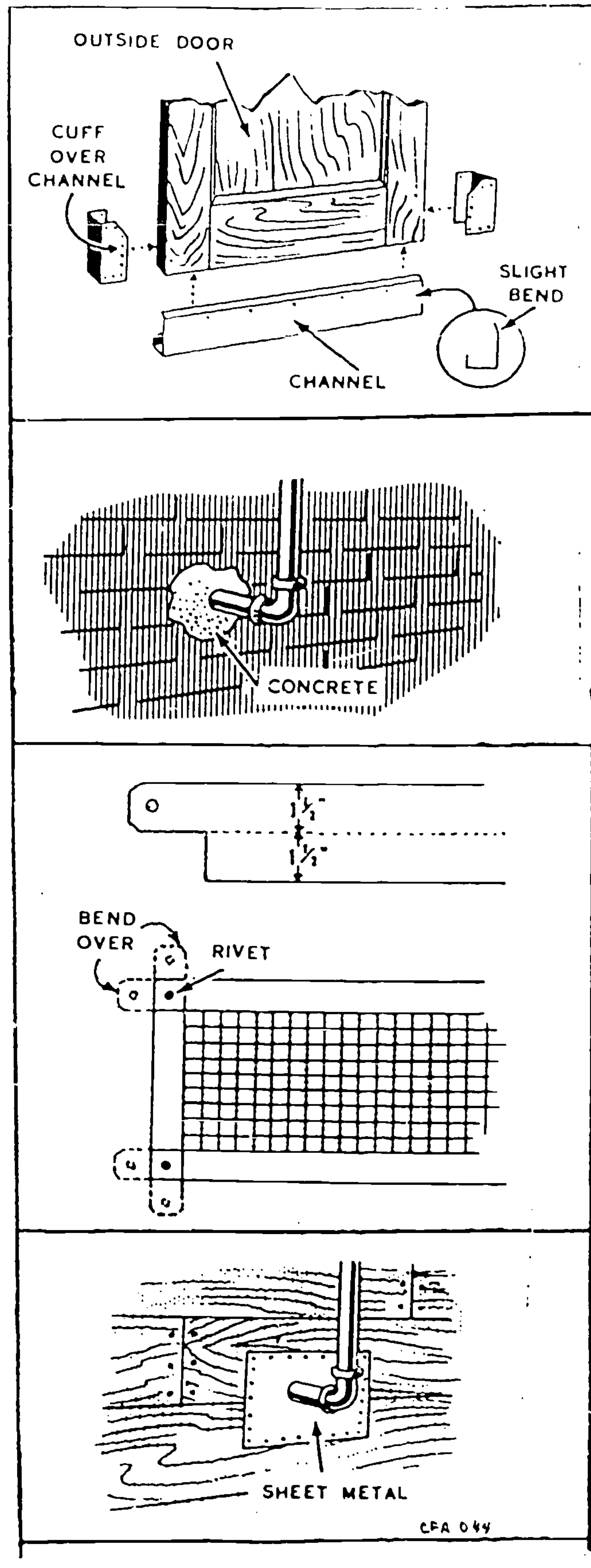


Figure 1-6. Methods of rodentproofing.

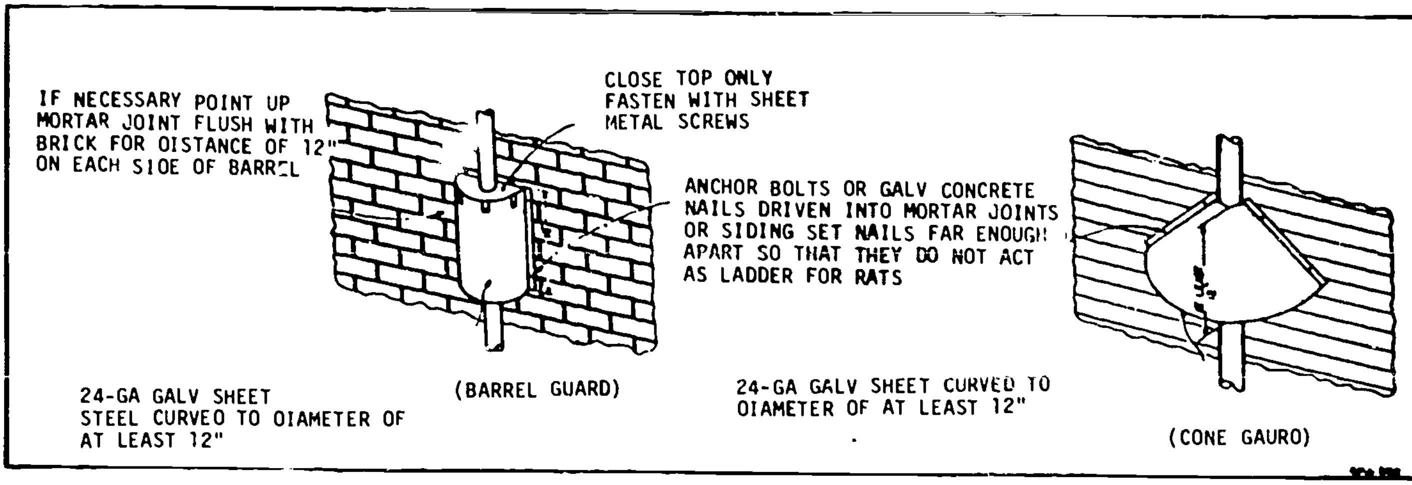


Figure 1-7. types of metal guards.

Traps are most effective set next to a wall beneath a runway made by leaning a board against the wall. Do not set the trap directly in front of the hole where the rat gains entrance to the room, since it is likely to become suspicious. If the rat becomes "wise," it may be necessary to bury the trap in a shallow pan of meal, sawdust or grain, with the trigger protruding. Make sure the action of the trigger will not be clogged by the material beneath it. The baits should be tied to the treadle with a thread or rubber band, thus making sure of pressure on the treadle. Old traps should be boiled, scraped, and kept clean. Dipping traps in melted paraffin lengthens wear, deodorizes them, and may make them spring more readily. Since rats are often attracted to traps with the odor of other rats on them, don't clean them too much. Too, an old trap—particularly a multi-catch trap—often works better than one that has never caught anything.

More rats are trapped on the first night than on any other night. After 3 to 4 nights of trapping, the catch may drop to zero. For this reason, it is essential to distribute a large number of traps on the first night of trapping. In various buildings, the number of traps may vary from 20 to 100 traps, depending upon the degree of infestation and the facilities for locating the traps.

Do not use petroleum oils to prevent rusting of traps since rats do not like such oils. Instead, use lard or some other animal fat. A trap with metal parts should be wiped with bacon rind to protect from rust and to make it more attractive to rats.

Trapping mice. Snap traps are great for residential mouse control, but you may get gripes from occupants: "I could have done that. I thought you were going to do something more professional." Inform the customer on the first call that several methods of control will be used, one of which is snap traps. Some pest managers aren't successful with snap traps because they don't put out enough of them. Even if you have three to eight mice, place at least 15 or 20 traps. You even can leave some traps for your customer. One benefit of snaps traps is that they hold the carcass so you don't have to go on a dead mouse hunt.

Proper placement of snap traps is very important. Place traps in areas where the mice are feeding. Don't be afraid to build a funnel system to make the mouse go through a narrow passageway into the trap. If traps are placed correctly, there is seldom need to bait them. If the trap is unbaited, the mouse will think it is just one more thing to crawl over and won't be so suspicious.

Using glueboards. Glueboards are effective to catch mice. They also are safe, nonpoisonous, easy to hide, and will hold rodents for hours. The problem with glueboards is that customers tend to dispose of them after only one catch. Also, the fact that the rodent does not die quickly is sometimes objectionable to others, and it's no fun for you either. Rats with one leg caught may chew off the leg to free themselves.You must tack glueboards to the floor to keep rats from dragging them about. Since a very tacky glue is involved, they can be very messy to handle, install, and service. However, where baits and traps cannot be used because of children, pets, or food, glueboards may be useful.

One way to avoid these disadvantages is to place the glueboards in bait stations or out-of-sight locations. Sometimes, an attractant such as candy or peanut butter in the middle of the glueboard gets the job done faster. Here are some other tips to enhance the efficiency of glue:

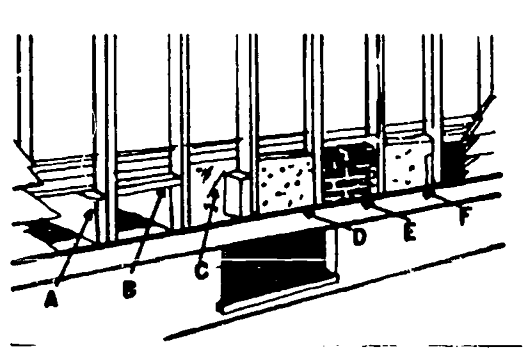
a. Make hollow tubes out of cardboard by bending the glue board into a cylinder and taping. These can then be taped to pipes hanging near ceilings, on narrow ledges, and other areas where rodents are running.

b. When you use a glueboard for rats, secure the board to the ground or floor covering. Otherwise, the rodent may drag the board away and die in the wall of a structure.

c. Use glueboards in protected, nondusty or nonwet areas. Otherwise, put them in bait stations to protect them. The bait station/glueboard method does repel rodents to some degree but it cuts contamination of the glue by dust.

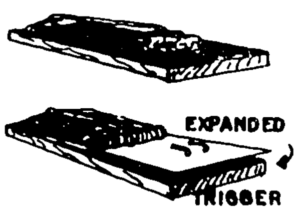
Exercises (A05):

1. Why is sanitation such a vital part of a rodent control program?



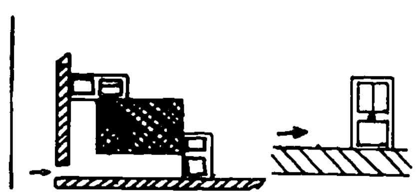
Methods of excluding rats from double walls: A common type of building construction (a) with open space between floor joists, giving rats free access to double walls; wooden 2-by-4 stops (b) are sometimes employed, but as these have an important function in fire control, noncombustible material should be used (wood is permissible, however, in upper floors); in old buildings galvanized sheet metal (c) may be cut to fit and nailed into place between studs, joists, floor, and sill; in buildings under construction noncombustible stops of cement and cinders (d) or broken bricks (e) are inadvisable, but preferable a good grade of rich cement (f) is recommended.

Figure 1–8. Methods of excluding rats from double walls.



(Above) A large snap trap set for use with bait. (below) The same trap fitted with a swuare of cardboard or metal as shown here can be used in rat runways without using bait.

Figure 1–9. Two types of rat traps.



Diagrammatic sketches of proper trap placement. Note that the traps have been set in runways with the triggers next to the wall. On the left a box has been positioned so that rats or mice will be forced to pass over the triggers.

Figure 1–10. Placing snap traps.

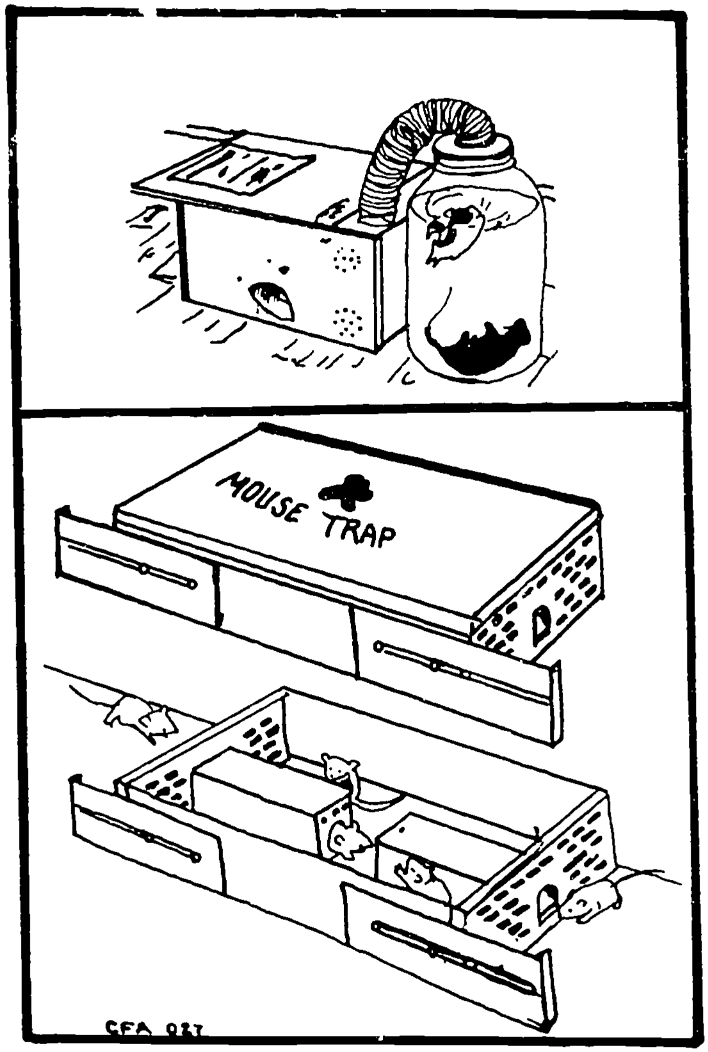


Figure 1–11. Repeating mouse traps.

2. Who is responsible for taking cultural control measures to eliminate potential harborages for rodents?

3. List 3 conditions you should ensure in surveying outside harborage areas around buildings.

4. In situations where complete ratproofing isn't possible, what action should you take?

5. What mechanical and physical controls are suitable for these areas?

   a. Openings in building interiors.

   b. Low openings near windows and doors.

   c. Wiring conduits.

   d. Wood sills and doors at ground level.

6. Under what conditions are rodent trapping programs particularly advisable?

7. How far apart should traps be placed when you're controlling rats? Mice?

8. Why should you not clean traps any more than necessary?

9. What advantage may an unbaited mouse trap have over a baited one?

10. What advantages and disadvantages do glueboards have in a rodent control program?

11. If you must use glueboards in dusty or wet areas, how should they be placed?

A06. Cite chemical controls for domestic rodents.

Chemical Control Measures. After we use sanitation and mechanical and physical controls to the fullest practical extent, the rest of the control must be done with poison baits. To use these measures for maximum results, you'll need a thorough knowledge of rodent behavior, because the complex balance of opposing rodent reactions, such as approach and avoidance, food consumption and rejection, and aggregation and aggression can help you get maximum control.

Since rats are creatures of habit and tend to feed on familiar things, results are often good when we bait with foods they're eating. The right bait will often have more bearing on results than will the choice of rodenticide or bait placement. As a general rule, Norway rats prefer meat and fish, while roof rats prefer fruits and vegetables. Mice seem to prefer bacon, sweets, grains or seeds, and peanut butter. Prebaiting for several nights before you use poisoned bait may help get them to accept whatever baits you use. The bait materials must be the same during both periods. Prebaiting helps to overcome the rat's natural avoidance of new foods and often overcomes bait shyness in rats previously poisoned. It is useful for controlling "difficult" rats with quick-acting rodenticides, but it is too costly for routine or large-scale use and it's unnecessary with anticoagulants. Test baiting is also a way to learn which baits rats prefer, how many baits you need, and where to place them.

Most poisons must either be mixed in a water solution or added as solids to bait materials that attract the rodents. All bait materials should be fresh and must not taste or smell of other chemicals. Anticoagulant poisons are commonly mixed with cereal baits such as corn meal, rolled oats, or cracked corn together with corn oil, peanut oil, sugar, molasses, or similar substances which may add to its attractiveness. Mix baits thoroughly to distribute the toxicant evenly. Meat, fish, cereals, fruits, vegetables, nuts, and many other baits are also used. Baits may be ground, sliced or cut into cubes, but crumb-sized or sloppy paste baits will reduce the chances of rodents' carrying baits to other areas. Make all recognizable foods unrecognizable.

If you mix your own baits, follow the directions on the registered label. Don't use more than the recommended amount of any poison because this will increase the danger of the bait to people and animals, and if may decrease acceptability of the bait to rodents. Too low a concentration will lead to incomplete control.

Try to always place baits, whether liquids or solids, in rodent runways. Solid baits should be placed in small cups or dishes so they can be easily picked up when they are no longer needed. Place all baits close to walls and near doorways wherever possible and do not put out more baits than the rats are likely to consume; it's a hazard to pets and children, and it wastes materials. Baits must be placed so they are not readily accessible to children and other animals. You'll need bait boxes in some areas for this reason. Since rats often feed in one place, a small number of bait stations will be sufficient. When it's practical, bait in the late afternoon so that the baits will be fresh at dusk when rodents generally become active. The amount of bait needed depends upon the number of rats present and the toxicant being used. Use enough bait to feed all the rats present. You can usually tell how much to use after one night of prebaiting.

Basically, we use three types of containers for dry, wet, or liquid baits (fig. 1-12). They have no top, offer little or no protection to the bait, and don't keep pets or children from the bait. Covered bait stations (fig. 1-13) confine the bait, protect it from the elements, and avoid environmental contamination, but they don't protect pets or children. Safety bait stations will protect the bait and keep pets and humans from ready access. Such containers can be secured to discourage tampering.

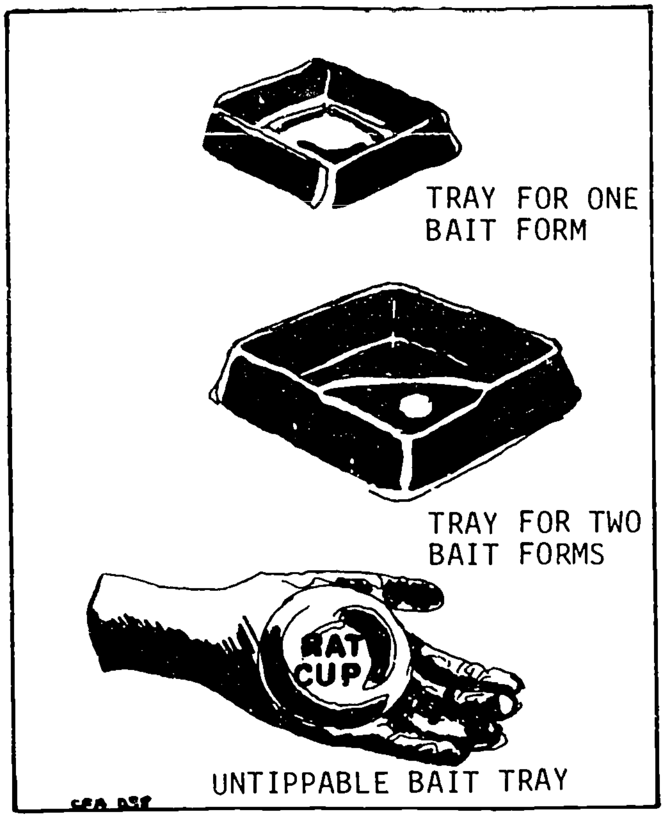


Figure 1–12. Rodent bait trays.

It is of utmost importance that you know about the rodenticides you're using and adhere strictly to label directions in using them. Safety is the first consideration. Some rodenticides can be fatal if ingested by humans or other nontarget animals. Under no circumstances should highly toxic materials be used by other than competent, certified specialists.

Although anticoagulants are considered relatively safe, they must still be used in a way that protects people and nontarget animals. Follow manufacturers recommendations and label directions for mixing and safe handling. Use only the concentrations recommended on registered labels for maximum effectiveness and to prevent increasing the hazard or reducing acceptance by rodents. Then place the baits in a safe manner to preclude contamination to food. Exposure within a building should be at floor level. Open bait trays can be used indoors only if placed in areas not readily accessible to the public, children, or nontarget animals.

There are several kinds of rodenticides available, commonly grouped as anticoagulants and single-dose, or quick-acting, rodenticides. Some of the anticoagulants are available to the general public as ready-to-use baits, but most are available only to specialists. They come as ready-made baits, concentrates to be mixed with baits or water, weatherproof pellets, paraffin blocks or cakes, and tracking powders. Whether you'll use them inside or outside, check the moisture conditions and use the right form. A loose-grain bait would not be appropriate for a sewer, nor would a paraffin block be in a hot boiler room.

The anticoagulant rodenticides we discussed in Volume 3 disrupt the normal blood-clotting mechanisms, causing rats to die of internal hemorrhaging. Most are slow acting and take several days of continuous feeding before a rat dies. A single dose is seldom lethal except with some of the newer single-dose anticoagulants. Depending on the product you use, keep enough baits for 10–15 days. Reasonable control

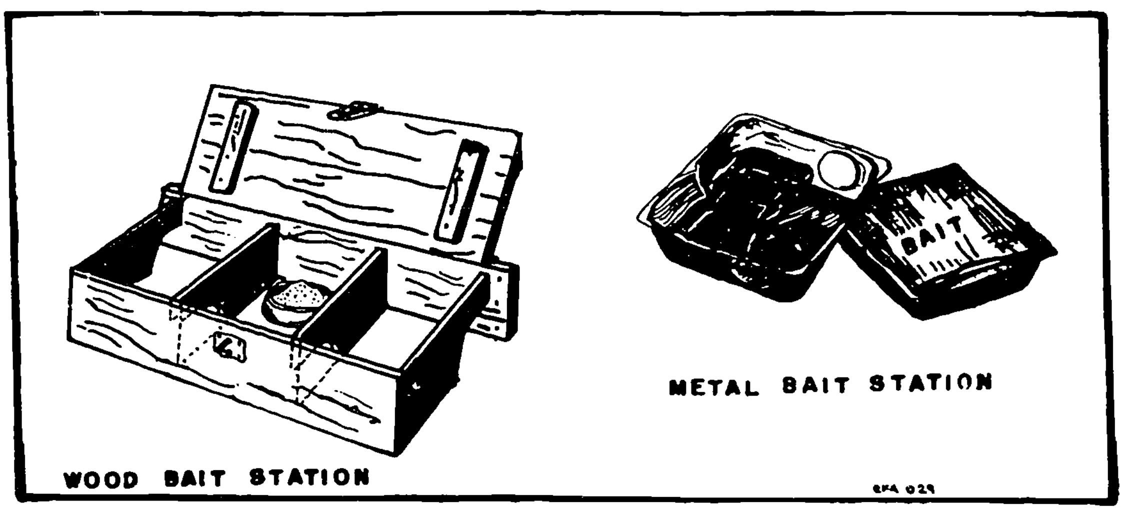


Figure 1–13. Covered bait stations.

of a rat population may not come for 2 weeks. Anticoagulant baits do not cause rats to go outside before dying. Therefore, odor problems will develop if rats die indoors.

Resistance of Norway rats to the anticoagulant, Warfarin, has been documented in several areas of the United States. To control such rat populations, you'll have to use other tools such as single-dose rodenticides (including the newer anticoagulants) and traps. Otherwise, neither switching anticoagulants nor increasing their concentrations in baits has proved effective on resistant rats.

The single-dose, or acute, rodenticide group includes the more toxic baits such as zinc phosphide, strychnine, and others. Each poison has its special characteristics, uses, and hazards, and these should be well understood. Not only can these poisions kill rodents, but they are dangerous to people and nontarget animals.

Zinc phosphide is a toxic and effective rat and mouse poison which has been used successfully for many years. It is a black powder with a distinctive odor that makes it unattractive to people and pets. Its safety record is very good, but it still requires special handling in a well-ventilated area when mixing. Contrary to long-standing belief, zinc phosphide baits stay toxic for a long time. Its quick action, effectiveness, and low hazard make it one of the most useful rodenticides.

Strychnine sulfate and strychnine alkaloid are sometimes used as rodenticides, particularly on poisoned seeds for mouse control. They do not normally give good results in rat control because of their extremely bitter taste and fast action. The sulfate is better for treating grains, as it will soak into the kernels, while the alkaloid must be coated on the outside with starch and other adhesives. Strychnine is extremely fast acting (death can occur as soon as 12 minutes after eating) and is toxic to all forms of life. Since it acts so quickly, strychnine doesn't usually have time to metabolize within the animal's body. There is a danger of secondary poisoning if another animal eats the dead rodent. These factors make strychnine a very hazardous material, which you should use only in special situations and with great care.

CAUTION: Be sure to mix baits as directed. Too much poison may give bait a strong taste or odor. Too little will not kill and may result in "bait shyness." Excessive amounts of poison increase the danger to people and domestic animals. Poor mixing results in nonuniform baits, poor kills, and a speedier development of bait shyness. Mechanical bait mixing equipment is necessary where large quantities of bait are mixed on a routine basis. You must clearly label poisons and mixing equipment. Do not use mixing equipment for other purposes. Lock up poisons and mixing equipment when they're not in use. Treat all poisons with respect. Avoid inhaling powders or getting poisons on hands, clothes, or utensils from which they may reach the mouth. Always mix poisons in a well-ventilated place, particularly when you are mixing dry ingredients.

Baits may be used in solid form, as cubes or slices coated with the more toxic poisons like zinc phosphide, or ground and thoroughly mixed with the poison. Ground baits may be distributed in about 1/2-inch balls, loose, or wrapped in 4-inch squares of waxed paper ("torpedoes").

Use baits liberally where you find many recently left signs of rats. A major fault in unsuccessful poisoning programs is the use of too few baits. Good places to set baits are in or near rodent burrows, runs, and harborage. Collect single-dose poison baits that are uneaten after 2 days. Burn or bury rodent carcasses.

Water requirements of rats and mice can be the basis for successful poisoning of these animals. Poisoned-water bait consists of water and a rodenticide designed to be disolved in water. If normal sources of drinking water can be eliminated or reduced, chances for success with this method are enhanced. Even though mice may depend on the water they get from food as their major source, they will usually drink water. If their normal supply of food has a low moisture content, their need for drinking water will be greater.

Multiple-dose anticoagulants are used differently from other rodenticides. Bait mixtures are frequently placed in paper pie plates or permanent bait stations. The number of pie plates or bait stations varies with the degree of infestation. Small pie plates hold 1/4 to 1/2 pound, but permanent bait stations often hold over a pound of bait mixture. Anticoagulant bait mixtures are usually exposed for a minimum of 2 weeks. Repeated doses must be consumed by the rodent for 5 or more consecutive days in order to kill. Therefore, you must protect other animals and shield baits from the weather with bait boxes, boards, pipes, or cans. Note locations of all bait containers so you can make inspections rapidly and replace consumed bait. At each inspection, smooth the bait so that you can see any new signs of feeding. Replace moldy, wet, caked, or insect-infested baits with fresh ones. If successive inspections show that bait is undisturbed, move it to an area showing fresh rodent signs.

For single-dose anticoagulants, maintain an uninterrupted supply of fresh bait for 10 days (15 for mice) or until signs of rat activity cease.

Perimeter control is very important in intercepting rats before they invade a building. Place weatherproof, permanent bait stations and weatherproof poison baits strategically ' g likely invasion routes, especially doorways, basement windows, and along building walls and shipping docks.

When you bait outdoors, place all baits in burrows, tunnels, deep into holes, or in covered rodent bait stations. All dry baits should be inspected at least once per month and replaced with fresh baits if they get infested with insects rats. Daily baiting is necessary if you use perishable baits such as fruits and vegetables. Place mixed cereal or solid baits in waterproof containers in a cool, dry place if they're stored for long. Upon completion of the program, pickup all bait boxes, containers, etc. for disposal, especially if they're accessible to the public, and destroy the dead rats.

To bait for mice, place large numbers of smaller baits, rather than smaller numbers of large baits; mice don't usually travel very far for food. Make it easy for a mouse to find your bait. Place cups of bait along walls and other runways actually touching the walls. A bait placed several inches from a wall may be by-passed consistently. Be very careful to bait near all openings to the outside of the building where mice may enter, and also bait next to all interior doors that stay open. Remember to replace baits frequently.

As with rats, it is desirable to remove dead mice, but carcasses are often in wall voids or other inaccessible places. If the dead rodent can't be retrieved, ventilate the area as well as possible and apply a masking agent. If a carcass is in a wall void, forcing a pint of masking agent in water into the area will usually get rid of the odor immediately. If the rodent can't be precisely located, apply the masking agent solution more generally. In severe cases, you may have to use a mist or ULV machine. Repeat applications may be necessary until the carcasses dry up. Available agents include Neutroleum Alpha, isobornyl acetate, and Styamine 1622. Follow label directions closely.

Exercises (A06):

1. List the basic food preferences for Norway rats, roof rats, and house mice.

2. What purposes are served by test baiting?

3. What negative effect may come from mixing the poison and the bait material improperly?

4. At what time of day should you apply baits? Why?

5. Under what conditions can you use open bait traps?

6. What are the three main types of available rodenticides?

7. What should you do if the rats in your area are resistant to Warfarin?

8. What are the three major attributes of zinc phosphide in a rodent baiting?

9. Why should you take great care in using strychnine to control mice?

10. Where should rodent baits be placed indoors? Outdoors?

11. After how long should you collect uneaten single-dose baits?

12. Under what conditions can water baits be most effectively used?

1-2. Field Rodents

While domestic rodents pose a continuing problem in many areas, numerous other rodents also require control. The many types of field rodents (also called feral rodents) are "native" species in the areas where they are found, and they do not follow people from place to place. Though some common names, such as "field mice," are widely used, the species differ from place to place. In addition to rats and mice, you may also have to control several types of feral squirrels.

A07. Verify or correct statements about the importance of native mice and rats.

Importance of Native Mice and Rats. The importance of the various native rats and mice of the family Cricetidae (or Miridae) depends on their species, their numbers, and the type and location of the military installation. All of these rodents serve as disease reservoirs. While many members of this family are mainly nocturnal, some are active enough in daylight hours to be attacked by biting flies. A single Neotoma live-trapped in Texas was a host for fleas, ticks, and three warble-fly larvae. In addition, this animal had plague. Wood rat nests in the Southwest are often infested with various species of Triatoma, transmitters of Chagas' disease.

The overall importance of these rodents at military installations is mainly economic. Native rats and mice can damage communication lines, particularly field telephone cable on the ground, which obstructs their runways. The rats and mice remove the insulation and often sever the cables. Rodents can find access to parked aircraft within which they destroy control and communication cables. Repellent-treated communication cables are now available.

Rice rats, and more so the cotton rats, damage waterways and impoundments by burrowing. Deer mice, or white-footed mice, are normally destructive only at the larger military installations with many acres of undeveloped lands. When they are very numerous, they can become pests. This often happens in logged-over forest areas where they destroy seeds in the ground or fall from the seed trees left for reforestation; in new areas seeded for forest trees; in grainfields, particularly those containing shocks of corn and wheat; and in feed and food storage places in farm buildings and houses. They also eat the buds and bark on young trees, but in this respect, they are not nearly so destructive as meadow mice.

The injuries inflicted by meadow mice and pine mice vary greatly from year to year, depending on the abundance of the rodents, the nature and extent of their food supply, and the weather conditions. The fluctuation in the numbers of the mice is continual, irregular, and abrupt owing to the varying birth rate, disease, food availability, and the extent to which they are preyed upon by their enemies (wild birds, mammals, and snakes). Thus, the mere presence of these mice is a menace requiring regular observation.

Even relatively little gnawing at vital points may greatly damage trees. As a rule, these rodents inflict the greatest injury to trees during winter under cover of snow. Therefore, you can expect more severe damage during a hard winter with deep snow than during a mild one. The rule is not invariable though; severe injury has been recorded at all seasons and under a great variety of conditions.

The kinds of crops injured by field mice are practically without limit, but orchard trees, nursery stock, small fruits, and shrubbery probably suffer the most damage. Root crops, tubers, and bulbs are very attractive to mice, particularly to pine mice, and loss is often as severe as damage caused by injury to fruit trees. Mice are also fond of clover and alfalfa, and the aggregate annual loss from inroads on these crops is considerable. Cereals are damaged most heavily in the shock, but they're subject to attack at all times. Because of these different habits, the greater part of the injury to trees and other vegetation by the meadow mouse is inflicted above the ground. Injury by the pine mouse is inflicted below the surface, where in the case of crops, it often remains unsuspected until harvest; or, in orchards, until the foliage of the undernourished, girdled trees begins to wilt. Meadow mice occasionally girdle the trunk of a tree below the surface of the ground, but they seldom continue to remove the bark from the roots as pine mice do.

Perhaps the most significant problems posed by field rodents is their attractiveness to birds of prey (raptors). Many of these rodents inhabit open fields, such as airfields. In turn, they may attract hawks, owls, and other birds to feed there—birds which are a distinct hazard to aircraft operations.

Deep snow and lack of clean cultivation allow meadow mice to work above the ground level without fear of detection. The reason it's important for you to distinguish between the two mice is that mechanical protectors and clean cultivation around trees, which are successful aids in controlling damage by meadow mice, have little effect on pine mice, which do not rely on surface vegetation for food or protection.

Exercises (A07):

Mark each statement being true (T) or false (F) and correct any false ones.

____ 1. Considerable damage to communication lines is done by native mice and rats.

____ 2. Deer mice or white-footed mice damage waterways and impoundments by burrowing.

____ 3. Rice rats and cotton rats are normally destructive only on large military installations with many acres of undeveloped land.

____ 4. Meadow mice usually will girdle the trunk of a tree above the ground.

____ 5. Root crops, tubers, and bulbs are very attractive to pine mice.

A08. Match various native mice and rats with their characteristics.

Characteristics and Biology of Native Mice and Rats. Native mice and rats belong to several families. There are many species with diverse food habits. While many are essentially omnivorous, they have, for the most part, adapted to a vegetarian diet. A few are distinctly destructive. Most can, at times, be detrimental to human welfare.

Meadow mice and pine mice. Although these mice are closely related, their habits differ, and as these habits affect control practices, it is important to be able to distinguish the groups. The range of the common meadow mouse and its allies includes almost all of North America southward to Guatemala, as well as the northern two-thirds of the Eurasian Continent. The range of the pine mouse is restricted to the eastern half of the United States, from the Atlantic coast to eastern Kansas and Nebraska, and from the Gulf of Mexico to the Great Lakes.

You can tell them apart by their appearance, the nature of their burrows, and the kind of injury they do. The mice of both of these groups, often called voles, are blocky little animals with relatively coarse fur, usually dark brown in color, and with small, beady, black eyes and almost-concealed ears. The pine mouse is somewhat the smaller of the two. Its reddish-brown fur is less shaggy and more velvety. Its tail is short, being about the same length as the hind foot. The tail of the meadow mouse (fig. 1-14), on the other hand, usually is nearly twice as long as the hind foot. The average weight of meadow mice is 1¼ ounces and that of pine mice is about 1 ounce. The females of each species weigh slightly less than the males.

Meadow mice are very prolific and under favorable conditions produce up to 13 litters a year. The number in a litter varies from 1 to 11, the average being 5. The size of the litter fluctuates with the population level of the mice, large litters predominating when mice are becoming abundant. Pine mice are less prolific: although they also

Figure 1–14. Meadow mouse (*Microtus* spp.).

may produce several litters a year, these number only 1–5 young each.

Both meadow mice and pine mice are active throughout the year, although meadow mice are most restricted in movements during the winter, and the latter are probably less in evidence during dry, hot weather. The outstanding difference in the habits of these two mice is that the pine mouse is a burrowing animal, living and feeding very largely underground, whereas the meadow mouse, although constructing shallow tunnels and nesting chambers underground, feeds mostly on the surface. Both of these voles are mainly vegetarian, though pine mice will feed on insects when insects are abundant.

White-footed mice. The white-footed mice (fig. 1-15), also known as deer mice, are widely distributed throughout North and Central America. They are found from sea level to the vegetation line of the highest peaks and from heavily timbered areas to the desert. There are many species and subspecies, but all have the characteristic white underparts and white feet. The color of the sides and upper parts varies from dark gray (nearly black) in regions of heavy rainfall to light yellowish-brown in desert regions. The species also vary in size, the combined head and body length running from 80 to 170 mm and tail length from 40 to 205 mm. The weight of adults ranges from 1/2 to 2 ounces. All have large ears, prominent eyes, and tails at least one-third the total length of the animal.

White-footed mice are almost completely nocturnal. They do not make runways of their own as the meadow mice do. They use such trails as the runways of meadow mice and the tunnels of moles and pocket gophers.

They are found in practically all types of habitats—in woodlands and swamps, along watercourses, in the wide, open spaces of the upland prairies, about rocks and cliffs, and in deserts. Those inhabiting the prairies, open cultivated areas, and fence rows usually make their nests in short, simple burrows. Those in woodlands live largely on the surface of the ground, building their nests and living quarters among the roots of shrubs and trees, in decayed stumps and hollow trees, and under logs. They may even make use of deserted nesting cavities of birds or abandoned birds' nests in bushes. A few live and travel about in cultivated fields and make permanent homes in barns and houses where the house mouse is not abundant. These mice do not hibernate. Their little tracks may be seen in the snow the day following the coldest night, showing that they were out seeking food.

White-footed mice are very prolific. They breed throughout the year in the temperate regions and produce 1–9 young per litter. Although they occur throughout the United States in great numbers, they concentrate in certain areas where they become of economic importance. They are extremely numerous in the western states.

As might be expected from their wide distribution, white-footed mice consume a great variety of foods, but they apparently prefer seeds, nuts, and grains. The seeds include those of grasses, weeds, shrubs, and trees. They often store them in burrows and in the cavities of old stumps. They will devour the bodies of mice that have been caught in traps and will kill and eat pocket mice. They also eat insects, their eggs, and their larvae.

Wood rats. Various species of these large rats (fig. 1-16), are widely distributed throughout North and Central America. They have long, hairy tails, which are bushy in some species. The ears are large and membranous. The skull is long, angular, and heavy. These rats are chiefly vegetarians. They eat flowers, fruit, seeds, stems, and bark. They often carry food to their dens, where discarded parts of plants may be added to mounds of sticks and twigs. Cactis and other fleshy plants serve as moisture sources in arid areas.

Rice rats and cotton rats. These rats (figs. 1-17 and 1-18 respectively) are distributed widely in North, Central, and South America. The rice rat eats a variety of seeds, hedges, fruit, and berries. It takes the large seeds of grama grass, wild rye, and marsh grass and is sometimes a pest in rice fields. When these foods are in short supply, the rice rat goes to the shore where it feeds on small crustacea and mollusks exposed at low tide. It also feeds on insects. The larger cotton rat has similar food habits and is a pest of sugar cane and sweet potatoes. In addition, it's a menace to ground-nesting birds, eating both eggs and young.

Exercises (A08):

1. Does each statement refer to meadow, pine, or white-footed mice; or to wood, rice, or cotton rats?

    ________ 1. Long, hairy tails which are bushy in some species; ears are large and membranous.

    ________ 2. Pests of sugar cane and sweet potatoes.

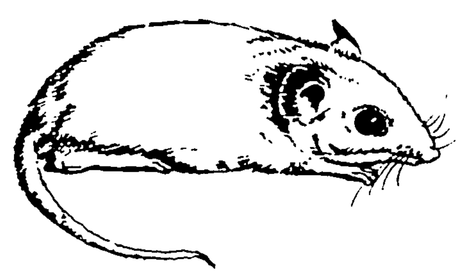


Figure 1–15. White-footed mouse (*Peromyscus* spp.).

Figure 1–16. Wood rat (*Neotoma* spp.).

Figure 1–17. Rice rat (*Oryzomys* spp.).

_________ 3. Have short tails, about the same length as the hind foot.

_________ 4. Have tails about twice the length of the hind foot.

_________ 5. Take large seeds of grama grass, wild rye, and marsh grass and are sometimes pests in rice fields.

_________ 6. These do not hibernate.

A09. Cite inspection and control measures for feral rodents.

Inspection and Control of Feral Rodents. Inspection for the native mice and rats involves finding the cause of damage and searching for runways and tracks. Native mice and rats can be controlled at military installations by trapping or poisoning.

Trapping. This is the best way to determine species and numbers. Meadow and pine mice are easily trapped in small wooden-based snap traps. Set these traps in the runways and at right angles to them so that a mouse following its usual route will pass directly over the trigger. Near the entrances to burrows is a good location for traps. For best results, the trap should be baited with oatmeal, apples, or vegetables, but mice can be caught in an unbaited trap if you properly set it in a runway. For convenience in finding a trap, mark the site with a bit of cotton twisted on a nearby weed or twig or on a stick stuck into the ground. Examine the traps and reset them twice daily. For trapping white-footed mice near buildings, the small wooden-based snap trap is very satisfactory. Bait the traps with rolled oats breakfast cereal or nutmeats. Mice can be controlled around seedbeds in forestry nurseries by trapping if enough traps are used to cover the area well. Set larger traps for the wood rats and cotton rats.

Baiting. The most effective and least expensive way to control meadow and pine mice is to use poisoned baits. For large-scale operations, you can also use poisoned baits to reduce the numbers of white-footed mice. Although the effectiveness of baits varies in different localities, even under some unfavorable local conditions, the proper application of well-prepared poisoned baits will kill enough mice to protect trees and crops.

In many cases, nearly all the meadow mice and pine mice may be killed by baits poisoned with zinc phosphide and strychnine. For controlling deer mice, strychnine alkaloid is only fairly efficient under most conditions. In areas where the acceptance of strychnine-poisoned bait is very low, you can use zinc phosphide baits as a followup. Zinc phosphide is highly toxic to mice and is taken readily.

Most phosphide compounds deteriorate rapidly on exposure to the air, but zinc phosphide retains its toxicity for 3 weeks or more on dry bait material. On moist bait, it loses its toxicity more rapidly, but even so, it is toxic long enough to make the bait effective. Zinc phosphide is insoluble in water but slightly soluble in fats and oils. Hence, oils may be used in the formulas.

Strychnine alkaloid is an effective poison, but its bitterness and its initial physiological action in cramping the muscles may cause the mice to fail to eat enough at one time to be fatal. In Western States where the mice are accustomed to feeding on grains, strychnine placed on oat baits often produces satisfactory results.

There are four good bait materials for meadow and pine mice: fruits, vegetables, grains, and seeds. Of the fruits, the apple is best; of the vegetables, sweet potato or carrot; and, of the grains and seeds, oats.

Figure 1–18. Cotton rat (*Sigmodon* spp.).

Deer mice prefer steamed rolled oats or wheat, but they accept rolled oats breakfast cereal and corn meal fairly well, and you can use them in a limited way. Such special baits as steamed rolled-oat groats and hulled sunflower seeds are well accepted by these mice. You can use them extensively if the materials are available at a reasonable cost. Poisons such as strychnine for mice and zinc phosphide for rats or mice are suitable for controlling these rodents. If you're conducting a long-term control program, weather-resistant anticoagulants are most useful.

Deer mice often follow meadow mice trails in orchards in tall grass, under mulch, in ruts, and along furrows. You can usually tell whether a runway is in use by its appearance and by the presence of freshly cut, short pieces of grass stems or of fresh droppings on the trail floor.

Place poisoned baits directly on the floor of used trails and cover them with a handful of grass or other litter. In areas where pine mice occur with or without moles, but not meadow mice, there may be few or no trails on the ground surface. This is often the case in sandy loam soil. The presence of mice is indicated by small, open holes about 1 inch in diameter. You can drop poisoned baits into these holes. Bait the area thoroughly, taking care to see that both the surface trails and the deeper pine mouse burrows are treated. Control depends as much on complete coverage of all mouse-infested sites within the area as on the effectiveness of the poisoned bait. Place baits wherever you find used trails, especially at all rock outcrops, along stone walls and drainage ditch banks, as well as at the base of each tree where you find mouse trails or holes. Baits not placed in trails are usually wasted.

Fumigating. You can use aluminum phosphide tablets very effectively to control burrowing field rodents and other burrowing pests. Apply 2–4 round tablets or 10–20 pellets to each den opening. Then seal the opening tightly by packing it with crumpled newspaper and shovel soil over the entrance. (Given the small size of burrows, you'll probably want to use smaller amounts than with animals such as woodchucks and prairie dogs unless soil moisture is low or the soil is very porous.) Make sure you follow all safety precautions on the label when you use aluminum phosphide.

Exercises (A09):

1. Where should you place snap traps for meadow and pine mice?

2. What baits should you put on traps for pine or meadow mice?

3. Where should you use zinc phosphide as a followup rodenticide?

4. How long does zinc phosphide retain its toxicity?

5. What bait materials work best for meadow and pine mice? For deer mice?

6. What poisoning materials should you use for a long-term control program for field rodents?

7. Where should you place baits in outdoor areas?

8. What are the application rates for fumigating burrows with aluminum phosphide?

A10. Identify feral rodents of the squirrel family with their physical descriptions.

Feral Rodents in the Squirrel Family. Of the many species in the squirrel family Sciuridae, the most troublesome at military installations are the ground squirrels (*Citellus*), the prairie dogs (*Cynomys*), and the woodchuck, groundhog, or marmot (*Marmota*). The burrowing members can cause serious economic damage (including erosion) by their extensive digging, but the family's greatest importance is that they serve as reservoirs of disease,—mainly plague and tuleremia. They also are hosts of the ticks that carry Rocky Mountain spotted fever.

Ground squirrels (*Citellus*). These rodents (fig. 1-19), erroneously called gophers, are found in Western North America from Alaska to Mexico. They are also found in eastern Europe and Asia south to Turkestan and Western Mongolia. Those of Western North America range from 23 to 48 cm from the tip of the nose to the end of the tail. They are gray to reddish brown. Most species have large ears, a rather long and narrow skull, well-developed cheek pouches, and long, fully haired tails.

These feral rodents burrow extensively when numerous. Temporary burrows are sometimes made to extend the area of foraging. They feed chiefly upon green vegetation early in the spring. Later they will feed on grass stems, fruit, berries, and many species of insects. They store seeds. In areas with cold winters, ground squirrels will hibernate.

Prairie dogs (*Cynomys*). These rodents are also found in the western United States and Northern Mexico. They are heavier bodied than are ground squirrels and have shorter hair, which lies close to the body. The head and back are tan or light brown. While the ground squirrels tend to be somewhat gregarious, the prairie dogs are truly colonial and live in "towns." Like the ground squirrel, the prairie dog feeds primarily on vegetation, but it will eat insects readily.

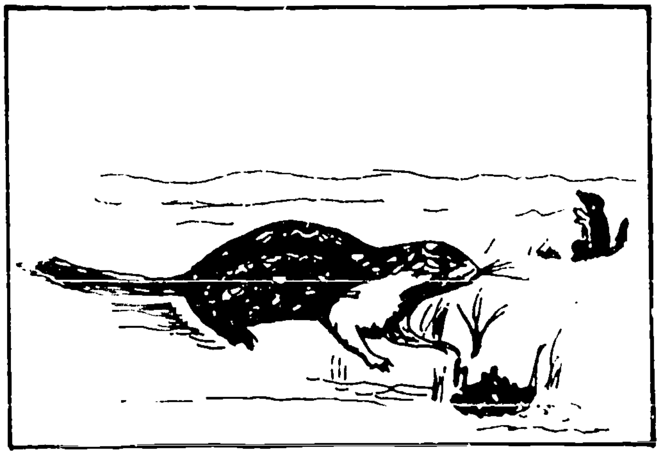


Figure 1–19. Ground squirrel (feral rodent).

Woodchucks, groundhogs, or marmots (*Marmota*). These feral rodents are found from the Eastern United States to the mountain ranges of California. They are also found in Western Europe and most of Asia. They are heavy, robust, well-furred animals. The crown of the head is darker than the body. Where terrain permits, burrows are constructed on hillsides or low, sloping banks. While they will occasionally eat grasshoppers, snails, and small birds, they are more herbivorous than are ground squirrels or prairie dogs. They enjoy clover, alfalfa, flower heads, and other herbaceous plants. In some mountainous areas of the Western United States, they are nearly as gregarious as ground squirrels. In the Eastern States, their burrows usually are more isolated. Hibernation usually lasts through late winter.

Exercises (A10):

1. To which species does each of these feral rodents belong? Give the species as well as the common names.
   a. This northern California rodent is gray to reddish brown, and it hibernates in the winter.
   b. This Georgia rodent is heavy and well furred and the crown of its head is darker than its body. It is mostly herbivorous, but it may eat small birds.
   c. This rodent lives in a colony in Northern Mexico. It is heavy bodied with a tan head and back.

A11. Verify or correct statements about controls for members of the squirrel family.

Control of the Squirrel Family. There are no special inspection techniques for burrowing members of the squirrel family. You can control them by baiting, gassing, trapping, or shooting them. Your choice depends mainly on the size of the job.

Shooting. This can be the easiest and cheapest control for an occasional ground squirrel or woodchuck, but land use may prevent it. Shooting is not an economical method for control in large areas of infestation.

Trapping. Like shooting, trapping can be a cheap and effective control for a limited infestation. Steel traps baited with bacon or peanut butter will readily take ground squirrels. Be sure to attach the traps to sturdy objects to keep them from being dragged into burrows.

Fumigating. Various fumigants are effective for the control of ground squirrels, prairie dogs, and woodchucks. To use carbon monoxide, park a jeep, truck, or tractor near the burrow and use a hose to direct the exhaust to the burrow. Pack soil around the hose. This procedure can be effective, but it is time consuming.

Calcium cyanide dust and aluminum phosphide are useful in control over small areas or as cleanup applications to eliminate scattered rodents not killed by poison when an area is baited. They are also useful at times when the animals will not accept poisoned baits. You can pump calcium cyanide into the burrows with a foot-pump duster or apply it to burrows with a tablespoon attached to the end of a 20-inch wood handle. Place a tablespoonful (1½ to 2 ounces) of the toxicant on the burrow floor as far in as you can reach. Cover the mouth of the burrow with sod. Place the sod upside down so that less soil will fall in to cover up the cyanide dust. Apply aluminum phosphide in the same manner as for feral rats and mice.

Exercises (A11):

Mark each statement true (T) or false (F), correcting any false ones.

________ 1. The choice of methods of controlling burrowing members of the squirrel family depends primarily on the size of the job.

________ 2. The easiest and cheapest control for an occasional squirrel or woodchuck is usually shooting.

________ 3. Steel traps baited with bacon or peanut butter may readily take ground squirrels.

_________ 4. Fumigants used to gas ground squirrels and prairie dogs are most effective when the soil is dry.

_________ 5. Poisoned baits are usually the most economical way to control burrowing members of the squirrel family.

A12. State the importance, features, inspection, and controls for pocket gophers.

Pocket Gophers. One of the most harmful and annoying rodent pests is the pocket gopher, a medium-sized burrowing animal, which gets its name from the fur-lined external cheek pouches in which it carries its food. The pocket gopher causes damage both by what it eats and by the aboveground mounds it leaves in burrowing and foraging. There are more than 100 varieties of pocket gophers in the United States. Most of them fall into three main genera: *Geomys*, *Thomomys*, and *Cratogeomys*. The genus *Thomomys*, (the western pocket gopher), includes all species west of the Rocky Mountains. The eastern pocket gopher, genus *Geomys*, occurs in the Eastern Gulf states and all over East and North Central Themerica. A third genus (*Cratogeomys*) occurs in parts of the Southwestern United States and Mexico.

General characteristics. All pocket gophers have many characteristics in common (fig. 1-20). They average about 5–7 inches, with some growing as long as 13 inches. Adult males are a little larger than adult females. Their front limbs are strong and carry long claws which are used for digging and, occasionally, fighting. They have relatively large incisors (front teeth) which are used for the same purposes. The muscular lips close around and behind the teeth, so that he gopher can use its teeth for digging without "eating dirt." Certain species often run backwards through their burrows with great ease, using their short, hairless tails as a guide. Coloring varies from light to dark brown. Chins and bellies may be almost white, reddish brown, or nearly black.

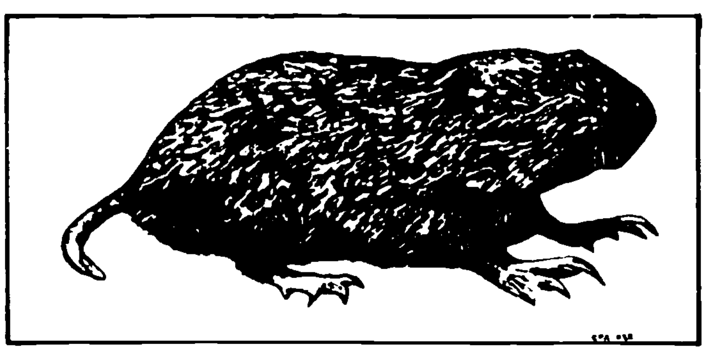


Figure 1–20. Western pocket gopher (*Thomomys bottae*).

The pocket gopher is active year round and lives alone, except during the spring mating season. A population of 50 gophers per acre is quite high, while meadow mice may reach 20 times this number during population eruptions. Diseases that can exert sudden and severe reduction in more crowded rodent populations are not as readily transmitted among gophers. Therefore, gopher population trends are not as markedly cyclic as those of some other species.

Control measures. The gopher's preference for underground solitude makes control difficult, but persistent effort will reduce and even eliminate them over a considerable area. Prompt attention to the first evidence—new mounds—in a garden or field will often save valuable plants and prevent other damage. Control is most effective when green surface vegetation starts to grow early in the fall or spring. Gophers are most active when the ground is soft and before young are born. Methods of control include trapping, fumigation, flooding, excluson, encouraging natural enemies, and poisoning. As we said, pocket gopher control is done best by trapping and poisoning. This is difficult, because the bait or trap can't be placed on top of the ground near a gopher mound but must be carefully located in the underground burrow.

Trapping. Because pocket gophers live in small underground burrows, special types of traps are required (ordinary mouse or rat traps are useless). The most successful trap is the Macabee—about 5½ inches long and made of wire except for the trigger (fig. 1-21). It springs when a gopher pushes against the flat trigger pan. Next most popular is a box type with a choker loop, that releases when the gopher seizes special bait on a trigger.

Traps are quick and positive when they're set right. They are inexpensive, they last indefinitely, and they're simple to use, but the labor of setting them is till a problem. You use a light shovel to dig down to the main run, which the gopher always keeps open. A 12-inch, stout iron spoon or narrow trowel is useful for exposing the main run and placing the trap properly. Select the freshest mount, and you can find the main run (probably) by following the angle of the dirt-plugged hole. Mounds are usually 6–15 inches from the main run, with the laterals nearly at right angles to it.

With the shovel, clear a place to set a trap in each direction (fig. 1-22). Clean out the main run with the spoon, disturbing it no more than necessary. A little loose dirt may be left in the bottom of the tunnel to cover the prongs and front end after you push the trap into place.

Many people cover the burrow with a clod or handful of grass or alfalfa so that little light reaches the trap. A gopher instinctively closes all open burrows tightly to keep out natural enemies. A trap placed in an uncovered hole may be sprung by the dirt the gopher pushes ahead in plugging the hole.

Each trap should have a light wire or cord fastening it to a marker stake that will keep it from being dragged far back into the tunnel by a wounded gopher or being removed by a dog or cat when it contains a gopher.

After you put out the traps, tramp down or kick the tops off all mounds nearby so that the next visit will show any new mounds where further effort is needed. For most efficient use of traps and best results, visit each setting morning and evening, or more often.

Fumigation. Fumigation, a successful method for controlling some rodents, is of limited effectiveness against pocket gophers. The extent of the burrow system, the chance for leakage through the softer earth of laterals, the closeness of the main runs to the surface, and the fact that gophers may quickly plug off their burrows to escape poisonous gas all make gas unsatisfactory.

Flooding. This method may drive gophers from their runways, but few actually drown. Individual gophers in lawns and gardens can be forced out by turning the stream from a hose down the burrow so the gopher can be clubbed as it emerges. A variation to flooding involves adding a high-suds laundry detergent to the water. Then as the water is sprayed in, the suds develop ahead of the water. You therefore get the same response from the gopher but use less water.

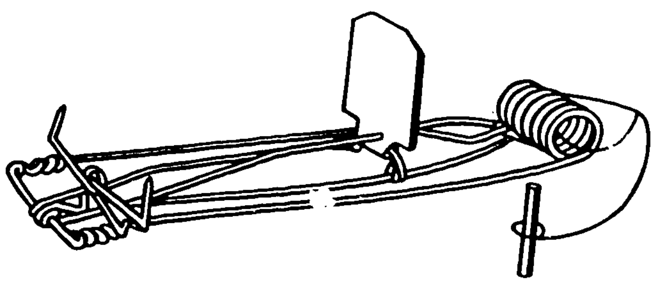


Figure 1–21. Macabee gopher trap.

Exclusion. You can protect small gardens or ornamental plantings of high value by fencing. To protect against both underground and overland invasion, the fence of small-mesh wire, sheet metal or concrete should extend a foot above the ground and 2 feet below. Protect young trees or grapevines by enclosing them in a wire-mesh basket or cylinder from ground level to 2 feet deep. Cases of unusually heavy and persistent burrowing in canal and ditch banks may require underground fences of wire mesh or concrete but this is expensive, and it's warranted only when gopher damage is quite costly.

Natural enemies. The barn owl and gopher snake are useful aids in gopher control. The owl nests in barns, steeples, palm trees, and holes in cliffs or earth bank. Its diet is almost entirely rodents, often mainly pocket gophers. A pair of owls may take 3–6 gophers daily in feeding their young; they rarely eat birds and never kill poultry. The gopher snake commonly eats gophers in fields and orchards but sometimes takes eggs from wild birds or from henhouses. Some house cats become expert at catching gophers.

Poisoning. Pocket gophers are controlled best by poisoning. Over large areas heavily infested with gophers, the cheapest control is poison bait. Probe to locate an open burrow (fig. 1-23), then drop poison bait through the probe hole (enlarged by digging). Take care not to drop dirt into the tunnel or cover the bait with dirt. Since pocket gophers' external cheek pouches are lined with fur, they don't absorb poison, and we have to depend on stomach poisons. Strychnine is effective for this purpose. Baits should be tinted with green food coloring so they don't attract other animals or birds, wild or domestic.

Strychnine alkaloid—coated grain is a relatively safe poison. It is extremely distasteful to humans and it has no secondary effect. An animal eating only the flesh of a

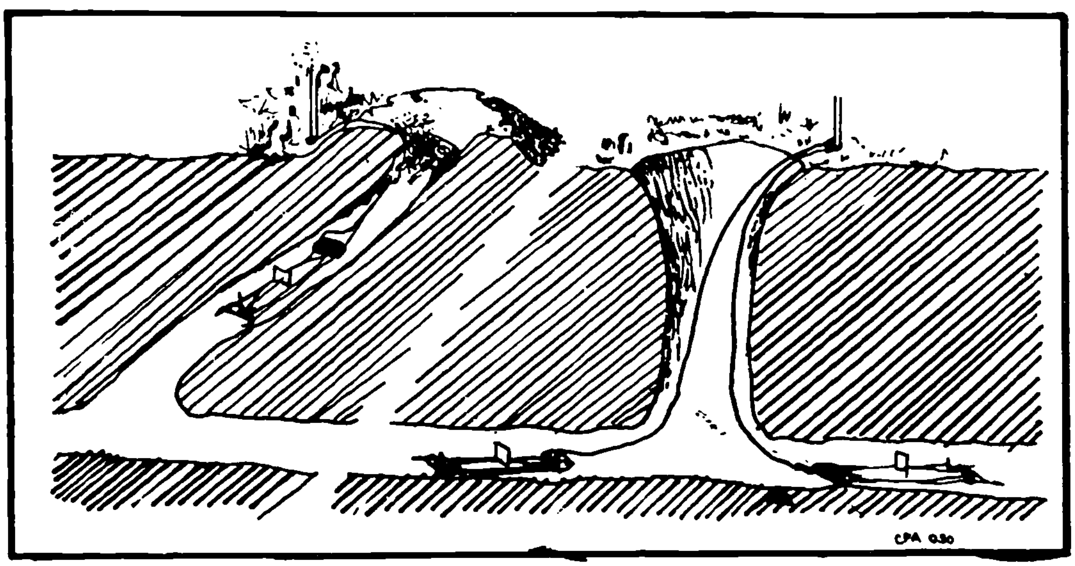


Figure 1–22. Gopher trap placement.

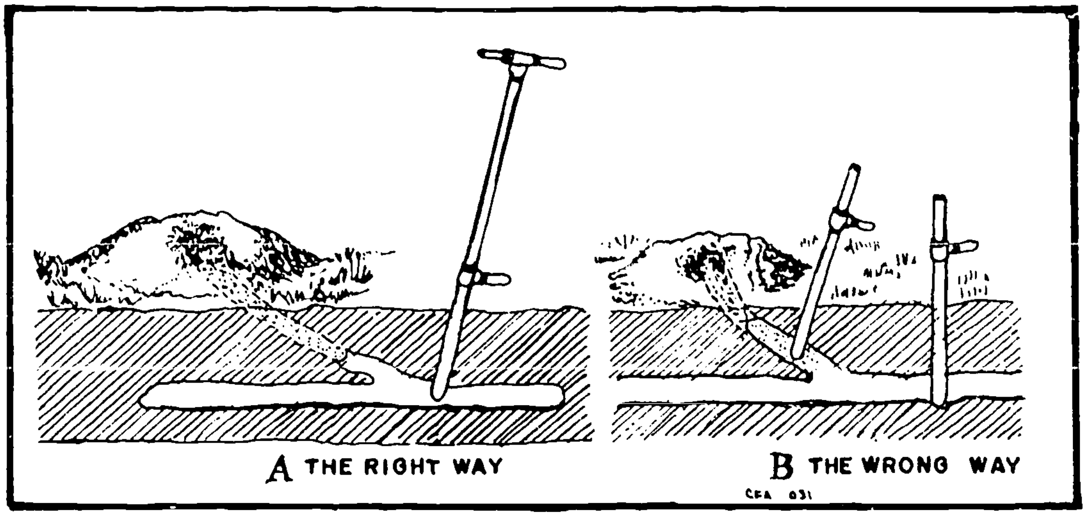


Figure 1–23. Probing for gopher runways.

poisoned gopher will not be affected. Use grains coated with 0.25 or 0.50 percent strychnine alkaloid. Use grains such as milo and barley for best results. The effective life of these baits is 2–3 weeks, depending on germination conditions in the soil. It is possible for a nontarget animal to get a lethal dose of strychnine by eating whole gophers. The rodent may have some of the bait in its cheek pouches or undigested in its stomach. This type of poisoning is unlikely, but it is possible.

Exercises (A12):

1. How do pocket gophers cause damage?

2. What physical features help a pocket gopher adapt to its environment?

3. During what seasons are pocket gophers active?

4. What are the best controls for pocket gophers?

5. Why is trapping for pocket gophers so hard?

6. Why doesn't fumigation help much in controlling pocket gophers?

Birds

EACH YEAR THE U.S. Air Force loses millions of dollars and hundreds of work-hours in maintenance because of damage to aircraft and equipment caused by birds. These losses result from bird strikes to aircraft and from bird droppings and nesting materials in and around airbase structures and equipment. The seriousness of this problem and the potential health hazards caused by birds in certain situations require pest bird management procedures for each airdrome environment. Bird control in the airdome environment can be a complex problem, but simple procedures done regularly can greatly reduce pest bird problems.

People have always been fascinated with birds, particularly with their ability to fly, but this fascination did not lead to an understanding of birds and their importance until recent times. Even when birds were recognized as an important food source, we hunted some species so extensively that we contributed to their elimination. Our failure to understand the role that birds play in nature also has destroyed their habitat and damaged the environment to the extent that some species have been eradicated totally, while others are near extinction. At the same time, some species have either benefited from habitat changes or have adapted to living near humans. Many of these species multiplied, and some that formerly were limited in their range are now found nearly worldwide. As the importance of birds became apparent and we began to understand our impact on birds and their populations, the protection and management of birds gained new emphasis. Laws, treaties, and regulations were established to protect birds and to ensure that they would be maintained as important natural resources. At first these laws concerned only game species, but now almost all of the birds in North America are protected by a number of laws, treaties, and regulations. You must be aware of the legal protection that has been given to birds. Any bird control program must comply with applicable regulations and should be coordinated with the appropriate local, State, and Federal wildlife authorities.

The information here is background you need to contain or eliminate real or potential pest bird problems. You should know and understand the basic principles of bird biology and behavior as they affect bird control and then choose the most appropriate control technique for the situation at hand.

2-1. Introduction to Bird Management

To develop and implement effective bird management programs, you need a basic understanding of terms that apply to bird management and the characteristics of some of the most common pest and hazardous bird species. That's the aim of this section.

A13. Associate bird management terms with their meanings.

Bird Management Terms. Let's look at six terms that have special meanings in bird management. *Bird damage* results when material or equipment is damaged as a result of bird activities. There is a distinct difference between a bird nuisance and bird damage. For example, a few noisy house sparrows around an office building may seem to be a problem but only may be an annoyance to workers. Bird damage occurs when the sparrows build nests in the building, leaving corrosive droppings or holes in screening. *Bird damage control* seeks to reduce the potential for damage caused by birds. The term "bird control" sometimes includes the control of both damage and hazards, but our goal is to reduce the damage and the hazards that birds can cause, rather than to control the birds. A *bird hazard* exists when birds represent a potential threat to health or safety. We should concentrate on bird hazards, rather than bird damage. In and near an airdrome the bird/aircraft strike hazard is frequently serious, and reducing this hazard becomes the most important task you have.

Bird management depends on changing the characteristics and interactions of birds, their habitat, and people to reach human goals. It refers to everything we do deliberately to affect birds, whether to encourage or discourage them from a given area, or to increase or decrease their populations.

Bird strikes (contact between a bird and a moving aircraft) cost lives and equipment; even minor bird strikes add up to thousands of dollars in annual repair costs. Bird strikes also can interrupt base missions. Aircraft collisions with birds are the most serious problem. Bird/aircraft strike problems can come during the takeoff, en route, or at landing and they're hazardous particularly during the low-level phase. The hazards during takeoff and landing are your main concern, so you must control bird activity on or near the airfield.

A given bird may be beneficial or injurious to human interests, depending on its activities at a specific time and place. The term *pest bird* refers to an individual, flock, or population causing economic damage or creating a health or safety hazard by its activities at a given time and place.

Certain species may become involved in hazardous or damaging situations more frequently than others because of their behavior patterns or habitat requirements.

Exercises (A13):

What is the term for each of these?

_________ 1. Any bird that is causing damage or creating a hazard by its specific activity.
_________ 2. A danger to health or safety caused by birds.
_________ 3. Economic loss caused by pest birds.
_________ 4. Anything done deliberately to affect birds.
_________ 5. Bird management in which the specific goal is to minimize the potential for damage.
_________ 6. Any contact between a bird and a moving aircraft.

A14. Identify various anatomical parts of birds.

Importance of Identification. Because of differences in habitat, requirements, and behavior, various groups and species of birds create different types of pest problems. Birds differ in their response to a given control measure. An effective technique for one species may be useless (or even illegal) for controlling another. Thus, it is very important to identify the birds causing the problem (the target species) before beginning any management or control measures. Proper identification of nontarget species also is necessary to evaluate the potential for undesirable consequences of a bird control measure.

Bird Topography. The body of a bird can be divided into logical sections; head, trunk, wings, and tail. Each of these sections has several parts upon which we base its identification.

Head. The head of a bird includes the neck, bill, forehead, crown, nap, lores, chin, and throat. The dorsal (top) part of the head and neck is divided into the forehead, crown, and nape. The part between the base of the bill and an imaginary line between the eyes is the forehead. The top of the head to the base of the skull is the crown. The nape, or hindneck, is the part between the crown and the back. The sides and undersides of the head have four major divisions. The lores are small areas behind the base of the bill and anterior to (in front of) the eyes. The side of the head from the base of the lower portion of the bill to just behind the eye is the cheek. The chin is the small area between the forks of the base of the lower half of the bill, and the part of the neck below this area is the throat. This is all well illustrated in figure 2-1.

The bill or beak is often the most notable structure on a bird. The size and shape of a bird's bill can tell you a great deal about the bird, including the type of food it eats and its mode of feeding. Always notice whether the bill is long, short, hooked, curved, wider than it is high, or distinctive in any other way (fig. 2-2). The shape of the bill indicates whether the bird feeds by probing (the tubular bills of sandpipers), tearing (the hooked bill of a hawk), seed-eating (the strong, conical bills of many sparrows). On birds such as hawks, pigeons, and doves, the upper part of the bill has a prominent fleshy base called the cere (fig. 2-2) that may help you identify them.

Trunk. The upper part of the body or trunk is divided into the back and the rump. The back is the anterior two-thirds of the upper trunk. The rump is the remaining area, extending from the back to the base of the tail. The underpart of the bird's trunk is divided into the breast, abdomen, sides, and flanks. The sides and flanks are the areas just under the wings. The breast is the anterior rounded part of the underside, while the abdomen, or belly, is the flatter part around and between the legs of the bird.

Wings. Although the wing feathers of a bird are divided into many groups, only a few are used repeatedly in bird identification. These include the primaries, secondaries, speculum, coverts, scapulars, and wing linings. The flight feathers are the primary and secondary feathers. The primary feathers are those longer feathers that make up the end of the wing and let the bird fly forward. They are attached to the manus (hand) of the bird. The secondary, inner, flight feathers are responsible mainly for lift, acting with the forward part of the wing much like an airplane wing. They attach to the ulna (forearm) of the wing. The secondary feathers of birds such as ducks have a color-patterned area known as the speculum. The majority of the smaller feathers on the wing are known as coverts. Covert feathers overlie the base of the primaries and secondaries and cover the rest of the wing. The covert feathers of the shoulder area are the scapulars. The wing lining is the covert feathers on the underside of the wing. On the upper surface of the wing, the edges of the scapulars or a row of coverts is often tipped with a color that is different from the surrounding feathers, appearing as wingbars when the bird is sitting. A wing stripe also can be seen in some birds when the bases of the secondary or primary feathers are lighter in color than the tips of the feathers. Noting the shape of a bird's wings (fig. 2-3) also can help identify a bird species.

Tail. The tail of a bird consists of the prominent tail feathers and the tail coverts. The large, conspicuous flight feathers of the tail are used as a rudder to steer, and then they spread to act as a brake. Tail shapes vary and can be used as identifying characters (fig. 2-3). Some birds may have colored spots near the tips of the outermost tail feathers, and these tail spots often are used in identification. The upper tail coverts lie above the base of the tail feathers and are not distinguished easily from the rump. The under tail coverts, at the base of the underside of the tail, are known collectively as the crissum.

Legs and feet. Noting the shape, size, and color of birds' legs and feet can be useful in field identification of some larger birds. Although these structures are sometimes hard to spot as field marks on smaller birds, the legs and feet help identify in-hand birds. Scale and webbing patterns, shape of leg cross sections, toe placement, and the shape of the nail or claw are all important identifying characters. Often bird remains can be identified using only the foot of the bird.

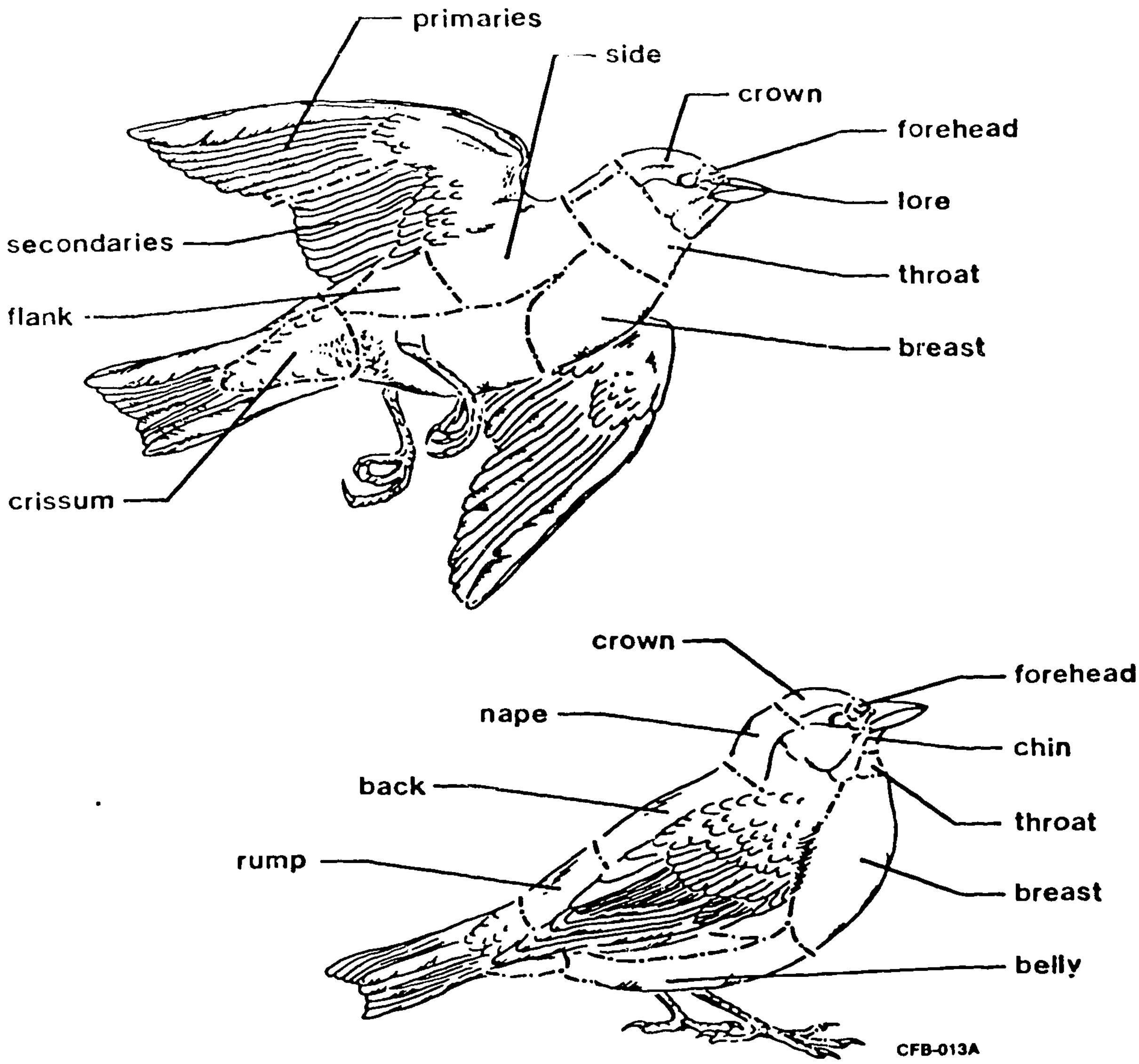


Figure 2–1. Topography of a bird.

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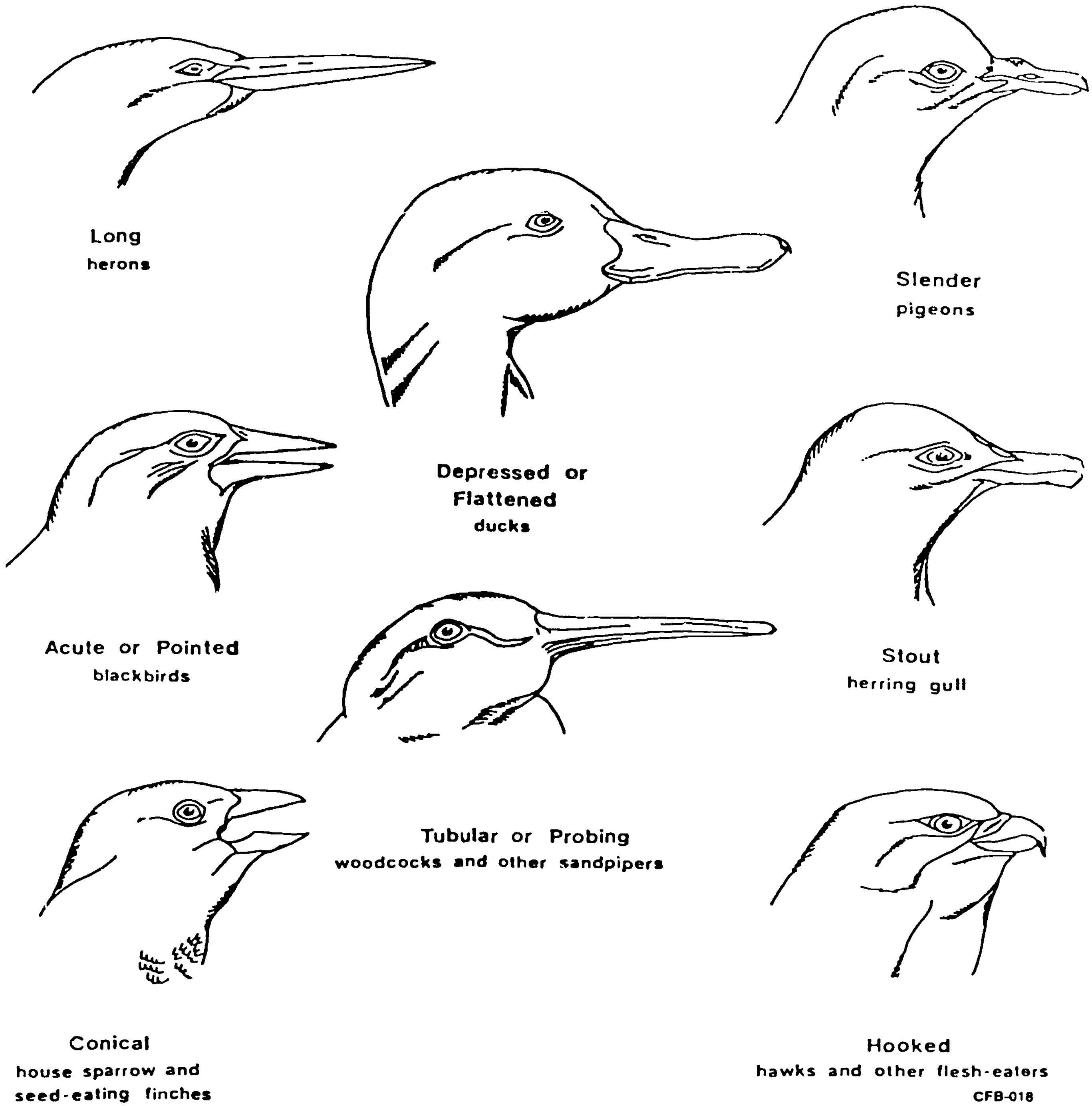

Figure 2–2. Bird bill shapes.

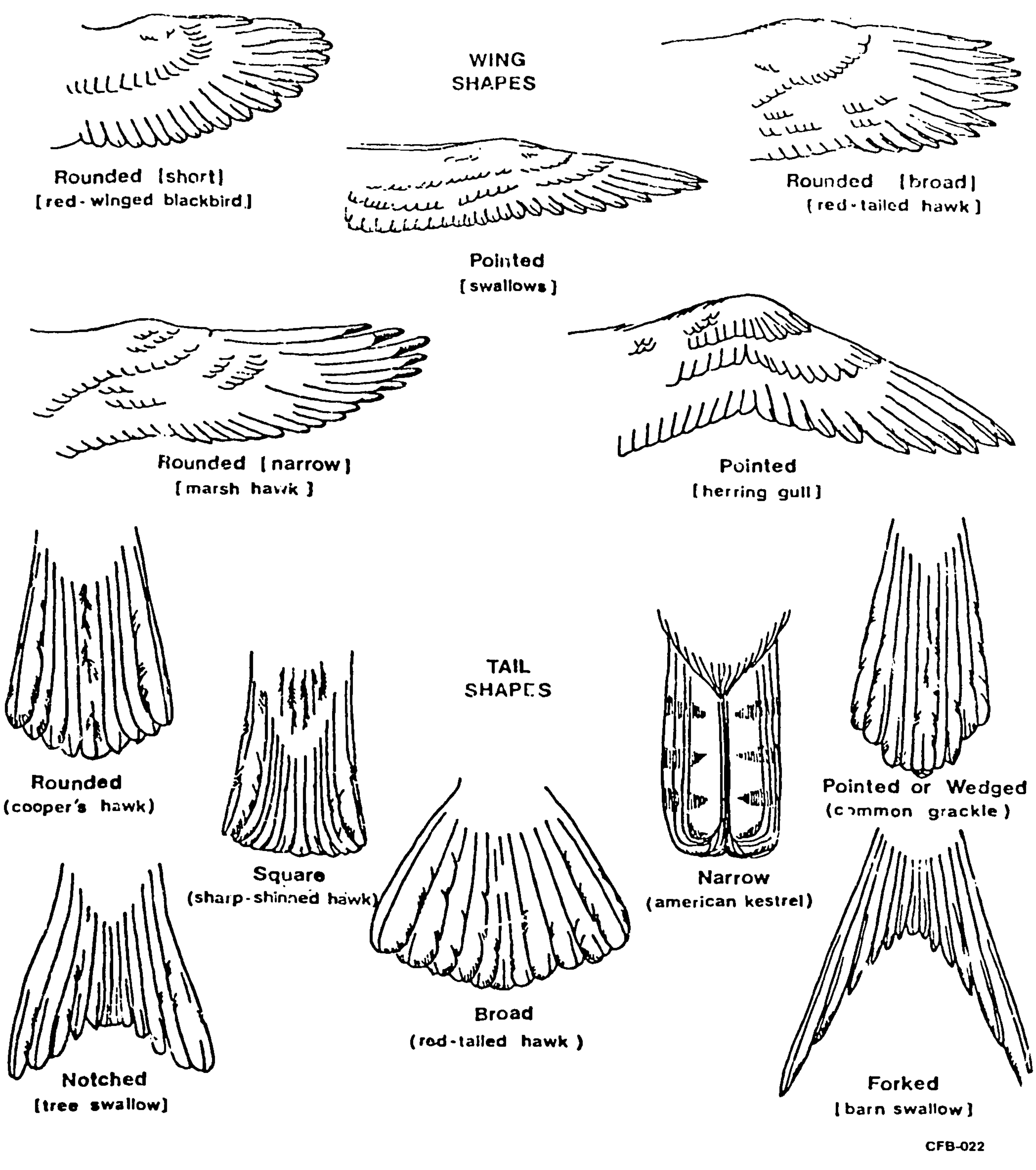

Figure 2–3. Wing and tail shapes.

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Exercises (A14):

1. On figure 2-4, label each topographical feature.

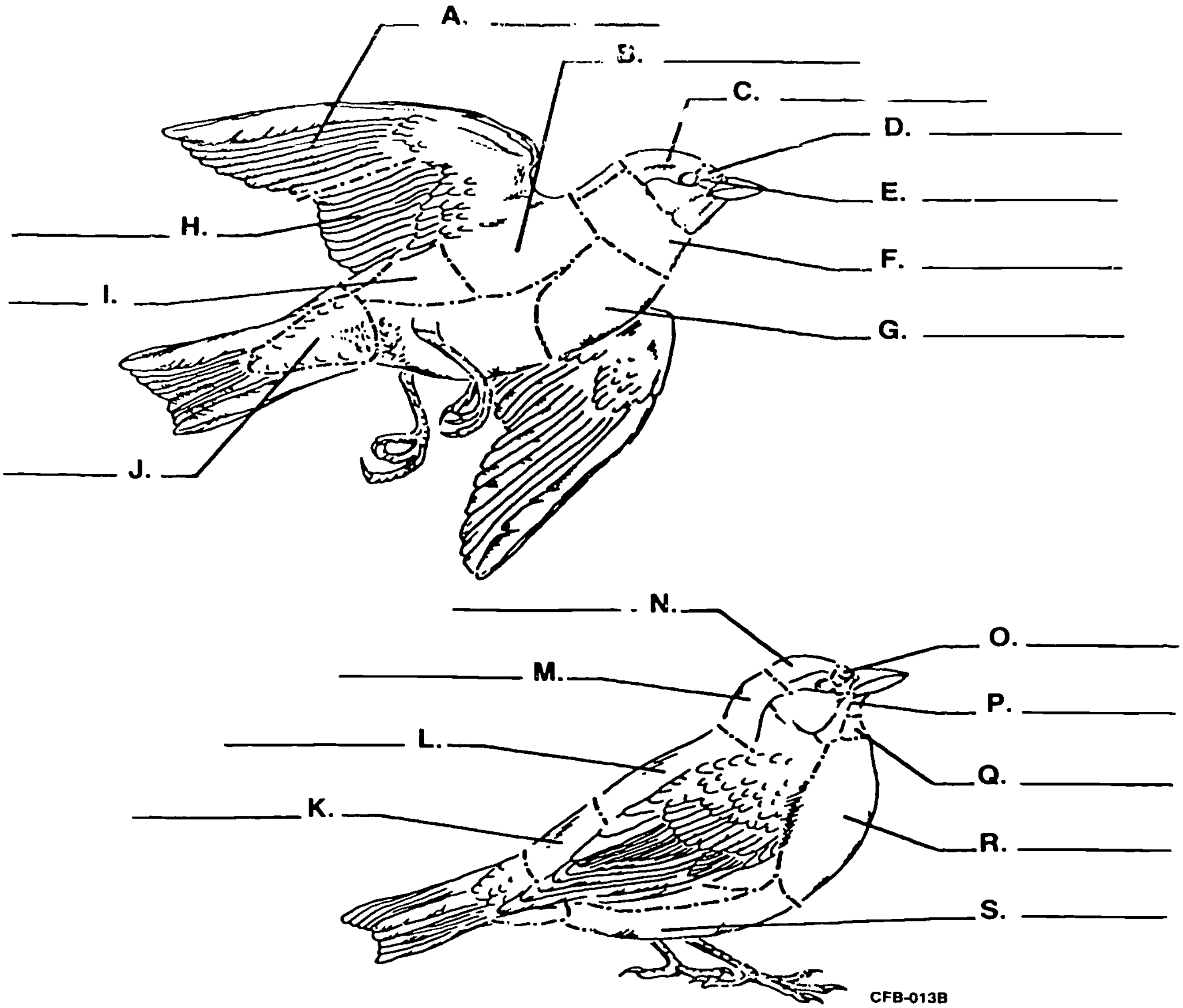


Figure 2–4. Objective A14, exercise 1.

2. What two feather groups make up the flight feathers?

3. What happens when a bird spreads its tail feathers?

4. What mode of feeding would be indicated by a hooked bill?

A15. Associate bird-borne diseases with their characteristics; cite economic, hazardous, and other bird problems.

Health Hazards. Birds are associated with several diseases. They can transmit disease to humans and animals by becoming a reservoir for disease organisms, by transmitting organisms into the air or through their droppings, or by serving as intermediate hosts for disease organisms. Among the better known diseases are histoplasmosis, psittacosis, and encephalitis, although nearly 100 diseases are alleged to have been transmitted to man by birds.

Histoplasmosis. Histoplasmosis is caused by a fungus, *Histoplasma capsulatum*. The disease is worldwide in distribution, but it is more common in certain geographical areas such as the Mississippi River Valley region and other river valleys in the Eastern and Southeastern United States. The disease is contracted by inhaling the organisms, which thrive in soils enriched by bird droppings. Histoplasmosis usually results in benign lesions of the lungs caused by an infection which often shows no symptoms. However, in advanced stages the disease can be fatal. You should be aware of the increased potential for the spread of histoplasmosis that exists in certain situations. When species such as domestic pigeons, starlings, and house sparrows roost near areas where people work, the potential for histoplasmosis increases. The histoplasmosis spores usually are spread when soils enriched by bird droppings are disturbed. For example, construction near active or unused bird roosts can expose workers to the disease. You should give special attention to these situations and include control measures in any pest management program.

Psittacosis. Psittacosis, often called ornithosis or parrot fever, is caused by a rickettsia organism called a *bedsonia*. The name "ornithosis" was applied after the disease was found in many wild nonpsittacine (nonparrot) birds. This disease is distributed throughout the world wherever birds are found. Inhaling dust with infective particles from bird droppings, feathers, bird bodies, and nasal secretions is a common source of human infection. During recent years, researchers have found that birds, such as pigeons, often carry the disease. Pigeons have been responsible for a number of outbreaks in New York, Massachusetts, Minnesota, and California. The disease often has been traced to pigeons that nest or roost on or in buildings where people work. Wild birds also can spread the organism to commercially raised chickens, ducks, and turkeys, which die quickly after showing only brief signs of illness.

Encephalitis. Encephalitis is one of the most serious diseases associated with birds. A number of encephalitis viruses are carried by birds (the primary hosts) and can be spread to people and horses by arthropod vectors, mainly mosquitoes and ticks. The viruses for Western equine encephalitis, Eastern equine encephalitis, St. Louis equine encephalitis, and several other encephalitides have been isolated in birds. These viruses attack the central nervous system, and the mortality rate during outbreaks often is high. Birds host a variety of other diseases that can be transmitted to man. Human infection usually is caused by the transmittal of the disease organism by an arthropod vector or through inhalation or ingestion of contaminated air, water, or food. The potential for such diseases is highest where large numbers of birds congregate, roost, or nest.

Personal hygiene. You must guard against personal infection, particularly when you handle birds or work in areas where birds have congregated. Always wear gloves when you handle live or dead birds. When you work in roosting areas, enclosed areas, or any where bird droppings are prevalent, wear rubber boots and gloves. To prevent infection by inhalation, wear a protective mask, preferably a disposable one. Immediately after the operation, shower and wash your clothes and all equipment in hot water with a strong soap.

Sanitary disposal of birds. If you must handle dead birds, take strict precautions to keep from spreading infectious materials. Always wear gloves. Wet the feathers of any dead birds thoroughly with a detergent disinfectant before you handle them, to immobilize lice and mites and help prevent the spread of airborne infective particles. Place such specimens inside plastic bags or other such containers before moving them to any other area. Get rid of specimens by incineration.

Bird strike losses. Each year the dollar loss from bird/aircraft collisions runs into the millions of dollars. The seriousness of the problem is indicated further by the loss of lives and the destruction of aircraft as a result of collisions with birds. A large part of the aircraft loss and damage is caused by birds striking aircraft windscreens or canopies. Such impacts account for more than half of the aircraft that are destroyed by bird strikes and about 40 percent of all accidents. You should note that about half of all birds strikes, and 42 percent of the bird collisions with aircraft windscreens and canopies, happen during takeoff and landing. Appropriate bird control in the airdrome environment can significantly reduce these incidents. You must realize that damage to aircraft is not caused only by large birds. While collisions with birds such as swans, hawks, and vultures have caused damage and loss of aircraft, collisions and engine ingestions of much smaller birds, such as starlings and swallows, have also caused damage and loss of aircraft and lives.

Other damage due to birds. While bird strikes account for most of the dollar losses caused by birds, other situations also cause concern. Bird droppings and nesting materials can damage equipment and supplies, particularly around hangers, warehouses, and other buildings. Birds also can damage agricultural crops, trees, and ornamental shrubs. Even small groups of birds can damage shade trees by eating buds during spring. Inside aircraft hangars, birds enter engine housings and can accumulate a considerable volume of nesting material within a matter of hours. Engines, idle for repair, are prime targets. Nesting material can cause jet engines to fail by clogging intakes, and static and rotating blades can be significantly damaged by nesting material. Such problems usually are associated with house sparrows and starlings that enter hangars. Birds that nest in buildings or on equipment also present fire hazards if their nests are built around or near electrical wiring and switch boxes. Even if nests are not in a situation to cause fires, electrical failures can arise from birds shorting electrical systems or from the corrosive effects of bird droppings on wires or wire insulation. Bird droppings in buildings are not only unpleasant but can result in substantial economic loss. Bird droppings corrode many metals and can cause serious damage if they fall into dismantled engines or build up on other equipment. In warehouses and other storage buildings, bird droppings on supplies often render them unusable or result in costly cleanup.

You must consider routine control of pest species, particularly pigeons, starlings and house sparrows as necessary to reduce hazards and prevent damage. These species should be eliminated to the greatest extent possible in the airdrome environment.

Exercises (A15):

1. To which diseases does each statement refer—histo[illegible]nosis, psittacosis, or encephalitis?

   _________ (1) Distribution is very common in river valleys of the southeastern part of the U.S.
   _________ (2) Attacks the central nervous system and has a high mortality rate.
   _________ (3) Has been traced to pigeons that occupy or roost on buildings.
   _________ (4) Birds are the primary host of this arthropod-borne disease.
   _________ (5) This is a fungal disease.
   _________ (6) This is found primarily in soil enriched by bird droppings.

2. What disease is caused by a rickettsia called a *Bedsonia*?

3. What keeps you from inhaling infection when you must work around bird droppings?

4. How should you get rid of dead bird specimens?

5. What two other factors are even more serious than the dollar loss from bird/aircraft collisions?

6. Around hangars, what are considered prime targets for birds to build nests?

7. What two small birds create special problems in aircraft hangars?

A16. Verify or correct statements about bird habits that conflict with people and about feeding habits of various birds.

Behavioral Habits of Birds. Birds have many behavioral characteristics that make their control different from that for other pests. In this lesson, you'll learn about some of these behavioral characteristics and patterns that are important to you.

Bird habitat. Each bird species has habitat requirements that determine where it will nest, roost, and feed. Pest bird problems often result from environmental situations that produce attractive habitats for large bird populations of a single species (a building with abundant roosting area for pigeons), or habitat that attracts large bird populations of different species (carelessly harvested grain crops attracting large flocks of blackbirds and starlings). Marshes, pine plantations, grasslands, and wooded areas are examples of natural habitats. Buildings with accessible girders, short grass on an airfield, and ornamental trees planted close together are examples of manmade habitats. You must learn to recognize these conditions. The advice of local wildlife authorities or State and Federal agencies often can help.

Roosting. A roost is where birds congregate at night, in bad weather, or at other times when they are not feeding. You usually will be concerned with birds that roost in large flocks. Gulls that roost on the ground during the day or night can become pest problems, as can large flocks of blackbirds, swallows, or other small birds that roost during the night. The areas where birds such as gulls, ducks, and geese roost in daylight, when they are inactive are called loafing areas. Roosting preferences vary widely from species to species. The roost site usually provides protection from weather and predators. Plantings, such as ornamental evergreens around buildings, often provide shelters and become roosting sites. Short grass on the airfield offers the birds protection from predators by allowing an unobstructed field of vision. Such situations are usually controlled by proper grounds maintenance. Even if the roosting site is some distance away from potential bird strike hazards, the pathway birds use to enter or leave the roost may create a problem. In such a case, reducing the attractiveness of the roost site is more effective than trying to alter the birds' routes. Species that typically roost on or in manmade structures are of particular concern. Domestic pigeons, starlings, and house sparrows find suitable roosting areas on ledges, rafters, and other structures that give them protection from harsh weather and predators. Since starlings and house sparrows will roost or nest in aircraft enclosures, try to reduce the attractiveness of such roosting areas.

Feeding. If a food source is related directly to bird control problems, control of the food source may be easier and more effective than direct control of the birds. Food and feeding habits of birds vary with species, season, and availability of particular food items. Several terms describe birds according to the type of food they consume. An insectivorous bird, such as a swallow, feeds primarily on insects. Carnivorous birds, such as hawks or owls, are meat eaters, feeding mainly on other birds, mammals, reptiles, amphibians, or fish. A herbivorous bird, such as a dove, feeds on plant material. A hervibore that feeds mainly on seeds and grains often is referred to as granivorous. Many species are omnivorous; that is, they feed on both plant and animal foods. The common crow and starling are good examples of omnivores. Crows consume fruits, grains, insects, young birds or bird eggs, reptiles, frogs, small mammals, carrion, and discarded human food. The starling, which feed on insects, fruits, grains, and seeds, also is known for feeding on garbage in and around towns and cities. Gulls are also a well-known omnivorous species.

Several of these terms may apply to a single species, depending on time of year or food availability. For example, during the nesting season red-winged blackbirds eat largely insects, while during the winter months they are granivorous. If weed seed availability is good, red-winged blackbirds consume large quantities of ragweed, bristle grass, panic grass, or other seeds during the summer. This feeding habit makes these birds beneficial to farmers during the summer, but since they eat large amounts of corn, oats, wheat, sunflowers, barley, and rice, they are also farm pests.

Some species, called scavengers, feed on the remains of plants and animals. Carrion eaters such as vultures are scavengers, as are those omnivores that feed on dead plants and animals and on garbage. Gulls and crows associated with garbage dumps and landfills are scavengers and can become serious pests when the dumps or landfills are near airfields.

Feeding flocks or individual birds may pose a bird/aircraft strike hazard. Species that feed on the ground, among vegetation, or on bodies of water may pose a problem as they move to and from a feeding area. Aerial feeders such as swallows can present a pest bird problem by feeding in the airdrome area. Terns, kingfishers, ospreys, and kestrels can pose a problem because they often hunt their prey by flying or hovering over a feeding area. Knowing the feeding habits of birds may help you tell whether a food source is the direct cause of the problem. You must find out whether pest birds are feeding, since controls for feeding flocks may be quite different from those for other flocks. Direct observation should tell you whether a bird or a flock of birds is feeding, roosting, loafing, or nesting.

Learning. Another important concept of bird behavior is their ability to learn. Learning results from experience, practice, trial, and error. For example, a bird may learn to find food at a certain location through experience if it has found food there in the past. Through practice or through trial and error, the bird may even learn how to remove food from a container at that location. Bird species differ in their ability to learn.

Habituation. Habituation is a type of learning defined as the declining response to a simple stimulus because no reward or punishment is associated with the stimulus. Simply, the bird gets so accustomed to a specific condition that it no longer reacts to that condition. A bird initially frightened away by the presence of a person may soon become tame if the presence of the person (the stimulus) doesn't result in any danger.

Habituation is extremely important to you because it can affect many pest control methods. At first, devices that repel birds with sharp, loud noises are often quite effective. The birds react to the loud noise and are frightened away. After some time, however, the birds' reaction to the noise decreases because they do not associate the noise with any punishment. Using repulsion techniques in conjunction with occasional real danger (such as live ammunition) can keep birds from becoming habituated to techniques. Control techniques will be discussed in length later in this chapter.

Exercises (A16):

Indicate each true statement and correct any false ones.

____ 1. Nesting, roosting, and feeding are determined within each bird species by habitat requirements.

____ 2. Short grass on an airfield and ornamental trees planted close together are examples of natural habitats.

____ 3. You, the pest manager, usually will be concerned with birds that roost in small flocks.

____ 4. Roost preferences vary widely from species to species.

____ 5. Short grass on airfields protects birds from predators by giving them an unobstructed field of vision.

____ 6. Species of birds that typically roost in or on natural structures are of particular concern to you.

____ 7. Domestic pigeons will roost or nest in enclosures of aircraft.

____ 8. Control of a food source may be easier and more effective than direct control of the bird.

____ 9. Food and feeding habits of birds are the same with species, season, and availability of food items.

____ 10. Hawks and owls are well known as carnivorous birds.

____ 11. During the nesting season, the red-winged blackbirds' diet consists largely of grains.

____ 12. Some of the red-winged blackbird's feeding habits are beneficial to farmers.

____ 13. Feeding flocks of birds pose no threat as a bird/aircraft strike hazard.

____ 14. Ospreys and kestrels can pose a problem because they hover over a feeding area hunting their prey.

____ 15. All bird species' ability to learn is the same.

____ 16. Habituation is an increasing response to a simple stimulus without punishment.

____ 17. Habituation is extremely important because it can affect pest control methods.

Match birds to their identification characteristics.

Common Pest Birds. To identify common pest birds and select effective control measures, carefully note the basic descriptions and characteristics. The most troublesome pest birds are gulls, pigeons and rock doves, house sparrows, starlings, and various types of blackbirds.

Gulls. Gulls are a group of large shore birds with long pointed wings, usually square tails, strong hooked bills, and webbed feet. Many species are similar in appearance, and field identification requires practice. You should note carefully field marks such as leg color, color patterns on back, head, and wing tips and the size of the bird relative to a known species.

domestic pigeon.. The Domestic pigeon apparently developed from the rock dove of Europe, Asia, and Africa and was introduced to this country as a domestic bird. Its rapid growth gave rise to the wild (feral) populations. The habitat of the wild pigeons was rocky cliffs, so the artificial cliffs created by buildings are appropriate habitat. Now pigeons are almost entirely dependent on the habitat humans have built. Domestic pigeons are common in towns, cities, farmyards, and other areas. Pigeons of North America vary greatly in color and even in size. Various color patterns of gray, black, white, and brown are common. Most types are plump birds with pointed wings and a square tail. Pigeon activities frequently conflict with our interests.

House sparrow. This particular bird, often called the english sparrow, is not a true sparrow; it is a small weaver finch introduced from Europe into North America. The house sparrow is very aggressive, has very few natural enemies, and has found abundant habitat associated with buildings and other manmade structures. Its messy habits are objectionable, and this species has outmaneuvered more desirable native songbirds for the available habitat. Adult males have a gray crown, black chin and upper throat, light-gray lower breast and belly, white cheek, and brown back and wings. Females and immature birds are dull brown with a tan stripe above the eye.

Starling. Starlings, another introduced species, are somewhat similar to to the blackbirds with which it often roosts and flocks. Spring birds have a bright yellow bill and a green and purple iridescence to their dark plumage. In fall the adult plumage becomes spotted with white, and the bill turns dark gray. The short tail and pointed wings are good field marks, especially for the drab, gray, immature birds. Because of the absence of natural enemies and other natural checks, the starling has increased rapidly. This adaptable and aggressive bird has prevailed over native birds in the struggle for available habitat and has found abundant nesting and roosting sites in our cities, where its presence in large numbers is likely to be objectionable. Large wintering flocks also are frequent pests at livestock and poultry feed lots.

Red-winged blackbird. The adult male red-winged blackbird is identified readily by the bright red covert feathers edged in yellow on a totally black body. Females are brown, heavily streaked, and spotted. Immature males are patterned like the female, although a trace of a reddish-orange wing patch often is evident.

Common grackle. There ar[illegible] color phases (purple and bronzed) of this species [illegible]d. The long wedge-shaped tail is the best field m[illegible]r this black-bodied bird with a purple, green, or bronze iridescence to its plumage.

Females are less iridescent than males, and juvenile birds are a uniform dull brown.

Other blackbirds. Several other blackbird species often are found in blackbird flocks or roosts that present a pest situation. You should be able to identify the brown-headed cowbird, rusty blackbird, brewer's blackbird, and yellow-headed blackbird, if they occur near your base.

Exercises (A17):

Match the bird in column B with the description in column A.

Column A	*Column B*
____ 1. Gray crown, black cheek and upper throat (adult male).	a. Common grackle.
____ 2. Long, wedge-shaped tail, black body, purple, green, or bronze iridescence to its plumage.	b. Gull.
____ 3. Varies greatly in color and size; various color patterns of gray, black, white, and bronze are common.	c. House sparrow.
____ 4. Pointed wings, square tail, and webbed feet.	d. Red-winged blackbird.
____ 5. Spring birds have bright yellow bill and a green and purple iridescence.	e. Rock dove.
____ 6. Females are brown, heavily streaked, and spotted.	f. Sartling.

2-2. Bird Surveys

Surveying for birds, as for other pests, is in deciding when—and if—controls are needed. As compared with other pests, however, bird surveys take on an added importance. Since many are protected by law, and the public generally holds birds in high esteem, you want a strong survey record to justify any control measures you take.

A18. Cite general principles of pest and hazardous bird surveys.

Surveying a Bird Management Problem. Before any bird problem can be controlled effectively and efficiently, it must first be identified and evaluated. For many types of pest bird problems, it's important to begin a control program while the problem is just beginning to develop or even before it begins. You should inspect the entire airbase at least once a month throughout the year. During spring and fall, when birds are migrating through the area, daily spot checks are needed in addition to the monthly inspections. For an effective survey, you must establish certain objectives to guide you.

Bird species identification. A primary objective of the survey is to identify the bird species that might pose damage problems or strike hazards. Some species or species groups (such as gulls and blackbirds) are more likely to become involved in pest situations than others and different birds will visit a given locality at different times of the year. During periodic surveys you should watch for the arrival of problem birds and to be ready to begin a control program before the birds establish a pattern for the season.

Existence of bird problems. The second objective of the survey is to find out whether there is a problem. The presence of birds, even in large numbers, is not a problem unless the birds are creating a strike hazard, a health hazard, or causing damage to buildings or equipment. If you find a problem, you must decide whether an active management program will help. During migration, the birds may soon leave on their own. In other cases, the expense of a management program might exceed the cost of the damage that would result if nothing were done.

Identification of bird behavior patterns. Another objective of the survey is to identify the specific behavior patterns that are causing the damage or hazard. Find out what the birds are doing, where they are doing it, and when they are doing it. For example: Are birds a problem because they feed near the runway, try to nest in aircraft, or roost near a housing area? These examples of bird behavior may cause problems because of where they happen. The time of day and time of year also can be important factors in the behavior patterns you must identify during the surveys. When are the birds doing the feeding, nesting, or roosting that cause the problem?

Relationships between birds and the airdrome environment. Another objective of your survey is to analyze the relationship between the birds and the airdrome environment, looking for the specific attraction that's bringing the birds. Birds, in general, need four things: food, water, a place to nest, and a place to escape their enemies or avoid harsh weather. Your periodic survey should tell you which of these four things is attracting the problem birds. More than one factor may be important to any situation, but quite often one is the key; if you get rid of it by habitat manipulation, the pest problem will be solved.

Survey Checklist. Along with conducting surveys, you need to devise a checklist for historical data on pests and hazardous bird species on your base. In addition to helping you identify and evaluate a pest problem and decide whether you need active control, these checklists document the inspection. Save them for reference when future pest problems arise or when the same problem recurs. Pest problems change with time, so it is very important to fill out the date, the time of day, and the weather conditions. Your checklist should cover about a dozen major areas.

Types of habitat. First, list the different types of habitat present on your base (obviously, habitats will vary from base to base). Second, during spot checks, this item lets you check the specific areas you inspected.

Inspecting building features for evidence of pest birds. List building features (all types of ledges, ventilators, beams, rafters, etc.) that pigeons, starlings or house sparrows like to use for roosting or nesting. For each feature, you can indicate the species and number of birds, bird droppings, nest material you find during inspections of housing areas, hangars, and other buildings. Try to sketch the situation as well as describe it in words.

Other pest bird problem evidence. This item is used to document evidence of other types of potential damage or hazards such as reports or complaints, birds loafing or feeding on or near runways, and birds crossing the flightpath of aircraft. You personally should investigate complaints before beginning a control program.

Summary of birds observed. Here you should record the species, numbers, location, and activity of birds you see during the inspection. Remember that you need a Federal permit before you start a control program that might affect any protected bird species. You can supplement your report with a map of the airbase and surrounding area, showing the locations of bird concentrations, attractive habitat features, and bird movement patterns (fig. 2-5).

Economic damage and health or safety hazard. This item requires careful analysis of the situation. Is damage being caused that will cost money to repair, or is it just a nuisance situation? Are the birds a hazard to aircraft or people?

Attraction of problem birds. Check for ecological factors that attract the birds to the place where they are a problem. This takes careful field observation; don't jump to conclusions.

Length of bird problem. Record how long the problem has existed. Check the lists from earlier inspections and ask people who have been working in the area.

Season(s) when problems exist. Record the season or seasons of the year. Again people and previous inspection records will help you.

Resident or transient birds. If you don't know whether the birds are resident or transient State or U.S. Fish and Wildlife Service biologists will identify the species, then tell you whether the birds are residents or just passing through. This answer will help determine the need for an active management program.

Time frame of bird problem. The time of a problem helps you decide whether a strike hazard can be avoided by careful mission scheduling. Use a graph with bird numbers plotted against time of day.

Active management needs. You need to find out whether the situation warrants the time and expense of an active management program. What would happen if you took no action? Take all available evidence and p experience into account, and don't jump to conclusions. If you are not sure, say so, and collect more information.

Exercises (A18):

1. For the many types of pest bird problems, when is it most appropriate to start a control program?

2. How can you anticipate the arrival of problem birds?

3. Briefly, what is our concern with bird behavior patterns?

4. What four factors usually attract birds to the airdrome, and how can we best solve the problem?

5. Why is a survey checklist essential in relationship to bird problems?

2-3. Bird Management Categories and Techniques

This section covers bird management techniques for hazardous and pest birds, but you should choose the control measures *only* after you've fully surveyed the situation. By doing this, you can develop the most effective control program possible and also avoid the public reactions that could result if your program isn't properly developed. Damage and hazard controls techniques fall into five general categories: altering the concept, altering the situation, exclusion, repulsion, and removal or reduction. For each specific bird problem, you should think through these five categories in turn, with an awareness of the variety of techniques available in each category. Each successive approach should be rejected only if there is no acceptable technique likely to be successful within that approach for the specific problem at hand. Table 2-1 lists active management techniques for some common damage and hazard situations. Let's look rather briefly at the first three control categories in this objective, then devote separate objectives to the last two categories.

A19. Cite ways we control birds by altering the concept, altering the situation, and excluding birds.

Altering the Concept. Altering the concept involves making a complete assessment of the situation at hand and deciding whether active management is really needed. The birds may merely be a nuisance or a transient problem caused by migration, with no active management program required. The cost of a management program also might exceed that of the damage being caused. Suspected bird damage situations should always be evaluated carefully. If thorough inspection reveals no economic damage, health hazard, or safety hazard, take no action. For example, someone may report large numbers of birds at a certain locality. If you find that their presence doesn't conflict with mission activities, don't try to control them. Not all birds around buildings are pests, and birds some people consider pests, others consider desirable.

Altering the Situation. Altering the situation involves either changing mission operations to avoid conflicts with birds or modifying the habitat by eliminating or reducing food, water, roost or nest sites, and perches near the airfield (the most permanent solution to many bird problems). Changing mission activities applies to many situations of a temporary nature (such as migratory birds). After evaluating the potential hazard in the particular situation, responsible individuals (at Base Operations, for example)

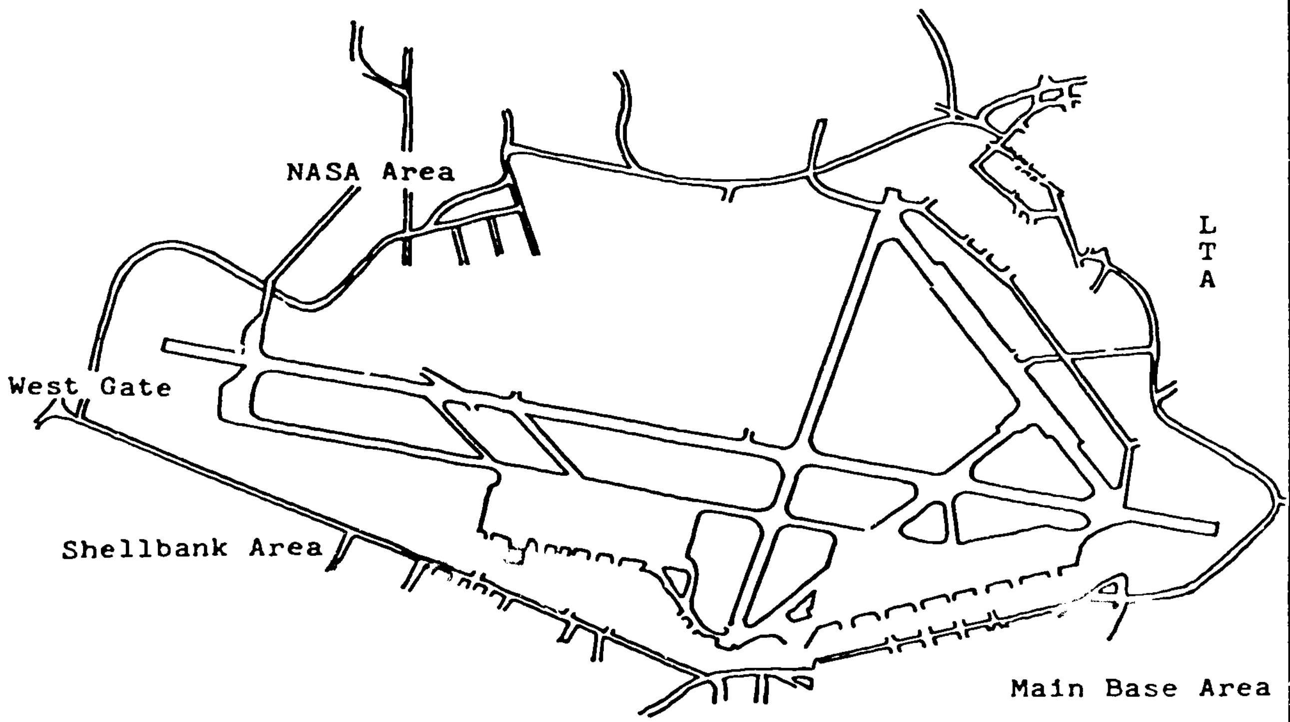
DAILY BIRD SURVEY

DATE:	TEMPERATURE:	WIND:	CLOUDS:

TIME:	RAINING, SNOWING:	GROUND CONDITIONS:

INITIALS:	BIRD WATCH CONDITIONS:

BIRD CODES: H.G. – Herring Gull; L.G. – Laughing Gull; B. – Blackbirds; R. – Raptors (Hawks, Owls, etc.); P. – P serines(Sparrows, ains etc.); O. – Other



NO.	CONDITIONS	ACTION TAKEN	RESULTS
1.			
2.			
3.			

CFB-021

Figure 2-5.

TABLE 2–1
GUIDE TO ACTIVE BIRD MANAGEMENT TECHNIQUES

Species	Situation	Potential Control Measures (in the order to be considered)
Pigeons	Around buildings	Design and construction Screening or netting Sharp projections Sticky repellents Water hoses Avitrol Pigeon trap Shooting
House Sparrows		Design and construction Screening and netting Sharp projections Sticky repellents Water hoses Avitrol Modified Australian crow trap Commercial live trap Nest-box trap
Starlings	Roosting in or on buildings	Design and construction Screening or netting Sharp projections Sticky repellents Distress/alarm calls Electronically produced noises Bird bombs
Starlings	Nesting around buildings	Design and construction Screening or netting Sharp projections Sticky repellents Nest-box trap
Gulls	Feeding on or near airfield	Elimination of food source Distress/alarm calls Electronically produced noises Airbursts or scare cartridges, bird bombs Automatic exploders
Other water birds	Creating strike hazard near airfield	Elimination of water source Elimination of food source Netting or wire Airbursts, scare cartridges, bird bombs Automatic exploders Rope firecrackers Shooting (waterfowl hunting)
Birds of prey	Creating strike hazard near airfield	Elimination of food source Elimination of nesting, roosting, or perching sites Sharp projections Sticky repellents Raptor traps
Other land birds	Creating strike hazard near airfield	Elimination of food source Elimination of nesting, roosting, or perching sites
Starlings	Feeding situations	Elimination of food source Distress/alarm calls Airbursts, scare cartridges, bird bombs Automatic exploders Rope firecrackers Avitrol Modified Australian crow trap Commercial live traps Starlicide
Blackbirds and/or Starlings	Roosting in trees	Elimination of roosting sites Distress/alarm calls Airbursts, scare cartridges, bird bombs Automatic exploders Sticky repellents Wetting agents
Gulls	Loafing on airfields	Elimination of roosting sites Elimination of food sources Elimination of water sources Distress/alarm calls Airbursts or scare cartridges, bird bombs Automatic exploders

*Altering the concept and using advoidance measures, which are not listed, should be considered (if applicable) prior to an active bird management program can select the type of changes in mission activities that may solve a particular problem. Two or more specific recommendations may be combined, depending on the severity of the problem at hand. You should go over the conflicting circumstances with the base flight safety officer, who can recommend the changes to the appropriate organization. Providing pilots information on birds is one way to alter the situation by changing mission activities. Pilots can be alerted to hazardous bird areas by posting information in Base Operations and by communication from the tower. Pilots can be told the numbers, location, and altitude of birds the same way they're told of severe weather conditions. Some changes that have been recommended by the Air Force Engineering and Services Center's Environmental Planning Directorate include restricting the use of certain runways, allowing only full-stop landings, avoiding long final approaches, reducing approach and climb-out speeds, restricting formation rejoins on departure, and raising radar vectoring altitudes. A base Bird Hazard Working Group (BHWG) is made up of members from Flying Safety, Director of Operations, Flight Facilities, Base Operations, and Civil Engineering. Ideally it is a subcommittee of an existing group such as the Air Traffic Control Board or the Safety Council. The group should review local flying to find what modifications are needed to reduce bird hazards and make pilots more aware of the hazards. Your shop and the BHWG should work together to eliminate food and water sources; to eliminate nesting, roosting, and perching sites; and to exclude birds.

Eliminating food sources. In many cases food is the major attraction for birds, and removing the food source will result in fewer birds in the area. Here are some typical food sources and ways to eliminate them. Exposed garbage at landfills attracts scavengers such as gulls, crows, and starlings. If a landfill is properly operated, with refuse being continuously covered with soil, large numbers of birds won't be attracted. You can encourage proper landfill operations. If necessary, landfills causing serious bird strike hazards should be closed and the refuse covered permanently. Garbage around buildings should be eliminated or kept in covered containers to preclude attracting pest birds such as starlings and pigeons.

Weed seeds in grassy areas attract many birds such as mourning doves and horned larks. The amount of weed seeds produced can be reduced by mowing or by regular herbicidal applications. For areas that can't be mowed, controlled burning may be an alternative. Safe burning takes predictable weather conditions and considerable skill; burning should be done only by experienced personnel.

Insects in grassy areas attract many types of birds including cattle egrets and meadowlarks. Timing the mowing to avoid exposing insects during heavy runway use may keep insect populations in check without creating a strike hazard. The mowing may have to be done at night or on weekends. If necessary, insects can be controlled by spraying.

Earthworms attract birds such as american robins to short-grass areas. After a rain, scavengers such as gulls may be attracted to runways to feed on earthworms. Runways can be swept clean of earthworms with runway sweepers.

Rodent populations in grassy areas may attract raptors (hawks and owls). Keeping the grass mowed short will eliminate the rodent habitat and, in turn, reduce the food source that attracts the raptors. A grass height of 8–12 inches will to discourage birds that prefer shorter grass for roosting without attracting large numbers of rodents and birds that prefer taller grass.

Carrion-eating birds (such as vultures, crows, and gulls) may be attracted by dead animals on the airfield. This food source can be reduced by frequent inspections, removal, and proper disposal of the carcasses.

Fruit and berries from trees, shrubs, and vines (including ornamentals) may attract birds such as swallows, warblers, or starlings. This food source can be eliminated entirely by removing the fruit-bearing vegetation. With ornamental plantings, it may be preferable to exclude the birds by netting during the fruiting time. Plant growth inhibitors may be used before fruiting to reduce food supply.

Agricultural land near an airfield can create a bird strike hazard by attracting large numbers of birds to a food source. For example, flocks of blackbirds may be attracted by grain crops or by grain wasted at harvest. Plowing or mowing exposes worms, grubs, and flying insects that attract birds. Such problems may be beyond your immediate control, but if the land is Government owned, the problem may be solved by not leasing for agriculture or by stipulating in the lease agreement that grain crops not be grown. Local farmers can be encouraged to plow the fields after harvest to reduce the amount of waste grain available.

Eliminating water sources. If birds are attracted by a source of water, removing that source will result in fewer birds in the area. Low areas or clogged drainage ditches may collect water, attracting waterfowl, gulls, or smaller shore birds. Eliminating such temporary water sources will reduce the attractiveness of the area to birds. You can get rid of the water by installing covered tile drains or by filling and regrading. Replace drainage ditches with buried drainpipe. Unclog all ditches, drains, and culverts and clear open drainage ditches at regular intervals. If permanent ponds create a strike hazard, draining and filling may be necessary.

Eliminating water sources solves the problem permanently at its origin if you follow periodic maintenance of drainage systems. Breeding areas for mosquitoes and other insects are also eliminated by removing water sources. Major filling and installation of drainage pipes and culverts are costly. Draining and filling permanent ponds is impractical, unless there's a very serious bird strike potential. Ponds, streams, marshes, and swamps often are strictly regulated by law. You may need local and State permits before you alter or eliminate them.

Eliminating nesting, roosting, and perching sites. If birds are attracted by the vegetation cover (or the openness) of an area reducing the cover will reduce the number of birds. Sometimes removing favored perches will discourage birds. Crows, starlings, and blackbirds that roost in trees often can be discouraged from using the roosting site by topping or thinning (pruning) the trees. A sparse tree canopy gives fewer perching sites and little protection. Remove more branches than you normally would remove in residential pruning. Where birds roost in tall trees, topping the trees to 20–30 feet may be effective. A more drastic measure would be the complete or nearly complete removal of the trees. You can discourage birds that roost in tall reeds (blackbirds or swallows) or birds (meadowlarks) that roost or nest in tall grass by cutting or mowing the plants shorter. For areas that can't be mowed, controlled burning may be an alternative. If gulls loaf in open areas of short grass, they can be discouraged by letting the grass grow tall enough to obstruct their vision and make it hard for them to spread their wings freely. Removing dead snags where hawks frequently perch may discourage the hawks. You must recognize that removing or thinning vegetation may just make the bird move to nearby sites. As with other methods of habitat manipulation, some of these controls can be costly in terms of labor requirements. As we said about water, habitat modification that may disturb or harass protected species will require appropriate permits. Since active raptor nests are protected by Federal law, you can't cut their trees without a permit. Controlled burning also requires appropriate permits.

Exclusion. Exclusion keeps birds from gaining physical access to an area where they can cause a problem, such as roosting or nesting in buildings. Some exclusion techniques are habitat modification. Exclusion is most effective when it is part of the design and construction of new structures, but there are ways to exclude birds from existing structures.

Design modifications. Structural design often is responsible for attracting domestic pigeons, starlings, and house sparrows. Unfortunately, you may not have a chance to comment on structural design during the planning stages, but design modifications or more construction may modify the features that attract roosting or nesting birds. You can box open eaves of a building and seal cracks or crevices that attract starlings or house sparrows. The building materials you need depend on the design modifications. Boards, bricks, mortar, or sheet metal are often appropriate, and screening is an alternative. Look for accumulations of bird droppings, protruding nest materials, or watch the birds with field glasses to keep from scaring them away from their nesting cavities. When you know the problem areas, choose the appropriate building material, remove nests, and seal off the opening.

Eliminate ledges used as perches by installing angled board, a piece of sheet metal, or a row of bricks. Design modification can be a permanent method of pest bird exclusion, and if it's not done during nesting, it is not likely to cause an adverse public reaction. This makes it a socially acceptable way to keep protected species, such as robins or swallows, from nesting on structures in the future.

Screens, nets, or wires. Exclusion by screens, nets, or wires consists of installing materials that will prevent the physical access of birds to areas where they roost, nest, or feed. Screening or netting frequently is used to keep pigeons, starlings, or house sparrows from roosting or nesting in or on buildings or other structures. Ventilation holes and chimneys can be covered with screening. Netting or crisscrossed wire can seat off drainage ditches or other water areas that attract water fowl, gulls, or other birds. Screening can exclude starlings and gulls from filter beds and settling tanks of sewage treatment facilities.

Pigeons and starlings sometimes can be discouraged from hangars or warehouses by suspending netting from the top of the large doorways. The birds may be reluctant to fly low enough to enter under the netting. This technique is not effective against house sparrows, nor has it been scientifically tested, so the maximum ground clearance that will be effective and the probability of success are unknown. Netting also is used in agricultural situations to protect fruit crops, vines, shrubs, or ornamental trees. In relatively small areas, use 1/2-inch mesh screening. To enclose larger areas, such as an aircraft hangar superstructure, or to partially screen large doorways, use nylon or polyethylene netting. Several materials can be used to cover fruit trees or vines, including acrylic fiber webbing and plastic netting.

To control pigeons, starlings, and house sparrows in aircraft hangars, clean the hangar with high-pressure water. Use deicing booms to wash down griders and remove nests. Turn off all electrical power to the building to eliminate the shock hazard. Scrape dropings from beams accumulated before you wash them, then spray with disinfectant where you remove nests. Wash hangar floors and treat them with disinfectant. Incinerate all removed nests and dead birds. Replace torn out insulation. Be sure the screening does not touch the insulation, or birds will pull insulation fibers through the mesh. Screen off all nesting and resting areas, such as edges of runs, ducts, and conduit races, spaces between the wall and utility runs, and around heating units. Suspend netting as required to enclose larger areas.

NOTE: If you think this sounds challenging, you're quite right. If you're planning to do this to any hangars or other areas, first contact your Command Pest Management professional or the Environmental Planning Directorate of the Air Force Engineering and Services Center.

Crisscrossing wire across water bodies takes at least 10-gauge wire to minimize the potential for injury to birds. Nylon monofilament lines of 50- to 100-pound test can be substituted for wire. Place posts about 6 feet apart on each side of the body of water, alternating their positions with those on the opposite site, and string the wire in a zigzag pattern about 12 to 18 inches above the waterline. This technique is effective against large birds only. If it's installed right, screening or netting is a permanent solution to a pest bird problem, although it takes periodic inspection and maintenance. Exclusion of birds is socially acceptable and should not cause a public relations problem. Netting and screening are appropriate ways to exclude protected species.

Sharp projections. Sharp projections, wires, or spikes can be used as barriers and repellents to perching birds on building ledges or other surfaces (fig. 2-6). Usually installed to discourage pigeons, starlings, and house sparrows from structures, sharp spikes also have been used to keep raptors from perching on runway marker lights. These devices are available in strip form and are attached with clips, fasteners, wire ties, or adhesive. Different designs are available for large birds, such as gulls or pigeons, and for smaller birds, such as Starlings or house sparrows. This material can be installed on ledges, rafters, window sills, or other locations where birds might roost, loaf, or nest. Wide surfaces may require two or more

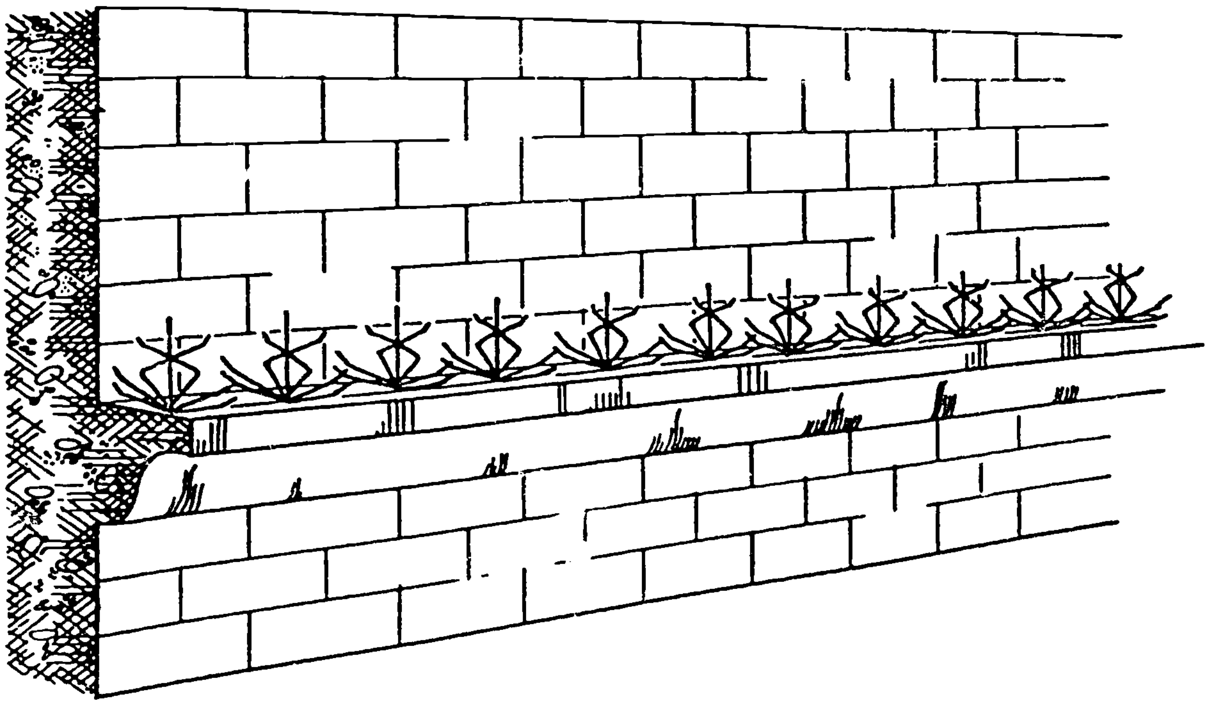


Figure 2–6. Application of sharp projections.

parallel rows of the material. You'll get instructions on adhesives, or fasteners, and spacing with the material. Find the appropriate locations for this material by watching birds directly or by noting heavy concentrations of droppings. Sharp projections are effective and permanent on ledges, rafters, and other structures, but obviously they mustn't be used in accessible areas where a safety hazard might result.

Exercises (A19):

1. When may you decide that no action is needed?

2. What is the most permanent solution to many pest bird problems on airfields?

3. What must you do before you cut trees that have active raptor nests?

4. Which type of exclusion technique will keep water fowl from drainage ditches and other water areas?

5. Which exclusion method is used to keep raptors from perching on runway lights?

A20. Cite repulsion methods for bird management programs.

Repulsion. Repulsion is simply scaring birds away. Many devices and techniques have been designed to repel birds. Techniques used for birds on airfields usually are visual (sight), tactile (touch), and auditory (hearing). For our purpose here we will concentrate on the auditory repulsion technique. In auditory repulsion (the type most commonly used to prevent strike hazards), the keys to success are diversity and intensity.

Recorded distress/alarm calls. This bioacoustic technique consists of using a loudspeaker and cassette tape player to broadcast a recording of actual bird distress or alarm calls to frighten away flocks of birds. Distress or alarm calls are highly recommended for dispersing flocks of gulls or other birds from an airfield. In the Air Force, gull control is their primary use. This technique also is frequently effective in dispersing blackbirds or starlings from roosts in trees or starlings roosting in hangars, and in other situations where flocks are a problem. in the past, it was thought that you needed a recording of the specific species involved for it to be effective, but this isn't necessarily true. You may want to try different distress call tapes, or even barking dogs. Repulsion is most effective with transient birds, and they're more effective with roosting or loafing birds than with those that are nesting. Auditory repulsion is not recommended for pigeons or house sparrows.

Equipment consists of a vehicle from which to broadcast the calls, sound equipment (tape player with loudspeaker), and the cassette tape recordings. The loudspeaker can be mounted on the vehicle. The sound equipment must play the tapes loudly and with good fidelity. A system with 30–50-watts power without distortion to produce 90–110 db (several feet in front of the speaker) and a frequency response of up to at least 20,000 Hz is recommended. The system can be powered directly by the vehicle through the cigarette lighter, using an AC/DC transformer. You can get recorded tapes of distress and alarm calls for various species from the Air Force Engineering and Services Center, Tyndall AFB, Florida.

As with other control techniques, it is best to start a repulsion program before the birds establish the habit of using the area. If the birds already frequent the area, watch their usual movement pattern; it's easier to herd them along accustomed flight patterns than to disperse them at random.

For loafing gulls, drive to within 100–200 yards of the birds. Note the wind direction because sound carries farther downwind. If birds are roosting in trees, you'll need to get even closer, because the trees will muffle the sound. In hangars, the sound may echo, making it unrecognizable to the birds. Try different spots within the hangar; you may need to move the speaker up to ceiling level. At tree roosts and loafing areas, play the tape from different locations.

To keep birds from getting used to this control technique, play the tape as little as possible and never let it run continuously. Two or three attempts should be enough. If the birds don't disperse after the third try, the call probably isn't going to work. Don't let the tape keep running, because this will persuade the birds that they are not in danger, and they will ignore the tapes.

Often the birds rise up and fly toward the loudspeaker when they hear the distress call. Sometimes they circle for a short time over the source and then fly away. At other times they may circle the vehicle and spiral higher and higher, creating a hazard to aircraft. For these reasons, you should use pyrotechnics, airbursts, scare cartridges, or live ammunition after [illegible] tape to speed their departure. For [illegible]lings or bl[illegible] is [illegible] play the tape in [illegible] second inter[illegible] a few minutes as the birds are arriving at the roost. [illegible] for 4 to 7 successive nights.

In many situations, tapes are probably the most effective repulsion technique. If the tapes are used properly, habituation is not as likely to occur as with other methods. Except for the reinforcing measures, you don't need other supplies. The birds are not harmed physically by the distress or alarm calls, and there's no fire hazard, no soiling problems, and no chemical residues.

Circling gulls may create an immediate strike hazard until they disperse. High background noise can keep the birds from hearing the recording. Echoes and distortion of the calls inside a hangar or between buildings may reduce effectiveness. The recordings are disturbing to some people. As with any repulsion method, the birds may become a problem elsewhere. Repulsion alone will not permanently solve a problem; habitat changes also should be made. Playing recorded distress and alarm calls is harassment, and you can't use it on some protected species without a permit. If you use live ammunition as reinforcement, depredation permits also are required for protected species, including gulls.

Electronic noises. Other electronic noises that simulate bird calls have been broadcast by loudspeakers much the same as the distress and alarm calls to repel birds. Ultrahigh frequency sounds (ultrasonics), which cannot be heard by humans, are not recommended for bird control because their effectiveness is unproven.

M–74 airbursts and scare cartridges. M–74 (M–74A1) airbursts are explosive charges fired from an AN–M8 pyrotechnic pistol (flare gun). Commercial scare cartridges are 12-gauge shotgun shells that propel a second charge instead of pellets. Fired in a flare gun with an insert or an open-choke or unchoked shotgun, the propelling charge ignites the fuse on the second charge as it projects the charge about 100 yards, where it explodes with a loud noise and a flash of light. Airburst and scare cartridges are fired into the air to repel flocks of birds such as blackbirds, starlings, crows, gulls, or waterfowl. Pyrotechnics in conjunction with distress and alarm calls will repel birds coming in to roost (blackbirds and starlings) or gulls loafing in the vicinity of runways, but they're seldom effective for pigeons or house sparrows.

You can get procedures for ordering M–74 airbursts from the munitions supply office, Security Police squadron (supply account code FK) on each base. Technical Order 11A–1–46, *Fire Fighting Guidance, Transportation and Storage Management Data and Ammunition Complete Round Chart*, gives information on shipping, storing, and handling airbursts. Technical Order 11W2–9–2–31 gives directions for manufacturing an insert (fig. 2-7) to fire 12-gauge scare cartridges in the flare gun. This combination gives you about the same range and efficiency as the M–74 airbursts but at a considerably lower cost. Also, it's easier to care for the flare pistol than the 12-gauge shotgun. The following instructions apply to the M74A1 simulator airburst and the 12-gauge scare cartridge. Whichever type you use, fire pyrotechnics at not less than 45° from ground level a[illegible] never i[illegible] the direction of any person, vehicle, or [illegible] 1000 feet. Carefully follow all [illegible] safety rules listed on AF Form 497, Air Force Polic[illegible]ement–Firearms Safety and Use of Force. The user must wear leather gloves, ear protectors, and goggles. All other people in the area should have ear protectors. There must be no smoking at any time within 50 feet of pyrotechnics. If pyrotechnics malfunction, stay clear of that area for at least 30 minutes. Relay the exact position of the malfunction to the base explosive ordinance disposal (EOD) office. They will send a team to the area for disposal. At no time may pest management personnel dispose of any malfunctioned pyrotechnics. Except during transportation, keep pyrotechnics under visual observation at all times after they are issued and until they are expended. Use two-way radios to coordinate with the

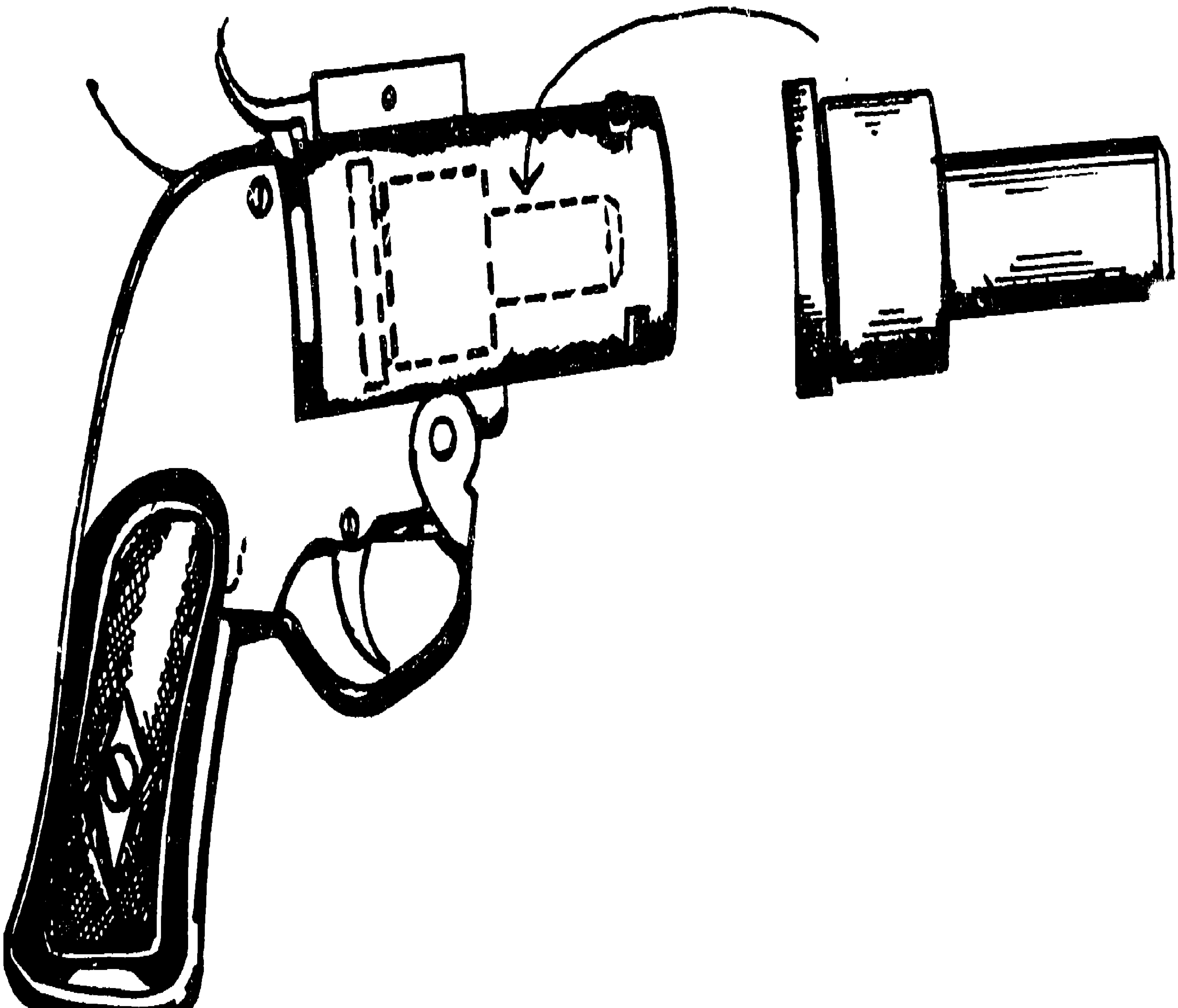


Figure 2-7. M-1 Pyrotechnic pistol and steel sleeve insert.

control tower before you fire any pyrotechnics. Store pyrotechnics in a metal box and secure the box in the vehicle during transportation. Before using pyrotechnics, notify the command post, hospital, Security Police, flying safety, and explosives safety offices.

Proceed to the area where the birds are a hazard. Get control tower clearance. Don all applicable safety equipment. Remove the pyrotechnics from the storage box and load the weapon. Grip the weapon with both hands, aim high towards the target, and fire. Inspect the weapon chamber and barrel before reloading to be sure it is free of obstruction. Dispose of empty casings properly. If they're left on the airfield, they may be picked up by birds and dropped on the runway, where they can be ingested by a jet engine. For the same reason, unexploded projectiles must be recovered by EOD personnel. After bird dispersal, return the pyrotechnics to the storage box and then to the appropriate office. To protect against fires, two 10-pound extinguishers for type B and C fires always must be available. In the event of a fire on the airfield, immediately stop using pyrotechnics, try to extinguish the fire, and have the control tower inform the fire department.

When pyrotechnic devices are used without other repulsion techniques, birds may habituate to the noise, reducing the effect. This tendency can be reduced by occasionally mixing in live ammunition to show the birds that a hazard is present. As we've seen, using pyrotechnic devices n conjunction with recorded distress or alarm calls can reduce the potential for habituation to either technique. The keys to success are *diversity* and *intensity*. Fire the airbursts or scare cartridges at irregular intervals, and combine their use with other repulsion techniques. In trying to disperse a roost, provide daily harassment (as the birds arrive) for up to 2 weeks.

Automatic exploders. Automatic exploders, sometimes called gas cannons, produce loud noises similar to those of a 12-gauge shotgun, but at regular intervals, to frighten birds away from airfields or hangers. Mainly for open situations, these exploders are reported to be particularly effective for waterfowl but have also been used (with varying degrees of success) for gulls, blackbirds, starlings, crows, and other birds, both feeding and roosting. They should be most effective on species that are regularly hunted and thus are likely to associate the noise with gunfire. Like the other noisemakers, they're generally ineffective on pigeons and house sparrows and they're best in combination with other controls. Airbursts will help keep the birds from getting used to the noise. Where birds are attracted strongly to an area, try explosions at 1- to 2-minute intervals. One cannon can repel birds from about 10 areas, so you'll need several for most airdromes. The effectiveness is increased if the cannons are pointed downwind. *Change the location frequently*, perhaps every hour, but at least daily, or the birds will soon ignore the noise. For ease of movement, you can mount the exploders on a vehicle. While it's in operation, check the mechanism periodically. Repulsion should start when birds start feeding or roosting in an area, rather than after a pattern has been set for the season. It is even better to start the program before the birds' estimated arrival time, based on past years.

A scareaway gun for bird dispersal listed in Table of Allowance 483 operates from liquid propane, ignited by a flint that sparks when it's struck by the firing mechanism. The timing of explosions is determined by gas pressure. This technique is not harmful to birds. Gas cannons have a low operating cost compared to shotguns or airbursts.

Exercises (A20):

1. Under what conditions do repulsion techniques work best?

2. In dispersing loafing gulls with recorded sound, what is the minimum distance the vehicle is driven to the birds?

3. What is likely to happen to birds when a distress call tape is allowed to run continuously?

4. List the characteristic that is essential to the 12-gauge shotgun when used to project scare cartridges.

5. When using pyrotechnics, what safety equipment must be worn?

6. Pyrotechnic devices are most effective when they are used in conjunction with what other repulsion technique?

7. What beneficial characteristic do gas-operated exploders have as compared with 12-gauge shotguns or airburst?

A21. Cite removal and reduction techniques for managing birds.

Removal or Reduction. These techniques attempt direct population control by capture or killing. This approach is rarely effective. Even if a large part of the flock is removed (a difficult task), other birds eventually will move in to replace them if the original environmental attraction remains. Killing birds also is likely to result in adverse public reaction. Nevertheless, there are instances when habitat modification, exclusion, or repulsion are not viable approaches, and direct population reduction is appropriate. In this area we are talking about trapping birds unharmed. We will discuss six types of bird traps.

Commercial live traps. Traps designed to capture birds unharmed are available in a variety of designs from commercial sources. Birds are attracted by bait, perhaps in combination with live decoys. Captured birds can be killed by gassing or, preferably, transported for release elsewhere. You can use commercial live traps to capture domestic pigeons, starlings, or house sparrows. Trapping is not practical over large areas or where large populations are present, but considerable numbers of pest birds can be removed from limited areas with persistent effort. If birds are not feeding, they may be encouraged by prebaiting. Birds are more easily attracted to bait in winter because natural food is less available. Starlings, however, do not usually feed near their roosts.

Traps can be manufactured within your unit if resources are available. Each trap is designed to capture a particular species. The designs include swinging-bob pigeon traps, funnel traps for pigeons, center-drop traps for starlings and house sparrows, funnel traps for house sparrows, and some novel designs. Many models capture dozens of birds at once, and some have multiple chambers to increase their capacity and prevent escape. Try to place traps where they will not be disturbed. Bait them (inside and around the trap) with appropriate food and ample wat . Pigeons can be attracted by whole corn, house sparrows by finely cracked corn, and starlings by cracked corn, peanut butter, or apples. Check all traps daily. Several calm, healthy birds left in the trap to serve as decoys will often increase efficiency. Handle protected species carefully and release them immediately. Nonprotected birds causing a pest problem should be released at least 40 miles away. You can cover the trap with a tarpaulin (after you remove protected species and kill decoys) and the birds by piping gas through a hose connected to the exhaust pipe of a vehicle. Incinerate dead birds.

Live-trapping and release is socially acceptable; and even if pest birds are killed by gassing, live-trapping is less likely to cause a public relations problem than poisoning. Protected species usually can be released unharmed, although frantic birds may be injured in the trap. Live-trapping is expensive and time consuming, because it takes considerable persistence to be effective even on relatively small populations in limited areas. Removal is not a permanent solution to a pest problem, as other birds will move in to fill the available habitat. Eliminating the habitat is the best solution.

***Pigeon traps*.** You can use these traps to help reduce the numbers of pigeons feeding, roosting, or nesting around buildings. (Refer to Volume 3, Chapter 2.) Place the traps near feeding or roosting locations, but where they will not be disturbed; a flat rooftop is often a good location. Watch the pigeons' feeding habits to spot suitable trapping locations; if they're feeding in open fields, place the traps in a field. If they've been feeding near the runway, don't trap there, but try to lure them away. Post signs to keep people clear of the trapping area. Spread preferred food such as cracked corn or other grain around the door of the trap and put an ample supply of bait and water inside. Tie the bobs open and prebait for 2 weeks to lure the pigeons to the food source and get them used to entering the traps, then untie the bobs to activate traps. Over several weeks, check the traps daily to remove captured birds for transport and release; leave two or three healthy birds as decoys and replenish food and water as necessary. If you leave too many birds in the trap, they'll eat all the bait and few other birds will be attracted. Try to leave the same birds as decoys each time so they will become tame. Leaving birds with distinctive color patterns will facilitate identification; bright-colored birds also seem to be more effective decoys than the duller blue-gray birds. Make a portable holding cage to carry the captured birds and mark them with indigo red dye so you'll recognize any that return to the area. Take the birds to a suitable area at least 40 miles from the base and release them. If any marked birds return, dispose of them as directed by the hospital commander. After several weeks of trapping, another prebaiting period is recommended, followed by several weeks of trapping. If trapping is unsuccessful, the birds must be destroyed.

Pigeons with leg bands or nontarget species such as mourning doves can be released unharmed. Trapping does not involve the hazards associated with toxic chemicals. Fairly large numbers of birds can be captured and removed, but at best, trapping will remove only 75–80 percent of the resident pigeons in any area. Results are slow, and it takes a lot of effort. As we've said over and over, removal is not permanent, because other birds will move in if the attraction remains. Pigeons aren't federally protected, so there are no legal restrictions on live-trapping in most places. In some areas, all birds are protected by local regulations, so always check with the base Staff Judge Advocate about permit requirements.

***Modified australian crow traps*.** These traps can capture starlings, house sparrows, blackbirds, and other problem birds in a fairly small They should be at least 8 feet long, 6 feet wide, and 6 feet high or even larger if practical. A 1.75-inch width of the entrance slots and a 9-inch minimum clearance at each end are critical. Place traps in an open area rather than under trees. For starlings (as well as many other birds), you should bait the traps with rotting apples, finely cracked corn, or feed pellets. Try to bait with a food that the birds are used to eating. If one trap location or type of bait doesn't work, try another. The trap will be most effective with 10 to 12 decoy birds in it. You may have to catch the first decoys some other way.

Provide the decoys with fresh water. You can make two suitable water containers by splitting an old rubber tire down the middle. Tend the traps regularly.

The modified australian crow trap is probably the best live trap yet devised—simple and effective. Protected species usually can be released unharmed, while nonprotected species can be killed or transported and released. Since the traps are large, they may need disassembly for moving or storage.

***Nest-box traps*.** Nest-box traps are used to reduce local numbers of starlings or house sparrows during their breeding season. Nest-box traps come in several different designs. There are plans for a house sparrow trap in Volume 3. For starlings, the trap is the same, but the opening is slightly larger (2 inches instead of 1½ inches). The front wall is put on last and fastened by screws to make repair easier. Glue pieces of hay and feathers to the back of the chamber, and use a tightly woven sack to receive the birds as they are captured. Place the trap on the side of a building or on a pole where the sack can hang freely and be easily reached with the use of a ladder. Getting rid of existing nesting sites may increase the effectiveness of the traps.

In a limited area, nest-box traps can effectively remove house sparrows or starlings, but they probably won't eliminate all the pest birds in any area.

Raptor traps. If raptors (birds of prey) create a strike hazard and you can't discourage them with other measures (such as eliminating the food source), you may be able to trap them with verbail pole traps or Bal-Chatri traps, and then release them elsewhere. Of course this takes the cooperation of the U.S. Fish Wildlife Service. They'll provide the traps or the information you need to build traps. Verbail traps are set on top of posts. As the raptor tries to perch on the post it lands on a trigger plate, which causes a spring to loop a cord around its feet. The Bal-Chatri trap is a cage of hardware cloth with the top covered by slipknot nooses of monofilament nylon (fishing line). Different sizes of traps are used for different raptors. A live lure such as a mouse, starling, or house sparrow (or perhaps a rabbit, chicken, or pigeon for owls) is placed inside the cage. A raptor landing on the cage gets its feet tangled in the nooses. Watch raptor traps continuously or check them very frequently to remove birds before they are injured. Releast captured birds at least 20 or 30 miles away to keep them from returning.

Trapping has no advantages over habitat modification or tactile repulsion techniques for discouraging raptors. The Bal-Chatri has several advantages in comparison to other raptor traps; specifically, it is simple, portable, easier to build than the Verbail trap, and there is little danger of accidentally killing the birds. As it is with other traps, habitat modification (or using tactile repellents on the perches) is a better, more permanent solution to a strike hazard. Raptors are protected by Federal law; you need a permit to capture them, and even then you need the cooperation of the U.S. Fish and Wildlife Service.

Nets. Birds can be captured by various types of nets, including cannon nets, mist nets, and floodlight traps. The cannon net uses rockets or mortar projectiles to carry a large, light net over a flock of birds attracted by bait. Mist nets are made of fine black nylon thread (like a hairnet) that 's virtually invisible, strung between two poles against a dark background. The floodlight trap is a huge funnel-shaped net (supported by a frame) into which roosting birds can be driven. The funnel narrows down to a tent, lit by floodlights, which functions as a holding chamber.

The cannon net was designed for waterfowl but it works for other birds. Mist nets will capture small birds such as house sparrows, if they can be placed to block the birds' normal flightpath. The floodlight trap was designed to catch starlings and blackbirds at night roosts. Like trappig, netting isn't likely to remove enough birds to be practical. If you think a pest situation warrants a netting, contact the U.S. Fish and Wildlife Service for permission, information, and help.

Shooting. Shooting can be used to eliminate small flocks of pest birds in limited areas. Live ammunition is most effectively used to frighten away flocks of birds or to reinforce noise techniques. In certain circumstances, hunting may be encouraged to control game birds such as waterfowl that may cause a strike hazard. Shooting has been tried as a control for gulls on airfields but was generally ineffective.

The firearm and ammunition used should have enough power to kill quickly, but shooting near buildings or equipment or using excessive firepower increases the chance of damage and the hazard to personnel. For pigeons, you can use birdshot in a .22-caliber smoothbore rifle or a .410 caliber shotgun, or even a high-powered air rifle. Larger bore shotguns can be effective in more open areas. Use the best marksmen available. A local rod and gun club or Security Police personnel may do the job. You can build a blind on the roof of a hangar from which to shoot the birds as they fly into the hangar or over the roof. Take adequate safety precautions, and restrict access to the area. Post guards in the hangar to keep people out. Remove aircraft and ground equipment from the washrack and hangar apron. Limit the firing zone to protect other buildings. If firing is directed toward the flight line, move aircraft to a safe area.

When you're using live ammunition to reinforce repulsion techniques, just kill an occasional bird. Leaving the dead bird where it is visible to the rest of the flock may increase the effectiveness of the program, but remove it when you leave the area to keep scavenger birds from getting it. It is important to be persistent. Discontinuing a program too early may lose whatever progress has been made.

Shooting is selective in terms of the species (or individual bird) to be eliminated. In some circumstances, it may be the least expensive and most rapid technique available. Shooting will reinforce other repulsion techniques and may greatly increase their effectiveness. Like other reduction techniques, it's rarely effective for population control. Other birds are likely to replace those shot. Live ammunition is hazardous to people and aircraft and may damage buildings or equipment. Shooting birds may cause bad public reaction. This technique cannot be used where firearms are restricted or in other areas where a safety hazard may result. Federal permits are required to kill protected species, including gulls and blackbirds. State permits may also be required.

Poisoning. All the other techniques are preferable to poisoning, but sometimes other approaches are not practical, and a toxic chemical is needed. If you have to kill the birds, rather than to merely repel them, or if rapid results are mandatory, you can use poisons more extensively, but only poisons registered by the EPA for birds. Unauthorized poisons are unlikely to be effective or may present a severe hazard to personnel. For one or more of these reasons, strychnine, thallium sulfate, and poison perches (containing Fenthion and Endrin) are not recommended. Poisons you may consider for use are Avitrol and Compound DRC–1339 (which is sold under the tradename Starlicide).

Avitrol. When birds eat bait treated with this toxic chemical, they react erratically, exhibit abnormal behavior and give distress calls. This frightens the rest of the flock away from the area. Avitrol is currently registered for use by authorized personnel as a repellent for gulls, starlings, blackbirds (including common grackles and cowbirds), crows, house sparrows, and pigeons. Since bait must be eaten, this technique only applies to situation where birds are feeding or can be prebaited to feed. Although pigeons react less than other species, this technique is recommended for them, because it is more effective than auditory repulsion.

Although Avitrol has been used successfully to repel gulls from airfields, it is not recommended in such situations because the attracted by prebaiting may create a serious strike hazard. You can use Avitrol to disperse gulls from landfills near airfields. Avitrol is not recommended to control Starling roosts, because starlings generally don't feed near their roost, but in feeding situations, it's quite effective against starlings. It's often more effective with large flocks of birds than with smaller ones.

Various types of grain treated with the chemical, as well as untreated grain of the same type for prebaiting, are available from commercial suppliers. Different concentrations and types of treated bait are registered for different uses. For pigeons, using whole corn minimizes the hazard to smaller, nontarget species that will not eat whole kernals. For house sparrows, treated mixed grain or fine corn chops (cracked corn) can be used. Treated corn chops (double strength) are usually accepted by starlings in feeding situations. For gulls at landfills, you can apply powdered concentrate of Avitrol to bread.

Prebaiting is the most important part of the control program, even when birds are already feeding in the area. The birds must get used to eating the same type of food and in the same place as the treated bait that will be used. Do not prebait in an area where protected nontarget species are feeding or will be attracted. Nontarget species that do not eat grain (e.g., american robins, mockingbirds, purple martins) do not pose a problem. If you have to prebait where the birds are not already feeding (such as hangar roof), allow a longer prebaiting period. It is advisable to allow 2 weeks for prebaiting although several days may be enough if acceptance is good. If possible, bait above the ground to minimize exposure of people, pets, and some nontarget species (e.g., mourning doves). A flat rooftop is a good location to prebait for pigeons. Elevated feeders can be built for house sparrows.

Prebaiting does several things. You learn the feeding habits of both target and nontarget birds. Prebaiting locations that attract protected species can be discontinued before you treat the bait. Also, the target birds get used to being fed and will readily take the treated bait when it is substituted for the untreated bait. For pigeons, put out the feed at the same time each day. A break in the pattern will result in a setback to the prebaiting program. Keep plenty of bait onhand, so that the supply does not run out before you get total acceptance.

After a feeding pattern has been established, immediately substitute treated bait for the untreated. When you handle treated bait, wear gloves and follow label instructions carefully, then change clothes and was thoroughly. Burn the downed birds and any excess bait and empty containes. Do not expose people to the fumes or smoke.

Only part of the flock needs to eat treated bait, so blend it with untreated bait of the same type. The higher the concentration of treated bait, the more birds will be killed. For example, a mixture of 30 parts untreated to 1 part treated (30:1) may repel flocks of pigeons with little mortality. Mixtures of 10:1 or 5:1 constitute reduction rather than repulsion, for many birds will be poisoned. The average amount of blended bait needed per treatment is 3-4 pounds for pigeons and about 1 pound for house sparrows. It may take daily treatment over a period of several weeks at increasing concentrations. Don't expect one hundred percent repulsion of either pigeons or house sparrows. You may need a regular maintenance program to keep the populations at acceptable levels.

For gulls at landfills, cut standard slices of bread into 12 sections. Treat only one-tenth of the sections (i.e., a 10:1 ratio) with Avitrol concentrate by shaking in a plastic bag. After prebaiting, broadcast the untreated bread and space the treated bread throughout the area. A typical application for 5000 gulls is 240 untreated pieces (20 cut-up slices of bread) and 24 treated pieces (3 pieces at each of 8 widely separated stations). One-half of this amount in any one feeding area is enough for smaller flocks. Repeated applications and site maintenance may be required for continued control. Repulsion is not a permanent solution to a pest bird problem. Unless techniques such as habitat manipulation or exclusion keep the situation from recurring, applications may need to be repeated.

Consult U.S. Fish and Wildlife Service personnel before you start a management program using chemicals. Permits are required for use on protected species, including gulls. Bait used for nonprotected species should not be exposed where it may be taken by protected species or where streams or ponds may be contaminated by runoff (i.e., drainage of rainwater).

Starlicide. Starlicide is the registered trademark for compound DRC-1339. It's available as a 0.1 percent mixture called Starlicide Complete. Apply Starlicide in a feeding trough 4 feet long, 12 inches wide, and 3 inches deep or in plastic pans. You may need to prebait with untreated feed pellets to get the birds used to feeding on pellets in the trough or pans. You can also broadcast bait on dry or frozen ground, but this increases the danger to protected species. If protected species feed on the bait, discontinue the program or try prebaiting in another spot. When the starlings or blackbirds are regularly feeding on the untreated bait, replace it with the treated mixture. Use no more than 20 lbs per acre for feedlots over 10 acres, or more than 50 lbs per acre for smaller lots. The poison may take up to about 48 hours to take effect, and birds never die less than 3 hours after ingestion. As always, wear gloves, burn the excess bait and dead birds, keep unused inaccessible to poultry or livestock, and follow label instructions carefully.

Starlicide is less toxic to mammals than Avitrol, and it's less toxic to light-colored birds than to dark birds (such as starlings) so the danger to many protected species is reduced. There is always some danger to protected species. Poisoning birds is unpopular and may cause an adverse public reaction, especially since the slow-acting poison will not take effect until birds have moved to another, perhaps more populated, location.

Exercises (A21):

1. Why are removal and reduction techniques rarely effective?

2. What are the two main attractants to birds when traps are used?

3. What should you use to bait starling traps?

4. In releasing nonprotected birds, how far should you take them?

5. Where should you place pigeon traps for best results?

6. How should you mark captured birds to help you recognize those that return to the trapping area?

7. How do the two most common types of raptor traps work?

8. With whom must you coordinate before you trap raptors?

9. What's the most effective bird control use of live rounds?

10. Why should you remove dead birds promptly when you finish shooting?

11. What effect does Avitrol poisoning have on a bird?

12. What birds is Avitrol labelled to control?

13. Why should you *not* use Avitrol to repel gulls from an airfield?

14. Why should you apply Avitrol baits above ground level?

15. List three reasons for prebaiting.

16. How should you put out Starlicide baits?

17. What advantages does Starlicide have over Avitrol for starling poison?

Miscellaneous Vertebrate Pests

THERE ARE A variety of vertebrate pests we haven't discussed yet. Some that you'll learn about in this chapter are rabbits and hares, bats, skunks, and moles. This chapter doesn't make a strong attempt at identifying the various species of these animals, since they may vary widely by region. If you have a pest problem with any of these animals, consult a local field guide or area wildlife authorities.

3-1. Rabbits and Hares

Rabbits and hares can be damaging both as medical and economic pests. Rabbits in particular can cause extensive damage to home gardens and newly established seedlings in forests.

A22. Verify or correct statements about the importance, characteristics, and controls for rabbits and hares.

Rabbits and hares belong to the order Lagomorpha. They used to be grouped with rodents, but they differ from rodents in that they have four upper incisor teeth rather than two. The second pair of incisors is smaller and is behind the first pair.

Importance. Hares and rabbits are the primary reservoir of tularemia. They are also reservoirs of spotted fever and, to a lesser extent, of plague. The rabbit tick, *Haemaphysalis leporis palustris*, plays an important role in transmitting spotted fever and tularemia from rabbit to rabbit and thus in maintaining natural reservoirs. Rabbits and hares are of economic importance at military installations because they damage trees and erosion-control plantings. Damage is most prevalent at installations in the Western United States where large populations of jack rabbits frequently develop. Although epizootics (sudden, widespread disease epidemics) drastically reduce their numbers at intervals of about 7 years, other control measures are often needed.

Characters and Biology. Hares and rabbits are heavily furred animals with long ears and elongated hindlegs. They inhabit most of the major landmasses and some islands. The true rabbits, of the genus *Sylvilagus*, include the cottontails, which range from Southern Canada south to Argentina and Paraguay; the smaller brush rabbit of the United States Pacific Coast; and the marsh rabbits, or swamp rabbits, of the Southern and Southeastern United States. True rabbit young are born naked, blind, and helpless. The hares, of the genus *Lepus*, are represented by the jack rabbit and by the varying hare, or snowshoe rabbit. The young hares are born in an advanced state with the eyes open and the body well furred. They can move about soon after birth.

Control. Methods for controlling rabbits and hares include poisoning, trapping, shooting, using repellents, and building barriers. You poison, trap, shoot, and reple them much the same as you would ground and tree squirrels. There are two kinds of barriers for rabbit control. Individual trees can be protected by banding them with a 1 or 2-foot-wide strip of tar paper or metal sheeting. Gardens can be protected by building rabbitproof fences and box traps baited with apples, lettuce, or carrots.

Since rabbits often prefer areas of heavy vegetation, brush, piles of debris, etc., you may be able to apply cultural controls by having these harborages eliminated. For repelling rabbits from a given area, you may use Gustafson 42–5, a commercial formulation of thiram fungicide labelled for repelling rabbits from fruit trees, shrubs, ornamentals, and nursery stock.

Exercises (A22):

Mark each statement true (T) or false (F) and correct any false ones.

____ 1. Rabbits and hares belong to the order Lagomorpha.

____ 2. Rabbits and hares have two upper incisor teeth.

____ 3. Hares and rabbits are the primary reservoir of tularemia.

____ 4. Rabbits and hares do extensive damage to trees and erosion-control planting.

____ 5. Hares and rabbits are heavily furred animals with long ears and elongated hindlegs.

____ 6. The young rabbits are born in an advanced state with eyes open and the body well-furred.

____ 7. To protect trees, bands must be 3 or 4 feet high.

____ 8. Box traps for rabbits should be baited with apples, lettuce, or carrots.

3-2. Bats

Throughout history, bats have aroused people's curiosity and interest. Have you, for example, heard any stories about cattle deaths by attacks of vampire bats or seen any old vampire movies lately? Luckily, bats of the U.S. feed on insects, many of them noxious. Natural bat roosts include caves and tree hollows, but a few species live in houses, thus earning the title "house bats." Bats found north of Mexico are almost entirely beneficial to people but occasionally become nuisances or pose public health problems. Fear of rabid bats has resulted in the use of chemicals to control them in buildings, often with disappointing results and side effects. This section discusses the biological and ecological role of bats and ways you can manage them when conflicts develop.

A23. Verify or correct statements about the biology and ecology of bats.

Biology and Ecology of Insectivorous Bats. The only truly flying mammals, bats, belong to the order Chiroptera—"flying hand." Bats are worldwide in distribution but mainly tropical. Their ability to fly, their secretiveness, and their nocturnal habits have undoubtedly contributed to bat folklore, superstition, and fear. The natural habitat of most North American bats is caves and trees. Many bats are found in mines and some in buildings. Day roosts are dark and secluded. Foraging areas are around water, forests, ravines, and buildings. With the advent of cold weather, bats migrate or hibernate in caves, mines, and sometimes in houses. These places usually have high humidity and above-freezing temperatures. Active, nonhibernating bats spend the day hanging in secluded retreats and become restless as evening approaches. Upon leaving their roosts to feed, bats usually first fly to a pond or other water source to drink. A second feeding period may occur just before daylight.

Most bats in North America are insectivorous, catching small flying insects, many harmful, by sonar or echolocation. Some bats may consume up to one-half their weight of insects in a night. The little brown bat (*Myotis lucifugus*), commonly found in buildings, feed on midges, mosquitoes, caddis flies, moths, and beetles. It's been estimated that 50 bats can easily capture 500,000 insects each night. *The mexican free-tailed bat (Tadarida brasiliensis)* forms the largest colonies of any mammal. Some Texas cave colonies contain as many as 20 million individuals and can eat more than 100,000 lb of insects nightly.

Many animals use sonar to navigate, locate, and avoid obstacles. Bats use sonar for those purposes and to capture flying insects. High-frequency sounds, inaudible to humans, produce echos permitting bats to measure distance. Bats also make audible sounds.

In the United States bats mate in the fall and winter, but the female may retain sperm in the uterus until spring when ovulation and fertilization take place. Pregnant females congregate in nursery colonies in caves, mines, buildings, or other dark retreats. No nests are built. Birth occurs from April through July and most species produce a single young, although some have twins and a few have litters of three or four. Young bats grow rapidly and are able to fly within 3 weeks. When they're adept at flying and catching food, juveniles become less dependent on their mothers and the maternity colonies disperse after weaning in July or August.

Around first frost, bats prepare for winter. Some species migrate relatively short distances, whereas certain populations of the mexican free-tailed bat may fly up to 1000 miles. Bats in the Northern United States and Canada may hibernate from September through May; hibernation for the same species in the southern part of the of their range may be shorter or even sporadic, and some fly during warm spells in winter. Unlike many small mammals, whose average life spans may be less than a year, bats often live 10 years or more. Two little brown bats were recaptured 29 and 30 years after being banded.

Almost all bats are of some economic importance, and those of the United States and Canada are beneficial because they are insects. The guano (accumulated bat droppings) was once commercially mined in the Southwest, and it is still mined in Mexico as nitrogen-rich fertilizer. The importance of the bat guano has declined because of reduced bat populations and the development of inorganic fertilizers.

Exercises (A23):

____ 1. Except for some squirrels, bats are the only true flying mammals.

____ 2. Caves and trees provide most of the habitat for North American bats.

____ 3. Typical winter bat roosts are caves and mines where humidity is high and temperatures are above freezing.

____ 4. In the U.S., bats breed in the spring and summer months.

____ 5. Young bats mature slowly, taking up to 2 months before being capable of flight.

____ 6. Unlike other small mammals with short lifespans, bats often live 10 years or more.

____ 7. Bats in North America are considered beneficial because of their diet.

A24. State how bats present nuisance problems to people.

Nusiance Problems Caused by Bats. Some bat species use structures in preference to their natural roosts, and others are forced to roost in buildings when natural roosts, such as caves and hollow trees, are destroyed (Fig. 3-1). Some caves (Fig. 3-2) are ruined by flooding, dam construction, burning of debris or by pesticides. Cave roosts also are destroyed by explosives used in mining and quarrying, vandalism, and tourism. Forest management programs, particularly removing diseased or old trees with hollows (Fig. 3-3) have also reduced the number of bat roosts.

As a result of these and other activities by people, bats have often been forced away from their natural habitat and toward homes, buildings, and other structures. In these

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Figure 3–1. Bat roosting sites in a house.

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Figure 3–2. Bat roosting sites in a cave and under rocks.

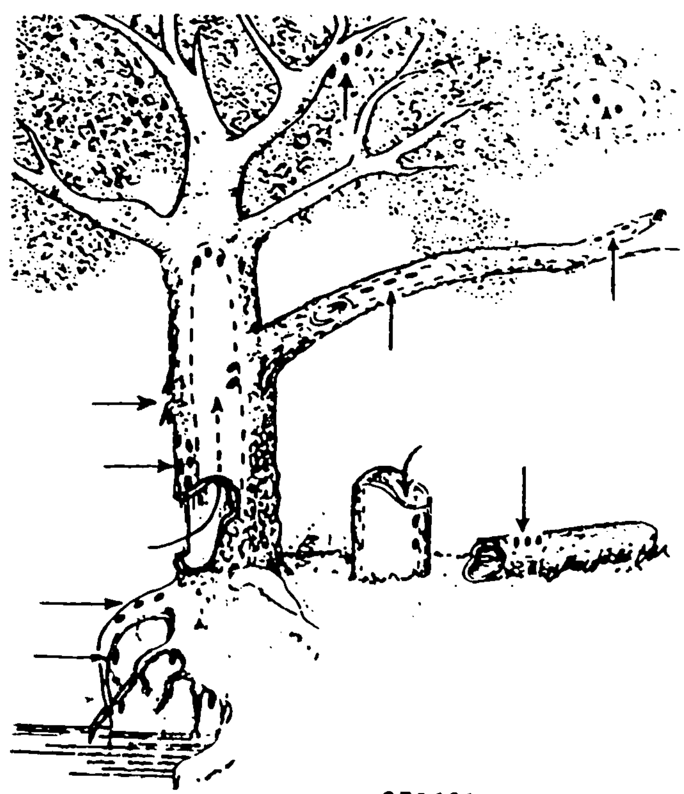

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Figure 3–3. Bat roosting sites in trees.

locations, the noise bats squeaking, scratching, scrambling, and crawling in attics, walls, and chimneys can be objectionable if the roost site is close to human living quarters. Bats nearly always reveal their presence by their fecal droppings left beneath entrance holes and below roosts. Brown stains and odors from urine, feces, and glandular body secretions may often indicate the presence of bats inside the structures. In old, loosely constructed buildings with an attic roost or a space between the wall and a chimney, excreta may seep through cracks and stain ceilings and walls. In churches, bats frequently enter through unscreened belfry louvers and leave droppings that are plainly visible on the front doorstep.

Bats inside buildings. Finding one or two bats in a building is probably the most frequent problem. The large brown bat accounts for most of these sudden appearances. Common in towns and cities, it often enters homes through open windows or ungrated fireplaces. These bats may occur singly, in pairs, or in small groups. If chimneys are used for summer roosts, the young may fall or crawl through the damper and into the house when they are learning to fly, and their parents may follow. Sometimes one or more bats may appear in a screened room, and then disappear by crawling under a door crack. In the latitude of New England, the big brown bat frequently hibernates in houses, getting entrance through crevices between the outer wall and the chimney, by a crack around a window, or through holes between loose boards or bricks. These bats may suddenly appear in midwinter during a warm weather spell and fly about the building. Migratory bats occasionally enter buildings overnight during their spring and fall migrations. A bat will usually find the way out by following fresh air; so the simplest way to get rid of the bat is to open all outside windows and doors. If it is still there at nightfall, turnoff the lights to help it find open windows and doors (instead, it *may* try to hide) behind drapes, curtains, or wall hangings). Bats usually will not attack a person even when they're being chased. If the bat refuses to leave, catch it in a net, small box, can, or a gloved hand and release it outside.

Most bats can squeeze through surprisingly narrow slits and cracks; the small ones can pass through a hole the size of a dime. The little brown bat can enter a space 5/8 by 7/8 in; the large brown bat can squeeze through an opening 1¼ by 1/2 in. Attractive openings are found in old frame structures where boards shrink, warp, or become loosened. Bats commonly enter buildings under the eaves, where gaps may develop. They are most often found in attics, between roofs and ceilings or roof spaces; in cornices, fascias, or other crevices around the roof; in walls, in chimneys, around drainpipes; behind rafters and sheathing in open barns; between a window and screen, and occasionally in crawl spaces. Depending on the size of the space and on the species, bats will be found singly, in small groups, or in colonies of hundreds and occasionally thousands.

Guano, urine, odor, and ectoparasites. Bat guano and urine accumulating in attics and wall spaces attract arthropods such as roaches and mites. The accompanying odor can be pungent but not dangerous. Bat ectoparasites, such as ticks, mites, fleas, and bugs, rarely attack humans. They are most likely to cause a nuisance after a house has been batproofed, thereby ridding the edifice of bats but leaving arthropods. Arthropod problems are unlikely except in large, well-established bat colonies where fumigation may be appropriate. Ectoparasites quickly die in the absence of bats.

Bats outside buildings. Some bats temporarily roost behind shutters; under wood shingle siding and roofing, roof gutters, awnings, and trim with overhang, under loose chimney or roof flashing and in open garages; on patios, porches, breezeways, open livestock shelters; and under sheets of tarpaper. Shutters on brick houses are especially attractive as day roosts for transient bats in migration and for males that frequently take refuge behind shutters during the nursing season. In exceptionally hot weather, individuals may abandon an attic and reside behind shutters. Big brown bats are partial to roosting behind the trim below roofs of houses. Unusual roosting areas include sewers, wells, and graveyard crypts. Bats also will fly around swimming pools, from which they may drink or catch insects attracted to water. Street and porch lights attract flying insects which, in turn, attract bats.

Exercises (A24):

1. How do people often force bats into buildings and other structures?

2. How is the presence of bats in a building often revealed?

3. Under what conditions may big brown bats occasionally appear in a building in midwinter?

4. How many bats are usually associated with problems within a building?

5. How do openings to buildings become available to bats?

6. How may arthropods become a problem in association with bats?

7. How are shutters on brick buildings attractive to bats?

A25. Match types of bats with their characteristics.

Species of Bats Causing Problems. Among the 40 species of bats in the United States, only a few cause problems in buildings. The most common house bats congregating in groups are called colonial bats. Other species live a secluded existence and are known as solitary bats. The three species of colonial bats people see most often are the little brown bat, big brown bat, and mexican free-tailed bat.

The little brown bat (*Myotis lucifugus*, fig. 3-4), is one of the most abundant species, often forming nursery colonies in buildings during the summer. Adults and young vacate the buildings in the fall to hibernate in caves and mines. Colonies may be as large as 2000. They have a wingspan of 8.9 to 10.8 inches. Their fur is dense, fine, and glossy. There are many species of small brown bats, but this is the one most often found in buildings.

The big brown bat (*Eptesicus fuscus*, fig. 3-5) is undoubtedly the most familiar to humans and the only species for which buildings are ideal for both raising young and hibernating. Colonies are small, ranging from 12 to 200. This is one of the largest bats commonly found in buildings; they have a wingspan of 13–14 inches. Most adults are copper colored, but may vary from light to dark brown. Each hair is bicolored—the basal half being almost black and the outer half brown.

The mexican free-tailed bat (Tadarida brasiliensis, fig. 3-6) is the most colonial of all bats. Its habits vary in different parts of the country. Primarily a cave dweller in the Southwest, a colony may include thousands of individuals. In Florida this bat never enters caves, and thousands have been found in a single building. Some populations migrate 1000 miles to overwinter in Mexico, while others are year-round residents. This is a rather small bat with long, narrow wings. Its wingspan is 11.3 to 13 inches. The body and membrane are dark brown. Some

Figure 3–4. Little brown bat (*Myotis lucifugus*).

Figure 3–5. Big brown bat (*Eptesicus fuscus*).

Figure 3–6. Mexican free-tailed bat (*Tadarida brasiliensis*).

individuals are dark gray or pale brown due to bleaching by ammonia fumes from guano deposits.

Solitary bats live alone in tree foliage or under bark, but never in caves. The red bat (*Lasiurus borealis*), the hoary bat (*Lasiurus cinereus*), and the silverhaired bat (*Lasionycteris noctivagans*) may occasionally enter buildings during spring and fall migrations as transients but do not permanently roost in buildings.

Exercises (A25):

Identify each of these as a little brown bat, big brown bat, mexican free-tailed bat, or solitary bat.

________ 1. These are rather small bats with long, narrow wings.

________ 2. These bats have dense, fine, glossy fur and a wingspan of 8.9 to 10.8 inches.

________ 3. These bats may migrate up to 1000 miles to overwinter in central America.

________ 4. These bats often use buildings for both hibernation and for raising their young.

________ 5. Adults of these bats often have coppery-colored fur and each hair is bicolored, the outer half being lighter than the basal half.

________ 6. These bats may occasionally enter buildings during migration, but don't permanently roost there.

________ 7. This is one of the most abundant species of bats; they often form colonies in buildings in summer months.

A26. Verify or correct statements about bat control measures.

Management Techniques for Bats. Many approaches to bat management have been tried in the past, with varying degrees of success. For example, DDT is highly effective against bats, but the environmental effects of it's longevity, and its progression up the food chain make it a poor control method.

In this lesson, we'll focus on permanent, nonchemical controls for bats, as well as how you as a pest manager may use repellents for temporary control of bats in structures.

Batproofing. Unlike rodents, bats will not gnaw their way through wood or building materials. Soft materials such as insulation batting can be easily attached to a building with a heavy-duty staple gun. Effective materials are those used in caulking, flashing, screening, and insulation. Weatherstripping, stainless steel wool, or stainless steel rustproof scouring pads will block long, narrow cracks.

Caulking. Cracks and crevices develop in a structure as it ages, and bats will take advantage of these openings. Caulking will seal the openings. There are various caulks which may be applied with a caulking gun. Latex, butyl, and acrylic have a durability of about 5 years and can be painted. Houses may need to be caulked in these places:

a. Between window drip caps (tops of windows) and siding.

b. Between door drip caps and siding.

c. At joints between window frames and siding.

d. At joints between door frames and siding.

e. Between window sills and siding.

f. At corners formed by siding.

g. At sills where wood structure meets the foundation.

h. Outside water faucets, or other special breaks in the outside house surface.

i. Where pipes and wires penetrate the ceiling below an unheated attic.

j. Between porches and the main body of the house.

k. Where chimney or masonry meets siding.

l Where storm windows meet the window frame (except for drain holes at window sills).

m. Where the wall meets the eave at the gable ends of a heated attic.

Weatherstripping. When bats crawl under doors, the space between the floor and the door bottom may be sealed with weatherstripping, a draft shield, or a gap stopper. A sand snake, like those used for inplace fumigation, is a simple draft excluder for the bottom of seldom-used doors. It's simply pushed against the crack at the bottom of the door.

Screening. Where screening is necessary, the openings must be small enough to prevent the access of bats. Steel hardware cloth should have a 1/4-in mesh with three meshes or more to the inch. Hardware cloth for ventilators should be 8 x 8 mesh. Inlet and outlet ventilators should be properly installed. The type of ventilator used, its location in the building, and the direction of prevailing air currents may be important factors because buildings of identical design, but different orientation, vary in their attractiveness to bats. Many ventilators are made with metal louvers and frames; others are custom made of wood to match the house design (fig. 3-7).

The soffit (the underside of an overhanging cornice) usually has ventilators which may be continuous, round, single-framed, or the soffit itself may be of perforated hardboard. Regardless of soffit type, the slots should not exceed 1/4 x 1 in.

Bats may use an unused or old chimney because its rough surfaces offer suitable places to hang. To keep bats from entering chimneys, install spark arresters or bird screens of rust-resistant material. They should completely enclose the flue discharge area and be securely fastened to the top of the chimney. When dampers aren't in use, they should be closed.

Insulation. Insulation repels bats by filling the roof and wall spaces they formerly occupied. Insulation materials include fiberglass, rock wool, cellulose, urea-based foam, urethane, vermiculite, perlite, polystyrene, and extruded polystyrene foam.

Bat repellents. Our occasional need for properly applied chemical repellents can be eclipsed quickly by the problems that develop if the chemicals are misapplied. Unfortunately, we must usually apply liquid repellents (most sprays) directly on the bats instead of painting it on surfaces where they land. This causes the affected bats to be

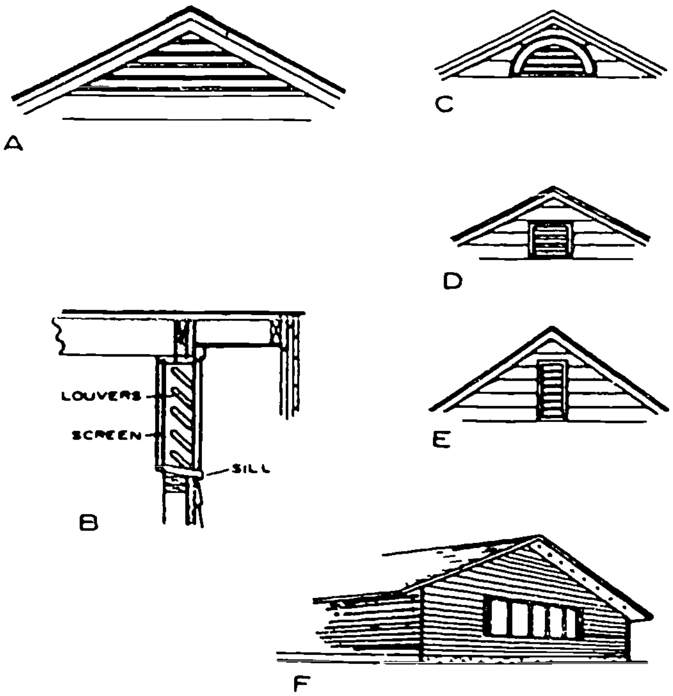

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Figure 3–7. Ventilator screening: A, triangular; B, cross section: C, half circle: D, square; E, vertical; F, soffit.

grounded (after scattering, for miles around in some cases), presenting a far worse problem. This means we need to deliver fumes rather than liquid in most instances. As in plugging access holes, we're limited to late summer and early fail for application; otherwise, young flightless bats may be flushed (spring through midsummer), or lethargic bats may be expelled (late fall and winter). Properly controlled, fumigation may be indicated in some expertly handled instances. In the vast majority of cases, chemical repellents are superfluous, because we can get better results by plugging accesses. Moreover, chemical repellents are only temporarily effective.

Naphthalene. Naphthalene (crystals or flakes) is the only chemical registered by the Environmental Protection Agency (EPA) as a bat repellent for indoor roosts (EPA registration Number 462–19). Naphthalene should be spread on the floor or applied between the walls, using about 5 lb for 2,000 cubic feet (should treat an average attic). As the crystals or flakes vaporize, bats may be repelled. Heavier dosages may dislodge bats in broad daylight within a few minutes after introduction. The bats do not return so long as the strong odor remains, but they will return when it dissipates. If necessary, repeat the application. Napthalene is most effective in confined air spaces. Humans should avoid breathing it, and people who are sensitive to it should avoid all contact.

Contact Repellents. Sticky repellents, such as rodent glue boards and sticky bird repellents, have been used in situations where roost surfaces and bat accesses may be coated. The glue may have to be replenished from time to time as dust makes it lose its tackiness. Compared to sealing access routes, sticky deterrents can only slightly successful, because bats are avoid the substances and because traffic over the treated surfaces will usually reduce their effectiveness.

Bat toxicants. Some public antipathy to bats, especially when they become a nuisance in houses, derives from phobias based upon myths. To many people, bat prejudice suggests that the answer to problem bat. is a bat toxicant, but you should avoid this approach for several reasons. It's a waste of time, because the animals usually are replaced promptly by other bats. It wastes time and money that should be spent on the only permanent solution, physical exclusion. It's not for disease control, because the incidence of rabies infection is extremely low. Bats are valuable in insect control. Most important, toxins such as DDT scatter sick bats over wide geographic areas where people and pets can be bitten as they investigate them.

The only rational reasons for using a bat toxicant are if all other feasible methods have been tried and failed, and if bat control is needed for a real public health emergency. Under these conditions, fumigants such as methyl bromide, hydrocyanic acid, or sulfuryl fluoride may be used. These products have directions for fumigating entire buildings, but they aren't currently labeled specifically for bat control. Therefore, you should contact Federal, State, and local officials before you try to fumigate infested buildings.

Exercises (A26):

Identify the following statements as being true (T) or false (F). Correct any false statements.

____ 1. Unlike rodents, bats will not gnaw their way through wood or building materials.

____ 2. Long, narrow cracks can be blocked easily and effectively with weatherstripping, stainless steel wool, or rustproof scouring pads.

____ 3. Once a building is caulked right, the caulking should last 10–15 years.

____ 4. Weatherstripping, a draft shield, or a gap stopper is suitable for blocking cracks where chimney or masonry meets siding.

____ 5. Sand snakes are suitable for sealing the bottoms of seldom-used doors.

____ 6. Half-inch mesh hardware cloth is needed when this material is used to seal off openings available to bats.

____ 7. Openings in soffits should not exceed 1/4 x 1 in.

____ 8. Spark arresters or bird screens are effective items for preventing bats from entering chimneys.

____ 9. Naphthalene used to repel bats from enclosed areas should be applied at the rate of 5 lbs per 2000 cubic feet.

____ 10. The most important reason for not using toxicants is that you may scatter sick bats over a large area where people or pets may contact them.

3-3. Skunks

Skunks are of social and economic importance because they emit nauseous odors, they are a reservoir for rabies, they destroy lawns and turf digging for insects, they kill poultry and birds, and they harbor ectoparasites. Except for that they're okay. They belong to the weasel family and are well-known furbearers. Being a frequent subject of stories and cartoons, skunks have characteristics and habits that you probably know even if you've never seen the animals in the wild. Since skunks are not particularly disturbed by people's presence and activities, they will frequently move in from their native habitat and take up residence beneath buildings. This is when you're generally called in.

A27. Cite behavioral and physical characteristics of skunks.

Behavioral Characteristics. Skunks are most active after dusk. They emerge from their burrows to feed on grubs and other insects, small rodents, garbage, birds and their eggs, fruits, and berries. In searching for grubs, they may uproot turf in lawns and golf courses. If it's approached, the skunk may eject its musk several feet. If a skunk is aggressive, stay clear, because it may be rabid. (This isn't to suggest that you try to shake hands if it isn't aggressive, Let's face it—skunk control is no bed of roses, but somebody has to do it.)

Of the five species of skunks found in this country, only three are of widespread economic or public health importance: the striped skunk and the western and eastern spotted skunks. The hooded and hog-nosed skunks may be local pests.

The striped skunk is found throughout the country except in the desert areas of the Southwest. The western and eastern spotted skunks live throughout about three-quarters of the country, being absent along most of the Eastern Seaboard, the Northeastern States, and the region around the Great Lakes. Hooded and hog-nosed skunks are confined primarily to areas of the Southwest and southward into Mexico. Their biology and habits don't vary much from those of the more widely distributed skunks. The problems are solved the same way.

Physical Characteristics. The striped skunk is about the size of an adult house cat, and its fur is mostly black with white on the top of the head and neck. In most animals the white extends posteriorly, usually separating into two white stripes. All-black or nearly all-black individuals are sometimes seen.

Spotted skunks, as their name implies, are black with white spots or short streaks of white. They are smaller than the striped skunk and about half the size of a house cat. They are found in a variety of habitats, including brushy areas, stream beds, rocky outcrops, road culverts, industrial yards rural homes and farm-yards, and suburban areas within about 1/2 mile of their natural habitat.

Although they occasionally dig dens in a fresh-cut bank, their dens are most often enlargements of burrows of other animals, rock piles or outcroppings, hollow logs, or even tree holes. When no natural sites are available, they may establish their dens beneath a house or other building if they can gain access. More than one family may occupy a den, but this is not common. Spotted skunks are much better climbers than striped skunks, so they are more likely to enter open unscreened windows or other openings of a house. Skunks can eject their "perfume" 6 to 10 feet against the wind (striped skunks have the greatest range). The Secretion is acrid enough to cause nausea, and it can produce severe burning or temporary blindness if it strikes the eyes.

The odor may be strong or only faintly evident at the dens. Occupied dens will often show signs of fresh digging, at least in the spring. Droppings will be evident and usually contain numerous insect fragments. Hair and rub marks also can be found.

Since skunks are nocturnal, they may go unnoticed until they take up occupancy under a building or confront some animal that disturbs them enough to use their scent. There is sometimes a faint lingering skunk odor where skunks have fed or traveled, even though they have not sprayed the area.

Exercises (A27):

1. What do skunks eat?

2. What three skunks are most widespread?

3. What is the range of the striped skunk within the U.S.?

4. What does the striped skunk look like?

5. What kinds of habitat do spotted skunks typically have?

6. Where do skunks typically set up their dens?

A28. State how to control skunks and their odors.

Skunk Control by Removal and Management (SCRAM). This acronym may be your first response to a skunk control situation, but—properly conducted—skunk control doesn't have to be a dangerous job. As furbearers, skunks are harvested seasonally in some states, so check with local fish and game officials before you try reduction. Legal provisions normally let us remove skunks where there's a health threat or damage. The best long-term solution to skunk problems beneath buildings is to screen or block them out. Seal all spaces beneath porches and stairs and all entrances or openings in building foundations.

Once skunks have made their home under a building, the problem is a little harder, for you have to be sure they're gone before you close the entrance. You can do this by closing off all but one entrance and then sprinkling a smooth layer of flour, about 1/8-inch thick, on the ground at the open entrance to form a tracking patch. Then examine the area for skunk tracks soon after dark. When tracks only lead out of the entrance, the opening usually can be safely closed off.

If you don't know how may skunks there are, you can hang a section of 1/2-inch hardware cloth over the opening, hinged at the top and left loose on the other three sides. It must be larger than the opening, so that it can't swing inward. The skunks will push it to leave, but they can't get back in. A pound or two paradichlorobenzene (PDB) or naphthalene crystals divided into four to six equal parts and placed under the infested building away from the entrance; this sometimes drives skunks out. It will keep them out if it's replenished occasionally. Vaport from ordinary household ammonia in shallow, open-top containers may do the job. Placing several floodlights across the room (or crawl space) from the skunks' normal entrance sometimes drives them out.

Live-catch box-type traps of wood, sheet metal, or wire mesh probably offer the best short-term method of removing skunks from beneath or around buildings. The traps should be about 10 x 10 x 30 inches or slightly larger. Place them where the animals are entering the building or in trails they are known to use. Bait can be fish (canned or fresh), fish-flavored cat food, raw or cooked bacon, or chicken parts. When you trap a skunk, approach it from behind and throw a cloth over the cage. Since a skunk isn't afraid of what it can't see, this might keep you from suddenly becoming less popular with friends. You can use chloroform, carbon monoxide, or carbon dioxide—orjust hold the trap under what to kill the skunk. Because of the potential for spreading rabies, we normally don't release trapped skunks.

Since an infestation beneath or around buildings normally involves only a few skunks, trapping is the best control. In years past, however, skunks were occasionally controlled with acute poisons such as strychnine, particularly where a rabies epidemic was involved in rural areas. Today, rarely does the situation warrant any toxicants for skunks beneath or around urban or occupied buildings.

Personal and Pet Deodorizing. A chemical called neutroleum-alpha is probably one of the most useful odor neutralizers available for getting rid of the unpleasant odor of a skunk scent. About a tablespoon of the water-soluble form in a water bath will decontaminate dogs and humans. It also can be used to scrub basements, garages, floors, walls, outdoor furniture, and other surfaces. At a higher concentration (two ounces to one gallon of water), it can be sprayed on the soil in a contaminated area. It is unfortunate that neutroleum-alpha is not always readily available when needed. If you're involved with skunk control keep some on hand. You may find the only local source to be a hospital or supply house. Neutroleum-alpha is used in a variety of deodorizing products. As a last resort, liberal applications of canned tomato juice can be used on contaminated dogs.

Exercises (A28):

1. Why should you check with local fish and game officials before starting a reduction program for skunks?

2. What's the best way to keep skunks out of a building?

3. How can you exclude them afater they're under the house?

4. How might you do it with PDB or naphthalene?

5. Where should you set box traps for skunks, and with what do you bait them?

6. Why don't we release trapped skunks?

7. What dilutions of neutroleum-alpha can be used to deodorize people, pets, and contaminated soil?

3-4. Moles

Mole burrows may cause a great amount of damage to lawns, gardens, golf courses, and other turf areas. Moles damage ornamental plants by destroying plant roots they search for earthworms and insect larvae. In this section, you'll study mole, recognition characteristics, biology, and control techniques.

A29. State the importance, physical features, and biology of moles.

Importance of Moles. Moles belong to the order Insectivora, family Talpidae. Their general distribution seems to depend largely on atmospheric humidity and the resulting condition of the soil. They are absent altogether from arid regions, and where the prairies of the Middle West merge gradually into the Plains, they live only along watercourses. In these regions the ground is too dry and hard during most of the year to support the earthworms and insect larvae upon which the mole depends for food. In the East, moles are most abundant in moist, rich soils along streams, particularly if these places are somewhat shaded. In the cooler, more uniform climate of the Pacific Northwest, they are plentiful anywhere in the well-watered valleys.

Moles often disfigure lawns, damage golf courses, and ruin seedbeds in gardens and nurseries. They cause damage in cornfields, gardens, and flowerbeds by eating seed corn and plant roots and also by traveling along the rows, heaving the plants out of the ground, and thus causing heavy crop losses. Mounds raised by moles in hayfields break or quickly dull the knives of the mower cutter bar or else necessitate raising the bar so much as to reduce the crop.

The mole is also a potential carrier of plant pests and diseases, and it may seriously increase their damage by scratching or eating infected bulbs or roots and then going to healthy plants. Moles spread such disease organisms as the mosaic virus and other bacteria or spores, as well as injurious nematodes. One mole can easily travel about 100 yards a day through loose soil.

Biology of Moles. So seldom is the mole seen, even by those familiar with its work, that it is often confused with other small creatures, particularly the shrew, the mole (or meadow mouse), and the pocket gopher. You can readily distinguish the mole from the pocket gopher by the absence of cheek pouches and by its less conspicious eyes. The mole is not a rodent, and it can be readily distinguished from any of this order and from the shrew by its short, stout, front limbs ending in broad, rounded hands with strong claws and with palms turned outward. It has a rather elongated body, close, plushlike fur, a pointed snout and a short tail.

Neither external eyes nor ears are ordinarily in evidence. If it's not totally blind, the common mole of the Eastern United States can at best merely distinguish between light and darkness, as its organs of sight lie wholly beneath the skin. The degeneration of these organs has apparently not proceeded so far in Townsend's mole (the largest mole on the continent), which usually opens its eyes when annoyed by an observer. The eyes of the star-nosed mole also are readily discernible. The mole lives mostly underground. Its experiences come through its sensitive touch, acute hearing, and highly developed sense of smell. While the animal is seldom seen above ground, it sometimes ventures out its tunnels, chiefly at night.

When a mole is living in lawns, gardens, or fields, telltale ridges or conspicuous mounds of earth plainly indicate its runways. The ridges show the direction and course of the animal's hunting paths, which are so close to the surface that the sod or the soil crust is raised. The mounds indicate deeper tunneling. Such mounds thickly dot the mole-infested area of the Pacific Coast. They are much rarer in the habitat of the common eastern species, but the star-nosed mole regularly uses this method to dispose of dirt from its tunnels. The number of mounds or ridges in a field does not indicate the number of moles. One Townsend's mole, for instance, in 77 days made 302 mounds on a quarter-acre field.

The mounds of Townsend's and other moles of the West Coast resemble superficially the earth heaps thrown up by pocket gophers, but usually they can be distinguished. The mole heaps are the more rounded and symmetrical and are built up, volcano fashion, by successive upheavals beneath and through the center of the pile. The soil that is thus excavated rolls down the sides from the summit. The pocket gopher, on the other hand, brings up the soil excavated in its workings and dumps it on the surface in armfuls, thus forming low, semicircular or fan-shaped accumulations of fine dirt more or less to one side of the burrow exit.

The more permanent tunnels of the mole commonly run along fences, hedges, walks, plant rows, and ridges of open fields, where the mole has some concealment or shelter. These burrows vary in depth from only 1 or 2 inches to levels beneath the reach of the plow. They constitute a labyrinth of runways, apparently constructed with no definite plan and including here and there an enlargement.

A mole's appetite seems to be almost insatiable. Held in captivity and given food to its liking, one will sometimes eat more than its weight in a day. The large quantity of food thus required is no doubt due to the intensely active life the little animal leads. Few other mammals are relatively as strong or do as much hard work in a day. The mole's food generally consists of adult insects and their larvae and earthworms. For the common eastern mole, earthworms and white grubs constitute the bulk of the food. Beetles and larvae, other ground-inhabiting insects and their cocoons and puparia, spiders, centipedes, and some vegetable matter are also in the eastern mole's diet. Townsend's mole lives largely on earthworms and larval and adult insects, but it takes considerably more vegetable matter than the eastern mole. As the mole's short teeth are not well suited to gnawing, damaged roots are mangled but not cut clean.

Moles probably never become dormant, but they dig runways mainly when soil conditions are favorable—after rains in summer or during periods of thaw in winter. At other times they search for food in their old runs or work at depths and places unaffected by frost or drought. Movements of soil-inhabiting worms and insects, including larvae, tend to bring fresh supplies of food into these tunnels.

Contrary to popular opinion, moles are slow breeders. Since their life of seclusion shelters them from many dangers, they can maintain their normal numbers without a rapid rate of increase. Moles grow and develop with surprising rapidity. For example, in the Northwest, most of the young are born in the latter half of March and the first half of April, spend about a month in the nests, and early in June are so well grown as not ordinarily to be distinguished from the parent moles. This rapid growth accounts for the fact that small young moles are seldom trapped. By the time they leave the home nest and take to the runways for themselves, they already have attained something like the size and proportions of adults.

Exercises (A29):

1. The general distribution of moles depend largely upon the atmospheric ____ and the resulting condition of the ____ .
2. In making their mounds and runways, moles often disfigure ____ , damage ____ ____ and ruin ____ in gardens.
3. The mole is a potential carrier of plant ____ and ____ .

Place the letter "T" before the true statements. Correct any false ones.

____ 4. The mole is a rodent short, stout, front limbs ending in broad, rounded hands with strong claws and with palms turned outward.

____ 5. If it's not totally blind, the common mole of the eastern part of the United States can at best merely distinguish between light and darkness.

____ 6. The mole lives mostly underground.

____ 7. The mounds show the direction and course of the animal's hunting paths, which are so close to the surface that the sod or the soil crust is raised.

____ 8. A mole's appetite seems to be almost insatiable.

____ 9. A mole's food generally consists of adult insects and their larvae and earthworms.

____ 10. Moles grow and develop with surprising rapidity.

A30. State how to control moles.

No special inspection methods apply to moles. Their presence is evident from their digging. The only way you can take a population survey is to watch them. If you make an opening in a runway, the mole will repair the hole the next time it comes that way. You can get a lot of information by checking, at short intervals through the day, small breaks you've made in a number of runs. You are as likely to find moles working at one hour of the day or night as at another, especially in seasons when there is little variation in temperature.

Mole Control. You can control moles by limiting their food; by trapping, drowning or fumigating; and by using repellents. You can control them in lawns and other turf areas effectively, though indirectly, with insecticides that control the beetle grubs and other lawn insects they eat. The moles are not affected directly by the insecticides in the dosages used, but they stay out of the area because of the absence of food.

Trapping is a universally applicable and satisfactory method of mole control, but it is successful only if you carefully consider the habits and instincts of the mole. The suspicious mole, for instance, is aroused when its sensitive nose encounters anything foreign in its runway, and it will immediately back up and burrow around or under an ordinary trap set in its tunnel. It is not suspicious of dirt blocking the runway, however, as burrows are often closed by farm machinery and by people and large animals stepping on them. The mole will immediately push its way into such a dirt blockade, reopen it, and continue on its way. This lets us use a trap that straddles, encircles, or is held suspended above the runway, with its trigger pan resting on or hidden in the dirt blockade. The unsuspecting mole pushes into the dirt obstruction, either lifting the trigger pan or pushing the dirt against the hidden trigger arm and thus releasing the trap spring.

Another fundamental condition you should remember is that the mole is sensitive to an unnatural environment. Never tear up large or numerous sections of the mole burrow trying to find a good spot for a trap. Keep in mind that a poorly set trap is a detour sign for the ever-suspicious mole. Selecting a frequently used runway for a trap set is of prime importance.

East of the Rocky Mountains, place the traps in the hunting tunnels, which are close to the surface and are indicated by the conspicious ridges. Since these surface runways are made for the primary purpose of finding food, many of them are not used more than once. Others, however, serve as highways and are used regularly. Ordinarily, a runway that takes a straight course for some distance or seems to connect two systems of workings will be in constant use. You can often find the used tunnels by poking a small hole into all tunnels in the area and noting later, usually within a few hours, which ones have been closed. In large fields you can drive a vehicle back and forth at intervals of 50 to 100 feet. The next day the regularly used runways will be raised again. When you can locate the deeper runs, which often are highways used by many moles, you can catch a number of moles by continued use of traps in the same place. Such deep tunnels are usually 3 to 12 inches or more below the surface, along fence lines or ridges in open fields, or at crossings from sodded to cultivated ground.

In such cases, a large field can be treated successfully by setting traps along the fence rows. As moles are active throughout the year, they may be trapped at any season, although it is not practical to carry on operations when the ground is frozen or very dry. The best time to trap is when you find fresh signs of mole activity.

The large moles of coastal Washington, Oregon, and California (*Scapanus* spp.) push to the surface numerous piles of earth (mole hills), indicating the approximate location of the deeper burrows. This habit lets us trap them in the deeper, main-traveled tunnels. To locate the runway, use a probe or slender metal rod 3½ or 4 feet long and about 3/8 inch in diameter, such as an end-gate rod, or a piece of 1/4-inch gas pipe. Push the probe into the soil 3 or 4 inches away from a mound. If you are directly over the runway, you will feel a sudden give as the rod breaks into the tunnel opening. If not, move the rod to either side, probing at 2-inch intervals around the mound until you break through into the runway. You can probe again a foot or so from the mound to determine the line of the tunnel.

Mole traps on the market are either the gripping type or the harpoon type (fig. 3-8 and 3-9). Gripping traps come in several designs, including the choker-loop trap, the scissors-jaw trap, and the diamond-jaw trap. All are about equally effective. The harpoon trap is more popular than gripper traps because it is set more easily. It is somewhat less efficient, though, because the mole may escape if the prongs don't hit a vital spot.

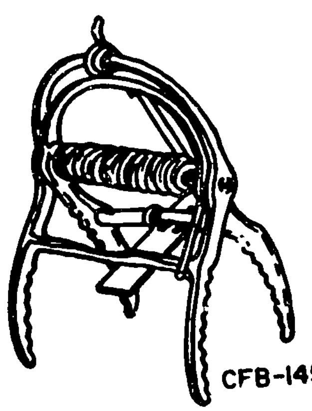

Figure 3–8. Gripper trap for moles (typical).

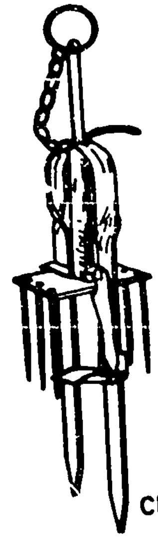

Figure 3–9. Harpoon trap (typical).

To use the harpoon trap, pack down the runway ridge with your foot and push the set trap (with safety catch in place) into the ground so that the trigger pan rests snugly in the depressed ridge and the two pointed supports straddle the runway evenly. Then release the safety catch. If the ground is hard or gravelly, spring the trap once to make sure that the inpaling spikes or prongs easily penetrate into the soil for their full length. If they do, reset the trap without changing its position; if not, select a new place.

To set a gripper trap, use a garden trowel to dig a trough across the burrow, a little deeper than the burrow, and just the width of the trap. Note the exact direction of the tunnel, and place the set trap so that its jaws evenly straddle, or its loop encircles, this line of course. Then block the excavated section with loose, damp soil from which you have removed all gravel and rubbish. Pack the soil firmly underneath the trigger pan with your fingers and set the trap so that the trigger rests snugly on the built-up soil (omit this step for the diamond-jaw trap). Finally, fill the trap hole with enough loose dirt to cover the trap level with the trigger pan and to exclude all light from the mole burrow. The mole in forcing its way through the soil blockade will be certain to spring the trap. Choker-loop and diamond-jaw traps, both of the gripper type, may be set successfully in loose, mellow, damp soils without making an excavation by following the method described for setting the harpoon trap.

You can *drown* out the moles by flooding the runways, especially during April, when the young are most likely to be trapped in the nest. *Gassing* has gotten increased attention in recent years, since the development of highly toxic and easily applied compounds. Calcium cyanide dust injected into the runway may destroy the moles under certain conditions or may cause them to avoid the gassed areas. The method is not very dependable, and the cost often is greater than the results justify. Aluminum phosphide pellets can be used for mole control the same as for field rodents (Chapter 1).

Repellents. The mole's ability to avoid poison often makes repellents more practical in small restricted areas of lawns or gardens. Lye, PDB, and napthalene are effective. Open the visible mole runways with your finger or a small stick. Insert a teaspoonful of one of these materials and close the opening carefully. Make applications at intervals of 8 to 10 feet along the raised runways and repeat them whenever sections of old runways show signs of use or when new ridges appear. Fencing small areas with woven wire or with concrete is sometimes practicable to protect valuable plants.

Exercises (A30):

1. List the general methods of mole control.

2. How can you control moles in lawns and yards?

3. What does a successful trapping program require of you?

4. East of the Rockies, where should you place mole traps?

5. What's the best time to trap moles?

6. What are the two main types of mole traps?

7. What fumigants are suitable for controlling moles?

8. What mole repellents can you apply in small areas?

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Answers for Exercises

CHAPTER 1

Reference:

A01 – 1. Buildings; food; property.
A01 – 2. Fields, grain elevators, processing mills, trucks, trains, and homes.
A01 – 3. Feces and urine; feed; human consumption; food.
A01 – 4. For food and for the sake of killing.
A01 – 5. Concrete, brick, wood, and even metal.
A01 – 6. Spontaneous combustion; nesting.
A01 – 7. The rat flea.
A01 – 8. Teeth and gum; bite; rat.
A01 – 9. House mouse; bite; mouse.
A01 – 10. Worldwide.

A02 – 1. (1) Longer than head plus body.
(2) Shorter than head plus body.
(3) Slender.
(4) Heavy, thick.
(5) Large.
(6) Small.
(7) Large.
(8) Small.
(9) Pointed.
(10) Blunt.
(11) Larger.
(12) Smaller.
(13) Larger.
(14) Smaller.
A02 – 2. a. House mouse.
b. Norway rat.
c. Roof rat.

A03 – 1. T.
A03 – 2. F; change "father" to "mother."
A03 – 3. F; change "dawn" to "dusk."
A03 – 4. T.
A03 – 5. T.
A03 – 6. F; change "4" to "2."
A03 – 7. T.
A03 – 8. F; change "noisy" to "quiet."
A03 – 9. T.
A03 – 10. T.
A03 – 11. F; they usually start a little after sunset each day.
A03 – 12. T.

A04 – 1. T.
A04 – 2. T.
A04 – 3. T.
A04 – 4. F; droppings may be a key.
A04 – 5. T.
A04 – 6. T.
A04 – 7. T.
A04 – 8. T.

A05 – 1. Because eliminating rodent food, water, and shelter can make the difference between success and failure in controlling them and preventing successful reinfestions.
A05 – 2. Building occupants or other CE sections, depending on the severity of the problem.
A05 – 3. Vegetation should be closely cut; lumber, rock piles, rubbish, old equipment, construction materials, etc., must be eliminated; other items should be stored at least 18" off the ground and 12" away from walls and fences; spaces under loading docks, outside storage sheds, etc. must be blocked off so no rodents can gain entry; old rat burrows and holes should be filled in with dirt; etc.
A05 – 4. Make sure enough ratproofing is done for your trapping and baiting programs to be successful.
A05 – 5. a. If they're larger than 1/4", they should be closed.
b. Cover with 1/4" mesh hardware cloth or other suitable material.
c. Close off and, if possible, limit to sizes that will prevent passage by rats and mice.
d. Sheath in sheet metal to prevent gnawing.
A05 – 6. Where there is a danger of contaminating food products or harming pets or children.
A05 – 7. Every 20 feet for rats; every 10 feet for mice.
A05 – 8. Because rats are often attracted to traps having the odor of other rats on them.
A05 – 9. If the trap is properly placed, the mouse will think the unbaited trap is just one more thing to walk over and won't be so suspicious.
A05 – 10. They are safe, nonpoisonous, easy to hide, and will hold rodents for hours; but customers tend to dispose of them after only one catch; the rodent's slow death may be objectionable; rats may chew off a leg to escape; and they may be hard to handle and service.
A05 – 11. Put them in bait stations to protect them.

A06 – 1. Norway rats like meat and fish; roof rats like fruits and vegetables; and house mice like bacon, sweets, grains or seeds, and peanut butter.
A06 – 2. It helps you learn which foods rats prefer, how many bait stations you need and where to place them.
A06 – 3. If you add too much poison, you increase the danger to people and other animals, and you may decrease acceptability of the bait to rodents. Too low a concentration may give incomplete control.
A06 – 4. Apply fresh baits in the late afternoon so that they will be fresh at dusk, when rodents become active.
A06 – 5. Only use them indoors and in areas not readily accessible to the public, children, and nontarget animals.
A06 – 6. Single-dose acute poisons, multiple-dose anticoagulants, and single-dose anticoagulants.
A06 – 7. Switch to single-dose poisons and/or traps, but not to other multiple-dose anticoagulants or to increased poison concentrations.
A06 – 8. It's effective and fast-acting, and it's a low-hazard rodenticide.
A06 – 9. Because it's very fast acting and hazardous.
A06 – 10. Indoors near rodent harborage, burrows, and runs; and outside in burrows, tunnels, deep into holes, or in covered bait stations.
A06 – 11. After 2 days.
A06 – 12. When you can get rid of most or all other water sources.

A07 – 1. T.
A07 – 2. F; this statement applies to rice and cotton rats.
A07 – 3. F; this applies to deer, or white-footed, mice.
A07 – 4. T.
A07 – 5. T.

A08 – 1. Wood.
A08 – 2. Cotton.
A08 – 3. Pine.
A08 – 4. Meadow.
A08 – 5. Rice.
A08 – 6. White-footed (deer).

A09 – 1. In runways near burrow openings at right angles to the paths so the mice will pass over the trigger.
A09 – 2. Rolled oats breakfast, cereal or nutmeats.
A09 – 3. Where strychnine is poorly accepted.
A09 – 4. For three weeks or more on dry bait material.
A09 – 5. Fruits, vegetables, grains, and seeds for pine and meadow mice; steamed rolled oats or wheat for deer mice.
A09 – 6. Weather-resistant anticoagulants.
A09 – 7. In trails, at all rock outcrops, along stone walls and drainage ditch banks, and at the bases of trees where you find mouse trails or holes.
A09 – 8. Apply 2–4 round tablets or 10–20 pellets to each den opening.

A10 – 1. a. Ground squirrel (*Citellus*).
b. Groundhog, woodchuck, marmot (*Marmota*).
c. Prairie dog (*Cynomys*).

A11 – 1. T.
A11 – 2. T.
A11 – 3. T.
A11 – 4. F; change "dry" to "damp."
A11 – 5. T.

A12 – 1. By what they eat and by the aboveground mounds they create when burrowing and foraging.
A12 – 2. They have long, strong limbs and strong claws adapted for digging and fighting and relatively sharp incisors for digging with lips that close behind the teeth to keep out dirt.
A12 – 3. They are active year round, but are least active during the spring mating season.
A12 – 4. Trapping and poisoning.
A12 – 5. Because traps must be placed and secured in the underground burrow.
A12 – 6. Because of the extent of the burrow system, the chance for leakage, the closeness of main runs to the soil surface, and the gopher's habit of closing off burrows when a poisonous gas is detected.
A12 – 7. Mix 0.25 or 0.50 percent strychnine alkaloid with grains such as milo or barley.

CHAPTER 2

A13 – 1. Pest bird.
A13 – 2. Bird hazard.
A13 – 3. Bird damage.
A13 – 4. Bird management.
A13 – 5. Bird damage control.
A13 – 6. Bird strike.

A14 – 1. a. Primaries.
b. Side.
c. Crown.
d. Forehead.
e. Lore.
f. Throat.
g. Breast.
h. Secondaries.
i. Flank.
j. Crissum.
k. Rump.
l. Back.
m. Nape.
n. Crown.
o. Forehead.
p. Chin.
q. Throat.
r. Breast.
s. Belly.
A14 – 2. Primary and secondary feathers.
A14 – 3. Acts as a brake to slow flight.
A14 – 4. Tearing food apart.

A15 – 1. (1) Histoplasmosis.
(2) Encephalitis.
(3) Psittacosis.
(4) Encephalitis.
(5) Histoplasmosis.
(6) Histoplasmosis.
A15 – 2. Parrot fever (psittacosis).
A15 – 3. A protective mask, preferably a disposable one.
A15 – 4. Incineration.
A15 – 5. Loss of lives and destruction of aircraft.
A15 – 6. Engines sitting idle for repairs.
A15 – 7. House sparrows, starlings, pigeons, etc.

A16 – 1. True.
A16 – 2. These are manmade habitats.
A16 – 3. Make that "birds that roost in large flocks."
A16 – 4. True.
A16 – 5. True.
A16 – 6. Species that typically roost on or in manmade structures are of particular concern to you.
A16 – 7. Pigeons roost on ledges, rafters, and other structures that give them protection from harsh weather and predators.
A16 – 8. True.
A16 – 9. They vary widely with these factors.
A16 – 10. True.
A16 – 11. It's largely insects then.
A16 – 12. True.
A16 – 13. They may pose a major strike hazard.
A16 – 14. True.
A16 – 15. They differ in learning ability.
A16 – 16. It's a declining response.
A16 – 17. True.

A17 – 1. (1) c.
(2) a.
(3) e.
(4) b.
(5) f.
(6) d.

A18 – 1. When the problem is just beginning to develop or even before it begins.
A18 – 2. Use past experience and good documentation.
A18 – 3. Since the place and time of birds' activity affect the problem, you must find out what the birds are doing, where they are doing it, and when they are doing it.
A18 – 4. Birds seek food, water, a place to nest, and a place to escape their enemies or avoid harsh weather, and we thwart them by habitat manipulation.
A18 – 5. To maintain historical data on pest/hazardous bird species. It will help you in identification and evaluation of pest problems so that you may decide if active control is needed. It also is useful in future surveys. You also should record weather conditions as they affect bird activities.

A19 – 1. If your inspection reveals no economic damage, health hazard, or safety hazard.
A19 – 2. Habitat modification.
A19 – 3. Get an appropriate permit.
A19 – 4. Netting or crisscrossing wires.
A19 – 5. Sharp spikes.

A20 – 1. They're most effective for repelling transient birds, and they're more effective on roosting and loafing birds than nesting birds.
A20 – 2. 100 yards.
A20 – 3. It makes the birds think there's no danger, and they will ignore the tape.
A20 – 4. It must have no choke or an open-choke barrel.
A20 – 5. Leather gloves, goggles, and ear protectors.

A20 – 6. Recorded distress or alarm calls.
A20 – 7. They have a low operating cost.

A21 – 1. Because other birds will eventually move in to replace those that were trapped or killed if the environmental attraction remains.
A21 – 2. Bait and live decoys.
A21 – 3. Cracked corn, peanut butter, or apples.
A21 – 4. At least 40 miles away.
A21 – 5. Near feeding or roosting sites where they won't be disturbed, such as on a flat rooftop.
A21 – 6. Mark them with indigo red dye.
A21 – 7. The verbail pole trap snares a raptor by its feet when it perches on a pole. The Bal-Chatri trap uses nooses to entangle the birds's feet when it's attracted by live bait in a cage.
A20 – 8. The U.S. Fish & Wildlife Service.
A21 – 9. To scare away birds or to reinforce noise techniques.
A21 – 10. To keep scaveners from eating the carcasses.
A21 – 11. The bird reacts erratically, exhibits abnormal behavior, and gives distress calls that scare away other members of the flock.
A21 – 12. Gulls, starlings, common grackles, cowbirds, crows, house sparrows, and pigeons.
A21 – 13. Because prebaiting may attract more birds and increase the strike hazard.
A21 – 14. To minimize exposure to people, pets, and nontarget species.
A21 – 15. You learn the feeding habits of both target and nontarget birds; you can stop using locations that attract nontarget species; and target birds can get used to being fed and will more readily take poisoned bait when it's applied.
A21 – 16. In a feeding trough 4 feet x 12 inches x 3 inches, or in plastic pans.
A21 – 17. It's less toxic to mammals and light-colored birds.

CHAPTER 3

A22 – 1. T.
A22 – 2. F; they have four upper incisor teeth.
A22 – 3. T.
A22 – 4. T.
A22 – 5. T.
A22 – 6. F; this applies to hares.
A22 – 7. F; 1 or 2 feet.
A22 – 8. T.

A23 – 1. F; delete the first four words.
A23 – 2. T.
A23 – 3. T.
A23 – 4. F; change "spring and summer" to "fall and winter."
A23 – 5. F; they mature quickly and can fly about 3 weeks after birth.
A23 – 6. T.
A23 – 7. T.

A24 – 1. By destroying natural habitat such as caves, and hollow trees, giving the animals no other natural places to go.
A24 – 2. By the noises they make within a building and by fecal droppings, stains, and odors from urine and glandular body secretions.
A24 – 3. They may come out of hibernation, suddenly appear from hiding places, and fly around the building.
A24 – 4. Only 1 or 2.
A24 – 5. In old frame structures, openings appear where boards shrink, warp, or become loosened.
A24 – 6. If they aren't controlled after a building is batproofed, or if the bat population is large and well established.
A24 – 7. They are attractive to transient bats during migration, and to males seeking refuge during the nursing season.

A25 – 1. Mexican free-tailed.
A25 – 2. Little brown.
A25 – 3. Mexican free-tailed.
A25 – 4. Big brown.
A25 – 5. Big brown.
A25 – 6. Solitary.
A25 – 7. Little brown.

A26 – 1. T.
A26 – 2. T.
A26 – 3. F; it should last about 5 years.
A26 – 4. F; these materials are for keeping bats from crawling under doors.
A26 – 5. T.
A26 – 6. F; quarter-inch mesh hardware cloth is needed.
A26 – 7. T.
A26 – 8. T.
A26 – 9. T.
A26 – 10. T.

A27 – 1. Grubs and other insects, small rodents, garbage, birds and their eggs, fruits, and berries.
A27 – 2. The striped skunk and the eastern and western spotted skunks.
A27 – 3. Everywhere except the Southwestern Desert.
A27 – 4. About the size of an adult house cat, with fur that's mostly black with white on top of the head and neck, and two white stripes down the back.
A27 – 5. They're found in areas such as brushy areas, stream beds, rocky outcrops, road culverts, industrial yards, around rural homes and barnyards, and in suburban areas within about 1/2 mile of their natural habitat.
A27 – 6. Occasionally in rock piles, hollow logs, tree holes, or a fresh-cut bank, but dens are usually enlargements of burrows of other animals.

A28 – 1. Because skunks are harvested seasonally in some states for their furs.
A28 – 2. Screen or block them out at all entrances or openings in foundations, porches, and stairs.
A28 – 3. Close off all but one entrance opening, then sprinkle a 1/8" layer of flour outside it as a tracking patch. Check for skunk tracks after dark, and when no tracks lead out but not in, seal the entrance.
A28 – 4. Divide 1 or 2 pounds into 4 to 6 parts and place them beneath the building away from the entrance.
A28 – 5. Place traps where the animals are entering the building or in trails they're known to use. For bait, use fish, fish-flavored cat food, raw or cooked bacon, or chicken parts.
A28 – 6. Because of the potential for spreading rabies.
A28 – 7. For people and pets, mix a tablespoon of the water-soluble form in a tube of water. For contaminated soil, add two ounces to a gallon of water and spray the area.

A29 – 1. Humidity; soil.
A29 – 2. Lawns; golf courses; seedbeds.
A29 – 3. Pests; diseases.
A29 – 4. It is not a rodent.
A29 – 5. T.
A29 – 6. T.
A29 – 7. Change "mounds" to "ridges."
A29 – 8. T.
A29 – 9. T.
A29 – 10. T.

A30 – 1. Food control, trapping, drowning, fumigating, and by using repellents.
A30 – 2. By controlling their food source with insecticides.
A30 – 3. That you carefully consider the mole's habits and instincts.
A30 – 4. In hunting tunnels close to the ground surface.
A30 – 5. When you find fresh signs of activity.
A30 – 6. Gripping and harpoon traps.
A30 – 7. Calcium cyanide and aluminum phosphide.
A30 – 8. Lye, PDB, and naphthalene.

STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 06 22

VERTEBRATE PESTS

Carefully read the following:

DO's:

1. Check the "course," "volume," nd "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the *best* answer to each question.

1. (A01) Rats destroy property by

   a. gnawing through wood, brick, and concrete.
   b. contaminating food.
   c. killing domestic animals.
   d. doing all of the above.

2. (A02) Which domestic rodent produces droppings that are small, rod-shaped, and about 1/8 inch long?

   a. House mouse.
   b. Pine mouse.
   c. Norway rat.
   d. Roof rat.

3. (A03) When rats are exposed to a new type of food, what is their first reaction?

   a. They avoid the new food.
   b. They eat only a token amount.
   c. They hide the new food.
   d. They eat until full.

4. (A03) Rats can make a standing high jump of approximately how many feet?

   a. 2.
   b. 3.
   c. 5.
   d. 7.

5. (A03) Which is the *best* statement about the feeding habits of domestic rodents?

   a. All three species have irregular eating habits.
   b. All three species have regular eating habits.
   c. Rats usually begin searching for food after midnight.
   d. Mice are steady eaters, rats are nibblers.

6. (A03) Select the food that is preferred by Norway rats.

   a. Onions.
   b. Celery.
   c. Oatmeal.
   d. Highly spiced foods.

7. (A04) Generally, finding rat droppings of several sizes indicates

   a. more than one type of rat is infesting the area.
   b. a heavy infestation of rats.
   c. the type of food rats have been eating.
   d. several ages of rats are present.

8. (A04) Where are Norway rat runs normally found?

   a. In the walls.
   b. On the roof.
   c. In the grass.
   d. Near the floor.

9. (A05) Sanitation for the control of rats and mice involves storage of foodstuffs how many inches off the floor?

   a. 2 to 3.
   b. 4 to 6.
   c. 12 to 18.
   d. 24 to 36.

10. (A05) What size mesh hardware cloth is suitable for rodentproofing?

    a. 1/8-inch.
    b. 1/4-inch.
    c. 1/2-inch.
    d. 3/4-inch.

11. (A05) How far apart should traps be placed to control rats?

a. 10 feet
b. 15 feet.
c. 20 feet.
d. 30 feet.

12. (A06) What type of bait does the Norway rat favor?

a. Bacon and grains.
b. Cheese and eggs.
c. Potatoes and nuts.
d. Meat and fish.

13. (A06) Test baiting serves all of the following purposes *except*

a. determining what foods rodents prefer.
b. determining what poisons rodents are susceptible to.
c. determining where bait stations should be located.
d. determining the number of bait stations needed.

14. (A06) When applying single-dose anticoagulants, you should maintain an uninterrupted supply of fresh bait for at least

a. 10 days.
b. 12 days.
c. 15 days.
d. 20 days.

15. (A07) The overall importance of field mice and rats on a military installation is *mainly*

a. economic.
b. morale.
c. nuisance.
d. medical.

16. (A07) Typically, field mice cause the most damage to trees during

a. the spring and early summer.
b. the summer and fall months.
c. a hard winter.
d. a mild winter.

17. (A08) What rat is chiefly vegetarian, eating flowers, fruit, seed, and bark?

a. Rice rat.
b. Pine rat.
c. Wood rat.
d. Meadow rat.

18. (A09) When trapping meadow and pine mice, what should you use as bait?

a. Bacon or eggs.
b. Oatmeal or apples.
c. Syrup or molasses.
d. Pork or beef.

19. (A09) When baiting for field mice, where should you place the bait?

a. Near the trunk of trees.
b. In grass close to a trail.
c. About one-half inch below ground.
d. Directly on the floor of used trails.

20. (A10) What factor is of greatest concern with having feral rodents on a military installation?

a. Morale.
b. Medical.
c. Nuissance.
d. Economic.

21. (A10) Which of the following feral rodents are colonial and live in "towns"?

a. Woodchucks.
b. Groundhogs.
c. Prairie dogs.
d. Ground squirrels.

22. (A11) What is the *best* bait to use in trapping ground squirrels?

a. Apple.
b. Oatmeal.
c. Candy.
d. Peanut butter.

23. (A11) Which of these fumigants is *not* suitable for controlling squirrels in their burrows?

a. Napthalene.
b. Aluminum phosphide.
c. Calcium cyanide.
d. Carbon monoxide.

24. (A12) What is the *best* way to locate the main runway of a gopher?

a. By observing the mounds.
b. By using a probe.
c. By flushing with a water hose.
d. By observing the grass above the runway.

25. (A12) Which grains work *best* when baiting for pocket gophers?

a. Barley and oats.
b. Oats and wheat.
c. Peas and beans.
d. Barley and milo.

26. (A13) If nesting sparrows leave corrosive droppings or holes in a building's screening, the problem is *best* described as

a. bird damage.
b. a bird strike.
c. a bird hazard.
d. a bird nuisance.

27. (A13) When birds present a potential threat to health or safety, the condition is referred to as

a. bird management.
b. a bird hazard.
c. bird damage control.
d. pest bird control.

28. (A14) The inner flight feathers responsible mainly for a bird's lift are called

a. coverts.
b. primaries.
c. scapulars.
d. secondaries.

29. (A14) The speculum of a duck's wing is part of the

a. secondary feathers.
b. primary feathers.
c. tail coverts.
d. scapulars.

30. (A14) The covert feathers of the shoulder area of a bird are referred to as

a. primaries.
b. speculars.
c. scapulars.
d. secondaries.

31. (A15) Both hisotplasmosis and psittacosis are commonly contacted

a. by touching bird droppings.
b. by touching or handling birds.
c. by wading in bird contaminated ponds.
d. by inhalation of bird contaminated dust or particles.

32. (A15) At what phase of flight operations do almost half of all bird strikes occur?

a. During enroute flight.
b. During take-off and landing.
c. During high altitude flight.
d. During engine warm-up and shutdown.

33. (A16) Which of the following characteristics determines where a given bird species will nest, roost, or feed?

a. Cover.
b. Colony.
c. Habitat.
d. Territory.

34. (A16) The areas where birds roost during daylight hours are called

a. loafing areas.
b. feeding sites.
c. resting sites.
d. roosting areas.

35. (A16) Birds that feed upon dead plants and animals are referred to as

a. scavengers.
b. granivores.
c. omnivores.
d. herbivores.

36. (A16) How do birds learn?

a. By observation, chanc ulus.
b. By trial and error, chanc stimulus.
c. By practice, experience, and observation.
d. by practice, experience, and trial and error.

37. (A17) Identify the pest birds that have long pointed wings, hooked bills, and usually square tails.

a. Gulls.
b. Pigeons.
c. House sparrows.
d. Common grackle.

38. (A17) Which of the following pest birds was introduced from Europe and is actually a small weaver finch?

a. Starling.
b. Rock dove.
c. House sparrow.
d. Sparrow.

39. (A18) Before any bird problem can be effectively and efficiently controlled, it must *first* be

a. identified and documented.
b. identified and evaluated.
c. evaluated and described.
d. described and documented.

40. (A18) In an effective bird management program, a complete installation inspection should be conducted every

a. two weeks.
b. six weeks.
c. month.
d. year.

41. (A18) What is the *primary* reason for determining whether birds observed are resident or transient?

a. Resident birds are protected by state law.
b. Migratory birds are protected by federal law.
c. Transient birds may soon leave the area on their own.
d. Transient birds are harder to repel than resident birds.

42. (A19) What bird control technique are you using if you reduce the bird's habitat in the area near an airfield?

a. Exclusion.
b. Repulsion.
c. Altering the concept.
d. Altering the situation.

43. (A19) What is the *best* solution for keeping birds from feeding on insects exposed during airfield mowing operations, thereby causing a strike hazard?

a. Apply a suitable avicide.
b. Apply a suitable insecticide.
c. Mow grass at night or on weekends.
d. Mow grass only when clearance is given by base operations personnel.

44. (A19) What is the most appropriate grass height for preventing gulls from loafing on airfields?

a. 3-5 inches.
b. 5-10 inches.
c. 8-12 inches.
d. 10-15 inches.

45. (A20) Recorded distress calls are suitable for dispersing

a. House Sparrows and Starlings.
b. pigeons and House Sparrows.
c. Starlings and pigeons.
d. gulls and Starlings.

46. (A20) All of the following are effective methods for repelling birds *except*

a. electronically produced noises.
b. recorded bird alarm calls.
c. airbursts and scare cartridges.
d. automatic exploders.

47. (A21) How far away should you transport trapped birds before you release them?

a. 10 miles.
b. 20 miles.
c. 30 miles.
d. 40 miles.

48. (A21) Which birds can you trap using a nest-box trap?

a. Starlings and pigeons.
b. House Sparrows and Starlings.
c. All types of blackbirds.
d. Any species of nesting birds.

49. (A21) Shooting birds with live ammunition is *best* used to

a. eliminate blackbirds from small areas.
b. reinforce active scaring techniques.
c. kill pigeons on top or inside hangars.
d. supplement bird poisoning efforts.

50. (A22) Which of the following characteristics is *not* true of hares and rabbits?

a. They can be controlled by epizootics alone.
b. They damage trees and erosion control plants.
c. They are carriers of spotted fever and tularemia.
d. They are heavily furred, with long ears and elongated hindlegs.

51. (A22) All of the following are true rabbits of the genus Sylvilagus *except* the

a. jack rabbit.
b. cottontail.
c. marsh rabbit.
d. brush rabbit.

52. (A22) Which of these pesticides is suitable for repelling rabbits from an area?

a. Maneb.
b. Chloroneb.
c. Thiram.
d. Malathion.

53. (A23) Bats are worldwide in distribution, but are found mainly in

a. temperate areas.
b. tropical areas.
c. subtropical areas.
d. deciduous woodlands.

54. (A23) After baby bats are born in the spring, they are able to fly in about

a. two weeks.
b. three weeks.
c. one month.
d. two months.

55. (A24) How many bats at most are typically found within buildings?

a. 1-2.
b. 5-7.
c. 10-15.
d. 25-50.

56. (A25) Which of the following is one of the largest bats commonly found in buildings, but forms only small colonies of 12-200 bats?

a. Red bat.
b. Little brown bat.
c. Big brown bat.
d. Mexican free-tailed bat.

57. (A25) Which bat is typically dark brown, but may be dark gray to pale brown due to ammonia fumes from guano deposits?

a. Hoary bat.
b. Big brown bat.
c. Little brown bat.
d. Mexican free-tailed bat.

58. (A25) Identify bats that live alone in tree foliage or under bark, but never in caves.

a. Solitary bats.
b. Colonial bats.
c. Pallid bats.
d. Feral bats.

59. (A26) Which of the following can be easily used to block the bottoms of seldom used doors?

a. Caulking.
b. Stainless steel wool.
c. Weatherstripping.
d. Sand snake.

60. (A26) Screening used to block access points for bats should be no larger than

a. 1/8" mesh.
b. 1/4" mesh.
c. 1/2" mesh.
d. 3/4" mesh.

61. (A26) When naphthalene is used to repel bats from an enclosed area, the rate of application is

a. 11 lbs per 2000 cubic feet.
b. 10 lbs per 2000 cubic feet.
c. 5 lbs per 2000 cubic feet.
d. 2 lbs per 2000 cubic feet.

62. (A27) In the U.S., all of the following skunks are of *primary* economic and medical importance *except* the

a. western spotted skunk.
b. eastern spotted skunk.
c. hog-nosed skunk.
d. striped skunk.

63. (A27) The striped skunk is generally found throughout the U.S. *except* in the

a. Northeast.
b. Southeast.
c. Northwest.
d. Southwest.

64. (A27) Which skunks are good climbers and occasionally have their dens in tree holes?

a. Striped skunks.
b. Spotted skunks.
c. Hog-nosed skunks.
d. Hooded skunks.

65. (A28) What is the *best* long-term solution to problems with skunks?

a. Screen or block them out.
b. Eliminate food sources.
c. Use toxic chemicals mixed with cat food.
d. Maintain traps on a regular basis.

66. (A28) Neutroleum-alpha is *best* used as a

a. toxic bait.
b. skunk attractant.
c. skunk repellent.
d. skunk odor neutralizer.

67. (A29) The general distribution of moles depends largely on the

a. atmospheric humidity and resulting soil conditions.
b. presence of grubs and worms.
c. looseness of the soil and its water content.
d. amount of large tree roots in the area.

68. (A29) About how many yards can a mole travel through loose soil in a day?

a. 5.
b. 25.
c. 50.
d. 100.

69. (A30) The universally applicable and satisfactory way to get rid of moles is by

a. drowning.
b. trapping.
c. gassing.
d. baiting.

70. (A30) In trapping moles, it is important to be aware of a mole's

a. feeding habits.
b. periods of inactivity.
c. unsuspecting nature.
d. sensitivity to an unnatural environment.

END OF EXERCISE

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012 and EO 9397. PRINCIPAL PURPOSES: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package. It is utilized by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's need. Failure to provide all information would result in slower action or inability to provide assistance to the student.

SECTION I: CORRECTED OR LATEST ENROLLMENT DATA: *(Mail to: ECI, Gunter AFS AL 36118)*

1. THIS REQUEST CONCERNS COURSE (1 - 6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7 - 15)	6. GRADE/RANK	7. NAME *(First initial, second initial, last name)* (17) (18) (19-32)
– –		

8. ADDRESS *(OJT Enrollees -- Address of unit training office with zip code. All others -- current mailing address with zip code.)*	(33-53) (54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33 - 39)

SECTION II: REQUEST FOR MATERIALS, RECORDS, OR SERVICE

(Place an 'X' through number in box to left of service requested)

FOR ECI USE ONLY

1	Request address change as indicated in Section I, Block 8.	
2	Request Test Control Office change as indicated in Section I, Block 10.	
3	Request name change/correction (Provide Old or Incorrect data)	
4	Request Grade/Rank change/correction.	16 G: 33
5	Correct SSAN. (List incorrect SSAN here) (Correct SSAN should be shown in Section I)	K: Vol 33 - 35, GR 36 - 38
6	Extend course completion date. (Justify in REMARKS)	M: 33 - 34, 35 - 40
7	Request enrollment cancellation. (Justify in REMARKS)	
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 Originals were: ☐ Not received ☐ Lost ☐ Misused	N: 33 - 35
9	Send course materials. (Specify in REMARKS) [ ] Not received ☐ Lost ☐ Damaged	P: Vol 33 - 35
10	Course exam not yet received. Final VRE submitted for grading on ________ (date).	TC 36 - 37, 38
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 not yet received. Answer sheet(s) submitted ________ (date).	DOE 39 - 45
12	Results for CE not yet received. Answer sheet submitted to ECI on ________ (date).	
13	Previous inquiry (☐ ECI Fm 17, ☐ Ltr, ☐ Msg) sent to ECI on ________ (date).	Q: 33 - 34 QQ, 38 1
14	Give instructional assistance as requested on reverse.	MC 39 - 42
15	Other (Explain fully in REMARKS)	

REMARKS *(Continue on Reverse)*

OJT STUDENTS must have their OJT Administrator certify this request.	I certify that the information on this form is accurate and that this request cannot be answered at this station. *(Signature)*
ALL OTHER STUDENTS may certify their own requests.	

ECI FORM OCT 83 17 (PREVIOUS EDITIONS MAY BE USED)

SECTION III: REQUEST FOR INSTRUCTOR ASSISTANCE

NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

VRE Item Questioned:

Course No ____________

Volume No ____________

VRE Form No ____________

VRE Item No ____________

Answer You Chose ________ (Letter)

Has VRE Answer Sheet been submitted for grading?

[ ] Yes [ ] No

REFERENCE

(Textual reference for the answer I chose can be found as shown below)

In Volume No ____________

On Page No ____________

In [ ] left [ ] right column

Lines _____ Through ______

MY QUESTION IS:

REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

56650 07 8411

CDC 56650

PEST MANAGEMENT SPECIALIST

(AFSC 56650)

Volume 7

Househoid, Venomous, and Vegetative Pests

Extension Course Institute
Air University

618

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SHEPPARD AIR FORCE BASE, TEXAS 76311

EXTENSION COURSE INSTITUTE (AU)
GUNTER AIR FORCE STATION, ALABAMA 36118

Preface

VOLUME SEVEN OF this CDC was developed to teach you about the various household, venomous, and vegetative pests you must deal with in your job.

In Chapter 1 you'll learn about the characteristics and controls available for pests such as cockroaches, ants, silverfish, firebrats, and other pests which may infest homes and other buildings.

Chapter 2 begins by discussing the types of arthropod and reptile venoms and how they affect victims. Then, you'll study the most common venomous arthropods and reptiles people encounter. The list includes bees, wasps, hornets, spiders, scorpions, and other venomous arthropods. The venomous reptiles you'll study include water moccasins, copperheads, rattlesnakes, and coral snakes.

In Chapter 3 you'll learn about weed growth and propagation, surface plants, aquatic plants, and control measures for weeds.

For easy reference, foldout 1 covering venomous snakes of the United States is bound in the back of this volume.

Code numbers appearing on figures are for preparing agency identification only.

The inclusion of names of any specific commercial product, commodity, or service in this publication is for information purposes only and does not imply indorsement by the Air Force.

This volume is rated at 27 hours (9 points).

Material in this volume is technically accurate, adequate, and current as of July 1984.

Acknowledgement

PREPARATION OF this volume was aided through the cooperation and courtesy of Harcourt Brace Jovanovich, publishers of the *Scientific Guide to Pest Control Operations*, 3rd edition. Information from this book was used to help develop information on characteristics and controls for various household pests.

In accordance with the copyright agreement, distribution of this volume is limited to DOD personnel.

Development of Chapter 1 was also enhanced by the cooperation and courtesy of Gie, Inc. Publishers, which publishes *Pest Control Technology* magazine. This periodical was of great assistance in developing information on pharoah ants and their control.

Permission to use materials by these publishers is gratefully acknowledged.

Contents

Household Pests

HOUSEHOLD PESTS rob U.S. citizens of millions of dollars each year, contaminating and spoiling far more than they eat. When present in a restaurant or store, they repel customers and cause economic loss. They damage clothing, rugs, and other items. They cause disease in and transmit disease to people and their domestic animals. In your job, you should be able to recognize common household species, know their public health importance, and be able to recommend and implement effective control procedures.

1-1. Cockroaches

Cockroaches (order Dictyoptera, family Blattidae) form the oldest group of insects. They are among the most persistent pests and exhibit a high degree of adaptability. Although many species live outdoors, others have moved indoors and have become among the most widely distributed and numerous of pests.

This section covers the cockroach species we consider to be important household pests, the history and habitats of these pests, and the controls you can use to manage them.

C01. State the importance and general identifying characteristics of cockroaches.

Importance. Cockroaches are the most important household pests infesting homes, hotels, restaurants, bakeries, and many other food serving establishments. Cockroaches have become well adjusted to living with people. They harbor in the cracks and crevices provided by buildings, living on bits of food scattered where people live or travel. Cockroaches have been reported nibbling on the eyelashes, fingernails, and toenails of sleeping children. They impart an unsavory odor and taste to food they infest. Cockroaches prey on bedbugs. They carry the organisms causing enteric diseases (diarrhea, dysentery, typhoid, food poisoning) from sewers and garbage cans to the food of humans. The rat tapeworm *(Hymenolepis diminuta)* can be picked up by cockroaches (as well as by mealworms, fleas, and other arthropods) and then transmitted to people through the insect's fecal material. This disease is not considered serious because of the limited number of human cases; the cockroach's role in its transmission can be considered minor.

General Characteristics. Cockroaches (fig. 1-1) undergo gradual metamorphosis and progress through nymphal stages to the adult. There are about 55 species in the United States, but only 5 are common pests indoors.

Most species have wings. When present, there are two pairs with the front pair usually being long, narrow, opague, and leathery. Cockroaches have chewing mouthparts and can usually be recognized by their oval, flattened shape, the head concealed under the pronotum, and the long bristlelike antennae.

These insects live in groups and are active at night. They prefer warm, damp, secluded hiding places during the daytime, such as electrical panel boxes, refrigerator insulation, sink cabinets, drainpipe areas, furnace rooms, sewers, food-service equipment, and cracks and crevices of floors, walls, and furniture.

The eggs of a cockroach are placed in a purselike capsule called the *ootheca*, which may contain from 12 to 50 eggs, depending on the species (fig. 1-2). The eggs are contained in two rows of divided chambers. The female may carry the ootheca protruding from the end of the abdomen for several days before she drops or glues it to a surface.

The tiny white nymphs that emerge from the eggs closely resemble the adults. They go through successive periods of growth separated by molts and form the adults.

Exercises (C01):

1. Cockroaches are the most important household pests infesting ____________, ____________, ____________, and ____________.

2. Where do cockroaches generally make their homes?

3. On what do cockroaches subsist?

4. List the enteric diseases are transmitted by cockroaches.

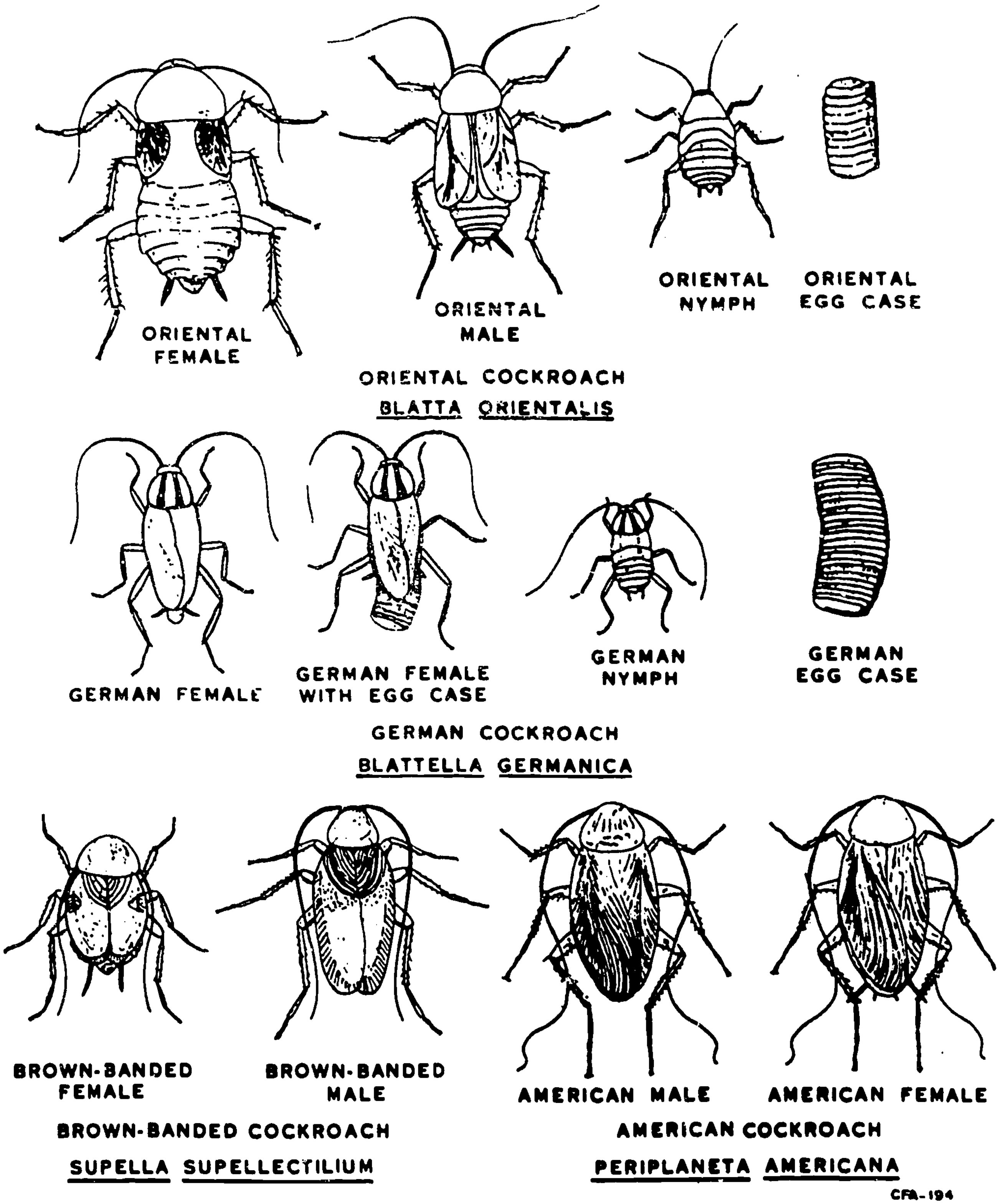
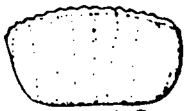


Figure 1-1. The cockroach.

Pennsylvania Woods Roach

1) Ootheca curved in an inverted half-moon shape; usually contains 16 eggs on each side. Normally found out of doors under bark of old logs and stumps — Pennsylvania Woods Roach

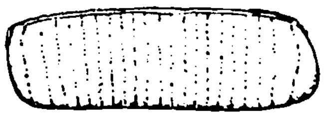
1') Ootheca straight, at least on the bottom side. Normally found in buildings...... 2



Brown-banded Cockroach

2) Ootheca one-fourth inch (or less) in length; no more than 9 eggs on each side — Brown-banded Roach

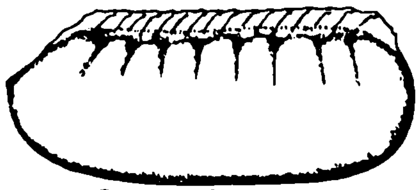
2'') Ootheca one-third inch or more in length. 3



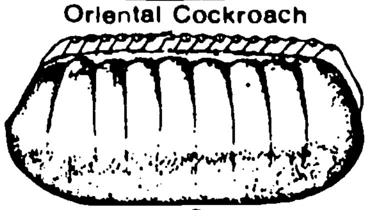
German Cockroach

3) Ootheca slender, about one-third inch long; light brown. Top and bottom sides parallel, contains 12 to 24 eggs on each side. Carried by the female until a day before hatching — German Roach.

3') Ootheca purse-shaped, not slender; length greater than one-third inch; dark brown to black. 4

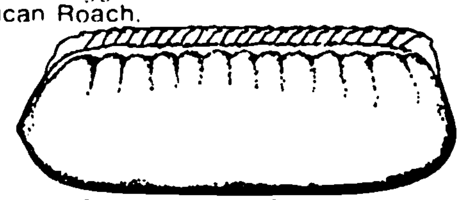


Oriental Cockroach



American Cockroach

4)* With 8 eggs on each side — Oriental Roach or American Roach.



Smoky Brown Cockroach

4)** With 12 eggs on each side — Smokey Brown Roach

4')** With 12 eggs on each side.

*The ootheca of these species are quite difficult to separate with accuracy

**The ootheca of the brown cockroach may key out at this point. It is difficult to distinguish between ootheca of these two species

Figure 1–2. Key to oothecae of some common cockroaches.

5. How may the rat tapeworm be transmitted to people by cockroaches and other insects?

6. How many cockroach species are there in the United S es? How many commonly infest buildings?

7. These insects live in groups and are active _______ _________________ and prefer ___________, ________, _______________ hiding places during the other part of the day.

8. The eggs of a cockroach are placed in a purse-like capsule called the ____________________.

C02. Identify physical and behavioral characteristics of common types of cockroaches.

Cockroach Identification and Characteristics. The five most important indoor cockroaches are the:

(1) German cockroach *(Blattella germanica)*.
(2) Brown-banded cockroach *(Supella supellectilium)*.
(3) Oriental cockroach *(Blatta orientalis)*.
(4) American cockroach *(Periplaneta americana)*.
(5) Australian cockroach *(Periplaneta australasiae)*.

German cockroach. The German roach is the most common roach in houses in the United States. In some areas people call it a "croton bug." Adults are pale brown and about 3/4 inch long; both sexes have wings as long as the body. You can distinguish them from other roaches by the two dark stripes on the pronotum (fig. 1-3). Young German cockroaches resemble the adults except that they are wingless and darker in color, often being nearly black. A single light stripe running down the middle of the back is the most prominent marking on the young cockroach.

The female carries her egg capsule protruding from her abdomen until the eggs are ready to hatch. The egg capsule is slender, about 1/3 inch long and tan in color. The nymphs may break open the capsule while it's still attached to the female, or she may deposit the capsule in some protected place where the young will be able to find food when they hatch. This is the only common house-infesting species that carries the egg capsule for such an extended period of time. Capsules removed from the female more than a day before time to hatch may not hatch. A female will usually produce 4 to 8 capsules in her lifetime. Each capsule has 30 to 48 eggs that hatch out in about 28 days at room temperature. Completing the nymphal stage under room conditions takes 40 to 125 days and the nymph usually molts 7 times before reaching adulthood. German roaches live as adults for about 1 year.

COCKROACHES: PICTORIAL KEY TO SOME COMMON SPECIES

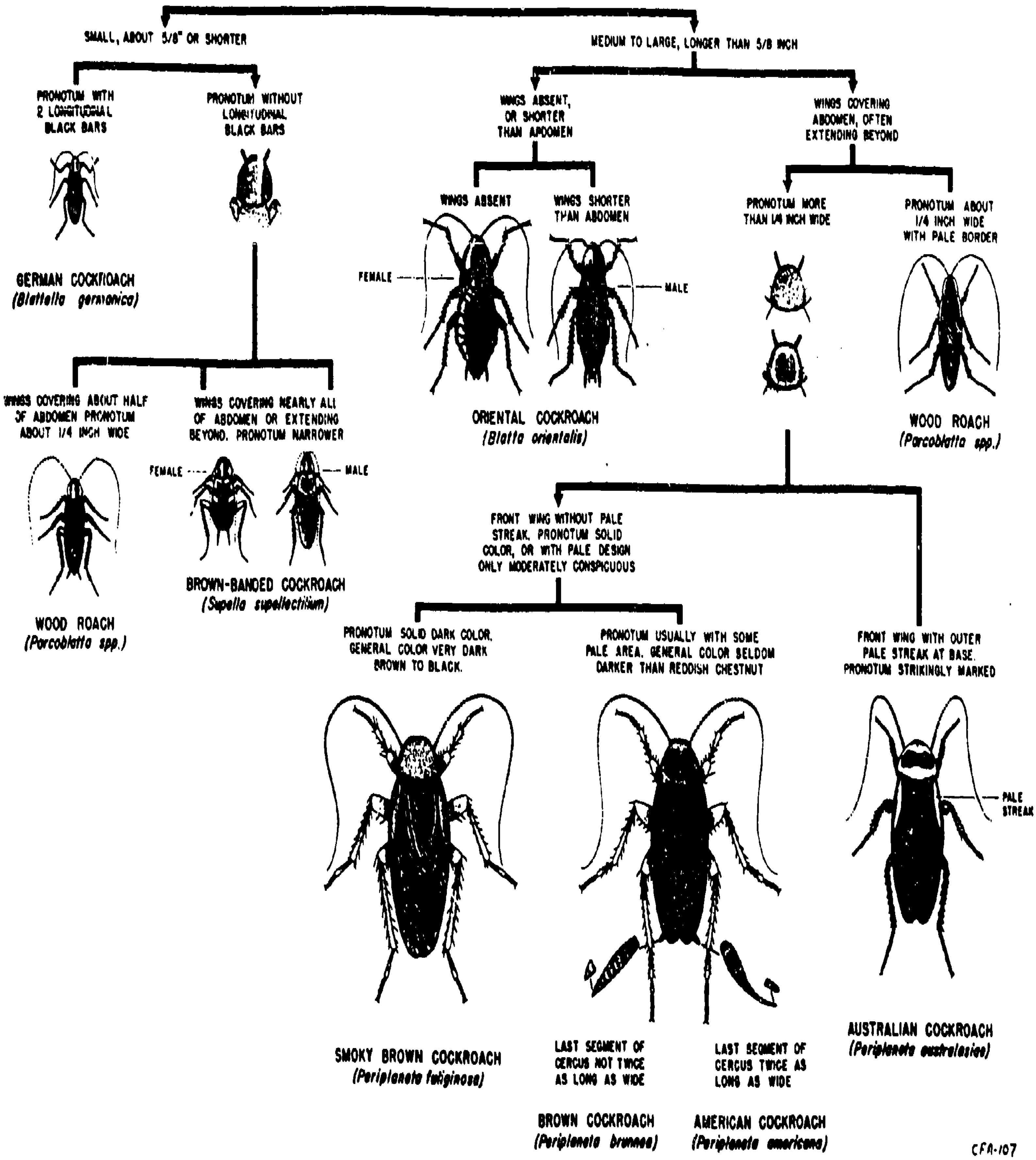


Figure 1-3.

Nymphs have habits similar to those of the adults. They dislike light and hide in dark crevices during the day and are active at night. If you see German roaches during the day or while there is much activity in the area, then the population is probably so large that available cracks are already full. They usually hide in areas close to moisture and food, which means kitchens and other food areas. They appear to prefer to rest on wood rather than on metal or other smooth surfaces. Large infestations do occur on metal surfaces when there are few other surfaces available such as in a food-handling facility with lots of stainless-steel equipment.

German roaches are general feeders, but they seem to prefer fermented foods—they *love* beer. If the adults have water, they can live about a month without food, but young nymphs die of starvation within 10 days. Without food or water, the adults die in less than 2 weeks. A regular need for water explains why they generally stick to moist areas such as kitchens and bathrooms.

You can sometimes find infestations in areas not generally suspected of harboring German roaches; for example, dresser drawers in bedrooms. When German roaches are found scattered through nonfood areas of a building, it usually indicates a very heavy infestation. Roaches in these areas will find food scarce, but they can feed on scattered crumbs, soiled clothing, and the glue on dresser drawers. German roaches are also found outdoors during warm months and this, too, is usually due to heavy infestations. In such cases, they are often associated with garbage containers.

As stated earlier, the German cockroach is the most commonly encountered of the house-infesting species in the United States. The reasons for this are somewhat complex, but the understanding of some of the factors involved are basic to your job.

In the first place, the German cockroach has a larger number of eggs per capsule and a shorter hatching time than the other species. It also requires a shorter period from hatching until sexual maturity, so that within a given period of time a population of German roaches will produce a larger number of eggs. On the basis of this fact, you can see that this species has a high reproductive potential.

Since the female carries the egg capsule during nearly the entire time the embryos are developing within the egg, many hazards of the environment which may affect the eggs are avoided. This means that more nymphs are likely to hatch and that a larger portion of the reproductive potential is realized.

The nymphs that hatch from each egg capsule tend to stay close to each other, and since they are often close to the female at time of hatching, there is a tendency for the local population density to be high. Being smaller than most of the other roaches, they are able to conceal themselves in places inaccessible to larger individuals.

All of these combined factors help give the German cockroach an advantage with regard to group survival.

The German roach is very active. Both the male and the female adults are fully winged although they rarely fly. They are regularly carried from place to place in such things as bagged potatoes and onions, bottle cases and cartons, and food packages. They travel readily from one location to another and can pass through very small openings. You must look very closely to find all places where roaches may be living. Places where the German roach are found will generally be characterized by a number of environmental factors. These places will usually be warm, dark, and will provide small cracks and crevices or small openings into dark, confined areas. Such places are usually moist or located near some source of water; they will be close to some sort of food suppiy.

You'll usually find German roaches clustered closely together. In populations that have developed a resistance to modern insecticides, however, there is good reason to believe that individuals may scatter widely throughout a building. This scattering results in distribution of individuals that are not easily found and that can breed and build up the roach populations again in a short time.

Brown-banded cockroach. This is one of the smaller roaches, rarely being more than 1/2 inch long. It is light brown and can be readily distinguished from the German roach by the presence of two lighter, transverse (running from side to side) bands across the base of the wings and abdomen in both the adults and nymphs. These bands may be somewhat irregular or broken and are more apparent on the young and the females than on the males. The female is much broader bodied than the male. Both males and females are quite active and the adult males fly readily when disturbed. Both adults and nymphs may jump when attempting to escape. They frequently occur in the same buildings as the German roach and you must be very careful to identify the species you're dealing with since the method of control is quite different for each.

A female carries her egg capsule for a day or two and then attaches it to a protected surface. The egg case is purse shaped, light brown in color, and is cemented in place, usually to the side or under surfaces of infested objects. Each female will produce about 14 capsules during her adult life, each containing about 18 eggs. These hatch in 50 to 75 days, depending on temperature. Under room conditions, nymphs mature in about 160 days. Adults may live up to 10 months.

You'll generally find nymphs and adults on ceilings, high on walls, behind picture frames and near motors of refrigerators and other appliances. Look also in light switches, closets, and furniture. They do not require as much moisture as German roaches, which helps explain why they are normally found in rooms other than the kitchen or bathroom. These roaches dislike light and are not normally seen during the day.

The brown-banded roach's favorite food seems to be starchy materials because of the areas where they are found. However, they can be found feeding on almost anything and have been known to chew on nonfood materials such as nylon stockings.

When making an inspection for brown-banded cockroaches, look beneath tables and chairs, dressers, and chests, also behind pictures, along picture molding, on rough plaster walls and ceilings, and most especially on the ceilings and upper walls of cabinets, pantries, and closets. No room is immune; nor is any piece of furniture—wood, metal or upholstered—if its construction provides shelter.

You may find tiny black droppings or castoff skins where they have fallen from above onto shelves or ledges.

These roaches are more often found in homes, dormitories, and hospital rooms than in stores, snack bars, and dining facilities. They are frequently transported in furniture and will rapidly spread throughout an entire building. They have long been abundant in the Southern States, but are now found as far north as Canada. In the cooler Northern States, they are generally found in the warmer parts of buildings.

Oriental cockroach. The oriental roach is also referred to as the "waterbug,""black beetle", and "shad roach". It is found in all parts of the United States.

Total length of this roach is about 1¼ inches in females and about 1 inch in males. The female has small, functionless rudimentary wings while those of the male cover about three-fourths of his abdomen. Neither the male nor the female will fly. Adults are very dark brown or black. Females are broader and heavier than males.

The female carries her egg capsule for about 30 hours, then she drops or attaches it to a protected surface near a food supply. The average female will produce 8 capsules, each containing 16 eggs that will hatch, under room conditions, in about 60 days.

Nymphs molt from 7 to 10 times and the nymphal stage usually takes about 1 year to complete. Unlike the other house-infesting species, the oriental cockroach appears to have a definite seasonal periodicity in its developmental cycle. The peak number of adults usually appears in late spring or early summer, but due to natural mortality, the number of adults in the population is generally quite low by late summer and early fall. There are usually a few live adults in the population throughout the year, but if nymphs have not reached maturity by late fall or early winter, their development seems to slow considerably, with maturity not being reached until spring.

The nymphs and adults have similar habits and are found associated with decaying organic matter indoors and out. You may find them in yards, beneath leaves, in dumps, and in the mulch of flower beds. They are also common in high-moisture situations such as sewers, drains, and dark and damp basements. Both the nymphs and adults are sluggish and are usually located at or below ground level. They are seldom found on walls, in high cupboards, or in the upper floors of buildings.

They feed on all kinds of filth and rubbish and other decaying organic matter. They seem especially fond of garbage and the contents of discarded tin cans. They can live for a month without food if water is available, but they die within 2 weeks without water.

In many areas the oriental cockroach spends considerable time outdoors during warm weather. In periods of drought there may be mass movement into structures, apparently in relation to humidity levels. As cold weather approaches (or sometimes during unseasonably cool periods) a similar indoor migration may occur in response to temperature. There may be considerable group movement within heated structures during cold weather, particularly in situations where certain areas of the building are maintained at a higher temperature than other areas.

American cockroach. The American roach is also known as the "waterbug,""Bombay canary", and the "flying water bug". It is the largest of the common species, growing to a length of 1½ inches or more. It is reddish-brown, with a yellow border on the back of the pronotum. Both male and female are fully winged, with the wings of the male extending slightly beyond the tip of the abdomen while those of the female are about the same length as the abdomen.

The female drops her egg capsule within a day after it's formed. It may simply be dropped in a suitable location (such as near a food source, along the walls of basements or—in the South—outdoors in decaying moist wood) or glued to some surface with secretions from the female's mouth. The female forms egg capsules at the rate of about one per week until 15 to 90 have been produced. Each capsule contains 14 to 16 eggs. At room temperature, nymphs will hatch out in 50 to 55 days. In the process of hatching, nymphs will molt leaving their cast skins in the egg case.

Young nymphs are grayish brown and each will molt 9 to 13 times before reaching maturity. After the first few molts, nymphs become more and more of a reddish-brown color. The time required for completing the nymphal stage varies from 160 to 971 days. At room temperature, an adult female will live for an average of about 440 days; males live for a somewhat shorter period.

You may find nymphs and adults in dark, moist areas, such as around bathtubs, clothes hampers, and in sewers. They are common in basements and are usually found high on the basement walls and in the corners. In the North, this roach is commonly associated with steam-heat tunnels. As this practice decreases in cities, the American roach in the North will be restricted primarily to large institutions and industries which still use steam-heat tunnels. The American roach is also common around manholes in sewers and on the underside of metal covers of large sump pumps in boiler rooms.

In the South, this roach is abundant in alleyways, yards, hollow trees, and palm trees. When palm trees are sprayed for other insects, the roaches leave the trees and enter homes. It has also been observed migrating from one building to another in the North during warm months.

These roaches feed on a variety of foods, but they seem to prefer decaying organic matter. They also feed upon book bindings, manuscripts, clothing, and glossy paper with starch sizing. Syrup and other sweets are attractive also. The adults can survive 2 or 3 months without food, but they can only live a month without water.

The adults have well-developed wings but seldom fly. They are capable of gliding long distances and will cover considerable distances if they take off from a tree or rooftop. It has been reported that this insect has been seen flying in the South (as far north as Kentucky).

Australian cockroach. The Australian roach is similar in appearance to the American roach but is rarely more than 1¼ inches long. It is reddish-brown and can be distinguished by a prominent yellow stripe along the outer front edge of its wings and by a prominent dark spot in the center of the pronotum.

An adult female drops her egg capsule in cracks, crevices, and other hidden areas shortly after it is formed. The eggs hatch in about 30 days after the egg capsule is dropped. There are about 24 eggs per capsule, but only about two-thirds of this number usually hatch. Egg capsules are compl-:ed and dropped at about 10-day intervals.

The nymphs are strikingly marked with distinct splotches of yellow on the dorsal side of the thorax and abdomen. Nymphs move about under loose bark and in moist decaying vegetation, as do adults.

This is mostly a southern roach but has been found in greenhouses and homes in the Northern States. It feeds mainly on plant materials, although it will feed on starchy materials such as book covers in homes.

Exercises (C02):

1. Match the types of cockroaches in column B to their specific characteristics in column A. Column B items may be used more than once.

Column A	Column B
____ (1) This large roach is about 1½ inch long or more, reddish brown, with a yellow border on the back of the pronotum.	a. German.
____ (2) This roach is about 1/2 inch long and light in color with two transverse bands across the base of the wings.	b. Brown-banded.
____ (3) Two dark stripes on the pronotum distinguish this roach from others.	c. Oriental.
____ (4) This large, reddish-brown roach has a prominent yellow stripe along the outer front edges of its wings.	d. American.
____ (5) Adults of this roach are very dark brown to black and are 1–1½ inches long. Females are broader and heavier than males.	e. Australian.
____ (6) Nymphs of this roach are originally grayish brown, but become more of a reddish-brown color as they molt.	
____ (7) Populations of this roach peak in late spring or early summer but are very low by late summer and early fall.	
____ (8) This is the only common house-infesting cockroach that carries the occtheca for an extended time.	
____ (9) This roach feeds mainly on plant materials but will attach to starchy materials such as bookcovers in homes.	
____ (10) This roach doesn't need as much moisture as the German cockroach and this accounts for it's being found more commonly outside kitchens and bathrooms.	
____ (11) This roach is associated with dark, moist areas such as around bathtubs, clothes hampers, and in sewers.	
____ (12) This roach is a general feeder, but seems to prefer fermented foods.	
____ (13) This cockroach is usually found in association with decaying organic matter indoors and outdoors.	
____ (14) This roach is more commonly found in homes, dormitories, and hospitals than in stores, snack bars, or dining facilities.	

C03. Describe control principles and techniques for cockroaches.

You can occasionally detect the presence of cockroaches by the damage they do or by the fecal matter they deposit. These are clues, and just as symptoms are useful to a doctor in diagnosing a disease, so will clues help you diagnose your roach problem. Cockroaches may use such things as glue, paste, starch, and certain color dyes as foods. As a result, such things as stamps, envelopes, book bindings, draperies, and some wallpapers may show signs of feeding. The size of the mandible marks and the apparent degree of vigor with which they feed are indications of the type of roach which did the damage. In a similar manner, the size and shape of fecal droppings are clues to the roach involved.

The greatest economic loss to cockroaches is a result of their habit of feeding in unsanitary places such as sewers, garbage disposal, storage areas, etc. They spread this filth from these areas to food supplies with far more goods being contaminated by roaches than eaten.

Cockroach Control Principles and Techniques. Controlling cockroaches takes a great deal of care and planning on your part. You must search closely for their hiding places and treat them thoroughly. Regardless of the type of insecticide used, chemicals you apply in or near regular hiding places will give much better control than those placed where roaches will only walk over them occasionally.

In controlling many species, good sanitation is fully as important as chemical applications. Work closely with building occupants to see that all possible sources of food supply are removed. Cleanliness and good housekeeping are very important. Occupants should never leave food products exposed and should always keep garbage in closed containers. They should give particular attention to dog and cat foods since roaches can live on these alone. Encourage occupants to eliminate dripping faucets and leaking water pipes and keep sewer openings screened. Incoming merchandise, especially groceries and drink cartons, should be inspected for cockroaches and egg capsules. Empty drink containers should be stored or discarded. Needless accumulation of boxes and other trash should be avoided. Excluding roaches by such methods as equipment design, good screening, tight-fitting doors, and by filling cracks and crevices is an important consideration in the total program of prevention and control.

In spite of rigorous sanitation, cockroaches do become established in some locations. Insecticides are then needed to affect practical control. Before or during treatment, make a thorough inspection with a flashlight to locate infested sites and use a flushing agent. Control chemicals may be oil-based sprays, emulsions, dusts and, for some species, baits. Your choice of the chemical formulation will frequently depend on the situation you must treat. Obviously, you can't use dusts where they would be unsightly or would cause contamination problems. On porous surfaces, oils will penetrate deeply and leave less residual insecticide on the surface than will a water emulsion. Usually a residual chemical is preferred for roach control, but in many instances, it may be necessary or desirable to use a contact spray. Frequently, you may use a combination of residual insecticide together with a contact insecticide. Common residual insecticides, applied as either oil-based sprays or water emulsions are 3 percent Malathion, 1 percent Diazinon, 0.5 percent Dursban, and 1 percent Baygon. These sprays should be applied to cockroach harborages with emphasis on cracks and crevices; minimize treatment of exposed surfaces. When it is necessary to treat exposed surfaces, make the application with a low-pressure spray. Avoid runoff or puddling. Excess spray should be wiped up immediately to avoid staining or damaging certain materials. Other precautions include:

- Do not apply oil-based insecticides near open flames, to tile floors or to plants.
- Do not use water-based sprays near electrical outlets.
- Remove pets and cover aquariums before spraying and allow treated surfaces to dry before dishes, foods, and other articles are placed on them.

The most important things to remember are to use only formulations registered by EPA for such use and to read and follow label directions to the letter.

Since you must use crack and crevice treatments in food handling facilities—and also since it works so well—you can use a simple technique of simultaneously inspecting and treating for cockroaches in these areas. Depending on the size of the job and the number of workers, you can use 1–3 people. For a large facility, such as a dining hall, here's a 3-person model that works well:

(1) Equip the first worker with an aerosol bomb to use as a flushing agent. He or she will precede the others, checking all cracks and crevices which may harbor cockroaches. This person must move slowly and carefully to ensure *complete inspection in all areas*. In anything except a small building or house, this should be the only job this worker has.

(2) The other worker(s) should have a liquid and a dust insecticide in equipment designed for crack and crevice application. In areas where the inspector finds cockroaches, a residual liquid or dust should be applied, whichever is safer.

(3) If possible, and if building conditions warrant, arrange to have somebody (possibly a masonry specialist) to follow the others and apply caulking to as many cracks and crevices as possible. This way, cockroaches in these areas are killed by the injected pesticide, and future cockroaches are prevented from re-entering these spots.

Contact or space sprays are used to knock down and flush cockroaches from hiding places. Use insecticides such as dichlorvos, synergized pyrethrins, and synthetic pyrethroids to supplement residual sprays. These contact sprays will irritate insects, causing a very rapid response. For this reason they are frequently used by pest managers to flush insects from their hiding places. Space treatments alone do not penetrate cracks and crevices well enough to provide effective control; however, cockroaches on exposed surfaces can be killed with space treatments.

Dusts are useful for placing insecticides into cracks and crevices, under large appliances, and other harborage areas. Light applications are usually most effective since heavy applications tend to be repellent. Dusts generally provide longer residual control than do sprays, but they become ineffective under conditions of excessive moisture. Dusts used include 2 percent Diazinon, 64 percent boric acid, and 1 percent Ficam. Silica aerogels, either alone or in combination with insecticides, are also available.

Baits are generally long lasting and can be applied to areas you can't effectively treat with sprays or dusts. Baits include an attractant, such as peanut butter or syrup, in addition to an insecticide. Baits recommended in cockroach control include 2 percent Baygon and 5 percent Dursban. Use baits in small amounts placed very close together in order to compete with other food sources. They are usually supplemental to dusts and sprays, and you must apply them so they are inaccessible to children and pets. Use caution when applying paste-type baits in heated areas, as heat often causes these formulations to run and drip.

Power sprayers, mist blowers, and thermal fog machines may all be used for roach control. Inside structures, however, a hand-operated compressed-air sprayer is most commonly used. To apply a residual over a general surface, use a fan or cone nozzle.

Dusters most commonly used in roach control are small rubber bulb or bellows-type hand dusters. Such dusters are designed so you can place a small amount of dust in narrow cracks and crevices.

German cockroach control. The German roach is usually found near a source of water and food. Check places such as cracks and crevices, under the tops of tables, behind sinks, in cabinets, the motor compartments of refrigerators and soft drink dispensing machines, underneath the bases of kitchen equipment on the floor, in switch boxes and fuse boxes, underneath cafeteria counters and soda fountains, in cash registers, in vegetable bins, around meat counters and check-out stands, under meat-cutting blocks, and anywhere else conditions are favorable. It is obviously impossible to list all places where the German roach may live, so you must look thoroughly to be sure you find all resting places similar to those mentioned here.

Because German roaches have become quite resistant to most chlorinated hydrocarbon insecticides, other chemicals are required to give residual control. Most frequently used are Diazinon, Dursban, and Baygon. Dichlorvos and synergized pyrethrins are often added to residual sprays for their flushing value.

Crack and crevice treatments are best for German cockroach control since you get them where they live. For this application, use a fine pin-stream nozzle or a nozzle equipped with an extension tube, and aim the insecticide as directly into the crack as possible so the insecticide will penetrate deeply. You don't need to have the sprayer pumped to a high pressure. Any pressure from 15 to 40 pounds is adequate. If you need to make a spot treatment, use a flat fan nozzle and be sure to use an insecticide approved for spot treatments if the control problem is in a food-handling establishment.

Where you have to spray near dishes, glassware, or cooking utensils, cover them with material such as a polyethylene sheet or a clean cloth before spraying and be sure not to contaminate any of them with insecticide.

Dusts used for German roach control will give longer lasting results if you can apply them in dry areas, and you can use them to supplement residual sprays. You can apply dusts with power dusters or plunger duster; however, the most common type used by pest managers is the hand-operated bellows or rubber-bulb duster. The duster you select should depend upon the size of the void area you must treat.

ULV applications of pyrethrins are being used to some extent in German cockroach control programs. These applications should be used to supplement residual sprays except in areas where the use of residual insecticides is prohibited.

With either liquids or dusts, you must have a clean rag handy to immediately wipe up any spilled materials which might be dangerous or unsightly.

In some areas, resistance to certain insecticides has been found in German cockroach populations. Resistance to chlorinated hydrocarbon insecticides such as chlordane is very common, but has also been found in more scattered instances to organophosphate materials such as Diazinon. Properly using only recommended insecticides is one way to get best control results. Remember, there are a number of reasons for poor control such as ineffective and incomplete application methods and the removal of the pesticide by cleaning before it has had a chance to do its work. Therefore, be careful not to blame resistance where other factors are responsible.

Brown-banded cockroach control. Brown-banded cockroaches, with their preference for very warm temperatures, are usually found widely dispersed in houses and only infrequently elsewhere. They are often difficult to control with either direct sprays, residuals, or by dusting because they live as individuals scattered all over the premises.

When you apply sprays or dusts, be sure you carefully treat such places as inside bureaus, shelves in clothes closets, ceiling light fixtures, and valances above windows. Learn their hiding places, and make a thorough inspection of the premises before you start.

Many pest managers use contact insecticides in mist or ULV machines to treat the whole area inside a house. When you use this technique, be sure to open all drawers and closet doors so the chemicals will have a better chance to reach the places where roaches are hiding. Then keep the building closed for several hours after application to assure adequate control.

American cockroach control. These large roaches are found in dark, damp, warm places and frequently congregate in colonies in more or less open spaces rather than in cracks and crevices. You'll most often find them near steam pipes, in sewers, grease traps, damp basements, and similar places.

Control American roaches with sprays, dusts, or baits. Residuals you apply in infested areas will kill American roaches slowly but effectively. Residual sprays that are recommended include 0.5 percent Dursban, 1 percent Diazinon and 1 percent Baygon. They can also be killed by spraying them directly with residual sprays or with the usual knockdown insecticides.

These roaches will also feed upon commercially available baits. It is important to remember that small amounts of baits should be placed less than 3 feet apart for maximum effectiveness, and you should usually use baits to supplement dusts and residual spray applications.

Oriental cockroach control. Oriental roaches prefer dark, moist situations when they live indoors and are frequently found in areas such as under porches, in crawl spaces, basements, and floor drains. You may also find them outdoors in abandoned cisterns, valve pits, and in garbage and trash dumps. You can control them with the same residual and contact chemicals you use for the American roach. The same bait formulations used for American cockroach control may also be used for Oriental cockroaches; however, the moist situations where you normally find the Oriental roach will render the application useless in a much shorter time whether it be baits or otherwise.

Because Oriental cockroaches often move into dwellings in large numbers, a barrier treatment is often used for their control. Treat the ground immediately around a building and the foundation with either a spray or dust application of Diazinon.

Exercises (C03):

1. List 5 nonchemical controls building occupants may take to help control cockroach infestation.
   (1)
   (2)
   (3)
   (4)
   (5)

2. Under what conditions should you avoid using residual dusts to control cockroaches?

3. What are your two most important considerations in choosing a chemical for cockroach control?

4. In what areas are dusts useful in controlling cockroaches?

5. Why is it important to make light applications of dusts?

6. How should you place baits used to control cockroaches?

7. List 8 areas where you should apply pesticides for German cockroach control.
   (1)
   (2)
   (3)
   (4)
   (5)
   (6)
   (7)
   (8)

8. In what way is ULV pesticide application useful?

9. After carefully surveying, where should you apply pesticide to treat brown-banded cockroaches?

10. What areas should you focus on for controlling American cockroaches?

11. What areas should you treat for Oriental cockroach control?
    a. Indoors—

    b. Outdoors—

1-2. Ants

Ants are among the most abundant of animals being found under both arid and humid conditions in the tropical, temperate, and upper temperate regions of the world. They feed upon every food consumed by humans and are troublesome household pests. You must be able to identify important ant species, know their habits, and be able to use the control measures that are effective in their management.

C04. Describe general characteristics and other aspects of ants.

General Characteristics. Ants usually have distinctly elbowed antennae in which the first segment is quite elongated. This long first segment at the antenna's base is called the *scape*. It is followed by a second segment which is much smaller and which, though properly called the *pedicel*, is very much like the segments beyond that make up the *funicle*. In some species the terminal two or three segments are enlarged and are known as the club (fig. 1-4).

The one or two basal segments of the abdomen are much smaller than those which make up the rest of this body region, giving the body of the ant a rather "thin-waisted" appearance. This thin waist, called the *abdominal pedicel*, may consist of one or two segments and each segment is somewhat enlarged on the upper surface. This enlargement may vary in shape from a slight hump to a rather high, flattened, platelike structure. It is very important to become familiar with this structure (usually called a *node* in publications on ants) since it is a characteristic which will separate ants from all other insects of similar general appearance. The number of segments in the pedicel and the shape of the node or nodes thereon is of considerable importance when you must determine the genus and species of an ant. Mature males and females of many species are winged as are adult termites. The front pair of wings of the ant are always longer and wider than the hind pair. When at rest the wings extend only slightly beyond the tip of the abdomen. The mandibles are the most conspicuous of the mouthparts. They are supplied with well-developed musculature they use to carry and break up food, excavate burrows in wood or in the ground, and as weapons of offense and defense.

The antennae of ants are especially important organs because they are the site of many sensory cells, particularly those of touch and taste.

Most of our domestic ants either do not have the ability to sting, or retain it only to a limited degree, but many ants of tropical regions are serious pests because of their well-developed ability to sting.

Though most ants are easily recognized, there are a few other insects that strongly resemble ants, and some of the winged forms of ants resemble winged termites. Ants have the front pair of wings larger than the hind pair while termites have the four wings all of about the same size. In addition, ants have the thin waist where the abdomen and thorax join while termites have a broad waist, and ants have elbowed antennae while termites have straight antennae. These last two features, the thin waist and elbowed

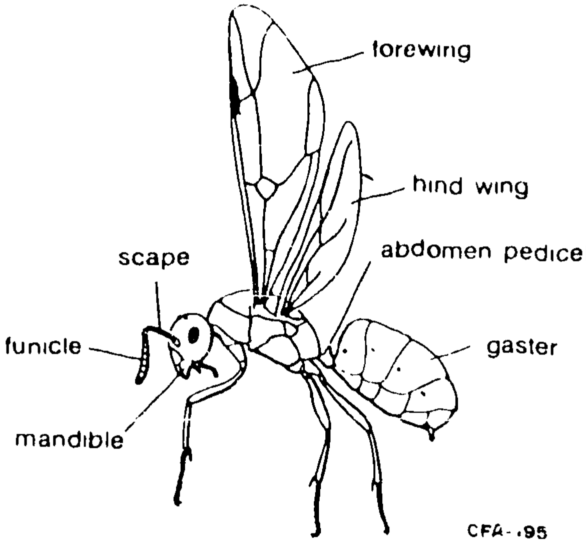


Figure 1—4. Diagram of a typical ant.

antennae, apply to both the wingless and winged forms of ants, and they are also useful in distinguishing them from other small insects with which they can be confused.

Biology. Ants experience complete metamorphosis: egg, larva, pupa, and adult. The egg is almost microscopic in size and varies in shape according to the species. On hatching, it produces a soft, legless larva. The larva is usually more or less translucent, gourd- or squash-shaped with the head at the narrow end. After feeding and several molts, the larva pupates. The pupa resembles the adult, but it is soft, white, and does not move about or feed. In some species, all of the pupae are naked; in others, the pupae are enclosed in silk cocoons; and in others, the pupae may be either. The pupae, especially those in cocoons, are commonly called "ant eggs" and are sold in pet shops under this name. If you move a stone or board under which a colony is living, you may see the adults carrying the pupae (or "ant eggs") and larvae off; and if you look closely enough, you may see the ants carrying the true eggs, which are very tiny.

New adults may need a few days to attain complete maturity after emergence from the pupae. During this period, their bodies become hard and attain the color of mature adults. Six weeks to two months or more are required for development from the egg to the adult stage. The time varies according to season, temperature, and species.

Ants live in colonies and have a well-developed caste system for dividing labor within the colony. In most of our common species, the colony is established by a newly mated queen, which drops her wings and digs a small nest or seeks a small cavity under a stone or a piece of bark to start the nest. The queen seals herself in this cell and remains nearly dormant while the eggs develop in her body. When mature, the eggs are laid and hatch in the sealed cell, with the queen nursing and feeding the larvae from hatching to pupation. The workers that develop from these first eggs are always undersized, which may be due to the small food supply available to them. These workers then dig an opening out of the cell and forage for food for both themselves and the queen. With an additional supply of food available, the queen is then able to lay more eggs. The workers care for the new eggs and the larvae which develop from them in each succeeding generation so the colony develops and expands rapidly. Numerous males and queens are formed as the colony develops and, at a suitable time, these leave the nest and establish new colonies.

Ant colonies normally have three distinct castes: workers, reproductive females (queens), and reproductive males (kings). Workers are sterile females and may vary considerably in size. All work in the colony, such as building the nest, caring for the young, and hunting for food is performed by this caste. Workers aren't always the same size in a given species. When the workers of a species are about the same size and structure, the species is called *monomorphic* (one form). An example is the Argentine ant. When workers of one species are of two or more sizes and types, the species is called *polymorphic* (many forms). An example is the black carpenter ant. Large workers with well-developed mandibles are called soldiers.

Queens are the largest individuals in a colony. Those which have not mated usually retain their wings while the mated queens do not. After developing the first brood of eggs, the queen is cleaned, fed, and otherwise cared for by the workers—her only function being to lay eggs. If the queen in a colony should die, she will be replaced by another queen so the colony will continue to exist. Most species have only one queen per colony, but colonies of some species may have many queens, such as with Pharoah ants.

The males perform no function other than to fertilize the queen. There are usually only a small number of them in any given colony and, in those species which have winged queens, the male also will have wings. After mating the male dies. Mating may take place in the nest, on the ground, or in the air. Males are produced only in old or very large colonies. Adult males do not remain in the nest long and may succumb to predators and the elements without mating.

Economic Importance. Ants may adversely affect people by stinging and biting; by invading and contaminating food; by nesting in lawns, golf courses and premises; by stealing seeds from seed beds or by feeding on germinating seeds; by defoliating or gnawing into plants and plant products, fostering other injurious insects, such as plant lice and mealy bugs; by gnawing holes in various types of fabrics, such as removing the rubber insulation from telephone wires or other equipment; by killing young poultry, birds, livestock or game; by annoying domestic animals by their presence; and possibly by transmitting certain human diseases in crawling over sputum, feces, carrion, etc. Carpenter ants can cause serious damage to wooden structures. However, only a small number of species or forms are involved, with most ants being neutral or even beneficial.

Exercises (C04):

1. What part of an ant's anatomy gives it a "thin-waisted" appearance?

2. Why is it important to note the shape of the node on an ant?

3. What purposes do antennae serve on ants?

4. Describe the physical characteristics of ant larvae.

5. What are the castes usually found in an ant colony?

C05. Identify various ant species with their physical and behavioral characteristics.

Common Ant Pests. Because of the wide variations in food and living habits of different species of ants, you must frequently know the exact ant you must control. The pictorial key in figure 1-5 will tentatively identify the common ants. Refer to the specific descriptions to find the species with which you're working. The key is designed as an aid in identifying common ants you may find around the home and may not help you identify species found in other situations.

Argentine ants (Iridomyrmex humilis). The Argentine ant is a severe pest in the Southern States and in California, although isolated occurrences have been reported from more northern areas. In areas of heavy infestation it may be found in practically every home. It does not sting but can bite severely.

Workers are 2.2 to 2.8 mm long and are light to dark brown in color (fig. 1-5). Queens are much larger—4 to 6 mm long. Many fertile queens are in each nest and apparently live in harmony with each other. Mating usually takes place inside the nest so winged forms aren't usually found. The queen, in addition to laying eggs, also cleans and feeds herself and is active in feeding and grooming the young. The sole function of the winged male is fertilizing the queen, and he is eliminated promptly from the nest after this.

Nests are built in moist situations such as in the soil, next to buildings and along sidewalks, beneath boards and plants, and under buildings. These nests are usually made near a good source of both water and food. This ant prefers sweet foods, principally such things as sugars, syrup, fruit juices, secretions of plants and honeydew from aphids, scale insects, and other insects. The ants forage for food along regular paths extending out from the nest and then branch out to explore every portion of an area. They enter houses in large numbers particularly when conditions outside the building are either too wet or too dry for them to live easily.

This ant tolerates humans and the city environment and will persist where other species of ants will not thrive. In many locations it may be the only ant species present. The workers are very aggressive and often eliminate other ants in the area. However, different Argentine ant colonies in the same area are friendly and do not fight. The ant is an exceedingly adaptable insect, which contributes to its success.

Fire ants (Solenopsis spp.). Many of the ants of the genus are called fire ants because of the severe reactions caused by their stings. These ants can cause death to young wildlife and produce sores and nausea in people. They are very active and pugnacious. Four species occur in the United States: The fire ant, *Solenopsis germinata;* the red imported fire ant, *S. invicta*, the black imported fire ant, *S. richteri;* and the southern fire ant, *S. xyloni*.

The fire ant is found in the Southern States from the Atlantic coast to Arizona. The abdomen is brown to black and the head and part of the thorax are yellow. Workers are 1.6 to 5.8 mm long. (fig. 1-5). Nests occur in loose soil with many craters usually scattered over an area of from 2 to 4 square feet. The openings are usually in such places as under boards and stones, by a tuft of grass, in cracks in concrete, and underneath houses. Nests may also occur in woodwork or masonry of houses. They feed on a variety of foods such as meat, grease, butter, nuts, seeds, and vegetables in the ground and may damage soiled clothing by gnawing on it.

The southern fire ant is found in the Southern States. Workers are a clear reddish yellow with habits similar to those of the other fire ants.

The imported fire ant is an important agricultural pest, rather than a household pest, which builds mounds of earth in the field and does great damage to crops. Its sting is severe and these ants frequently make it difficult for field workers. This ant is found in the Southern States from North Carolina to Texas.

Pharoah ants (Monomorium pharaonis). The Pharaoh ant is light yellow to red, 1.5 to 2mm long, and is found throughout the United States and Canada. You can easily distinguish it from the thief ant by the presence of three segments in the antennal club (fig. 1-5). It is one of the most important ant pests in homes because its small size enables it to get into almost anything and because of its food preference, which ranges over a wide variety of substances such as syrups, fruit juice, jelly, cakes, pies, greases, dead insects, and meats. It is predacious on many insects and has been found in large numbers in hospitals where it feeds on open wounds.

Nests are found between walls, under floors, above ceilings, behind baseboards, in old trash, or outside in gardens and along walks. They like to nest in warm places near furnaces, heat ducts and hot-water pipes. The nests are frequently very difficult to find since the ants range widely from them, usually over established trails you may find along window sills and baseboards.

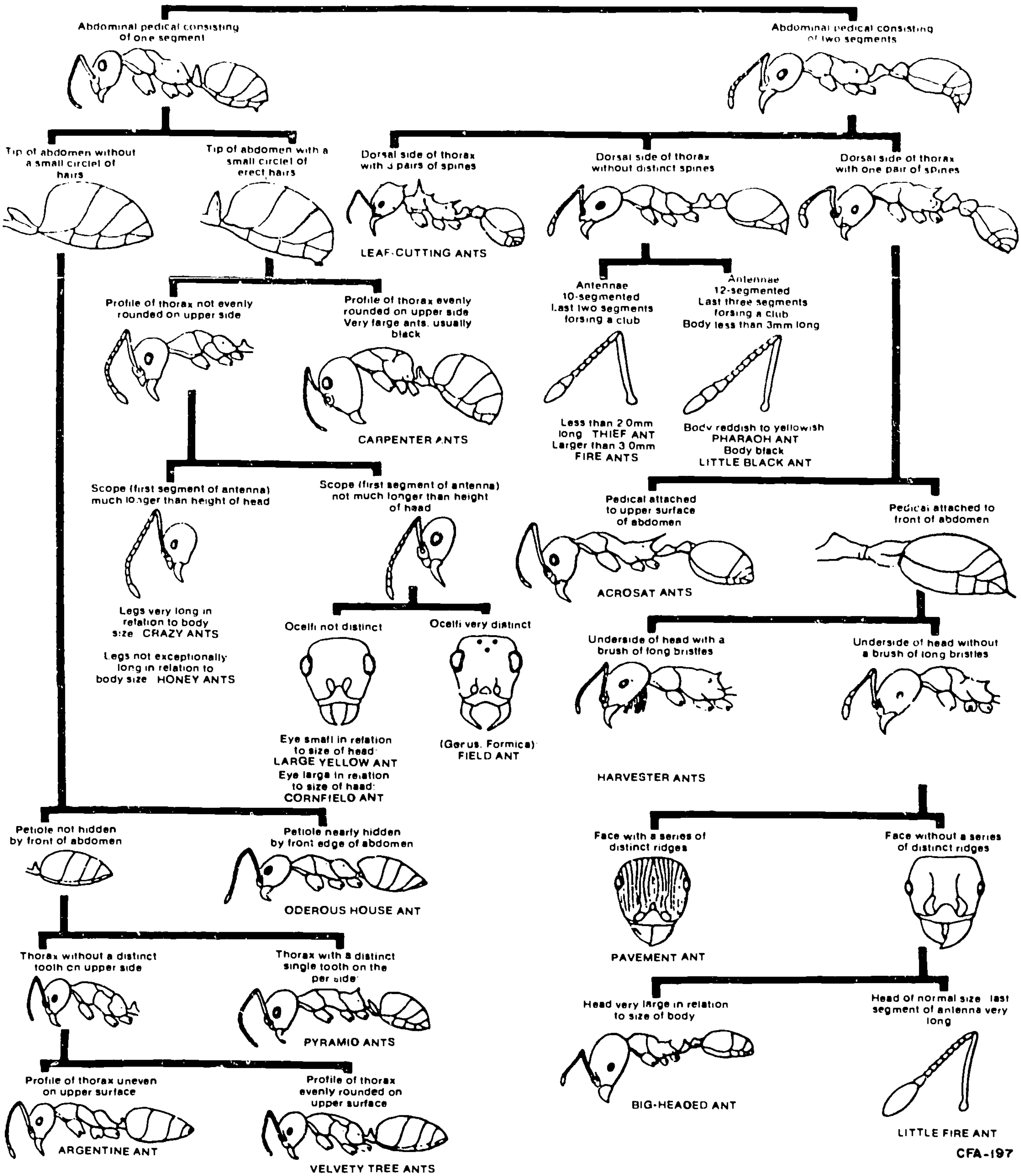


Figure 1–5. Pictorial key of ant workers that may infest buildings.

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This ant is very persistent and difficult to control. It has the faculty for appearing all of a sudden in various places within the house and getting into things. Its nature of being scattered about and in well-protected areas makes it more difficult to control. It is also common in hotels, large apartment houses, grocery stores, and other places where food is handled commercially.

Colonies may be very large (up to 300,000) with many queens in a given colony. Sexually mature forms are winged and they mate and go through the usual life cycle. Mating occurs in the nest throughout the year. New colonies are formed when a group of queens and workers split from the mother colony. Swarms are never seen.

Thief ants (Solenopsis molesta). This is one of the smallest of ants, being 1 to 1.5 mm long and varying in color from yellow to dirty brown and having a two-segmented antennal club (fig. 1-5). It is found over most of the United States. It often lives in the nest of larger ants, feeding on the larvae of their hosts; thus, its common name. In the home, its food is mainly greasy materials such as cheese and meats, although they will feed on sweets occasionally. Such meats as bacon, ham, and prepared meats are especially attractive to thief ants. They may also be found feeding on stored seeds or dead animals and may even attack young chickens.

This ant is so small it may often escape the naked eye even though it's common around kitchen sink or cabinets. Unobservant people may complain about the flavor of food without realizing that it's infested with thief ants. The ant nests in cracks and crevices of walls and cabinets. It is very persistent and may be difficult to control.

Odorous house ants (Tapinoma sessile). This very important household pest is distributed all over the United States. The brownish-black worker is 2 to 3 mm long. It is frequently confused ith the Argentine ant from which it can easily be distinguished by its darker color and the fact that the front of its abdomen overhangs and hides the petiole (fig. 1-5). When crushed, this ant gives off a very unpleasant odor, so you should definitely avoid the cowboy-boot approach to physically control it.

Nests are constructed in a great variety of situations both indoors and outdoors. Outside, they are usually shallow and underneath a board or stone. Indoors, they frequently nest in walls and underneath floors. Colonies are large and each may contain several active queens. The workers forage out from the colony along regular trails as does the Argentine ant, and their food habits are similar. These ants are more likely to move indoors late in the year when honeydew, one of its primary foods, is less abundant. During periods of rainfall or leaf fall, aphids and honeydew are reduced so the ants must range more widely for food and are likely to invade homes.

Field ants (Formica spp.). The many species and varieties of these ants infest fields, lawns, and gardens throughout the United States. Length usually varies from 3 to 7 mm and they may be brown, black, red, or have combinations of these colors (fig. 1-5). They prefer sweet foods and also feed on other insects. They commonly build nests along fences, sidewalks, flower beds, and in lawns. They are most likely to be pests of recreational areas. When infestations are heavy, individuals may wander into homes looking for food. One species you may encounter from time to time is the Allegheny mound builder, *Formica exsectoides*. This ant builds large mounds of earth during its nesting activities. It's seldom found in the home, but has caused "fire ant scares" in the Northeastern United States. Other common species are relatively large and black.

Some field ants capture the larvae and pupae of other ants and raise them in their own nests. The emerging adults become slaves for the field ants; thus, field ants are often called slave ants.

Exercises (C05):

1. Match the types of ants in column B with their characteristics in column A. Some column B items may be used more than once.

Column A

____ (1) These ants have been found in large numbers in hospitals where they may feed on open wounds.

____ (2) Workers of these ants are 1.5 to 5.8 mm long and may cause severe reactions from their stings.

____ (3) These ants may construct nests in a wide variety of situations both indoors and outdoors.

____ (4) These ants commonly build nests along fences, sidewalks, flower beds, and in lawns. They are most likely to be pests in recreational areas.

____ (5) Workers of these ants are 2.2 to 2.8 mm long and are light to dark brown in color.

____ (6) These ants are light yellow to red, 1.5 to 2 mm long, and are found throughout the U.S. and Canada.

____ (7) These are among the smallest of ants, being 1 to 1.5 mm long, and varying in color from yellow to dirty brown.

____ (8) These ants have a brown-to-black abdomen with the head and part of the thorax being yellow.

____ (9) These ants build nests in moist situations such as in the soil, next to and under buildings, along sidewalks, and beneath boards and planks.

____ (10) These ants are similar to Argentine ants, but have a darker color and an abdomen that overhangs and hides the petiole.

Column B

a. Argentine ants.
b. Fire ants.
c. Pharoah ants.
d. Thief ants.
e. Odorous house ants.
f. Field ants.

C06. Identify details regarding ant control programs.

Controlling Ants. The actual procedures you follow in ant control may depend greatly upon the species of ant involved and the nature and location of the infestation in question. Your ability to identify the ants will help you decide where to begin your search for the infestations. In some cases you can take note of certain characteristics of the nest and recognize the type of ant involved.

If an ant colony is established within the structure, killing the exposed workers seldom gives permanent relief from the pests because the reproductives will continue to produce more workers. A chemical barrier is effective for ants nesting outdoors that invade the buildings for food, but this barrier is only temporary. Workers from the nest outdoors will again invade the building when the chemical residue becomes ineffective. Only destroying the nest gives permanent relief from that particular colony.

Several insecticide formulations are useful in ant control—sprays, dusts, granules, and baits. Aerosols are effective only if you need to knock down and kill swarmers indoors. Sprays are usually effective, and you should use them where possible. However, there is evidence that some ants will avoid areas treated with certain kinds of insecticides and if they can find other routes to food and water, poor control will result. Therefore, when ants are nesting in houses or other structures, try to surround the entire nest area with a residual treatment for complete control. This is particularly true when dealing with a pest like the Pharaoh ant, which has large colonies and many queens. It would be easy for this ant to find other routes, and if the residual treatment did not take in the entire colony, the colony would be split up into several segments. To ensure that the entire colony is surrounded, apply the residual treatment first to areas known to be beyond the infestation. Then work toward the center of the infestation. For these reasons, you should regard all residual chemical treatments as barriers only—unless you can apply the chemical directly to the nest.

Dusts and granules are also useful. You can blow dusts into nests and wall voids or other areas where ants are hiding. Some dusts are repellent to some, if not all, ants. Make your dust applications light to minimize any repellent action. Granules are useful for treating outdoor areas and crawl spaces for ants.

Baits are useful when you can't locate or treat the nest, and you can't use residual sprays effectively. Commercial baits can be classified as weak baits and do not cause the ants to be repelled as they would be to strong baits. There are two limitations of this type bait: control takes a long time, perhaps one to three months; and the baits must compete favorably with other food sources. Some commercial baits have a sugar base, others have an oil base (peanut oil is commonly used). You may want to combine these types. To help you select the proper bait, study the ant's feeding habits to determine what type of food it prefers. Although small quantities should suffice, try to place baits so the ants will have no difficulty locating them. This means distributing many small bait placements in concealed locations throughout the infested area.

Species nesting indoors. Certain species of ants are more likely than others to nest inside the home. The thief ant, Pharaoh ant, and the odorous house ant fit into this category. Controlling these ants is much more likely to be effective if you can trace the foraging workers to the vicinity of the nest. This is difficult, however, and may give misleading information. Workers may sometimes appear and disappear quickly at one or two points beneath a baseboard, behind a sink, or under a cabinet, but the nest may be in the wall or in the false bottom of a kitchen cabinet some distance from the point of entry. A concentrated treatment only at the points where you see them may be almost useless if the workers can find alternate routes to food. It is good practice to force a dust containing 5–10 percent Sevin into all cracks and crevices for several feet on each side of the place where you see the ants. Also it often helps to drill small holes into the void for treatment.

A good rule to follow is to treat baseboards, door moldings and other cracks along the length of any wall where you see ants emerging. Wet the surface of the baseboard with a continuous film of 1.0 percent Baygon, 1.0 percent Diazinon or 0.5 percent Dursban. Then apply a similar film to about a 4-inch strip of the floor next to the wall. You should apply this treatment to both sides of the wall whether it's an inside or an outside wall. Treat any cracks in the wall or at the top of the wall. The object of this residual treatment is to completely surround the nest area so that any ants leaving the nest will be forced to cross a treated surface. This may be difficult to do if the wall in question joins many other walls, if the nest is beneath flooring, or if the colony is extremely large as with Pharaoh ants. Start far enough away from the infestation so you can surround the entire nest and then work towards the nest.

Baits may be very useful and there are good commercial formulations containing Baygon that are effective and quite safe to use. One of the less desirable factors in older bait formulations has been the highly toxic agents employed. An advantage of baits which is not a factor in other means of ant control is that the workers take the pesticide back to their nest where it can be fed to larvae and reproductives. Place baits along trails the ants follow (out of the reach of children and pets or in containers they can't get into). Eliminate food sources as much as possible. Then use a residual treatment of insecticide in food storage areas (kitchen, pantry) to make such food sources unavailable to the ants. Be careful not to contaminate food or surfaces which exposed food will contact.

Pharoah ant control can be a particularly difficult job with this indoor-nesting species. This is because of it's unique characteristics such as *fractionating* or *satelliting*. This applies to their habit of gathering eggs, larvae, and pupae and breaking up into several small colonies where only one large colony existed earlier. They typically do this when almost any insecticide is introduced into their private domain. Since these newly formed colonies don't usually forage for a few days, you might improperly conclude that you got control of them; when in fact, you only divided their forces.

To effectively control pharaoh ants, you must use a bait that foraging ants won't detect as toxic, so they will take it back to the bulk of the population waiting in the nest. One such material is Pharorid, a trademark of Zoecon Chemical Corporation. Pharorid contains the active ingredient methoprene, which is an insect juvenile h ·ione that arrests the growth of developing ants.

Research has shown that the methoprene · rmulation is most effective as a bait in a mixture of liv honey, and spongecake in a 2:1:1 ratio. Although the Pharorid label simplifies the mixing process by suggesting the use of powdered liver, treating with the bait mixture is very time consuming. A U.S. Army team required 600 work hours to control a pharaoh-ant problem in an army medical center with over 226,000 square feet of floor space.

Pharorid is an excellent product, but it is not without its drawbacks. If you use methoprene, you must accept that it's a slow-acting insecticide which takes up to 20 weeks to be effective. Methoprene also tends to degrade rather rapidly, so you must work with it on a fairly tight timetable to get results.

In addition to or in place of methoprene, you may also use boric acid injected into cracks and crevices. Studies have shown that insects don't detect boric acid as a danger.

The most ideal way to control the ants is through pretreating structures before construction is completed and the ants become entrenched.

Species nesting outdoors. The remainder of the ants listed earlier are more likely to nest outdoors than within a structure. They become pests by foraging inside for food. It is important to find the nest in infestations of these ants and to treat them heavily by applying generous amounts of the residual sprays and dusts listed above for species which nest indoors. If your equipment can blow dusts into the nest with sufficient force, they will generally be distributed through the nest rather well. It may be desirable, particularly in large nests, to pour about 2–5 gallons of water into the opening after dusting to be sure the dust reaches the desired location. You can also sprinkle a dry wettable powder onto the nest and wash it in with a hose. This is much more effective than using a dust. In some mound-building species it may help to scrape off or break up the mounds just before you treat it. In addition, the wall or walls through which the ants are entering should receive barrier treatments to eliminate building access routes. It is important to spray all runways (such as pillars, steps, etc.) and entry ways (such as vines, bushes, and wires) that ants can use to gain entrance. Also, treat the soil surface around the perimeter of the building with about a 3-foot barrier. Granules are useful for this kind of treatment.

If ants are scattered in a lawn or garden, a broadcast treatment may be needed. In situations where colonies are very large, particularly if the Argentine ant or one of the fire ants is the culprit, a broadcast treatment again will be necessary. Wettable powder sprays are best for this type treatment.

Two percent Baygon bait is effective outdoors for harvester ants, fire ants, and leaf-cutting ants which have nests deep in the soil that you can't reach with other formulations. Sprinkle the granular bait around the entrance to the nest. It should be remembered that this treatment may take a month or more before you get total control.

Exercises (C06):

Identify the following as being true (T) or false (F). Correct any false statements.

____ 1. The procedures you follow for controlling ants are largely dependent on the species of ant involved and the location of the infestation.

____ 2. If outdoor-nesting ants are entering a building for food, a chemical barrier can be useful for temporary control.

____ 3. Chemical applications often act only as barriers to ants unless you can directly treat the nest.

____ 4. Dusts are highly beneficial for ant control along exposed routes where ants are known to travel.

____ 5 For indoor-nesting ants, gaining control is easily done by treating all voids and crevices within the infested area.

____ 6. When treating baseboards, your treatment should be applied to both sides of the wall whether it's an inside or outside wall.

____ 7. For maximum effectiveness when applying ant baits, other food sources should be reduced either by removal or by applying a chemical barrier to make existing food sources unavailable to the ants.

____ 8. Methoprene or boric acid are useful in baits for Pharoah ants since the insects don't detect them as a danger.

____ 9. For large outdoor nests, dust effectiveness can be increased by pouring 2–5 gallons of water into the dusted nest to ensure the dust reaches the desired locations.

____ 10. Wettable powder pesticides are best suited for broadcast applications over large outdoor areas for ant control.

1-3. Silverfish and Firebrats

Although these insects are not nearly as important as the cockroaches, they do become severe pests in many homes and other facilities at times.

This section will give you information pertaining to their importance, characteristics, and the controls that can be employed against them.

C07. Specify the characteristics and importance of silverfish and firebrats.

Importance and Characteristics. Besides the fact that these insects are annoying, they attack such materials as book bindings, photographs, wallpaper, labels, and the sizing of any of these paper products. They also attack starched clothing, linen, rayon, cereals, and grain. In spite of their prevalence and constant close association with humans, silverfish and firebrats don't appear to be vectors of any human diseases.

The silverfish (fig. 1-6) and firebrats (order Thysanura family *Lepismatidae*) are the most common forms of these primitive insects. They are small (i9 mm long), carrot shaped, fast moving, wingless insects with long antennae. The abdomen of these insects is long and bears three appendages (a pair of *cerci* and a median caudal *filament*) on the posterior end. The color of the silverfish is a uniform glistening silver, while the firebrat is grayish and mottled with dark markings.

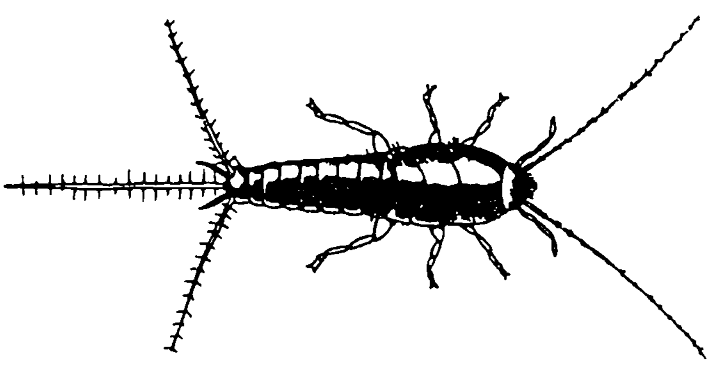

Figure 1–6. A silverfish.

Silverfish and firebrats exhibit little or no metamorphosis, and the young look much like the adults. Development of the common silverfish *(Lespisma saccharina)* takes about 12 weeks from egg to adult. Silverfish range far from their hiding places at night to find food, and they will quickly infest an entire building. They harbor where they can easily get to food and moisture. Firebrats harbor under hot, dry conditions, such as behind stoves or around fireplaces.

Exercises (C07):

Identify the statements below as true (T) or false (F) and correct any false statements.

____ 1. Silverfish and firebrats attack book bindings, photographs, wallpaper, labels, and sizing of paper product.

____ 2. They also attack cereal and grain but not clothing.

____ 3. Silverfish and firebrats do not seem to be vectors of any human diseases.

____ 4. Silverfish and firebrats are the most common forms of these primative insects.

____ 5. Silverfish have two sets of wings while firebrats have only one set.

____ 6. Silverfish and firebrats sometimes infest entire buildings.

C08. State the control measures for managing silverfish and firebrats.

Exercise the same care in controlling silverfish and firebrats in homes, dormitories, bakeries, and dining facilities as you would in controlling cockroaches.

Preventive Control. Occupants can help control silverfish and firebrats to some extent by inspecting furniture, carpets, and other cloth goods before placing them within a facility, especially those items that have been stored or shipped during transfers.

Reducing food supplies to the least amount possible may be of some benefit in preventing damage. Physically excluding these arthropods from susceptible stored fabrics will prevent infestations.

Chemical Control. You can control silverfish and firebrats by applying liquid residual pesticides such as 1 percent Baygon, 0.5 percent Dursban, 1 percent Diazinon, or 2 percent Malathion. Just as for treating for cockroaches, you should give close attention to basements, attics, closets, around bookcases, behind baseboards, and around steam and water pipes. Since firebrats prefer hot and dry areas, treat oven areas, around fireplaces, boiler rooms, and other hot, dry areas as well. Use oil solutions where areas permit, or you may use dusts such as 2 percent Diazonon or silica gel in wall voids, crawl spaces, and attics. After applying a residual, you may want to use a space spray to get them moving faster. This is advisable in attics or in storage areas where residual spraying is of limited use.

Exercises (C08):

1. What two preventive measures are most applicable to controlling firebrats and silverfish?

2. List the areas you should focus on when treating for silverfish.

3. What additional areas should you treat for firebrats?

4. Where residual treatments are limited, what additional action might be necessary?

1-4. Earwigs

In your job, you will be called upon to rid various base facilities of earwigs from time to time. Although this task is generally not continuous, you must still be able to identify these insects and control them. The term "earwig" is believed to have been derived from the belief that this insect would enter the ears of people while they slept and bore into the brain. In truth, earwigs are harmless to humans.

Earwigs are important household pests because they gather in lawns and invade building in great hordes. (Well, they don't exactly vibrate pictures off the walls, but they can get to be rather "icky.") They can be serious morale and economic pests because the presence of these hordes often prevents people from enjoying outdoor activities and can depreciate property values. This insect is a pest of vegetation in a minor way, but it is also beneficial because it feeds upon other insects.

C09. Specify correct details regarding the identification, habits, and habitats of earwigs.

Identification, Habits, and Habitats of Earwigs. Earwigs belong to the order Dermaptera and are short-winged insects that have a pair of forceps at the posterior end of the abdomen. These forceps are relatively straight in the female but are bowed outward in the male. The adults are about 16 mm long, dark reddish brown, with a reddish head, and pale yellowish brown legs in color. They have biting mouthparts.

These insects are omnivorous and will eat almost anything they can chew. They aren't known to fly readily or travel very far by crawling. Earwigs have a gradual metamorphosis. Their entire development from egg to adult is completed in about 5 months.

You can find earwigs outdoors in dark, moist crevices, such as between building foundations and soils, and under boards, stones, and welcome mats. Indoors, you'll find them hiding in baseboard crevices, under furniture, and in basements.

Exercises (C09):

Identify the following statements as being true or false and correct any that are false.

____ 1. Earwigs belong to the order Acarina.

____ 2. Earwigs are short-winged insects that bear a pair of forceps at the posterior end of the abdomen.

____ 3. Adult earwigs are about 16 mm long, dark reddish brown, with a reddish head and pale yellowish brown legs.

____ 4. Earwigs will develop from eggs to adults in about 2 months.

C10. Identify correct statements regarding earwig control.

Controlling Earwigs. To prevent earwigs from entering buildings, you can apply a residual emulsion or suspension containing an approved insecticide outdoors. Apply the insecticide to the soil in a band 5 feet wide around the entire building. Treat the foundation wall from the ground to a height of 2 to 3 feet.

As a residual, you can spray or brush an approved insecticidal suspension on door and window sills, behind stoves, and other out-of-the-way places where you find these insects indoors. Use only the crack and crevice

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treatment in areas where foods are stored, prepared, and served.

Nonchemical controls for earwigs generally aren't very effective; however, clearing vegetation away from building foundations and ensuring that doors and windows fit snugly in their frames may prevent entry of these pests.

Exercises (C10):

Decide whether the following statements are true or false. Correct any false ones.

____ 1. A good method of controlling earwigs is to paint or spray a residual emulsion on a band 5 feet wide around a building.

____ 2. You should treat cracks and crevices only in areas where food is prepared, stored, and served.

____ 3. Nonchemical control of earwigs is normally effective.

1-5. Bedbugs

The common bedbug has been a pest to people since prehistoric times and has spread to most parts of the world. This insect has been prevalent in Europe for centuries and has been in this country since the early colonial days, although it apparently was unknown to the American Indian. The bedbug gains access tc homes through traveling bags and laundry or by migration. It is frequently transferred from person to person in transportation facilities.

This section identifies the bedbug and its importance, describes its characteristics, relates its life history and habits, and names the controls you can use against bedbugs.

C11. Describe the bedbug's appearance and its relationship with people.

Identifying Characteristics. The bedbug belongs to the order Hemiptera and the family Cimicidae. The adult (fig. 1-7) is about 5 mm long, 3 mm wide, and a reddish-brown color. The flattened oval body is adapted for hiding in narrow crevices. The head bears a pair of four-segmented antennae and piercing-sucking mouthparts which fold to lie between the first pair of legs. The wings are represented by pads. The body may become greatly enlarged and blood red as it takes a blood meal.

Relationship with Humans. Both sexes of the bedbug feed on mammalian (any of the highest class of vertebrates) blood, particularly that of humans. Bedbug bites differ from flea bites because they don't leave a red spot surrounded by a circular reddish area fading into the normal skin as does the flea. Bedbugs have not been proven to be an important disease bearer, but heavy infestation can lead to human nervous and digestive disorders. The two species of bedbugs that attack people are *Cimex lectularius* and *Cimex hemipterus*, the first one being predominant in temperature regions and the second being predominant in tropical regions.

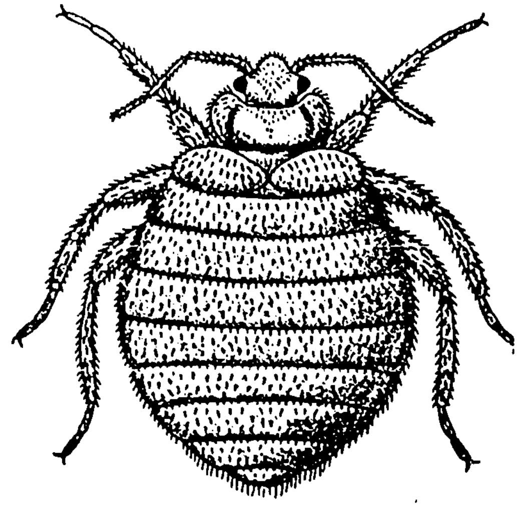

Figure 1–7. The bedbug.

Exercises (C11):

1. What are the size and color of the normal adult bedbug?

2. What is the appearance of the bedbug during a blood meal?

3. What sex and species attack humans?

4. What effects do bedbug bites have on humans?

C12. State the general habits and development of bedbugs.

Habits. You can detect bedbug infestations by the characteristic buggy odor, blood stains on sheets, and fecal stains along crevices. You'll seldom see this insect during the daytime because of its nocturnal habits.

Development. Bedbugs develop through gradual metamorphosis. The female lays very few eggs until she has had a meal of blood. Generally, a single blood meal is sufficient for each instar or nymphal stage after the first. She lays from 1 to 5 eggs daily for about 2 months or until about 200 eggs are deposited. Complete development from egg to adult takes 18 to 56 days (depending on the temperature). The adult lives 6 to 12 months. The female can live nearly a year without food and can endure freezing temperatures for varying periods of time.

Exercises (C12):

1. What condition will help you detect bedbug infestations?

2. What time of day are bedbugs usually seen?

3. Bedbugs develop through what type of metamorphosis?

4. How long does complete development from egg to adult take for bedbugs, and on what does it depend?

5. How long do adult bedbugs live?

6. The female can live nearly a ________ without food.

C13. Specify appropriate bedbug management techniques.

Controlling Bedbugs. You can effectively control bedbugs in living quarters by applying 0.5 percent Diazinon solution to infested mattresses, pillows, bedsteads, baseboards, furniture, crevices, and behind doors and window frames. One application of an approved chemical solution should control bedbugs for more than a year. The bedbug is so susceptible to insecticide poisoning, it's possible to eliminate it completely from living quarters and other places. Fumigation and other types of treatment are unnecessary; controlling bedbugs has changed from a major problem to a very minor one.

When you are preparing to spray quarters, remove the clothing, rubber material, gas masks, and other objects that you must protect from kerosene. Do not remove bedding or other items that may be infested, because the bedbugs may be transferred to a new location. For good results when spraying, follow the steps outlined below:

(1) Move beds away from the wall to permit spraying the wall surfaces.

(2) Fold mattresses and place in the center of the bed at an angle of 45°.

(3) Open windows for ventilation before starting spray operations. Apply residual spray at a rate of 1 gallon to 1,000 square feet of area. Use a standard sprayer with a fan-spray nozzle and a pressure of 30 to 40 psi. Apply the spray to the point of runoff, but avoid filling the air with a foglike mist.

(4) With a two-person crew, begin at one end and work around the room, spraying cracks, wall beams and braces, and other places likely to harbor bedbugs. Spray to a height of about 4 feet from the floor for single beds and 6 feet if double-tier beds are used.

(5) Spray one end of the bed, including the coils and covers, and one folded edge of the mattress. Return up the opposite side and spray the bed, coils, corners, and mattress edges. Observe all recommended safety precautions when spraying.

Exercises (C13):

Identify the following statements concerning bedbug controls as true or false. Correct any false statements.

____ 1. The control of bedbugs is a major problem.

____ 2. When spraying for bedbugs, remove only items which are not infested.

____ 3. Move beds away from walls to permit spraying of wall surfaces.

____ 4. Leave mattresses flat when spraying.

____ 5. Keep windows closed to prevent the escape of the insecticide.

____ 6. Apply 0.5 percent Diazinon solution at the rate of 1 gallon to 1,000 square feet of area.

____ 7. Spray to a height of 4 feet for single beds and 6 feet for double-tier beds.

1-6. Crickets

As a pest manager, you will be required to rid base facilities of crickets at various times. Thus, you must know the identifying characteristics and habits of these insects.

C14. Relate common crickets to their descriptive statements.

Identification and Habits. Crickets belong to the order Orthoptera. They have biting mouthparts, long legs adapted for jumping, and may have wings when full grown. They develop by gradual metamorphosis, going from the egg through a series of nymphal instars to the adult. The adult male produces the familiar chirping sound by scraping his upper wings together.

The house cricket (*Acheta domestica,* fig. 1-8), is found throughout the United States. This shiny, black insect is fond of warmth and often becomes troublesome in food-handling areas and homes. In warm weather, it lives outdoors, especially in garbage dumps, and enters the home chiefly in cold weather. They may be numerous in newly constructed homes. Cave and camel crickets occur throughout the world. They are usually wingless and have antennae that may be four or five times as long as the body. These large nocturnal insects are usually brown or gray and may be found in outbuildings or basements. They apparently do little, if any damage. Jerusalem crickets *(Stenopelmatus fuscus)* are large, clumsy insects with big heads. Many people in the Southwestern United States believe they have a venomous bite, but they are harmless.

Exercises (C14):

1. Match the cricket species in column B, with the descriptive statements in column A. Column B items may be used more than once.

Column A	*Column B*
_____ (1) Many people believe this type of cricket has a venomous bite.	a. Jerusalem cricket.
_____ (2) Fond of warmth and is often troublesome in food-handling areas and homes.	b. House cricket.
_____ (3) Antennae may be four or five times a long as the body.	c. Cave and camel crickets.
_____ (4) Large, clumsy insects with big heads.	
_____ (5) Usually brown or grey.	
_____ (6) Enters the home chiefly in cold weather.	

C15. State the controls you can use against crickets.

Controlling Crickets. You can effectively control crickets by applying approved residual insecticides indoors. Apply these residuals to floors, walls, around fireplaces and dark crevices, in basements, and behind baseboards. Treatment in food-handling facilities must be restricted to cracks and crevices. Apply the formulation to surfaces by spraying or brushing.

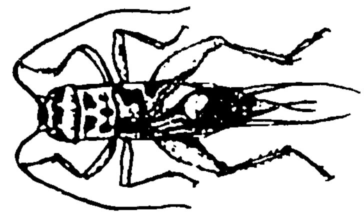

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Figure 1–8. House cricket.

You can also use baits indoors for controlling crickets by placing the baits in areas where crickets are numerous and tend to congregate.

To prevent crickets from entering buildings, spray residuals in a 5-foot band on soil around the structure and on the foundation wall to a height of 2 to 3 feet.

Make sure you use chemicals in accordance with the recommendations provided on the pesticide label.

Exercises (C15):

1. Where should residuals be applied indoors for cricket control?

2. Treatment in food-handling facilities must be restricted to _______________ and _______________.

3. Besides sprays, what other formulation can you use indoors for controlling crickets?

4. Baits are placed in areas where crickets are numerous and tend to _______________________________.

5. To prevent crickets from entering buildings, you can apply residual sprays in a _________________-foot band on soil around the structure and the foundation wall to a height of ________ to _______feet.

1-7. Pillbugs and Sowbugs

Pillbugs and sowbugs are distributed throughout the world but are most abundant in areas of high humidity. These crustaceans are of concern to you as a pest manager only when they are present in great numbers.

Pillbugs and sowbugs are important to humans only as nuisance pests when they enter buildings. They are unsightly and they cause special concern to many people, especially those who are not familiar with them.

C16. Associate given identifying characteristics and habits with the pillbug and sowbug.

Characteristics and Habits. Contrary to popular belief, pillbugs and sowbugs are not the same. Sowbugs can be distinguished from pillbugs because sowbugs cannot roll up into a ball as the pillbug can. This characteristic of the pillbug has prompted many people into referring to it as a "roly poly." Another characteristic of sowbugs that distinguishes them from pillbugs is the two prominent taillike appendages that are not present on pillbugs.

Both sowbugs and pillbugs are oval and somewhat flattened in shape. Both are grayish to black in color and are about 12.5 mm long.

Pillbugs and sowbugs belong to the class Crustacea, order *Isopoda*, thus they have a need for high humidity. These crustaceans prefer very moist areas and can be found outdoors under almost any object. They may also be found under piles of decaying grass cuttings and vegetable matter and in cracks that are between building foundations and soils. Indoors, pillbugs and sowbugs can be found primarily in damp basements and ground-level floorings of buildings.

Sowbugs and pillbugs normally feed at night upon decaying vegetable matter, roots of small plants, and often on mushrooms. Females give birth to living young which develop into adults through a series of molts. Because these crustaceans are generally inactive during the winter months, they are pests only during warm weather.

Exercises (C16):

Identify the statements below as they apply to pillbugs sowbugs. Place a P or an S in the blank spaces provided to indicate pillbug or sowbug. Some statements may apply to both.

____ 1. Not capable of rolling up into a ball.
____ 2. Belong(s) to the class Crustacea.
____ 3. Feed at night on decaying vegetation, roots of small plants, and sometimes mushrooms.
____ 4. Sometimes referred to as a "roly poly."
____ 5. Two prominent taillike apendages.
____ 6. Oval and somewhat flattened.
____ 7. Grayish to black in color.
____ 8. About 12.5 millimeters in length.
____ 9. Give birth to living young.

C17. Describe measures for controlling pillbugs and sowbugs.

Physical Controls. Since these crustaceans congregate in large numbers under and between objects, you can pour hot water over them to destroy those in a certain group. You can also spray hot water around the edges of building foundations to kill any pillbugs and sowbugs that congregate in these areas.

Cultural Controls. Site sanitation includes such measures as removing grass and leaf piles, picking up objects on the ground, and keeping the area free of garbage.

To control these pests in basements and ground floor areas without chemicals, keep these areas dry and well ventilated. Make sure doors and windows fit snugly in their frames and that objects are stored off the floor and away from walls. Raise windows in dry weather for ventilation, but keep windows and doors closed in damp weather.

Chemical Measures. You can control these crustaceans chemically by applying an approved pesticide emulsion or suspension to entire lawn and turf areas or as a band treatment around a building foundation. Of course, you must apply these formulations in accordance with the information provided on the pesticide label.

Exercises (C17):

1. Pillbugs and sowbugs can be controlled by using what 3 control measures?

2. They can be killed by pouring ________ ________ on them.

3. What cultural controls help control pillbugs and sowbugs?

4. Control of these pests in basements and ground floor areas without chemicals can be done by keeping these areas ______________ and well ________________.

5. Chemical control of these crustaceans may be obtained by applying an approved pesticidal emulsion or solution to what areas?

Venomous Pests

IN RECENT YEARS the number of hospital admissions due to bites and stings by venomous arthropods has exceeded admissions for treatment of snakebite. The arthropods most frequently listed as responsible have been wasps, bees, ants, caterpillars, spiders, scorpions, and centipedes. Only about one-third of the deaths due to venomous animals in the United States in the last few years were caused by snakebite; the others were caused by venomous arthropods.

There are about 136 species of snakes in this country, only 21 of which are poisonous and likely to cause death. At lease one deadly species of snake is found in every State except Alaska and Hawaii.

This chapter will cover the importance, characteristics, and controls of venomous insects, arachnids, and snakes.

2-1. Arthropod and Reptile Venoms

Injury from venoms produced by arthropods and reptiles is a common public health hazard. Millions of people within the United States are affected each year by venoms produced by these creatures. This section covers the types of venom arthropods and snakes produce, the mode of action of these venoms, and how these venoms are introduced into humans.

C18. Identify toxins that produce given effects.

Types of Venom Produced. There are five basic types of venom arthropods and reptiles produce:

(1) Hemolytic toxin.
(2) Neurotoxin.
(3) Urticating toxin.
(4) Vesicating toxin.
(5) Hemorrhagic toxin.

Most arthropods and reptiles in the United States produce a hemolytic venom.

Mode of Action of Venoms. Hemolytic toxin causes a breakdown of red blood cells. It may kill large blocks of tissue in the area of the envenomization.

Neurotoxin is a systemic toxin that affects the nervous system. It inhibits reflexes and may cause shock in severe cases.

Urticating toxin simply produces wheals (raised areas) on the skin.

Vesicating toxin produces blisters on the skin.

Hemmorhagic toxin prevents the normal clotting ability of blood. Thus, it causes a reddening of the skin in the area of envenomization.

Exercises (C18):

Indicate the toxin that produces each of the following effects.

1. ______________________ inhibits reflexes and may cause shock.

2. ______________________ produces skin blisters.

3. ______________________ causes a breakdown of red blood cells.

C19. Relate given envenomization methods and venom types to the appropriate arthropods and reptiles.

Methods of Envenomization. Most envenomization occurs through stings and bites. Other methods include pinching and contact. The methods of envenomization, the types of venoms introduced, and the producers are outlined below:

Envenomization Method	*Toxin*	*Producer*
Stings	Hemolytic	Insects: wasps, mud daubers, yellow jackets, hornets, honeybees, and bumble bees. Arachnids: scorpions.
	Neurotoxin	Arachnids: scorpions (two species within the U.S.).
Bites	Neurotoxin	Arachnids: black widows and brown widows. Reptiles: coral snakes. Insects: wheal bugs (both hemolytic and neurotoxin).
	Hemorrhagic	Insects: bedbugs and thrips.
Contact	Urticating	Insects: puss caterpillars, IO moths, and saddle-back caterpillars.
	Vesicating	Insects: blister beetles Diplopids: millipedes.
Pinching	Hemolytic	Chilopids: centipedes.

Exercises (C19):

1. Match the producers in column A with the envenomization methods and toxin types in column B. You may use the items in column B more than once.

Column A	*Column B*
____ (1) Yellow jacket.	a. Neurotoxic bite.
____ (2) Scorpion.	b. Hemolytic sting.
____ (3) Black widow.	c. Vesicating contact.
____ (4) Bedbug.	d. Hemorrhagic bite.
____ (5) Puss caterpillar.	e. Neurotoxic sting.
____ (6) Millipede.	f. Hemolytic pinch.
____ (7) Centipede.	g. Urticating contact.
____ (8) Coral snake.	

2-2. Bees

This section covers good and bad aspects of bees in relation to humans, the general characteristics of bees, important bee families, and measures you can take to manage bees.

C20. Identify the beneficial and detrimental aspects of bees.

Bees are generally more beneficial than detrimental to humans; however, the degree to which they help or hurt depends on the bee species and location.

Beneficial Aspects. Honeybees are the most beneficial bees to humans in respect to food production. These bees produce honey, and most important of all, they pollenate crop-bearing plants. Honeybees also produce beeswax. Beeswax is used extensively as a sealant because it does not harden readily and remains pliable for many years. Beeswax is also used for lubricating bow strings. Some people use beeswax as a kind of "natural" chewing gum.

Bumblebees are helpful to people because they pollenate plants that can't be pollenated by honeybees. Some plants have a nectary so deep that only the bumblebee with its long tongue can cross-pollenate them.

Although the carpenter bees are important in plant pollenation, this beneficial aspect is often overshadowed by its detrimental habits.

Detrimental Aspects. Honeybees, bumblebees, and carpenter bees are all important from a medical standpoint. The hemotoxic venom causes local pain usually followed by swelling and reddening of the sting area. Some people are naturally immune to bee stings and won't swell at all, while others will swell excessively and be confined to bed. In some cases, the effects of bee stings can cause nausea, fainting, and even death.

Carpenter bees are more important from an economical standpoint than from a medical standpoint because they can cause fairly extensive structural damage to wood buildings.

All bees can be a severe nuisance pest to humans at times.

Exercises (C20):

In the space provided by each statement below, place a C to indicate a correct statement or an I to indicate an incorrect statement; correct the false statements.

____ 1. Bees are generally more beneficial than detrimental to people.

____ 2. Honeybees are more beneficial than bumblebees to people.

____ 3. Food production is one of the least beneficial aspects of the honeybee.

____ 4. Beeswax hardens and remains useful for years.

____ 5. Bumblebees pollenate plants that cannot be pollenated by honeybees.

____ 6. Carpenter bees are less beneficial than honeybees or bumblebees, but they are also less detrimental.

____ 7. Bee stings are often painful and cause sickness and discomfort but never death.

____ 8. Bees can be severe nuisance pests to humans at times.

C21. Identify bee species with their given descriptions.

Characteristics of Bees. All bees are insects belonging to the order Hymenoptera but not all belong to the same family, nor do they have the same characteristics. Since the carpenter bees were discussed in Volume 5, only the characteristics of the honeybees and bumblebees are discussed here.

Honeybees. Honeybees belong to the family Apidae. They are characterized by their construction of vertical combs of wax and the fact that the queen alone cannot start a new colony. There are several races of honeybees, and each race has varying characteristics. For example, the Italian bees are a gentle race, but the German bees are agressive and need no prompting to sting. Fortunately, the Italian honeybees are more prevalent in the United States.

Honeybees are social insects that live in large colonies of up to 20,000 bees or more. Honeybees have a distinct social order called a caste system. The castes of the honeybee consist of the queen, worker, and drone. The workers are about 15 mm long and have very hairy faces. They have a saclike organ, called a pollen basket, on the outer surface of each hind tibia. They use the pollen basket to transport pollen back to the hive.

Bumblebees. These bees belong to the family Bombidae and generally nest inside holes in the ground, such as those constructed by burrowing animals. Bumblebees live in colonies during the summer but only the queens survive the winter. Bumblebee colonies differ from the honeybees in that there are several queens in a bumblebee colony, compared to only one in a honeybee colony. The colonies also differ in that bumblebees have no worker caste. Thus, the undeveloped female queens must carry out all chores.

Bumblebees are much larger than honeybees and their bodies are hairier. They do not have pollen baskets but have a spur on each hind tibia.

Exercises (C21):

Give the name or names of the bees that best fit the following descriptions.

1. ______________ These bees belong to the order Hymenoptera.
2. ______________ These bees belong to the family Apidae.
3. ______________ There are several queens in this kind of colony.
4. ______________ These bees generally nest inside holes in the ground.
5. ______________ These colonies have no worker caste.
6. ______________ This kind of bee includes gentle Italian bees and agressive German bees.
7. ______________ Undeveloped female queens must carry out all chores.
8. ______________ These bees do not have a pollen basket.

C22. State control techniques for bees.

Controlling Bees. Since most bees are very beneficial, you should make every possible effort to control them without harming them. Of course, you must also protect yourself to keep them from hurting you.

Personal protection. The best way to protect yourself from bees is to avoid them. If you see bees working in an area, leave them alone because most will not harm you unless you disturb them. If you are involved in outdoor activities, check the area thoroughly for signs of bee swarms or hives and avoid the areas used by bees if possible. People that are allergic to stings should undergo a series of desensitization shots to increase their tolerance to stings.

Physical removal. You can effectively control honeybees simply by transferring established colonies from one area to another. To remove an established colony, expose the colony in order to cut away the combs. Fasten the comb portions containing brood into frames with cotton string to entice the bees into the hive. Keep the hive for a couple of days near the entrance to the area where it was established. Remove swarms of honeybees from bushes or other exposed areas by holding a white cotton cloth beneath the mass and raking them gently away. After you have collected the bees, transfer them to a beekeeper or to an open field.

When you give bees to beekeepers or collectors, you solve the problem of controlling them. In addition, you do the environment a favor and you don't have to kill the insects with chemicals.

Collecting honeybees is an art that should be done only by experienced people. If you are inexperienced, and you must remove honeybees, be sure you're clothed properly and wear a bee net over your head. Wear loose-fitting clothing with the cuffs of sleeves and legs tightened over your gloves and boots to prevent the bees from entering. Tie the bottom of the bee net securely over the collar of your clothing to prevent bees from getting inside the net.

Chemical control. Bees are generally susceptible to insecticides (dusts, sprays, or aerosols) and are easily controlled when they are swarming or when the colony is exposed. Since bees are inactive at night and are massed in their colony, take control measures in the late afternoon or early evening.

Controlling bees that are established in inaccessible areas is more difficult and you may need to make several treatments to kill the entire colony. Insecticidal dusts are more effective in this instance because they can be blown into the area for workers to carry into comb cavities. You should repeat this process weekly for 2 to 3 weeks.

Exercises (C22):

For each of the situations below, state the control techniques that would be most appropriate.

1. A colony of bees has swarmed and is infesting a decorative bush outside the main entrance to the commissary; they are a serious threat to the commissary patrons. What should you do?

2. A colony of unwanted bees is nesting in an animal burrow on the golf course; they are a hazard to golfers, and several people have been stung. What control measures should you take?

2-3. Wasps

At times, wasps become severe pests to humans, especially when they build nests near or in homes and other structures.

This section covers the important activities and the general characteristics of wasps as well as the measures you can use to control them.

C23. Identify important aspects of wasps.

Important Aspects of Wasps. Like bees, all wasps are medically important to people because of their stinging ability, and as with bees, the reactions of humans to their stings depend on each person. Also, since many species are social insects, they're likely to be found in large numbers in the nest's vicinity.

Wasps are very beneficial to humans in food production, but most help in a way different from bees. Wasps neither produce honey nor beeswax, but they serve as plant pollenators to a small degree. Wasps are more important in food production as being parasites of many insects that can destroy crops.

There are several wasps that destroy vegetation, and there are others that parasitize insects and arachnids that are very beneficial to us.

Exercises (C23):

1. Like bees, all wasps are medically important to humans because of their _________ ability.

2. The reaction of a person to a wasp sting depends on the ________________.

3. The most important aspect of the wasp's benefit to humans is that they are parasitizers of many ________________ that are responsible for destroying ________________.

4. There are several wasps that destroy ________________.

C24. Identify the general characteristics of wasps.

General Characteristics. Wasps belong to the order *Hymenoptera*, which also includes bees and ants. The adults have two pairs of membranous wings. The adult females have ovipositors they use to deposit eggs or to sting people and other animals. In some wasps the ovipositor is very prominent and nonretractable; in others, the ovipositor can be retracted into the abdomen, completely concealing it.

Most wasps that are generally beneficial to humans are loners and do not construct massive nests. This way of life might account for the reason we don't consider them to be severe pests to people.

The significantly harmful wasps are generally social insects that build large nests around, on, or in our buildings and work areas. These wasps are attracted to sweets, fruits, and meats. They may actually bite off portions of foods. This attraction explains their presence around homes and picnic activities. The social wasps may construct mud nests that resemble beautifully fashioned vases, globes, or mud clods. They may also construct paperlike nests with exposed or concealed cells. You may find these nests around the eaves of buildings, within attics, in shrubs, brush piles, woodpiles, in holes in the ground, or under objects on the ground.

Exercises (C24):

Identify as true (T) or false (F); correct any false statements.

____ 1. Wasps belong to the order Hymenoptera, which is also represented by bees and ants.

____ 2. The purpose of the ovipositor in the female wasp is laying eggs.

____ 3. Wasps live in colonies and are severe pests to humans.

____ 4. Wasps that do live in colonies construct nests of mud or a paperlike substance.

____ 5. Wasp nests may be found in a variety of different locations.

C25. Identify correct details regarding wasp control methods.

Wasp Control Measures. For the most part, wasps are active only during daylight hours. For this reason, you should only take control measures in the early morning or late evening when most of the wasps are still on the nest.

Almost any insecticide will control paper wasps if you quickly spray it into or onto the nest, but you must exercise caution to keep from getting stung. Here are some rules to follow that will help you get quick control and reduce the risk of wasp stings:

a. Try to control the nest while most of the wasps are still on it, such as in the early morning.

b. Use an insecticide with quick knockdown capabilities. This includes pesticides such as 1 percent Diazion, 1 percent Baygon, 0.5 percent Dursban, or 2 percent Sevin. The newer, long-range aerosol cans are particularly useful, especially for nests beyond the range of manual sprayers.

c. Move cautiously around the nest, but get close enough to get an accurate "shot" at it before any wasps can move away.

d. If you must treat a nest during the day, wear protective clothing such as boots, heavy coveralls, veiled headwear, and heavy gloves. Then, make sure you secure these items so no wasps get between you and your clothing. (Things like that can ruin your whole day

Although oil solutions may have a quicker impact on the wasps, don't use them if spray drift represents a danger to vegetation or treated surfaces. In most situations, it's probably a better practice to use an emulsion. After the adults are killed, try to knock down the nest and crush it. Don't worry if you can't do this, though, since it's not likely that the larvae and pupae will survive the residual treatment.

Exercises (C25):

Identify as true (T) or false (F). Correct any false statements.

____ 1. Wasp control measures are best conducted in the daytime when most wasps are away from the nest.

____ 2. Almost any insecticide will control paper wasps when applied directly to the nest.

____ 3. Oil solutions should always be used against wasp nests to ensure the quickest possible knockdown.

____ 4. After wasps on a nest are killed, you should try to knock down the nest and crush it.

2-4. Hornets and First Aid for Stings

Although hornets are a type of wasp, they are included in a separate section because their characteristics are somewhat different from the other types of pest wasps.

This section covers the characteristics of hornets, controls for hornets, and the first aid treatment for hymenopterous stings.

C26. Describe the importance, classification, habits and control of hornets.

Importance. Although hornets parasitize certain insects and arachnids, their danger to humans overshadows their small degree of helpfulness. These insects are quite vicious and inflict very painful stings, even more painful than yellow jackets. Of course, the effects of hornet stings depend on the individuals that have been stung, as other hymenopterous stings. Hornets are the most feared of all the hymenopterous insects.

Classification. Hornets belong to the order Hymenoptera, family Vespidae, as do the more common pest wasps. The hornet that is most common and distributed throughout the United States is the baldfaced hornet *(Vespula maculata)*.

This species is a large (about 22 mm long), black and white hornet. It's white markings are the main features that distinguish it from the true yellow jackets. Also, the thorax and abdomen are much broader than other wasps and these parts are not separated as distinctly as the thorax and abdomen of other wasps.

Habits. Hornets construct paperlike nests as do other pest wasps, but the nests of hornets are completely enclosed with a paperlike covering and may resemble a massive "bloated football" or an inverted teardrop (fig. 2-1) near the suspended end. Hornets often attach these nests to a tree limb or beneath any projecting surface.

Control. One of the oldest and most effective ways to control hornets predates the use of organic insecticides. You simply affix a torch to the end of a rod of sufficient length, light it, and hold it up to the bottom of the nest, holding it in place until the nest is completely burned. Tree pruners are now available which have hollow telescoping aluminum handles. This implement is especially good for this sort of treatment, being light, sturdy, and nonflammable.

Clearly, with this type of action, you've got to take proper safety measures. Coordinate your work with the base fire department and, as a minimum, have a hydraulic sprayer filled with clean water. Use this to spray the area surrounding the nest after you've burned it. If the area around the nest is brush and dry, you should possibly have larger equipment available from the fire department. Additionally, make sure you wear all your protective clothing as described for wasps.

There are other materials and techniques you can use to control hornets and other wasps. One product is Wasp

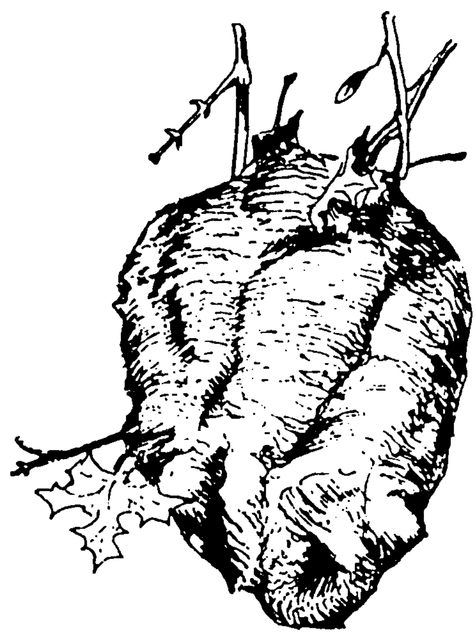

Figure 2–1. Hornet nest.

Freeze, which contains highly volatile solvents and pyrethrins and is packaged in a pressurized container. This combination produces almost instant knockdown of insects hit and is applicable for use against any of the paper wasps, even ground-nesting wasps such as yellow jackets. No other insecticide needs to be introduced into the nest, as the volatile solvents apparently kill all adults present, and the immature stages die from lack of care.

Exercises (C26):

1. Compare the beneficial and detrimental aspects of hornets.

2. The most common hornet distributed throughout the U.S. is the ____________ ________________.

3. What main characteristic distinguishes the baldfaced hornet from the true yellow jackets?

4. How do hornet nests differ from those of yellow jackets?

5. What is the oldest and possibly most effective control measure for hornets?

6. What two safety concerns are of primary importance when you use burning to eliminate a hornet nest?

C27. Describe first aid treatment for hymenopterous stings.

First Aid for Hymenoptera Stings. Unless you have received several stings at one time, a good first aid treatment is normally sufficient. However, if you have received many stings or if you are allergic to stings, you should receive treatment for shock and get medical help as quickly as possible.

Unlike the wasp and hornet, the bee's ovipositor has barbs on it. Therefore, when the bee uses it as a weapon, the stinger, poison sac, and other parts of its anatomy are torn from its body and remain in the victim. Thus, the first aid for treating bee stings differs from treatments for wasp and hornet stings in that the bee stinger must be removed.

To remove the stinger, place the sharp edge of a knife blade immediately below the sting entrance and position it flat against the skin with the sharp edge closest to the exposed portion of the sting. Carefully pull the blade in the same direction as the angle of the stinger to avoid breaking it off. This method prevents squeezing more venom from the poison sac. *Do Not* use tweezers.

Once the stinger has been removed, apply a paste of water and bicarbonate of soda (baking soda) to relieve the pain.

NOTE: Never rub a sting area. Rubbing only speeds the flow of venom into the blood and increases the inflamed area.

Exercises (C27):

1. What action should you take if you get several hymenopterous strings?

2. How does treatment for a bee sting differ from that for a wasp or hornet sting?

3. Since the bee stinger has a poison sac attached to it, you should not try to remove it with ____________________.

4. After removing the stinger, what action can you take to relieve pain?

5. Why should you never rub a sting area?

2-5. Spiders

There are only a few spiders that are dangerous to humans within the United States, but spiders of all types are probably more feared by humans than any other venomous arthropod. This fear of spiders is a result of not knowing their characteristics and not recognizing the few species that are dangerous.

This section will cover the general characteristics of spiders, the most medically important spiders within the United States, spider habits and habitats, as well as measures you can take to control spiders.

C28. Specify correct statements regarding the importance of spiders.

Importance of Spiders. Contrary to the popular belief that most spiders are poisonous and harmful, they are actually more beneficial than detrimental. Spiders occupy a wide variety of ecological niches, ranging from treetop level in tropical rain forests (hunting or wolf spiders), to positions over well-defined hunting trails, to silk-lined, underground tunnels.

All spiders are predaceous, feeding largely on insects. Because of their habits, they can often play an important role in maintaining the balance of nature and limiting insect populations. However, dangerously venomous spiders often occur in or around living quarters. This creates situations where people may brush against webs or be bitten while putting on clothing where spiders hide.

The most important species are members of the genera *Atrax* in Australia; *Harpactirella* in South Africa; *Chiracanthium* in portions of the Far East and the Pacific Islands; *Glytocranium*, *Phoneutria*, *Pamphobeteus*, *Ctenus*, and *Lycosa* in some portions of South America; and *Loxosceles* in South, Central, and North America. The most important species that occur within the United States belong to the genera *Latrodectus* (widow spiders) and *Loxosceles* (brown spiders).

The important spiders within the genus *Latrodectus* include the black widow *(Latrodectus mactans)*, the brown widow *(Latrodectus geometrices)*, and the red widow *(Latrodectus dishoti)*.

The brown recluse *(Loxoceles reclusa)* is the only dangerously poisonous member of the genus *Loxosceles* within the United States.

The most important poisonous spider within the United States is the black widow spider. The bite of the female black widow spider, although not as important as generally believed, can produce death—the death rate being about 5 percent. Although very young children or the very aged are supposed to be most susceptible to black widow spider venom, most U.S. deaths occur among males bitten in the genital area, usually while using outdoor privies. Most of these deaths are among migrant workers in the California vegetable fields. The male black widow spider has very little venom and the mouthparts are not strong enough to penetrate human skin.

Both sexes of the brown recluse can inflict poisonous bites to mammals. The typical reaction to its bite is *necrosis* (killed tissue) at the site of the bite. The victim may not know he or she had been bitten for 2 or 3 hours, or a painful reaction may occur immediately. This stinging sensation usually leads to intense pain. A small blister usually rises and a large area around the bite becomes congested and swollen. The patient may become restless, feverish, and have difficulty in sleeping. The local pain is frequently quite intense and the area surrounding the bite remains congested and hard to the touch for some time. The tissue affected locally by the venom is killed and gradually sloughs away, exposing the underlying muscles. The edges of the wound thicken and are raised while the central area is filled by dense scar tissue. Healing occurs quite slowly and may take 6 to 8 weeks. The end result is a sunken scar which has been described as resembling a hole punched or scooped from the body. Scars ranging from the size of a penny to a half-dollar have been reported. The necrotic condition described above is typical of all bites of the brown recluse, but in some cases a general systemic reaction may occur. Luckily, this tendency seems to occur rarely and is usually the result of a "full" bite (i.e., the injection of a maximum amount of venom), or extreme sensitivity to the venom. This general reaction to the bite of the brown recluse usually requires hospitalization. Those in poor general physical condition, young children, and older people are more likely to be affected seriously by the bite of the brown recluse.

Exercises (C28):

Identify the statements below as true (T) or false (F) and correct any false statements.

____ 1. Spiders are considerably more beneficial than detrimental.

____ 2. All spiders are poisonous and predaceous.

____ 3. Spiders play an important role in limiting the insect population.

____ 4. Dangerously venomous spiders occur in a very few areas of the world.

____ 5. The most important poisonous spider in the United States is the brown recluse.

____ 6. The male black widow spider has very little venom and the mouthparts are not sufficiently strong to penetrate the skin of humans.

____ 7. The female brown recluse is the only one of the species which is poisonous.

____ 8. The full bite of a brown recluse is no more serious than a partial bite.

____ 9. The very old or the very young are likely to be affected most seriously by the bite of a brown recluse.

C29. Describe details regarding spider classification and characteristics.

Classification and Characteristics. Spiders belong to the order Araneida in the class Arachnida. They are found worldwide, but most live in the temperate and tropical zones.

Many spiders use their poison to paralyze their prey. Although the venom is sufficient for this purpose with insects and some small animals, humans are not generally bothered. Very few spiders have mouthparts that can penetrate the skin of humans, and most of those that do have venom can produce only local symptoms or an occasional allergic reaction.

Spiders, like other arachnids, have eight legs, no wings, and no antennae. Unlike scorpions, ticks, and mites, spiders (fig. 2-2) have an unsegmented abdomen attached to the cephalothorax by a short pedicel or stalk. The eyes are simple, usually eight grouped together or separated across the head. The head also has a pair of antennalike or leglike pedipalps and a pair of chelicerae with fangs. There are many types of spiders with considerable variation in size, color, locomotion, web-spinning characteristics, methods of hunting and catching prey, shelter-seeking, and other distinctive characteristics. After they hatch from eggs, immature spiders pass through several instars before reaching sexual maturity. Typically, females pass through more instars than do males. The lifespan varies with such factors as food supply, natural enemies, temperature, and humidity.

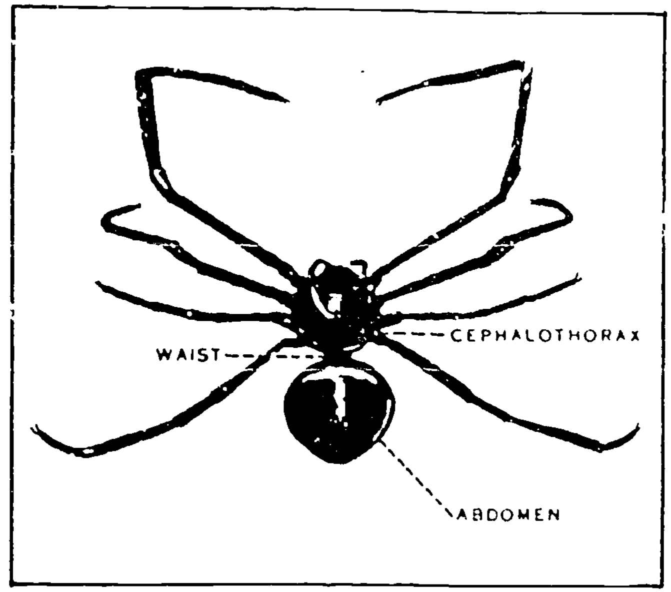

Figure 2–2. Black widow spider.

Exercises (C29):

1. In what zones are spiders generally found?

2. How do many spiders use their poison?

3. The venom of most spiders is sufficient as far as insects and small animals are concerned, but __________ are not generally bothered by the venom of most spiders.

4. Very few spiders have __________ that can penetrate the ______________ of humans.

5. Typically, female spiders pass through more ______________ than males.

C30. Identify spider characteristics regarding their identification and habits.

Black Widow Spider. The female black widow spider (Lactrodectus mactans) is 12 to 14 millimeters in length while the male is about half that size. The entire body is usually a bright, shiny black (fig. 2-2) except for the markings; however, on some specimens the thorax and legs may be a dark brown. There are short, black hairs covering the body and legs but they are so fine you won't usually notice them. On the underside of the abdomen, the female has an hourglass-shaped spot which is usually a bright red, although orange to cream colors may occur on those found in some geographical areas. In addition, the males have rows of red spots and diagonal yellowish stripes of various straw-colored markings on the upper surface of the abdomen. These markings may be present in various combinations. The legs may be alternately pale and black banded. Immature females vary in their markings so that their appearance may be a cross between that of the adult male and female.

The female black widow produces several sacs with an average of some 200 eggs each in round, creamy-white cases attached to her web. The eggs usually hatch in 2 to 4 weeks to very tiny, gray, active spiders which are cannibalistic. The eggs are usually laid during the summer and the young forms reach maturity the following spring. These spiders are found on the underside of privy seats, in piles of lumber and trash, and in empty paint cans and buckets. People frequently find them beneath houses in some areas, and they may occur in storerooms and garages. The web is extremely irregular and very loosely woven, and the tube into which the female retires is not in plain view. Black widows live in dark areas and generally avoid light. Their normal food is insects, and they usually bite people only if they are disturbed.

Brown Widow Spider. The female brown widow spider *(Lactrodectus geometri[illegible])* is usually brown to grey in color and has the red-to-orange hourglass marking typical of widow spiders. At present, this spider is found only in Florida on or near buildings.

Unlike the egg sacs of a black widow spider, those of the brown widow are tufted and fluffy and honey gold in color.

Red Widow Spider. The female red widow spider *(Latrodectus bishopi)* is quite different in color from other widow spiders. The legs and cephalothorax are generally reddish brown and the abdomen is basically dark brown splotched with yellow and has a red-to-orange spot on the underside, unlike the hourglass marking that is typical of other widow spiders.

The only place this spider is found at present is in the palmettos and scrub-pines of southern and central Florida. The egg sacs of this spider are generally white, smooth, and round.

Northern Widow Spider. The female northern widow spider *(Lactrodectus variolus)* is very similar in color to the black widow spider except it is not shiny black but, instead, is smokey black.

This spider is distributed from northern Florida to southern Canada and is very common in British Columbia. It is generally found in isolated woods, in tree stumps, and in brick or stone walls.

The egg sacs of the northern widow spider are paperlike and brown in color.

Brown Recluse Spider. The brown recluse spider *(Loxosceles reclusa)* is of medium size, measuring about 10 to 15 millimeters long and 5 to 7 millimeters across. The legs are long and both legs and body are covered with minute brown hairs but appear almost bare to the unaided eye. The body color varies from light greyish brown to dark brown. The most distinguishing mark is the dark fiddle-shaped band on the anterior portion of the carapace, which narrows to a thin centerline extending almost to the abdomen (fig. 2-3). Unlike most spiders, this species and its close relatives have six instead of eight eyes.

The brown recluse spins a medium-sized irregular web with a maze of threads extending in all directions without definite pattern or plan. The web fibers tend to be very viscid, or sticky. In the laboratory this spider often constructs a retreat of loose silk in one part of its web. For a retreat in winter in its out-of-doors habitat, the brown recluse spins a tube of thick silk which somewhat resembles the hibernation retreat made by jumping spiders. Females usually produce more than one egg sack with a maximum production of five. Egg production averages about 135 with hatching occurring in 2 weeks. The setae of the young are very dark; the abdomen is yellow/brown; and the rest of the body color is pale tan. Except for the "fiddle" pattern not being evident on the carapace, the spiderlings resemble the adult. There are eight instars in the development to the adult stage, the first one occurring within the egg sac and all others outside. The duration of the second through the eighth instars is variable, sometimes extending for as long as 200 days. Indoors these spiders are commonly found in houses and associated buildings, boiler houses, schools, churches, libraries stores, and other such buildings. Because the spiders are sedentary and avoid the light they are seldom seen, but they can be found in almost any place that has been relatively undisturbed for a long period of time, such as behind pictures, beneath and behind furniture, in boxes of toys, in clothing, and among stored papers. Even though the brown recluse is most often found in and around houses, its natural habitat seems to be out of doors, at least in the southern part of its range. In outdoor locations it has been found beneath flat rocks, under loose bark, in crevices of old decaying logs, and in trash piles.

Exercises (C30):

1. Match each type of spider in column B with its description in column A. Items in column B may be used more than once and may apply to more than one description.

Column A	Column B
____ (1) The male is about half the size of the female.	a. Red widow.
____ (2) Red to orange hourglass marking.	b. Brown recluse.
____ (3) Red to orange marking unlike the hourglass.	c. Black widow.
____ (4) Covered with minute brown hairs.	d. Northern widow.
____ (5) Young spiders are cannibalistic.	e. Brown widow.
____ (6) Found in palmetto and scrub-pines of southern and central Florida.	
____ (7) Smokey black instead of shiny.	
____ (8) Fiddle-shaped marking on the anterior portion of the carapace.	
____ (9) Found in Florida.	

2. The female black widow produces several sacs with an average of ______________ eggs each.

3. How long does it usually take black widow eggs to hatch?

4. When do black widows usually lay their eggs and when do the young reach maturity?

5. List the areas where black widows are usually found.

6. The normal food of the black widow is ______________, and they usually bite people only if ____________________.

7. What is the most distinguishing mark of the brown recluse spider?

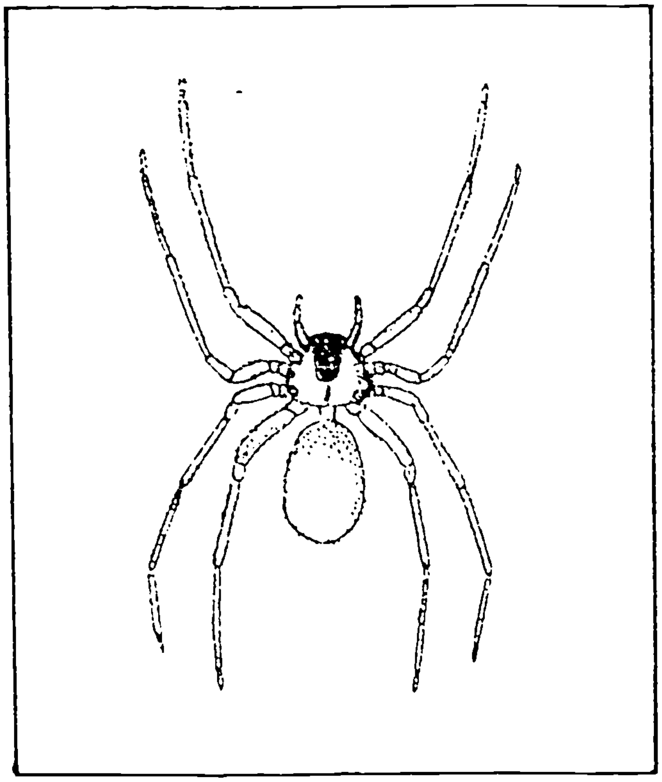

Figure 2-3. Brown recluse spider.

8. The female recluse usually produces more than _______ egg sac with a maximum production of _______________.

9. Indoors, where is the brown recluse commonly found?

10. Why are brown recluses seldom seem?

11. Although often found in houses, the natural habitat of the brown recluse seems to be _____________________________________.

C31. Identify proper control measures for spiders.

Controlling Spiders. Cultural control methods, such as eliminating all possible breeding areas, are of considerable value in eliminating black widow and other spiders. Take care to destroy the webs in buildings and inhabited areas and to kill the spiders by crushing or with insecticides. You should always destroy the egg sacs found in the webs since as many as 300 young spiders may emerge from a single sac.

Indoor spider control may involve nothing more than vacuuming up the spiders and their webs and egg sacs. Space treatments of 1 percent DDVP, 0.25 percent synergized pyrethrins, or 0.25 percent Resmethrin are often useful for clean outs and for eliminating outdoor species found indoors. If spiders are breeding indoors or if outdoor species are migrating indoors, you can use residual sprays of 1 percent Baygon, 1 percent Diazinon, 0.5 percent Dursban, 3 percent Malathion, or 2 percent Sevin. Spray all areas where you find spiders and pay particular attention to dark corners. Two percent Diazinon dust may be useful in crawl spaces and attics.

You'll need to conduct an outdoor treatment to control spiders which migrate inside or to eliminate spiders on porches, under eaves, and other areas outside the building. Occasionally, area treatments are necessary to eliminate heavy infestations. The residual sprays listed above are also recommended for use outdoors.

Controlling black widows. You'll generally find the black widow in its irregular-shaped web near the ground. Common web sites are under stones, loose bark, in water faucets or woodpiles, rodent burrows, garages, storage buildings, etc. Most human envenomizations occur when the spider is inadvertently trapped against part of the body or when the web is accidentally touched.

Frequent cleaning to remove spiders and their webs from buildings and outdoor living areas by building occupants will decrease the possibility of accidental bites. Routinely hose-washing potential spider habitats, such as under steps and around windows and doors, will discourage the black widow from living in these places. When you must work in spider-infested areas, wear gloves and a long-sleeved shirt. If warranted, you may treat the outside or inside of a building with an approved insecticide, as described above. Apply the spray around windows, stairs, closets, or other spider habitats, both indoors and outdoors according to instructions on the pesticide label.

Controlling brown recluses. Within its range, the brown recluse spider will readily establish populations inside parts of buildings which are generally dry, littered, and undisturbed for long periods of time. The spider also can be found outside in protected areas (under rocks and loose bark). Members of this species are nonaggressive and normally try to escape whenever they are threatened. Thus, most instances of bites occur when the spider is inadvertently trapped, such as when the victim puts on clothing in which the spider is hiding, steps on a wandering spider at night, or cleans closets or other storage areas where the spider lives.

Any of the following actions will help building residents prevent contact with the brown recluse spider: shake out clothing and bedding before use; eliminate collections of papers and unused boxes; thoroughly clean beneath and behind furniture; remove spiders, webs, and egg cases from living and storage areas; and properly use appropriate general use insecticides.

Exercises (C31):

1. List areas where you may typically find black widow spiders and their nests.

2. What action should building occupants periodically take to control black widow spiders?

3. When applying residual pesticides for black widow control, where should you treat?

4. List the areas where you may typically find the brown recluse.

5. What controls will help protect occupants from contact with brown recluse spiders?

Identify these statements as being true or false; correct any false ones.

_______ 6. Cultural controls can be of considerable value in controlling spiders.

_______ 7. Spider egg sacs need not be destroyed since young spiders will not survive without adult care.

_______ 8. Space treatments may be used indoors or outdoors to control spiders.

_______ 9. Area treatments outdoors may occasionally be needed to control large spider populations around buildings.

2-6. Scorpions

Scorpions are most common in the southern regions of the United States from the Pacific to the Atlantic. Most scorpions within the United States are categorized as pests within buildings and outdoor areas commonly used by people. There is only one scorpion of medical importance within the United States.

This section covers the importance, description, habits, and habitats of scorpions. You will also learn about the controls and first aid treatment for scorpions.

C32. Identify details regarding the importance of scorpions.

Importance of Scorpions. There are 4 families of scorpions with over 300 species distributed throughout the tropics, subtropics, and temperate regions of the world. Many scorpions invade dwellings in search of food or shelter. Others are normally found in the locations frequented by humans. While most scorpions can cause only painful stings, some species cause many deaths. The medical importance of a scorpion is determined by its habits and venom potency, not by its size. Some of the most dangerous species seldom attain a length of more than 7.5 centimeters. In contrast, stings by scorpions 12 to 15 centimeters long may produce only temporary local pain in humans.

Most scorpions of medical importance are members of genus *Centruroides* in portions of the Southwestern United States and throughout Mexico; genus *Tityus* in Central and South *America; genera Buthus* and Androctonus in the Middle East and North Africa, and genus *Parabuthus* in South Africa. Dangerous venomous species may also occur in other sparsely settled portions of Africa and Southeast Asia where no meaningful clinical records are kept. *Centruroides sculpturatus* is the only dangerously poisonous scorpion known to occur in the United States; it's found mainly in southern Arizona and parts of neighboring states.

Exercises (C32):

1. Place the letter X in the provided space before each true statement.

____ (1) There are over 300 species of scorpions.

____ (2) The only poisonous scorpion in the United States is found mainly in southern Arizona and parts of neighboring states.

____ (3) Some of the most dangerous species of scorpions usually attain a length of more than 15 centimeters.

____ (4) Many scorpions invade dwellings in search of food or shelter.

____ (5) The medical importance of a scorpion is determined by its habits and venom potency, not by its size.

C33. Cite details regarding scorpion identification and habits.

Identification, and Habits of Important Scorpions. Scorpions belong to the order Scorpionida in the class Arachnida. They have four pairs of legs and one pair of large claws, or *pedipalps*. The body has two divisions—the anterior, unsegmented cephalothorax and the posterior, segmented abdomen. The last six abdominal segments form the "tail," with the end segment modified in the form of a hooked stinger (fig. 2-4). The end segment, or *telson*, has two poison glands. The tail is carried arched over the back, and the stinger is inserted into a victim by a quick forward thrust. The venom is ejected through the needle-sharp, hollow stinger. Adult scorpions vary in length from less than an inch to 3 inches or more. Colors vary from nearly black to straw-color. Some scorpions are striped and most have smooth bodies, though some are hairy.

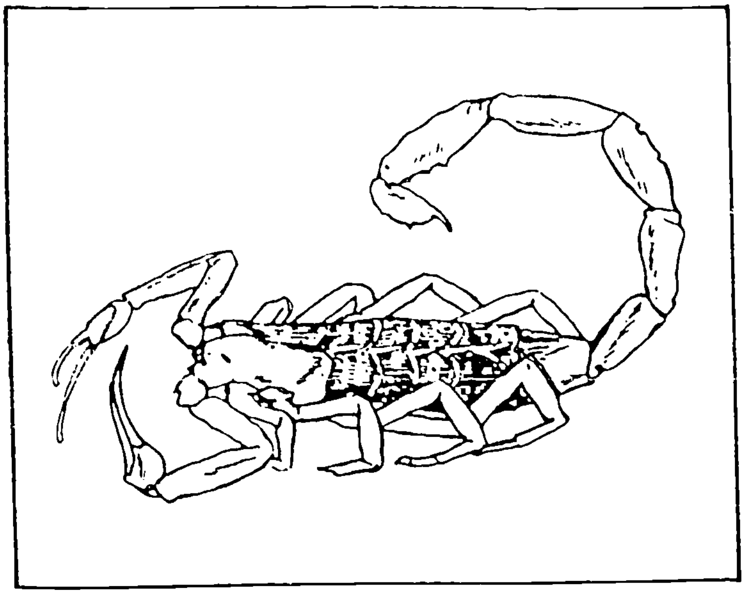

Figure 2–4. A scorpion.

Poisonous scorpions in the United States are 2–3 inches long and straw yellow in color. The length is 5 to 8 centimeters and the width of the cephalothorax is about 6 millimeters. The tail is about 1.5 millimeters in diameter and bears a subaculear tooth at the base of the stinger. The pedipalps are long and slender.

Scorpions do not lay eggs, but give birth to living young. The young are carried for some time on the back of the female. Scorpions are nocturnal and are seldom seen during the day unless they are disturbed in their hiding places. The most common poisonous species in the United States, *Centruroides sculpturatus*, is frequently found under loose bark of various trees, particularly eucalyptus and cottonwood, or under old logs and rocks. They are found occasionally on outside walls, particularly on buildings where a large amount of water is present, such as washhouses. They are also frequently found under wet rags, in folds of newspaper and magazines, and occasionally on clothing taken from a clothes basket. Indoors, scorpions are found in areas where insects are plentiful, such as under the house, in attics, or in hollow walls. In some buildings, scorpions may be found more or less routinely, which indicates that they are breeding in the area. However, if they only appear once or twice a year they are probably being brought into the house in packages of vegetables, boxes, and firewood.

Exercises (C33):

1. Scorpions have ____________________ pairs of legs and ________________ pair of large claws or pedipalps.
2. The body has ____________ divisions: the anterior, ________________ celphalothorax, and the posterior ____________________ abdomen.
3. The last six abdominal segments form the ____________, with the end segment modified in the form of a hooked ____________________.
4. The poisonous scorpion occurring within the United States is ______________ ______________ in color.
5. Scorpions are ________________________ and are seldom seen during the day.
6. Scorpions are found occasionally on outside walls, particularly on buildings where a large amount of ____________________ is present.
7. Indoors, scorpions are found in areas where insects are plentiful, such as under the ________________, in ___________________, or in hollow ___________________.

C34. State control measures for scorpions.

Controlling Scorpions. Avoidance is the best control method for scorpions, and this includes:

- Picking up objects carefully so as not to be stung by the scorpions which may hide beneath them.
- Emptying shoes and slippers vigorously before putting them on.
- Not walking around barefooted after dark.
- Shaking out clothing.

Home occupants shouldn't dump clothing on the floor but should carefully hang them preferably away from the wall. Folded bedding may also serve as hiding places for scorpions. Beds in heavily infested areas should be kept away from the walls; and in some cases it may be necessary to place the legs of the bed in clean, widemouthed glass jars. These jars should not have water in them, as this might lead to mosquito breeding.

General cleanup of trash piles by building occupants, will help control scorpions by cutting down on their hiding places. Remember that insects are the principal food for scorpions, and that killing such insects, particularly those that live on the ground, will be of benefit. Scorpions can go into hiding for 2 or 3 months after a period of abundant food, and can live as long as 6 months without food or water. Many species require from 3 to 5 years to reach maturity; thus, hunting out and destroying these animals on a regular basis will cut down on their numbers enormously.

Trapping scorpions can be done in heavily infested areas by dampening a burlap sack or other piece of heavy, coarse cloth and spreading it on the ground in the evening. Scorpions will crawl under it during the night and can then be easily destroyed the next morning.

Many attempts have been made to control scorpions by using fogs, mists, and aerosols. Generally speaking, these methods are of very little value because of the scorpion's habit of hiding in cracks and crevices which are seldom reached by such treatments. Residual spraying or dusting of breeding areas with Diazinon or Propoxur gives good control.

Exercises (C34):

1. The principal food for scorpions is ____________________.

2. How long can scorpions go into hiding after a period of abundant food?

3. How does general cleanup of trash piles by building occupants help control scorpions?

4. How can trapping scorpions be carried out in heavily infested areas?

5. What two pesticides are used to control scorpions?

C35. Specify first aid procedures for scorpion stings.

First Aid for Scorpion Stings. Follow the procedures below for a victim stung by a poisonous scorpion:

(1) Immediately after the sting, place a ligature (a tourniquet) between the sting and the body. Tie it as near to the sting as possible to prevent rapid absorption of the venom. A shoelace or something equally slender makes a good ligature, but a handkerchief is poor. Loosen the ligature briefly every 3 to 5 minutes.

(2) Put an ice pack directly on the site of this sting and have the victim hold it there.

(3) Antivenins are available for poisonous U.S. and Mexican species and some others; thus, professional medical assistance must be obtained as soon as possible.

Exercises (C35):

1. What should you do for a victim stung by a poisonous scorpion?

2. A piece of ____________________________ should be placed directly on the site of the sting.

3. The ligature must be loosened every __________ to __________ minutes.

4. What is available for the poisonous U.S. and Mexican species of scorpions?

5. Even if first aid has been rendered what should you do for victims stung by poisonous species of scorpions?

2-7. Other Venomous Arthropods

This section identifies venomous arthropods of less medical importance than those already covered in this chapter. They are less significant because they do not attack often and are not very toxic to humans. The arthropods covered here are centipedes, millipedes, conenoses, caterpillars, and moths. You will also learn about control measures for them.

Centipedes belong to the class Chilopoda. Millipedes belong to the class Diplopoda. Both are found mostly in the tropical, subtropical, and warm-temperature regions of the world. They are all predaceous, and have well-developed poison glands for killing their prey.

Conenoses, also known as assassin bugs, belong to the class Hexapoda, order Hemiptera, and the family *Reduviidae*. They are carnivorous insects and are generally predaceous to other insects and to arachnids.

Caterpillars are the larvae of moths and butterflies, and are in the order Lepidoptera. In the United States, there are 10 families with species troublesome to humans. There are many more irritating species scattered widely throughout the world. Our discussion will begin with centipedes.

C36. Differentiate between identifying characteristics and toxic effects of venomous arthropods.

Centipedes. Centipedes are flattened dorsoventrally. The body is made up of a distinct head and 15 to 170 or more similar segments. Each segment has one pair of tracheal openings and one pair of strong mandibles, and two pairs of maxillae. Individuals of some species attain a length of 25 centimeters or more. Adults of several species have shining greenish or blackish bodies, and orange or red legs and heads. Some are yellowish with dull red, longitudinal bands. Some centipedes are markedly phosphorescent. Sexes of centipedes are distinct, and the females either lay eggs or give birth to live young. The young resemble the adults, having about the same number of segments.

Centipedes differ from millipedes (class Diplopoda), which have two pairs of legs on each body segment, a nearly rounded rather than flattened body, and which feed principally on decaying vegetation. Centipedes hide by day under stones, rubbish, leaves, logs, and in other dark areas. They feed by night on earthworms, insects, mice, or lizards, depending on their size. They kill or paralyze their prey quickly with venom and chew it for ingestion with their mandibles. The common, long-legged house centipede *(Scutigera forceps)* is usually regarded as quite beneficial because it feeds on household insects.

Importance. Most centipedes are harmless, since only a small number have fangs strong enough to penetrate human skin. They bite large animals only in self-defense. The secretion injected is primarily a digestive enzyme, containing only a small proportion of venom. The amount of this material introduced depends somewhat on the size of the centipede and on the time elapsed since the fangs were last used. The small, fast-running, house centipede *(Scutigera cleoptrata)* has been known to pierce the skin and cause pain. The larger house centipede *(Scutigera forceps)* can bite and cause intense local pain. Other centipedes can also inflict very painful bites. The 25-centimeter *Scolopendra gigantea* of the tropics is considered very poisonous, its bite sometimes requiring hospitalization of victims.

Effects and first aid. Centipede bites may cause local pain, erythema (abnormal redness), hardening of the skin, formation of papules, rash, swelling, purple patches, and swollen axillary glands, but such symptoms usually subside within 24 hours if the wound is uninfected. No deaths have been recorded from the bites. Treatment usually consists of locally applied agents, such as weak ammonia, compresses of sodium bicarbonate, or epsom salts to relieve pain.

Millipedes. Millipedes are more cylindrical than flat. The body is made up of a distinct head and a trunk that consists of several segments. Each trunk segment has two pairs of jointed walking legs which lack poison claws. The head has a pair of short antennae, a pair of mandibles, and two pairs of maxillae.

Millepedes range in size from less than 2.5 millimeters to 16 centimeters. They are slow moving despite numerous legs, and are nocturnal, secretive, vegetarian, and terrestrial. They lay eggs, and the young resemble the adults but have fewer abdominal segments and only three pairs of walking legs.

Importance. Millipedes may be accidental parasites of humans, inhabiting the intestinal and urinary tracts. Some produce offensive fluids from paired glands located in the abdomen. These fluids have sometimes produced a dermatitis in humans.

First aid. Victims contaminated with the fluid excreted by millipedes should deluge the contaminated area with soap and water immediately. This will remove the fluid and should be all that's needed.

Conenoses (Assassin Bugs). Conenoses have a cone-shaped head, with a three-jointed proboscis that is carried in a folded position close to the body (fig. 2-5). When disturbed, it projects the proboscis forward in a manner similar to a spring that has been bent over and has had one end released. Conenoses range in size from 12 to 25 millimeters and are basically brown in color. Some have wide white to yellow spots on each side of the abdomen. The wings are about as long as the abdomen and are folded one on top of the other.

These insects are attracted to lights at night and will commonly enter buildings. They are blood-sucking insects that usually feed upon other insects although they will readily feed on mammals, including humans. Some species have been so persistent in human bedding that they are commonly known as Mexican bedbugs. Conenoses can produce a very severe reaction through their bites to humans even though the bite might not be felt as it is occurring.

Conenoses lay their eggs on plants in outdoor areas, but, inside, they lay the eggs in dark and dusty cracks, crevices, and corners. The eggs hatch into nymphs which pass through eight nymphal instars before they reach the adult stage.

Importance. For the most part, conenoses are beneficial to humans in that they attack other insects and are known to be predaceous upon bedbugs. However, they are also known to be vectors of Chagas' disease, and they produce a very strong hemolytic-neurotoxin venom. Their bites may not even be recognized (because of the anesthetizing effect) until the insects have completed their feeding, which might last anywhere from 3 to 7 minutes.

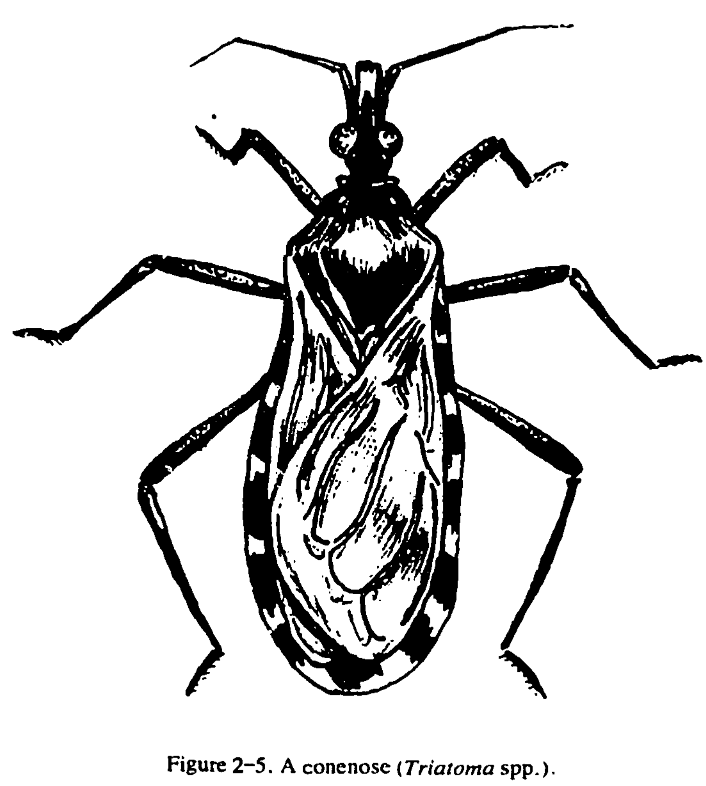

Figure 2-5. A conenose (*Triatoma* spp.).

Effects and first aid. There may be no reaction to the bite of a conenose by some individuals, but to others, the reaction might be severe with the effects of the venom lasting for several months. The venom produced by conenoses is hemolytic and neurotoxic. You should treat the bite area with iodine to prevent secondary infection. Place a paste of bicarbonate of soda and water over the bite area along with an ice pack to localize the venom and to give temporary relief until you can get professional medical assistance.

Caterpillars and Moths. The larvae of some moths and butterflies have large spines which, while harmless, create the false impression that the caterpillars are dangerous. On the other hand, most of the caterpillars with urticating or nettling hairs appear harmless. Some are actually attractive, being strikingly colored. Lepidoptera exhibit complete metamorphosis. The caterpillars hatch from eggs, and, upon maturity, transform to pupae. Most species of moths spin cocoons where they pupate. After pupation, the sexually mature adult emerges. Most adults are capable of flight, but some females are wingless.

While the medical importance is due mainly to urticating hairs, some caterpillars, such as the larvae of the cabbage butterfly *(Pieris brassicae)*, have poisonous body fluids which produce intestinal inflammation and death in cattle which may eat the caterpillars with their food. One caterpillar, the mealworm *(Asopia farinalis)*, can act as the intermediate host of the rat tapeworm *(Hymenolepis diminuta)* which occasionally infests humans. *Ophthalmia nodosa* is a disease of the conjunctiva, cornea, or iris of the eye caused by nettling hairs. In a few cases, the adult Lepidoptera have nettling hairs; but in some of these cases, these are larval hairs adhering to the adult. Symptoms produced by the urticating hairs differ with the species of moths and with the individual reaction differences of the victims. Cases of caterpillar rash are more widespread than people commonly think, and can be easily misdiagnosed in areas where they aren't common. The venom of caterpillars is produced in glands located at the bases of hairs, sometimes outside the body surface. These may occur singly or in clusters of tubercles on the body of the insect. When a victim contacts the spines, the venom may emerge through an opening at the tip of the spine; or a portion of the hair or spine may break off in the wound, thus releasing the venom. The more important venomous Lepidoptera are described below.

Puss caterpillar. The puss caterpillar is about 1 inch long when full grown. It has a thick, fleshy body completely covered and hidden by long silken hairs of a tawny-to-grayish greyish color (fig. 2-6). The upper side appears to have a convex form. Under the long hairs are numerous short spines in rows on tuberculate ridges and connected with underlying hypodermal poison glands. This species is quite common in the Southern States, and at times becomes very abundant. At such times a great many cases of stinging have received medical attention. Schools have been closed in some areas until the caterpillar was brought under control. The severity of the symptoms depends largely upon individual reactions. The initial reaction is usually an intense burning pain immediately after contact. This is followed by raised papules and reddening, then by generalized swelling and numbness, which may be accompanied by nausea and vomiting. Stings on the wrist have resulted in swelling of the entire arm to about double size. Fever and symptoms of nervous disorder are not uncommon in children.

Brown-tail moth. The brown-tail moth larva is about 3.8 centimeters long. The head is light brown; the body is dark brown to almost black with a broken white line on either side and two conspicuous reddish spots on the back near the posterior end. Numerous tubercles with long, barbed hairs and with short, brown hairs between are located on the back and sides of the body. This insect is a serious pest of fruit and shade trees in the Northeastern States. The larvae are the most notorious of our poisonous caterpillars. Short, barbed hairs are easily lost by the caterpillar. Further, the cocoons and even adult moths harbor these hairs which are easily carried by wind currents. On striking the skin, these hairs cause intense itching on exposed parts of the victim's body. They adhere to clothes drying on the line; then they cause severe dermatitis when the clothing is worn. Ingestion of these hairs by swallowing or inhaling can cause serious internal disturbances and injury. Nodular conjuctivitis is caused by hairs that get into eyes.

White-marked tussock moth. This moth has a larva which is considered one of our most beautiful caterpillars. The head and the glands of the sixth and seventh abdominal segments are a bright vermillion. A band on the back is velvety black, bordered with yellow, subdorsal stripes. There is another yellow band on each side just below the spiracles. On each side of the prothorax there is a slender tuft of long, black hairs with plumelike tips. A similar brush is located on the back of the eighth abdominal segment. The first four abdominal segments have dense, brushlike tufts of cream colored or white hairs. This moth is a general feeder on foilage of deciduous trees and shrubs, and is often a serious pest of shade and fruit trees. It is found from Colorado to the Eastern States. The short barbed hairs can cause considerable skin irritation. The nettling hairs are found on all stages of the larvae. They are scattered over the body in the first two instars, while they are localized in the white dorsal tussocks of the first four abdominal segments in the later stages. The hairs are interwoven in the cocoons at the time of pupation.

IO Moth. This moth is widely distributed throughout the Eastern and Central States. The larva is probably the most generally known of the nettling caterpillars in the United States. It feeds on a wide variety of food plants, including willow and even corn. The full-grown larva is about 6.4 centimeters long. It is pale green with sublateral stripes of red and cream (fig. 2-7). Numerous green spines, with a few black ones among them, radiate from tubercles on the body creating a mossy appearance. Some of the long spines have hairs, but the poison spines have peglike tips and are connected with very large venom glands. These spines do not normally break off and drift with the wind as do the spines of some caterpillars. Only the tip breaks in the wound. Direct contact with the larva and its nettling spines is normally required to produce the intense itching caused by the venom.

Figure 2–6. Puss caterpillar *(Megalopyge opercularis).*

Saddle-back caterpillar. This caterpillar is found throughout the Central, Eastern, and Southern States where it feeds on a wide variety of forest and fruit trees. However, it is not normally numerous in any location. It has a purplish-brown spot surrounded by a large green patch on the back giving the appearance of a dark saddle on a green saddle blanket (fig. 2-8). It has tufts of bristling stout spines with acutely pointed tips. The spines are connected with poison glands. The spine tips break off in the skin; and the venom is forced into the wound. The poison affects some people severely, causing extreme pain.

Exercises (C36):

1. Match the arthropods listed in column B to their appropriate description in column A. Column B items may be used more than once.

Column A

_____ (1) Generally feeds on foliage of deciduous trees.
_____ (2) Purplish-brown spot surrounded by large green patch.
_____ (3) Carnivorous insect and is generally predaceous to other insects.
_____ (4) More cylindrical than flat.
_____ (5) Flattened dorsoventrally.
_____ (6) Poison spines have peg-like tips connected with very large venom gland.
_____ (7) Spines are connected to poison gland.
_____ (8) Youths resemble adults.
_____ (9) Has cone-shaped head with three-jointed proboscis that is carried in a folded position close to the body.
_____ (10) Two pairs of legs on each body segment.
_____ (11) Serious pest of fruit and shade trees in the Northeastern States.

Column B

a. Centipede.
b. Millipede.
c. Conenose.
d. Puss caterpillar.
e. Brown-tail moth.
f. White-marked tussock.
g. IO moth.
h. Saddle-back caterpillar.

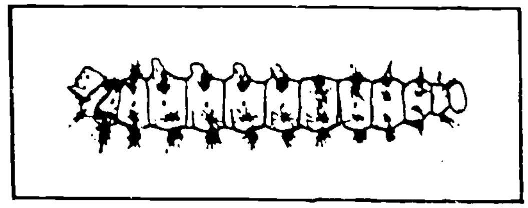

Figure 2–7. IO Moth caterpillar *(Automeris io).*

Column A *Column B*

_____ (12) Under long hairs are numerous short spines connected to underlying hypodermal glands.
_____ (13) Pale green with sublateral strips of red and cream.
_____ (14) The head is light brown; the body is brown to almost black.
_____ (15) Head and glands of the sixth and seventh abdominal segment are bright vermillion.
_____ (16) Thick, fleshy body completely covered and hidden by long hairs of tawny-to-grayish color.

C37. Identify control measures for miscellaneous venomous arthropods.

Controlling Miscellaneous Venomous Arthropods. This lesson outlines measures you can use to control centipedes, millipedes, conenoses, and venomous caterpillars and moths.

Controlling centipedes and millipedes. About the only preventive measures recommended for avoiding these insects' bites are proper screening to keep them out of buildings and caution while disposing of them. Troops on duty in areas where large centipedes are prevalent should be advised not to touch them or attempt to catch them. Fortunately, large centipedes are seldom, if ever, so numerous as to necessitate special control measures. Properly fitting doors and good screening should keep centipedes and millipedes out of living quarters. Troops in

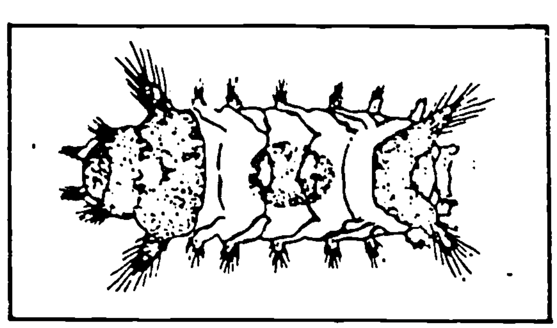

Figure 2–8. Saddleback caterpillar *(sibine stimulea).*

the field should use caution in putting on boots and other clothing which may have been on the ground overnight. Presence of centipedes and millipedes in tents in tropical areas is a good reason for sleeping in a properly "tucked-in" bed net. Contact sprays will kill centipedes and millipedes. Residual sprays are moderately effective.

Controlling conenoses. Since conenoses fly readily and are attracted to lights, it is imperative that buildings are properly screened. Doors and windows should fit snugly in their frames.

If a conenose happens to get on you and you are aware of it, brush it off gently and swiftly to prevent being bitten.

Where conenoses are abundant, you can apply residuals around doorways, window frames, and around lighting. Be sure to use an insecticide recommended for this type of treatment and apply it according to label instructions.

Controlling caterpillars and moths. Control measures for these venomous arthropods are the same as those used to control ornamental and turf pests which were discussed in Volume 5. When you use chemical control measures for those caterpillars that easily shed their nettling spines, you should try to kill them in the shortest possible time. Slowly dying caterpillars move contortedly and will shed many hairs and spines before they die.

Exercises (C37):

1. Proper screening is an effective deterrent to infestations of what pests?

2. Which pest seldom requires special control measures since they are rarely numerous.

3. Where should residual insecticides be applied to control conenoses?

4. Caterpillar and moth controls are the same as for what other pests?

5. For caterpillars that easily shed their nettling spines, why should you try to kill them in the shortest possible time?

2-8. Snakes

In this section, you will learn about the identifying characteristics of poisonous snakes within the United States. This section will also give you information about snake habits, habitats, and bite symptoms, as well as the first aid treatment for snakebites.

C38. Identify general facts regarding snakes.

Facts About Snakes. Snakes are important in maintaining the balance of nature. They control destructive animals, such as field mice and other rodents. They have aesthetic value or beauty in themselves, just as birds do, and they are a very interesting group. Many have commercial value, the skins of which are used in making leather goods.

Snakes belonging to the families Crotalidae and Elapidae are poisonous; however, fatalities resulting from snake bites in the Unites States have never been high, considering the size of the country and its large population.

Fear of snakes is due to a lack of knowledge concerning the identification of poisonous snakes and some of the fallacies (not facts) that have been passed down through generations. The following are some of the common fallacies and facts about snakes:

a. Snakes are slimy. This is not true. Snakes are actually cleaner than we are. They have hard, glossy shields and scales covering their bodies. For this reason, they appear slimy.

b. The forked tongue of some snakes is poisonous. No, the tongue is a harmless organ which is not poisonous (in even the poisonous species) and is a highly sensitive organ of taste and smell. It also detects vibrations.

c. The tails of some snakes sting or have poisonous properties. Some snakes such as the "horn snake" (the correct name of which is the mud snake) have hard, scaley, and pointed tails which they will deliberately press against your hand when you restrain them but their tails are *not* poisonous.

d. Some kinds of snakes commonly attack people. There have been two recorded instances of snakes having made unprovoked, offensive movements toward people. One was a black snake with her young and the other was an eastern diamondback rattlesnake with her young. Both snakes were in an enclosed area. Snakes are also prone to bite if they are disturbed when shedding skin and during the breeding period.

e. The glass snake is a snake. It is not a snake but a lizard with a tail twice as long as its body. The tail will grow back if it's broken off.

f. Snakes can charm birds. No, the bird is either frozen with fear or it's pretending it is hurt to draw the snake away from its young.

g. A snake will not cross a horsehair rope. A horsehair rope does not stop a snake.

h. Snakes take milk from a cow. Snakes will drink milk from a saucer but not from the cow.

i. The hoop snake will chase a person by holding its tail in its mouth and rolling over and over. This fallacy is also commonly attached to mud snakes and is physically impossible. Snakes have a backbone just as people do.

j. The spreading adder or blow snake (correctly called the hog-nosed snake) exhales a poisonous vapor when approached or offended. These snakes do inflate their lungs and hiss loudly when disturbed, but there is no poisonous vapor emitted. These snakes are so harmless that if the hissing sounds and flattened head do not succeed in scaring the attacker, the snake will roll over on its back, open its mouth wide, and play dead. It is also very hard to enrage or excite this snake enough to make it bite.

k. Snakes can't bite under water. Water moccasins eat fish, so how do they catch them? They bite them and inject poison.

Exercises (C38):

Identify each statement as true or false. Correct any false statements.

____ 1. Snakes help in maintaining the balance of nature.

____ 2. Poisonous snakes belong to the families Crotalidae and Elapidae.

____ 3. Fatalities from snakebites in the United States are relatively high.

____ 4. Snakes are not slimy.

____ 5. Snakes can't bite under water.

____ 6. The spreading adder exhales a poisonous vapor.

____ 7. People fear snakes because snakes often will deliberately make unprovoked offensive attacks on man.

C39. Identify characteristics of snakes in the family Crotalidae.

Family Crotalidae. The poisonous snakes of the United States belong to two families: Crotalidae and Elapidae. The family Crotalidae, (long-fanged pit vipers) includes the bushmaster and fer-de-lance of South America and the copperhead, water moccasin, and rattlesnake in North America. Pit vipers strike their prey from a lateral loop and inject a large amount of toxic venom, which almost immediately overwhelms the victim. When the prey dies, or is almost dead, the snake swallows it. Refer to foldout 1 in the back of this volume as you study the physical characteristics of snakes in this and the following lesson.

Pit vipers are so named because of the facial pit between the eye and nostril on either side of the head. This pit is lined with a delicate epidermis and connects with a well-developed nerve which extends to the brain. Because of the presence of this nerve, it is believed that the pit is sensory in nature, being receptive to heat waves and thus directing the strike. The pupil of the eye is vertically elliptical, and the head is flat and triangular shaped, having poison glands and retractable fangs rigidly attached at their base to movable maxillary bones.

Water moccasin. This is a stout and heavy-bodied snake with an abruptly tapering tail and a chunky, ugly head. The average length is 3 to 4 feet, but some specimens have been found which were 5 feet long. The body color is dark brown or olive with 10 to 15 wide, black, transverse blotches (barely showing, or not at all, on the back of old snakes), more sharply defined on the sides of the body than on the back. The upper and lower lip plates are yellow and the inside of the mouth is white; hence, they are commonly called *gappers* or cottonmouths (but you should *never* get so close as to be able to identify it on this basis). The abdomen is yellow and is blotched with dark brown or black. The young resemble copperheads because they have a pinkish or reddish brown coloration on the body with a coppery-looking head. There is a broad, dark band through the eye.

Distribution. Moccasins are found from the swamps of Virginia through Florida, along the Gulf States to East Texas. The range northward extends through eastern Oklahoma, Arkansas, Mississippi, southern Illinois, Indiana, and Tennessee.

Habitat. They are semiaquatic, found along sluggish streams, bayous, lagoons, and swamps and other bodies of water with thick, marginal vegetation.

Food. They feed on frogs, fish, other snakes, birds, small mammals, lizards, small turtles, baby alligators, and salamanders.

Breeding. This usually takes place in March, and 7 to 12 young are born alive in August or September. The pit vipers all produce living young (viviparous). The young are more brillantly marked than the adults and, as we have mentioned, are frequently confused with copperheads.

Habits. Moccasins are sluggish and irritable in the wild state. A thoroughly aroused cottonmouth throws its head upward and backward and holds its open mouth, wide revealing the white interior. These dangerous snakes closely resemble several of the nonpoisonous water snakes and it's difficult to distinguish among them in the field. Behavior offers some of the best clues. Water snakes usually flee quickly or drop with a splash into the water, but cottonmouths often stand their ground with a vibrating tail or, if you're lucky, will crawl slowly away. In the fall, moccasins retreat to higher ground to hibernate and thus are not necessarily found in the immediate vicinity of water.

Copperheads. These are richly colored, heavybodied snakes with 15 to 25 chestnut-brown crossbands on the hazel or pinkish-brown body. These crossbands are constricted on the midline of the snake's body so that they appear as hourglasses from the top and as inverted Y's from the side. The average length of copperheads is about 3 feet. The uniform, coppery tinge of the head has given this snake its most popular name. The abdomen is pale pinkish brown, with a row of dark spots on each side (ventral view). The copperhead is also known in some parts of the country as a rattlesnake pilot, pilot, or chunk head.

Distribution. Copperheads are found in central Massachusetts and through all of the Eastern States to northern Florida, along the Gulf States to Texas, thence northward through Arkansas, Oklahoma, Kansas, Missouri, Illinois, Indiana, Ohio, Pennsylvania, and New York.

Habitat. These snakes are *arboreal* tree and bush dwellers) as well as terrestrial, frequently climbing vegetation in search of food. They are found in rocky or wooded areas such as the mountainous and ledgy regions of the North and inhabit the damper deciduous woods and low-lying stretches of cypress growth of the South. They live together in small numbers throughout the year. They are commonly found in deserted quarries in the North, where they hibernate in the rocks with their close relatives, the branded rattlesnakes.

Food. This snake has a highly variable diet, feeding on small mammals and birds, other snakes, frogs, and insects such as caterpillars and cicadas. The food preferences seems to be seasonal.

Breeding. Mating takes place in April or May and 6 to 12 brilliantly colored young are born alive in August or September. The young have sulphur-yellow tails.

Habits. As in the case of other pit vipers, copperheads coil and rapidly vibrate their tails when disturbed. Their coloration is highly protective, especially when these reptiles are motionless against a background of autumn-colored leaves. As a general rule, they are less irritable than the water moccasin and will seek cover swiftly when disturbed, except when they are cornered. Old stone walls and natural, ledgy terrain should be approached with caution because they are common resting places for this snake.

Rattlesnakes. These are the most interesting and important reptiles, inhabiting North America, because at least one species is found in every state except Alaska and Hawaii. Rattlesnakes are so named because they have horny interlocking joints at the end of the tail that make a sharp rattling sound when shaken. Some species attain such a large size that they rank high in terms of deadliness among the venomous snakes of the world. They are highly variable, ranging from 18 inches in the case of the pygmy rattlesnake *(Sistrurus miliarius)* to 8 feet for the eastern diamondback rattlesnake *(Crotalus miliarius)*. The same species may vary in color. There is great color variation in both yellow and black phases of the banded or timber rattlesnake. The massasauga *(Sistrurus catenatus)* is partial to bogs and swamps, while the horned rattlesnake, or sidewinder, thrives in dry desert areas. Rattlesnakes have been found in every State except Alaska and Hawaii, but their headquarters (according to number of species) is the Southwest. Except for the Southwest, there are few areas where more than one or two species occur. The borders of the ranges of the different species may extend slightly into that of another. Because of the highly diversified habits and characteristics of this group of snakes, we will consider only the eastern diamondback rattlesnake, the largest and most deadly poisonous reptile found in the United States. It ranks among the world's most deadly snakes.

Distribution. The eastern diamondback is found from Florida, in many of the adjacent Keys, northward through the costal plains to southern North Carolina and westward along the Gulf States to extreme southeastern Louisiana.

Description. It is a stout-bodied olive to dark brown snake with a bold pattern of large black or brown diamonds down its back. These diamonds have bright yellow borders, about the width of a single scale, which become obscure toward the tail. Beneath the eye is a dark band, bordered on each side with a narrow band of bright yellow. The abdomen is dull yellow. With the exception of a more vivid pattern, young specimens are like the parent. They commonly grow to 6 feet but may attain a length close to 9 feet and weigh 12 to 15 pounds or more.

Habitat. This snake inhabits the wild brush country of the Southern lowlands, where pines and palmettos flourish. These snakes have been commonly observed hiding under the broad leaves of the dwarf palmettos during the day and leaving them at twilight to feed. So closely do the body colors blend with the vegetation and the effects of sunlight and shadow, that these snakes are seen with some difficulty.

Food. These huge snakes feed largely on rabbits and quail, principally the former. They wander into areas of dwarf and scrub palmettos in search of their prey. Hunters and other persons who have occasion to enter such diamondback-infested areas should take the necessary precautions to keep from being bitten. A description of the poisonous potentiality of this reptile is shown in the following example. The maneuvers of the average specimen when feeding in captivity are interesting. A medium-sized rabbit is placed in the cage, and the snake shifts its coils to a striking posture. The rabbit shows no sign of fear and may hop toward the reptile, which draws back its head. While nosing about, the rabbit momentarily presents its side to the snake and like a flash the deed is done. The human eye can observe but two things; first, the snake appeared to strike at the rabbit, and secondly, to have barely touched it with its jaws..The snake is back in the original position before the rabbit's frightened squeal is over. The little creature bounds forward, rolls on its side, kicks convulsively, and is dead. Barely 1 minute passes from the time of the serpent's strike to the rabbit's death.

Breeding. An average of 9 or 10 living young are born in August or September. They are about 14 inches long.

Habits. This snake is chiefly terrestrial in its habits, as are all of the *Crotalus* species, but it is also somewhat arboreal, seen occasionally in low, scrubby bushes. It is also aquatic because it takes to the water, even crossing salt water among the nearby Florida Keys. It may even be seen a few miles out at sea, swept there by the outgoing tides. The pygmy rattlesnake and the massasaugas differ from other *Crotalus* species in that they are smaller in size and thus have proportionately smaller rattles. They have nine large symmetrical shields or plates on top of the head similar to the other pit vipers (copperheads and water moccasins), and they inhabit a damper habitat. The poison of some pygmy rattlers is acutally more toxic, drop for drop, than venom of the larger species.

Exercises (C39):

1. Match each type of snake in column B to its description statement in column A. Column B items may be used more than once.

	Column A	*Column B*
____ (1)	At least one species is found in every State except Alaska and Hawaii.	a. Water moccasin.
____ (2)	The inside of the mouth is white.	b. Copperhead.
____ (3)	Crossbands on the body appear as hourglasses from the top and as inverted Y's from the side.	c. Rattlesnake.
____ (4)	They are sluggish and irritable; will drop quickly into water; and retreat to high ground in the fall.	
____ (5)	Have horny interlocking joints at the end of the tail.	
____ (6)	The largest and most deadly poisonous reptile found in the U.S.	
____ (7)	Found from the swamps of Virginia through Florida, along the Gulf States to Texas, extends through eastern Oklahoma, Arkansas, Mississippi, southern Illinois, Indiana, and Tennessee.	
____ (8)	Feeds on frogs, fish, other snakes, birds, small turtles, baby alligators, and salamanders.	
____ (9)	Mates in April or May; gives birth to from 6 to 12 brilliantly colored young with sulphur-yellow tails.	
____ (10)	Feeds on small mammals, birds, other snakes, frogs, and insects.	

C40. Identify characteristics of the Elapidae snake family.

Family Elapidae. With the exception of the coral snakes. this family inhabits chiefly Asia, Africa, and the Malay Archipelago. Two of its more formidable family members are the black mamba of Africa, the males of which actually go out of their way to attack humans during the breeding season, and the king cobra, which has caused as many as 20,000 deaths yearly in India.

The Elapidae family contains two species of coral snakes found in this country *Micrurus* and *Micruroides)* which differ from many of their family relatives by lacking the "hood" apparatus which the cobra has. The coral snake grasps its prey by the neck or body and rapidly chews the poison in; considerable venom is injected and the prey is thus weakened for the swallowing process. The coral snake holds on and the fangs are worked along the body until the prey is shifted into a position from which it may be swallowed head first.

Description. These snakes are smooth, shiny, and cylindrical. The body is ringed with bands of red and black with more narrow bands of yellow. The snout is black with the black rings bordered with yellow and the colors red and yellow touching. The venom-conducting apparatus consists of short, stout, always erect, and immovable fangs on the forward part of the upper jaw. The pupil of the eye is round and the head is the same size as the neck.

Distribution. *Micrurus* is found from North Carolina south through Florida, westward to Texas, and northward up the Mississippi to Indiana. *Micruroides* is found in Arizona and New Mexico.

Habitat. These snakes, which average 2 to 2½ feet in length, are secretive and sometimes burrowing, found commonly under the bark of decaying logs. They spend most of their lives in such places but frequently come out after heavy rains in search of food.

Food. These snakes feed mainly on small snakes and lizards.

Breeding. In contrast to the pit vipers, they are oviparous, laying up to seven elongate eggs in decaying bark or damp soil. Little else is known about their breeding habits.

Habits. They are seldom encountered because of their secretive habits, but they are sometimes handled by children and other people (through ignorance of their poisonous properties) because of their attractive coloration and unoffensive nature. They rarely bite but are extremely dangerous. These snakes do not strike, as do the pit vipers, but grab their prey and *chew* the venom in. Their venom is also different from that of the pit vipers. The coral snakes have a neurotoxic venom which attacks the nervous system and the thoracic muscles, especially those of the diaphragm, so that breathing is difficult. In comparison, the poison of pit vipers is hemotoxic and effects the tissue and the red blood cells.

Exercises (C40):

Identify the statements as true or false and correct any false statements.

____ 1. Coral snakes have a hemotoxic venom.

____ 2. The males of the black mamba of Africa go out of their way to attack humans during the breeding season.

____ 3. The cobra and coral snakes are from different families.

____ 4. The king cobra has caused as many as 20,000 deaths yearly in India.

____ 5. Coral snakes have a "hood."

____ 6. Coral snakes are smooth, shiny, and cylindrical.

____ 7. *Micruroides* is found in New York and New Mexico.

____ 8. Coral snakes average 2 to 2½ feet in length.

____ 9. Coral snakes are usually found in open spaces sunning themselves.

____ 10. Coral snakes lay eggs.

C41. List the symptoms and signs of envenomization by pit vipers and coral snakes.

Symptoms and Signs of Snakebite. The following outline of signs (what another person can observe) and symptoms is divided according to the snake family causing the poisoning.

Envenomization by pit vipers.

a. Presence of one or more fang puncture wounds (fig. 2-9).
b. Prompt and progressive swelling.
c. Pain.
d. Ecchymosis (bruiselike discoloration).
e. Nausea and vomiting.
f. Bleeding from the fang punctures.
g. Blister formation.
h. Respiratory and visual difficulties.
i. Shock.
j. Local necrosis (decay of tissue), often severe.

Envenomization by coral snakes:

a. Presence of tooth puncture wounds.
b. Blurring of vision.
c. Ptosis (drooping of eyelids), unsteady gait.
d. A feeling of thickened tongue and throat, slurring of speech, and tingling sensations.
e. Soft tissue swelling at the puncture point.
f. Drowsiness, lassitude.
g. Nausea and vomiting.
h. Excessive salivation and sweating.
i. Burning pain at the site of injury (pain and swelling occasionally may be absent in the presence of envenomization by certain elapids).

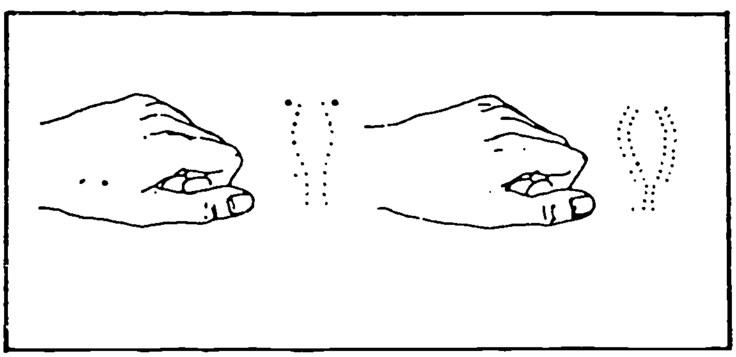

Figure 2–9. Snakebites.

Exercises (C41):

1. List the symptoms of pit viper envenomization.

2. List the signs of coral snake evenomization.

C42. Specify correct statements regarding snakebite treatment.

Treating a Snakebite. In the course of your work, you may be required to enter snake-infested areas. Never enter such an area alone. Follow the approved practice of proceeding in groups of at least two or three individuals. If you or one of your coworkers is bitten in spite of precautions, you should seek professional medical attention at once.

If you can get professional medical treatment within an hour after the time of the bite, you should disregard extensive first aid. Keep calm and proceed for treatment.

In the event that you are snakebitten and first aid is required, there are six rules you should bear in mind:

(1) *Keep calm*. Excitement stimulates the flow of blood and shortens the length of time required for the venom to reach vital organs.

(2) *Identify the snake, if possible*. Its identity is necessary before specific antivenin treatment can be given. If you are the victim, don't spend more than a few minutes at this activity and don't move more than a few feet away. Remember, DO NOT stimulate blood flow unnecessarily. If you are able to kill the snake immediately, check for fangs in the snake. Also, check for fang marks at the site of the bite (fig. 2-9). If the snake is poisonous, swelling occurs rapidly. The skin becomes a dark purple and ordinarily two puncture points, made by the fangs, are seen clearly, as shown on the left in figure 2-9. Sometimes only one puncture mark appears. Scratches accompany the puncture wounds. Nonpoisonous snakebites, shown on the right in figure 2-9 appear only as scratches.

(3) *Immobilize the bitten part* in a position below the level of the heart.

(4) *Apply a constricting tourniquet*. Put it 2 to 4 inches closer to the heart than the site of the bite. Reapply the band ahead of the swelling if it progresses up the arm or the leg. If you positively identify the snake as a viper (rattler, moccasin, or copperhead), apply the tourniquet tight enough to stop blood flow in the veins. Be sure you have a

pulse below the tourniquet. Release the tourniquet 1 minute every 30 minutes.

(5) If you are giving first aid to another person whose breathing fails, *administer mouth-to-mouth or mouth-to-nose artificial respiration*. Obtain assistance from the nearest medical source at the earliest possible moment.

(6) Make incisions and begin suction as soon as possible. You should take this step preferably within 10 minutes but not after 1 hour following the bite. You should perform this procedure only when the snake is identified as poisonous or when swelling, pain, and other symptoms, as listed previously, have developed and you cannot reach the services of a doctor within an hour. Here are the general rules for incision and suction treatment:

(a) Sterilize a sharp instrument.

(b) Make the cuts through the fang marks parallel to the long axis of the limb and deep enough to allow free bleeding. Cuts should be about 1/4 inch deep and 1/4 inch long. Do not make crosscut incisions. The incision must penetrate the skin but not enter muscles or underlying structures (tendon, blood vessels, or nerves). (NOTE: You should never make incisions on fingers, hands, wrists, toes, feet, or ankles unless it is extremely necessary or the part is so swollen that such incisions cannot damage underlying structures.)

(c) Perform suction with suction cups or by mouth, spitting frequently, and continue for at least 30 minutes. (Snake poison is harmless in the mouth unless there is a cut there.) If you are the victim, you can do this yourself if you can reach the fang marks with your mouth.

(d) Get medical help as soon as possible.

Exercises (C42):

Identify the statements as correct or incorrect; correct those that are incorrect.

____ 1. Never enter snake-infested areas alone.

____ 2. Pest management personnel may administer antivenin.

____ 3. When treating for snakebite, institute incision and suction within 10 minutes but not after 2 hours.

____ 4. Snake poison is harmless to the mouth which has no cuts.

____ 5. Nonmedical personnel should never make incisions on fingers, hands, wrists, toes, feet, or ankles unless the part is highly swollen.

____ 6. The best rules to follow when a worker is bitten by a snake are to help the victim keep calm, identify the snake, and get medical help as soon as possible.

C43. Identify measures to control snakes.

Snake Control Measures. There are two main types of measures designed to control snakes—site sanitation and avoidance.

Site sanitation. Removing brush and woodpiles, keeping vegetation cut short, and trimming vines and brushes will eliminate harborage areas and will discourage snakes because this eliminates rodents from the area which are the main food source of snakes. An effective rodent control program will aid immeasurably in controlling snakes.

Avoidance. The best personal protection against snakes is to avoid their natural habitats. If you must enter these areas, wear hip boots and make sufficient noise so that the snakes can get out of your way or at least warn you. Do not sit on logs or rocks until after you have made a thorough inspection.

You will probably be required to answer calls concerning the presence of snakes in or under various base facilities. In this event, you should wear hip boots and have a bright, reliable flashlight and a good set of snake tongs because you must inspect every area possible within the facility, including the attic and under the flooring, providing the facility is designed in this manner.

Exercises (C43):

1. An effective ______________control program will aid immeasurably in controlling snakes.

2. What is the best personal protection against snakes?

3. When looking for snakes under buildings, you should wear__ ______________ _____ __________ and have a bright, reliable ____________________.

Vegetative Pests

WEEDS ARE "plants out of place." For example: a farmer who raises wheat takes pride in a good stand. Yet, the farmer's wife will quickly extract the same plant from her zinnia bed.

On an Air Force base, there are areas where plants are desirable, including lawns, golf courses, road embankments, railroad right-of-ways, and runway shoulders. In these areas we control the weeds.

There are also areas where any vegetation is undesirable. Some of these areas are around fuel, oil, and paint storage areas; certain buildings and shops; under fences; and along roads and railroads. Some vegetation control along drainage and irrigation ditches is also required.

This chapter covers the growth habits and propagation of plants and describes important aquatic, woody, grassy, and herbacious broadleaf plants and their control.

3-1. Weed Growth and Propagation

This section briefly covers the growth habits and propagation of plants in general to give you a basis for further discussion of aquatic and other types of plants and their control.

C44. Identify growth characteristics that enable weeds to exist.

Growth Characteristics. The most important growth characteristic of weeds is their ability to thrive in cultivated land. Some features that contribute to the successful growth of unwanted plants and their ability to persist in spite of human efforts to the contrary are:

- Underground roots or stems.
- Abundant seed production.
- Rapid growth.
- Competitive ability.
- Unpalatability to livestock.

Underground roots or stems. Unwanted plants with underground roots or stems will persist from year to year even though seed production is prevented. The underground parts of some plants will spread in all directions, sending up aerial stem buds at intervals. These plants are spread and actually favored by cultivation, since cultivation spreads small pieces of roots over other areas.

Abundant seed production. Many plants produce thousands of seeds, and some of these seeds can live in the soil from 10 to 50 years.

Rapid growth. Some plants can grow to maturity and set seed in only 1 or 2 months. For this reason, seeds are often formed before we can take adequate control measures.

Competitive ability. Some weeds can overtake and retard desirable plants even though the latter have a headstart. For this reason, they often win out over other plants for light. In addition, some weeds have needs for mineral nutrients and water that exceed those of desirable plants.

Unpalatability to livestock. Frequently, pasture weeds are distasteful or poisonous to animals. Often they are protected by spines or similar structures. For these reasons, they are free to reproduce and spread unimpeded to new areas.

Exercises (C44):

1. What is the most important growth characteristic of weeds?

2. List other growth characteristics of weeds and explain briefly why they enable weeds to persist.

C45. Associate certain plants with statements regarding their propagation and identification.

Annuals. Annuals are plants that mature in one season. They are propagated only by seeds. Foxtail, crabgrass, ragweed, wild buckwheat, and several mustards are examples.

Foxtail. The foxtails are grasses of roadsides and waste places. They are striking plants because of their dense, cylindrical, spikelike inflorescences (flowers). The yellow foxtail is shown in figure 3-1. This plant is distinguished by the tawny color of the spikes.

Crabgrass. An example of crabgrass is shown in figure 3-2. Crabgrass is an annual plant that flourishes midsummer to fall. It is highly branched with the stem prostrate and rooting. The inflorescence is a terminal cluster of spikes. The seeds are slightly hairy.

Figure 3–1. Yellow foxtail.

Ragweed. You have probably come in contact with ragweed sometime during your life. Ragweed is one of the plants that gives hayfever sufferers much trouble. You can see this plant in figure 3-3. This is an annual weed of rural and urban waste areas. The plant is erect and branched and, depending upon the species, may be from 1½ to 3½ feet tall. The leaves are formed of leaf parts arranged featherlike along each side of a leaf stem. They show a great deal of variation from species to species. The yellow flowers are borne on tall spikes.

Wild mustard. This plant, shown in figure 3-4, is an annual weed of waste areas and cultivated ground. It is a low plant with many branches. The four-petaled yellow flowers develop into numerous siliques (capsulations). These contain the smooth, black, globular seeds.

Shepherd's purse. This weed, shown in figure 3-5, is one of the most widely distributed weeds in the world. It can be either an annual or a winter annual (one which germinates in the fall, lives over winter, and matures early the next season) in lawns, gardens, or waste areas. The plant has a basal rosette of deeply toothed leaves, with a few arrow-shaped leaves on the erect stalk. The seed pods or "purses" are also on the stalk. The seed pods form from terminal white flowers, and they contain numerous yellowish seeds.

Biennials. Biennials require two seasons to complete the reproduction cycle. Their growth period is longer than that of winter annuals. Since they are propagated by seed only, seedlings can be treated as the seedlings of annuals.

Common mullein, shown in figure 3-6, is also known as Jacob's staff, torch plant, and flannel leaf. Common mullein is a biennial, and it produces its rosette of velvety basal leaves in the first year. In the second year, it sends up its stalk on which is borne a terminal spike of yellow flowers. Burdock, evening-primrose, common mullein, and yellow goatsbeard are biennials.

Perennials. Perennials are plants that live more than 2 years. Many have several means of perpetuation. They are provided with storage organs in the form of stolons (above-ground stems), rhizomes (underground stems), bulbs, crowns, and roots. The perennial weeds with creeping roots or stems are the most noxious. Supplies of food are laid up in these organs by the plant to feed a new growth the next year. The new shoot comes from a bud and lives on stored food until it becomes established. Unlike the annual plant, the top growth of a perennial may be killed and still the plant can live and propagate itself because of its storage organs. To control perennial vegetation, the food reserves must be materially reduced or the storage organs destroyed.

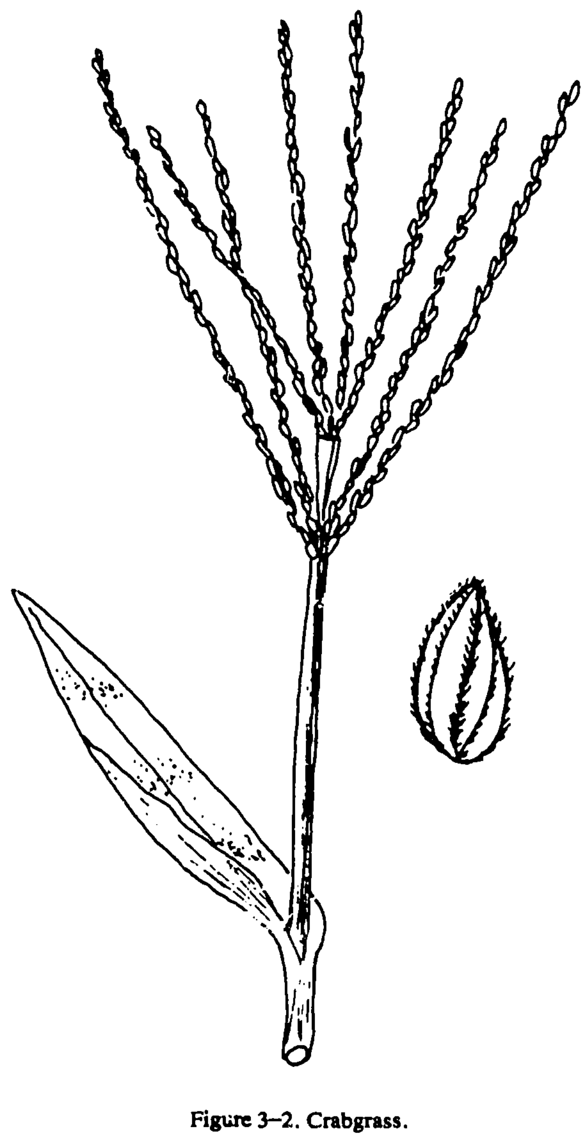

Figure 3–2. Crabgrass.

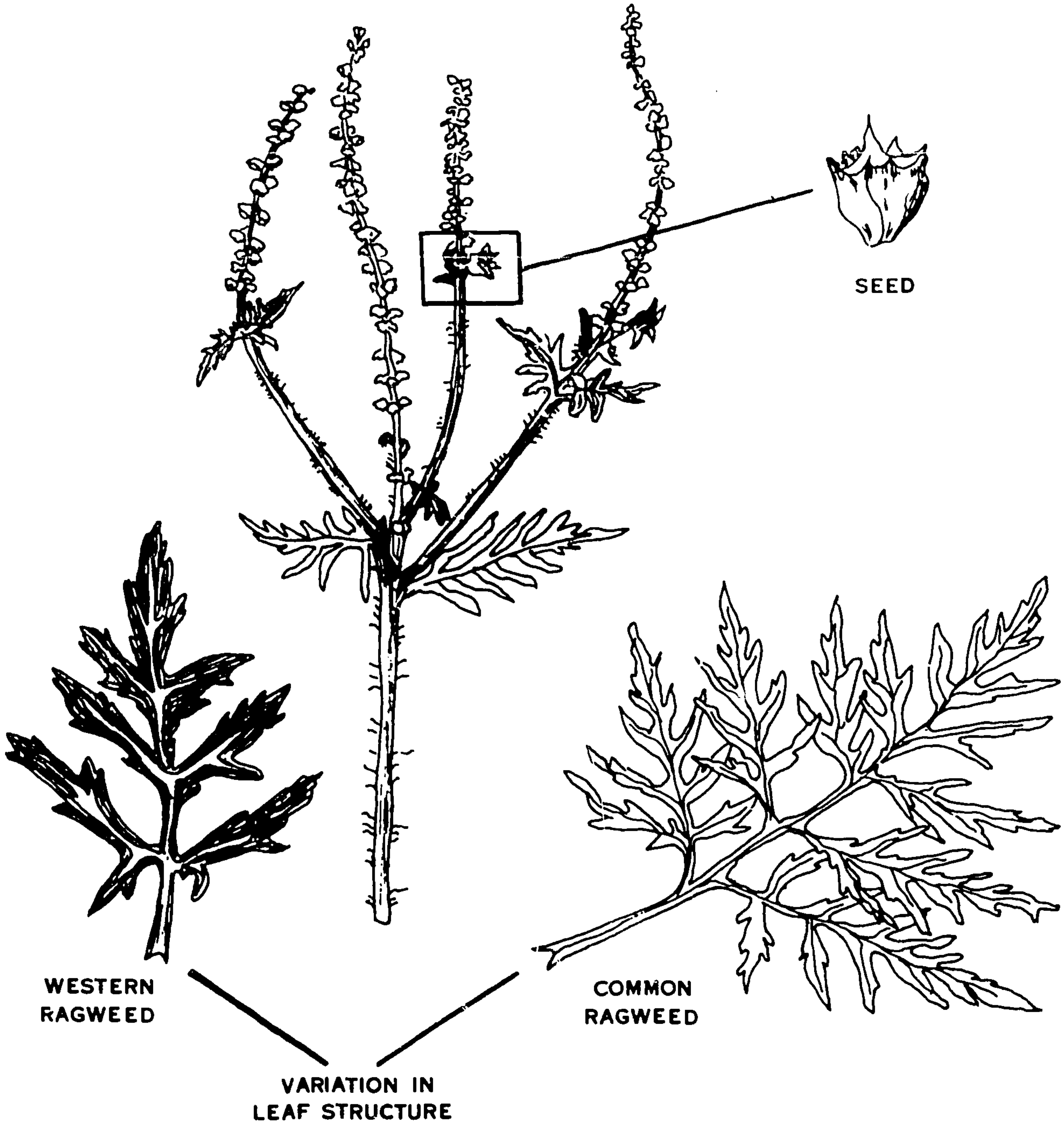

Figure 3–3. Ragweed.

Figure 3–4. Wild mustard.

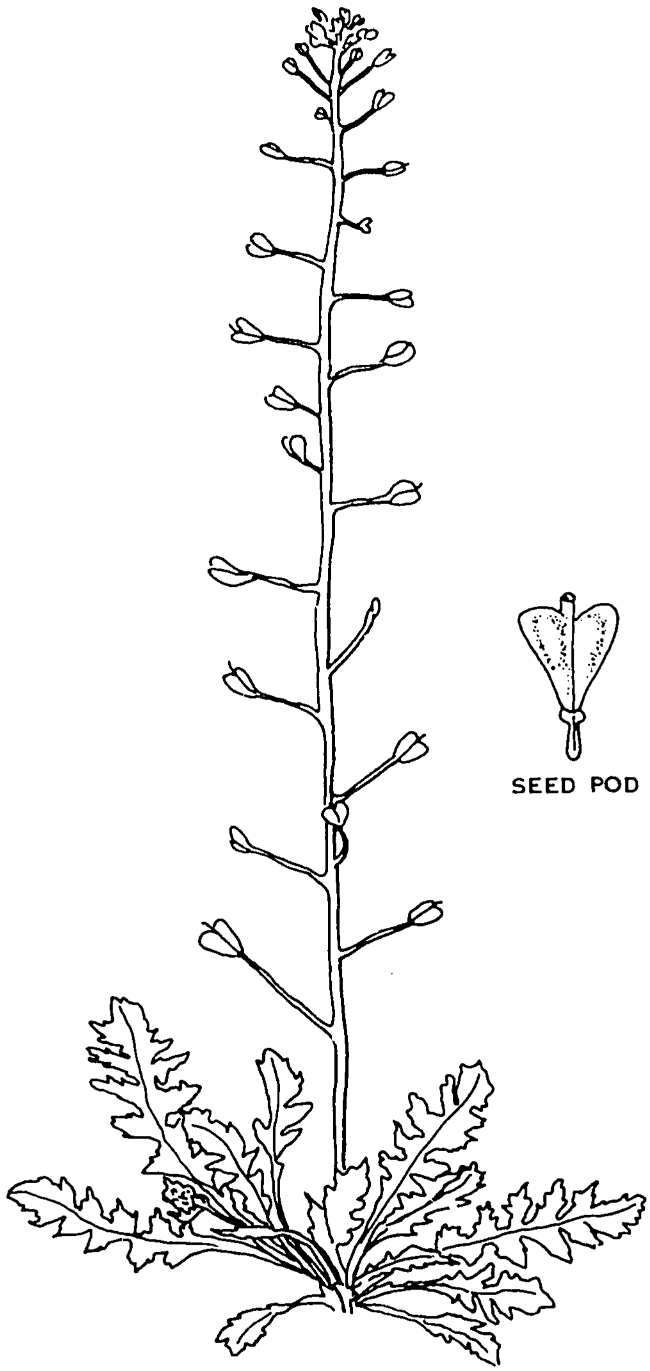

Figure 3–5. Shepherd's purse.

The food stored by the plant is the excess manufactured by the green leaves and stems over and above what is necessary for growth; therefore, if photosynthesis can be prevented, the buildup of reserves will be curbed. For control of perennials, the new growth is allowed to draw on food reserves until it becomes sufficiently established to manufacture its own food and then the top growth is killed. Quackgrass, Canada thistle, Johnson grass, buttercup, and nutgrass are perennials.

Canada thistle. This plant is possibly the most noxious perennial weed in the United States. It grows up to 1 yard high, with grooved, hairy stems and irregularly lobed or toothed leaves. The root system is deep, wide, and spreading. The plant blooms in late spring and summer, depending upon location, and produces small lavender flower heads. Figure 3-7 illustrates the Canada thistle.

Johnson grass. Another weed. Johnson grass, shown in figure 3-8, is a perennial weed posing a big problem in the Southern States. It is 3 to 6 feet tall and has wide leaves with a thickened, light-colored midvein. The panicle (flower cluster) is loose and turns reddish at maturity.

Buttercup. This weed is most commonly found in shady, moist areas such as pastures, woodlands, and ditches. Notice in figure 3-9 that the stems are slender and branched from the base. The lower leaves are round, on long petioles, and the upper leaves are often divided into leaflets. The flowers are small and yellow.

Yellow nutgrass. This weed, shown in figure 3-10, is a perennial weed infesting lawns. Its name comes from the nutlike tubers found on the roots of the mature plants. The stem is a yellow-green color and triangular in cross section. When you look down on the plant, the leaves appear in three ranks, corresponding to the three sides of the stem.

Figure 3–6. Common mullein.

Figure 3–7. Canada thistle.

Exercises (C45):

1. Match the plant types in column B with the statements pertaining to the propagation and identification of plants in column A.

Column A

____ (1) Annual weed of waste areas and cultivated ground, with four pleated yellow flowers containing smooth, black, globular seeds.

____ (2) Possibly the most noxious perennial weed in the United States. grows up to 1 yard high, with grooved, hairy stems and irregularly lobed or toothed leaves.

____ (3) The stem is yellow-green and triangular in cross section.

____ (4) Most commonly found in shady moist areas, such as pastures, woodlands, and ditches.

____ (5) Gives hayfever sufferers much trouble.

____ (6) One of the most widely distributed weeds in the world. The seed pods form from terminal white flowers and contain numerous yellowish seeds.

____ (7) Also known as Jacob's staff, torch plant, and flannel leaf.

____ (8) Highly branched with the stem prostrate and rooting. The inflorescence is a terminal cluster of spikes; the seeds are slightly hairy.

____ (9) Grasses of roadsides and waste places. They are striking plants due t[illegible] dense, cyli[illegible] spikelike infloresce[illegible]

____ (10) Three to 6 feet tall, and has wide leaves with a thickened, light-colored midvein.

Column B

a. Shepherd's purse.
b. Canada thistle.
c. Yellow nutgrass.
d. Foxtails.
e. Wild mustard.
f. Common mullein.
g. Buttercup.
h. Crabgrass.
i. Johnson grass.
j. Ragweed.

3-2. Surface Plants

There are three main categories of surface plants that you may have to control on your installation. These are woody plants, grasses, and herbaceous broadleaf plants.

C46. Identify characteristics of surface plants.

For the most part, woody plants on Air Force bases have been planted or left alone to aid in base beautification or as wind breaks. In most cases, woody plants are more of a problem in forestry and range management; however, they can be a serious problem along streets, fence rows, ditchbanks, railroads, power lines, and water and sewer distribution systems.

Characteristics of Woody Plants. Woody plants are plants that have thick trunks, relatively sturdy branches, and barklike coverings. Woody plants include trees, shrubs, and vines. Trees are normally regarded as being large woody plants that have a single stem or trunk, for self-support, and several branches. Shrubs have the same characteristics as trees but are generally not more than 10 feet tall. Vines are woody plants that climb or sprawl and do not have a self-supporting trunk.

Woody plants have extensive root systems. Some of these plants have sprawling roots, others have a deep root system, and still others have both types.

Characteristics of Grasses. Even though grasses are quite beneficial to humans, they can become pests when they are in the wrong places. When this occurs, grasses become weeds and must be controlled. To do your job, you must be knowledgeable of the characteristics of grasses.

Grasses are plants that have long, thin, narrow leaves, and they usually grow more outward along the ground than upward. Regardless of whether the long, thin, narrow-leafed plant is tall or spread along the ground, you can recognize it as a grass if it has sheathing at each leaf base. All grasses are monocots (they have only a single cotyledon). The cotyledon is a tiny leaflike structure that emerges from the germinated seed. Grasses have fibrous root systems and tend to be both perennial and annual. Probably one of the best and most easily recognized characteristics of a grass is the parallel venation of the leaves.

Characteristics of Herbaceous Broadleaf Plants. There are some general characteristics that you can use to separate broadleaf and grassy weeds. Most broadleaf plants have relatively wide leaves, comparatively speaking, and the leaves have netlike venation. In broadleaf plants, there are normally clusters of leaves at the ends of branches and growth of the plants extends from growth nodes located at the end of branches. Broadleaf plants are dicots, which means that two leaflike structures (cotyledons) appear immediately after the seed germinates. The root system of herbaceous broadleaf plants is relatively deep and strong. The root system normally consists of a taproot with many small lateral roots extending from it.

Exercises (C46):

Identify the following statements as true (T) or false (F). Correct any false statements.

____ 1. Woody plants are plants that have thick trunks, relatively sturdy branches, and barklike coverings.

____ 2. Woody plants include trees, shrubs, and vines.

____ 3. All woody plants are self-supporting.

____ 4. Shrubs and trees have the same characteristics.

Figure 3–8. Johnson grass.

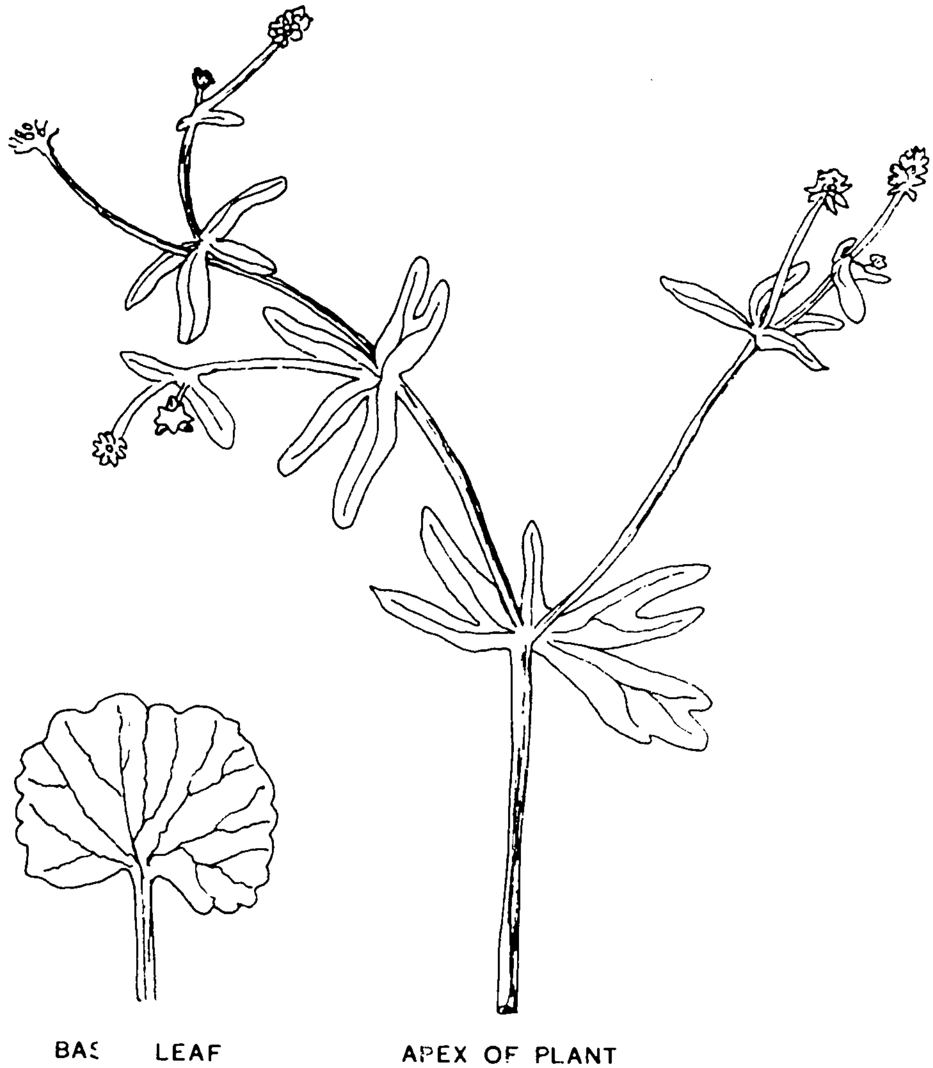

Figure 3–9. Buttercup.

Figure 3–10. Yellow nutgrass.

____ 5. Woody plants have either deep roots or sprawling roots.

____ 6. A plant can be recognized as grass by having sheathing at each leaf base.

____ 7. Grasses have fibrous root systems and tend to be both perennial and annual.

____ 8. Gr... are ...cribed as plants with long, thin, narro... that grow more outward along the ground tha.. upward.

____ 9. Most grasses are polycots.

____ 10. The tiny leaf-like structure that emerges from the germinated seed is called a monocot.

____ 11. The leaves of broadleaf plants can be distinguished from grasses by their netted venation in the leaves.

____ 12. The root systems of herbaceous broadleaf plants are relatively shallow and weak.

3-3. Aquatic Plants

Aquatic plants are becoming a major problem within the United States. Almost everyone becomes concerned with aquatic plants at one time or another because each body of water from roadside ditches to the largest lakes support aquatic vegetation. Controlling these plants is essential in all aspects of water use, including irrigation, drainage, animal consumption, recreation, pollution, and public health.

C47. Identify growth and general characteristics of aquatic plants.

Types, Growth, and Characteristics of Aquatic Plants. As the term implies, aquatic plants are plants that grow in or near water. These same plants become recognized as aquatic weeds when they interfere with the intended use of a water area where they are located.

Aquatic plants are generally classified into three groups: (1) floating, (2) submersed, and (3) emersed.

Floating plants. Floating plants are plants that germinate in the bottom of a body of water at first and, soon after germinating, become separated from the soil and float on the surface of the water. Once they are separated from the soil, they no longer depend upon the soil.

Submersed plants. Submersed plants are aquatic plants that complete their entire life cycle below the water surface. However, some of these plants may have floral parts that extend above the water surface. Most of these plants are rooted, but some, such as algae, are not rooted.

Brazilian elodea, widgeongrass, common bladdewort, vallisneria, coontail, marine naiad, and broadleaf watermilfoil are examples of common rooted submersed aquatic plants.

Emersed plants. Emers... ...lan... ... plants that are firmly rooted to the soil in ...ity to water. During normal growth, these pla... ...end above the water surface.

Spatterdock, fragrant waterlily, American lotus, watershield, pickerelweed, arrowhead, buttonrush, cattail, softstem bulrush, softrush, maidencane, torpedograss, sawgrass, foxtail, and reed are common examples of emersed aquatic plants.

Exercises (C47):

Identity the following statements as being correct (C) or incorrect (I). Explain any incorrect statements.

____ 1. Floating plants germinate at the bottom of a body of water and float to the surface, but are still dependent upon the soil.

____ 2. Submersed plants are aquatic plants that complete their entire life cycle below the surface of the water.

____ 3. Some submersed plants have ...ral parts above the wat... surface.

____ 4. Emersed plants are firmly rooted to the soil in close proximity to water and no part of the plant shows above the surface.

3-4. Controlling Vegetation

In this section we discuss details related to vegetation control. You'll learn about both chemical and nonchemical controls for grasses and herbaceous broadleaf plants, as well as control measures for specific areas you may have to treat on your installation.

C48. Identify important herbicide use precautions.

Precautions for Using Herbicides. There are several actions you must take before you apply herbicides:

(1) Identify the weeds you want to control.

(2) Select the right herbicide to control these weeds without harm to desirable plants nearby.

(3) Read the herbicide label.

(4) Mix the chemical according to mixing directions. Do not use more than recommended amounts.

(5) Plan to apply the materials when and how the directions indicate.

(6) Select the proper equipment.

(7) Study the safety precautions on the label.

Herbicide labels. Labels on the herbicide container are written with great care to state only facts. Recommendations on labels for materials sold interstate must be registered with the Environmental Protection Agency before the label can be authorized. Always read the label. It tells, first, what the herbicide is. For instance, 2,4–D is sold as a sodium or amine salt or a volatile or low-volatile ester. Recommendations differ for various herbicides and for various formulations of the same basic chemical.

The label tells the amount of acid equivalent, phenol equivalent, or active ingredient in the product. This information helps you compare the concentrations in various formulations. The label also makes use recommendations and gives rates and time of application. Certain warnings are stated when necessary to protect you from accidental poisoning or irritation by the chemical and to protect susceptible plants from injury.

Protecting desirable plants. Certain precautions are necessary to prevent damage to nearby beneficial plants. This damage may result from drift, washing, or leaching.

Drift hazards. Remember that drift hazards are greatest when herbicides that affect the leaves of plants are used. These may be of the growth-regulating type or of the contact type. Danger is least when liquid applications are made of nonvolatile herbicides at low pressures. Keep in mind that drift occurs not only with volatile herbicides but also from a high-pressure spray that is atomized into a mist.

Washing. Washing is an important hazard on slopes, bare ground, and pavements. The herbicides may be carried by surface runoff to valuable plants downhill. Do not drain or flush equipment where runoff to desirable plants may occur.

Leaching. Leaching moves chemicals downward through the soil. If they are readily absorbed by roots, plants whose roots extend under the treated area are likely to be injured. Avoid treating such areas with soil sterilants. Do not drain or flush equipment where leaching to the roots of desirable plants may occur.

Protecting game and fish. Most herbicides are less dangerous than insecticides to wildlife. There are a few, however, such as the arsenicals and dinitros, that can poison animals. Most injury results from overdoses and spillage. Indiscriminate spraying and spraying that results in defoliation of vegetation can destroy cover, but herbicides can also be useful in management. Openings in wooded areas, such as the clearing for utility company rights-of-way and spraying hardwoods in stands of pine can be beneficial to wildlife.

A few herbicides are very toxic to fish, but many can be used safely for the control of aquatic weeds. The control of submerged weeds in ponds or streams can be beneficial to fish population. Safe amounts of herbicides, expressed in parts of the chemical per million parts of water, vary widely with the age, size, and species of fish.

Whenever a proposed spraying program might endanger game and fish, consult the Federal or state fish and wildlife service for advice.

Exercises (C48):

Complete the following statements pertaining to precautions to be observed for using herbicides.

1. What precautions must you take before applying herbicides?

2. When are drift hazards greatest and when are they least?

3. When does drift occur?

4. On what areas is washing an important hazard?

5. Leaching moves chemicals ________________ through the soil.

6. Most herbicides are less hazardous than insecticides to ________________.

7. Most injuries to wildlife are the result of __________ and ________________.

C49. Identify herbicide uses and classifications.

Classifications and Uses of Herbicides. Herbicides are grouped on the basis of use into selectives and nonselectives and on the basis of mode of action into contact, translocated, and sterilant chemicals.

Selective. These herbicides kill certain weed species without seriously injuring the desirable plants among the weeds. Those that kill crabgrass or dandelions in a grass sod are examples. Certain herbicides kill broad-leaved weeds and not grasses, or vice versa.

Nonselectives. These herbicides kill vegetation with little discrimination. Certain species, however, are resistant and escape. Resistant species are physiologically resistant to the chemical; some plants that escape are perennials that have part of their root system below treated layers of soil; others are annuals and shallow-rooted perennials that reinfest an area after the chemical has leached below the surface layer.

Contact herbicides. Herbicides in this class kill the tissues that are wetted with the spray. Whether the plant dies or recovers depends on whether it has a protected growing point. Perennials usually have underground buds that will regrow.

Contact herbicides include aromatic solvents and herbicidal oils. The aromatic solvents are also called solvent naphthas or petroleum naphthas. They include a variety of petroleum and coal distillates that can be used in heavy concentrations for aquatic-weed control. Kerosene, especially as sold in the Eastern United States, mineral spirits, tractor distillate, low-grade diesel oil, and similar aliphatic materials do not control submersed weeds. The most effective products are those with flashpoint above 80° F., distillation between 278° F. and 428° F., and an aromatic content of at least 85 percent. These solvents are highly flammable and irritating to the skin, eyes, and respiratory tissues. Livestock tend to avoid drinking treated water. Vegetation is not harmed when irrigated with treated water.

Aromatic solvents are deadly to fish. They are used in irrigation and drainage ditches, especially in short ditches (6 to 8 miles or less) with even sides and bottoms and with flows of 1 to 70 cubic feet per second.

Herbicidal oils are used as vegetation top killers, as solvents in the formulation of herbicides, and as carriers for herbicidal chemicals. Oils that kill by contact should not be used as solvents or carriers of translocated herbicides, since a quick kill of the conducting tissue prevents translocation of the chemical.

Oils vary widely in their composition, value for herbicides, and flammability. Generally, the toxicity to plants is greater with increased content of aromatics. Aside from composition, the value for herbicides is influenced by some physical properties. If the boiling point is low, the oil may evaporate too rapidly; if too high, it does not penetrate plant tissues. The viscosity, or flowing quality, should permit use in cool weather. Specific gravity is important in aquatic-weed control. The flammability is indicated by the flashpoint; the lower the temperature at which an oil-vapor-air mixture ignites, the greater the danger of explosion.

Oil sprays, that wet leaf surfaces and penetrate waxy leaf surfaces more effectively than water sprays, are less easily washed off the plant, and evaporate more slowly under high temperatures. The effect of oils on perennials is temporary. Oils are used for a quick kill of top growth—a chemical substitute for mowing. They penetrate the leaves of nongrass plants but kill grasses by creeping down the stem to the crowns and roots. Repeated treatments are necessary where seasons are long and rainfall is high. The cost depends on distance from source of supply. If relatively nontoxic, large volumes are necessary especially for oil-tolerant species, and aerial applications are impractical. Some of the disadvantages of the oils used alone can be overcome by fortifying them with phenol compounds or using them in conjunction with soil sterilants. The necessary volume can be reduced; the toxicity to tolerant weeds can be increased; a wider range of oils can be used; and the initial kill can be hastened, but the cost is higher.

The fortified oil sprays in low volume are effective on small weeds. When plants, especially grasses, are tall enough to protect their crowns, larger spray volumes are required. Emulsions provide larger volume although they do not increase toxicity to plants. The oil content can be varied 10 percent for easy-to-kill species and up to 25 percent for hard-to-kill species. Frequently, a fortified oil emulsion is more economical than a straight oil emulsion. Oils used as solvents or carriers may or may not be toxic to plants.

The fortified oil emulsions are well suited for killing all vegetation on roadsides, ditchbanks, and similar places and for spot treatments of shallow-rooted perennials. The staining that may result from oils carrying the dinitros when used on sidewalks and driveways is objectionable. Weed oils are preferred for such use and for oil-tolerant weeds.

As a class, oils are insoluble in water; when mixed with water in the presence of a surfactant, they form an emulsion. The fortifying chemical is dissolved in either the water or the oil, or both.

Translocated herbicides. These chemicals are absorbed by the leaves and stems or by the roots, and move through the vascular system to leaves, buds, and root tips. When absorbed by the leaves and stems, the chemical is commonly moved with the food materials that were manufactured in the leaves and stems. When absorbed by the roots, the chemical moves in the water-conducting tissue. The growth-regulator type of translocated herbicide is a synthetic compound that behaves like a plant hormone. It accumulates mostly in areas of rapidly dividing cells upsetting the normal metabolism of the plant and causing death of the cells. Foliar applications of translocated herbicides are of great practical value, because small amounts are effective and they can be applied in small volumes of water.

The foliage-applied nonselectives are used primarily to kill weeds on land later to be cropped; but they also are useful on land where long residuals are not required, where quick kills are needed, and where weeds have survived or escaped control with a soil sterilant. Some of the selectives, like the phenoxy compounds, remove broad-leaved weeds from grass sods; while others, like dalapon, control grasses without severe injury to most broad-leaved plants. These herbicides are used where the killing of vegetation for long periods is undesirable.

Soil sterilants. This herbicide makes a soil incapable of supporting higher plantlife, but it does not necessarily kill all life in the soil, such as fungi, bacteria, and other microorganisms. Its toxic effects may remain for only a short time or for years. Residual toxicity depends on: (1) the chemical and its rate of decomposition or leaching, (2) the colloidal and chemical content of the soil, (3) species tolerance, and (4) rate of application.

Herbicides vary in their rate of disappearance from the soil because of volatility, susceptability to decomposition by soil micro-organisms, and solubility. For example, some of the carbamates are volatile at high temperatures and rapidly lose their toxic effect during the summer months. Certain soil micro-organisms effectively decompose 2,4–D. Amitrole is soluble in water and readily leached.

Some herbicides are readily absorbed by mineral and organic colloids and rendered unavailable or made slowly available for plant absorption. The fertility and pH of a soil are also influencing factors in the persistence or availability of toxic amounts of certain chemicals. For example, monuron and diuron are absorbed on clay colloid particles so that leaching is difficult. Sodium chlorate is more easily absorbed by plants growing in soil low in nitrates.

[illegible] species vary widely in tolerance to soil sterilants, [illegible]ut heavy rates of application generally last longer than light rates.

When present in the soil, sterilants prevent the growth of green plants. These chemicals are used in storage areas, lumberyards, and parking lots; on tennis courts, under pipelines and transformer cages; under guardrails and surrounding signposts on highways and lights on runways; near fire hydrants, trestles, and bridges; on utility rights-of-way; on gravel blanket areas; around buildings, utility poles, and tank farms; along fence rows; for firebreaks; and in similar areas where any plant growth is undesirable. There are two major problems in maintaining bare ground: (1) no herbicide kills all species at reasonable rates of application and (2) reinfestation results from weed seeds in the soil after the herbicide has been leached below the surface. Meet these problems by using a combination of chemicals effective against the weed species to be killed and by repeated applications of the proper herbicide to kill seedlings.

The arsenicals are among the cheapest herbicides, but they must be handled carefully. Two groups of arsenicals used for killing weeds are inorganic and the organic.

The inorganic arsenicals include sodium arsenite, lead arsenate, and calcium arsenate. They are all highly poisonous to humans and other animals if swallowed. Since they are highly persistent in the environment, they are not commercially available.

Th[illegible]cals include disodium methylarsonate [illegible]arsonate. Both compounds are considerably less toxic than the inorganic arsenicals to humans and livestock, but they are harmful if swallowed. Both are applied postemergence for the control of crabgrass in turf.

Exercises (C49):

1. Match the herbicide classifications in column B with the statements pertaining to the uses of herbicides in column A.

Column A	*Column B*
____ (1) Kill certain weed species without seriously injuring the desirable plants among which they are growing.	a. Contact.
____ (2) Kill tissues wetted with the spray.	b. Soil sterilant.
____ (3) Makes soil incapable of supporting higher plant life.	c. Selective.
____ (4) These chemicals are absorbed by the leaves and stems or by the roots, and move through the vascular system to leaves, buds, and root tips.	d. Translocated.
____ (5) These herbicides kill vegetation with little discrimination.	e. Nonselective.

C50. Identify biological and mechanical control measures for grasses and herbaceous broadleaf plants.

Integrated Controls for Grasses and Herbaceous Broadleaf Plants. These plants may be controlled through biological, mechanical, and chemical measures. Although the biological and mechanical controls are generally slower and more expensive than chemical controls, they should be implemented whenever and wherever possible to protect the environment.

Biological control. In order for biological controls to be effective, the predators or parasites introduced must feed only on the weed species you want to control. The predators and parasites you use in the control should not be a food source for other living organisms within the area. In addition, they must be adapted to the surroundings and have the ability to find the host. Biological control is often the only control available for controlling weeds in inaccessible areas.

Biological control of grasses and herbaceous broadleaf weeds includes use of certain insects, arachnids, fowl, grazing animals, and other plants.

Control by insects. The goatweed beetle has been used successfully for controlling the rangeweed *(Hypericum perforatum)* in many areas of California and the Pacific Northwest. The cactus moth is very effective for controlling prickly pear cacti. The flea beetle has shown promise in controlling the Canada thistle in areas of Canada and the Pacific Northw[illegible]

Control by [illegible]vl. Geese are used in many instances to co[illegible]rol you[illegible] weeds in such crops as cotton, strawberries, and mint.

Control by grazing animals. This concept is based on the placement of grazing animals that eat the plants you want to control in the infested area.

Control by other plants. Some degree of success in controlling undesirable vegetation has been obtained by certain plants in producing selective phytotoxins. For example, black mustard was planted in regions of California to inhibit the germination of chaparral, an undesirable range plant, but did not inhibit other range plants that were desired.

Mechanical control. Grasses and herbaceous broadleaf plants can be controlled effectively through mechanical measures if you implement the right measure at the right time. The proper mechanical control and the appropriate time for controlling plants depends on whether the plants are annuals, biennials, or perennials.

Cultivation. In most cases, cultivating is the most practical mechanical control for controlling annual and biennial weeds when the area is cultivated shallow in early spring, and frequently thereafter until midsummer. This process reduces competition to desirable crop plants and prevents flowering and seeding.

Cultivating undesirable perennial plants will cause the plants to starve because cultivation will prevent the plants from manufacturing additional food. It will also cause them to expend the food that is already stored within the plant. Controlling perennial plants through cultivation should be done shortly after the plants have produced new foliage.

Mowing. Mowing is relatively effective for controlling some species of annual weeds if you mow often enough and before the flowers mature. Mowing should be conducted at a height that is low enough to remove the flora but high enough to still permit competitive ability.

Burning. Although burning is an unpopular word among environmentalists, it does have some merit in the control of undesirable vegetation. Fire is more effective for controlling annual plants than perennials. Burning is a useful mechanical control measure for removing vegetation along fire breaks, waterways, railways, and security fences. Burning vegetation is popular in tropical regions because the ashes provide additional nutrients to the low-nutrient soils generally found in tropical regions.

Mulching. Mulching keeps light from the plants. Photosynthesis is thus reduced and the plants die or do not grow. Materials used for mulching include sawdust, hay, straw, manure, paper, and plastic. The area being treated must be completely covered with mulch. The layer of mulch must be thicker for perennials than for annuals. Deep-rooted perennials, such as morning glory plant, may require a layer of mulching material 3 to 4 feet thick.

Exercises (C50):

Identify the following statements as being true or false and correct any false ones.

____ 1. Grasses and herbaceous broadleaf plants may be controlled by biological mechanical, or chemical means.

____ 2. Biological and mechanical controls are slower but less expensive than chemical controls.

____ 3. In order for biological controls to be effective, the predators or parasites introduced must only feed on the weed species desired to be controlled.

____ 4. Biological control of grass and herbaceous broadleaf weeds includes the use of certain insects, arachnids, fowl, grazing animals, and other plants.

____ 5. The goatweed beetle has been used to control the prickly pear cacti.

____ 6. The flea beetle has been used to control the prickly pear cacti.

____ 7. Geese are used to control young weeds in crops.

____ 8. An important consideration in mechanical plant control is whether the plants are annuals, biennials, or perennials.

____ 9. Plant control by cultivation is one of the most practical mechanical methods.

____ 10. Controlling perennial plants through cultivation should be done shortly before new plants can produce additional food.

____ 11. Mowing should be done before the flowers mature.

____ 12. Control by burning is effective for controlling annual plants but is undesirable from an environmental standpoint.

____ 13. Burning has a detrimental effect on the nutrients in the soil.

____ 14. Mulching excludes the light from plants, thus reducing photosynthesis.

C51. Identify details regarding chemical controls for grasses and herbaceous broadleaf plants in specific areas.

Chemical Controls for Grasses and Herbaceous Broadleaf Plants in Specific Areas. There are specific areas on and adjacent to Air Force installations where partial or complete vegetation control is require[illegible] ome of these areas are in and aroun[illegible] roads, [illegible], utility lines, and railroads. In [illegible], weed control must be effective in turf areas, such as lawns, athletic fields, golf grounds, parade grounds. etc.

Paved highways. Vegetation that encroaches on the edges of asphalt pavement or grows up through cracks and holes causes premature breakdown of the pavements. You can control this type of vegetation with presurface and postsurface application of herbicides. Shoulders next to the trafficway, medians separating divided highways, and islands at highway intersections are often surfaced with asphalt. On such areas, apply the herbicide to the gravel base just before the asphalt is poured. A standard highway watering truck can be adapted for this use by equipping it with a loading pump to circulate the spray material and with standard asphalt nozzles that deliver a fan spray.

Several herbicides prevent the emergence of plants through the pavement, but they vary in cost and in injury to vegetation next to the pavement. Plant growth on the unpaved area, particularly on fill slopes, may be desirable to prevent erosion. The following products control vegetation at the accompanying rates per foot-mile. (Rates per foot-mile × 8.25 = rate per acre.)

Chlorate-borate, 200 pounds (25 percent sodium chlorate)
Dalapon, 10 pounds
Dalapon-silvex, 2.5 gallons (4lb dalapon + 1/2 lb silvex per gal)
Diuron, 5 pounds
Erbon, 5 gallons (4lb per gal)
Monuron, 5 pounds
Monuron-TCA, 0.9 gallon (3lb per gal)
TCA, 25 pounds

Postpaving treatments are necessary later to prevent encroachment from [illegible] and [illegible] any vegetation growing up through cracks in old pavements. Use re[illegible] treatments with dalapon-silvex mixture or use dalapon on grasses and 2,4–D or amitrole on broadleaved weeds.

CAUTION: Erbon, monuron, and chlorate-borate mixture can injure vegetation some distance from the edge of the pavements; and monuron, diuron, and monuron-TCA can injure plants next to the treated area.

Roadsides. Herbicides are useful in the maintenance of roadsides if they are properly applied. The greatest dangers come from drift, runoff, improper application, and leaching to roots of desirable species under the treated area.

Before spraying, make a survey of the area, spotting any slopes subject to erosion, the location of desirable vegetation, and the density and height of brush.

CAUTION: Drift hazards are greatest when growth-regulating herbicides, such as 2,4–D, 2,4,5–T, and silvex or contact herbicides are used as sprays, but damage often results from careless application. Drift occurs not only with volatile herbicides, such as the esters of 2,4–D and 2,4,5–T, but also with any spray that has been atomized into a mist by high pressure and a small nozzle opening. The volume of spray per unit area also influences drift. Where there are adjacent susceptible plants. [illegible] ast 10 gallons per acre and move the sprayer at a low [illegible]

It is especially important to reduce mist when you spray with a handgun. Operate at low pressure (30 to 60 psi). Direct spray downward as much as possible, and do not spray when it is windy. When you are treating edges of roads, spray from the outside toward the pavement.

Runoff is an important hazard on slopes, bare ground, and pavements. Cutback asphalt applied with a soil sterilant helps to hold the chemical in place. Use 39 gallons per 1,000 square feet, or 1,700 gallons per acre, or use a light covering of road oil. If there has been an excavation, add a layer of crushed rock. Trees and shrubs some distance from soil treated with soil sterilants may be killed if their roots extend below this area.

Utility lines. Make two complete sprayings of all transmission lines at 2-year intervals—the first to kill as much growth as possible and the second to kill escapees and resistant species. Spray only those species that grow tall enough to interfere with the lines. If the plants are over 6 feet tall, cut and spray the stump.

Fenuron pellets at 12½ pounds per acre, active ingredient, kill alder, blackberries and sumac; elderberry, elm, hawthorn, maple, or willow are not killed, but all species are defoliated.

TCA and dalapon are moderately effective on conifers.

Foliage sprays of 2,4,5–T, at 2½ pounds per 100 gallons of water, control many species of hardwood brush throughout the season. They are most effective when applied soon after leaves are fully expanded and when the plants are growing actively. Esters of 2,4–D plus 2,4,5–T in equal proportions (brush killer) kill alder, smooth and staghorn sumac, and willow.

Railroads. There are three areas on [illegible] on which weed control is necessary: the ballast, the [illegible] bed, and the right-of-way. The ballast is a strip 12 to 16 [illegible] wide, made up of coarse material, such as [illegible] ders or gravel, that should be kept free from weeds. Because the ballast is so porous, it does not retain chemicals well. Insoluble herbicides, those absorbed through leaves, and contact herbicides are most suitable.

The roadbed (berm) beyond the ballast requires weed control, but elimination of vegetation increases erosion. The rest of the area to the right-of-way fence is similar to roadsides. If control is effective during the first 2 years by heavy rates of application, it can be maintained with reduced rates thereafter. The effectiveness of some soil sterilants like diuron and simazine may not show up until the second or third year of use, especially in dry areas or with deep-rooted weeds.

Apply 5 to 8 gallons of dalapon-silvex m[illegible] re, in 150 to 300 gallons water per acre-mile on ballast and berm areas, or 5 to 6 quarts of DNAP and 300 gallons of diesel oil per mile on roadbed. For heavy growth, add 300 gallons of water.

Turf. Weeds in lawns, athletic fields, golf grounds, parade grounds, the turf portions of roadsides and railroad right-of-way, and similar areas are controlled by good maintenance practices supplemented with chemical herbicides. It is important to prevent the encroachment of weeds by maintaining competition from vigorously growing turf grasses. The principal factors in maintenance are soil, grass, water, mowing, and pests.

Both the physical and chemical properties of the soil are important. Adequate organic-matter content, drainage, and aeration are as essential as proper fertility. The selection of the grass or grasses to be seeded is also important. Each type has its requirements for optimum adaptation. Water not only keeps plants from wilting, it is itself a nutrient and it acts as a solvent and carrier of nutrients and food. The frequency and height of mowing are important. The height is determined by the kind of grass, and the frequency depends on rate of growth. Pests include insects diseases and weeds. These often require treatment beyond good maintenance practices. Insecticides, fungicides, and herbicides are supplementary controls.

Chemicals are useful for killing weeds (1) in preparation for seeding, (2) where weeds have become established in disturbance areas, or (3) where, for other reasons, there is an incomplete cover of desirable grasses.

Turf weeds comprise (1) broad-leaved species that can be killed with one group of herbicides without seriously injuring turf grasses and (2) undesirable grasses that can be controlled by a second group of chemicals. The morphological and physiological differences between broadleaf weeds (dicotyledons) and grasses (monocotyledons) make selective control possible. Where weedy grasses are to be removed from turf grasses, selectivity is done usually if the weed is an annual and the turf grass is a perennial.

Exercises (C51):

Identify the following statements as being correct (C) or incorrect (I). Explain why the incorrect statements are not true.

____ 1. Vegetation along the edges and in the crack of asphalt pavement are very difficult to control.

____ 2. Presurface treatment may be done with a standard highway watering truck.

____ 3. Care must be taken during postsurface treatment to prevent injury to plants adjacent to the roadway.

____ 4. When treating roadsides, proper application will ensure safety for desirable plants.

____ 5. Spraying when windy will guarantee best results.

____ 6. When treating utility lines, all species must be treated.

____ 7. Utility lines should be treated every 2 years.

____ 8. Foilage sprays are most effective when applied soon after leaves are fully expanded and when the plants are growing actively.

____ 9. Railroads require treatments in three areas; the ballast, the roadbed, and the right-of-way.

____ 10. The railroad treatment for roadbed should kill all vegetation.

____ 11. Lawns, athletic fields, parade grounds, and golf courses can be controlled primarily by good maintenance practices.

____ 12. In lawns, all undesirable plants can be controlled by the application of one herbicide.

C52. Cite details regarding integrated controls for aquatic vegetation.

Integrated Control Measures for Aquatic Vegetation. The control of aquatic plants is based upon the type and location of the plants to be controlled. Controlling aquatic plants presents many problems for you because controls often affect other aquatic life. Although chemical control methods are most popular, most aquatic plants can be controlled effectively by mechanical methods, even though these methods are generally more expensive and slower than chemical methods. Biological control is also used on a limited basis.

Mechanical control. Mechanical control methods for aquatic plants include pulling, chaining, dredging, drying, burning, and mowing. The methods you use should depend on the size of the area type of terrain, and availability of equipment and operators.

Pulling or raking. Small bodies of water can be temporarily rid of aquatic plants by hand pulling or raking the plants from the water.

Chaining. Aquatic plants can be removed from canals and drainage systems by dragging a heavy chain between two tractors on opposite banks. The chain should be towed in one direction and then back in the opposite direction to be most effective. Dragging the chain through the water will detach rooted submersed plants and emersed plants from the bottom of the body of water. Once these plants have been detached from the bottom they should be removed from the water by raking.

Dredging. Dredging seems to be equally effective for all types of aquatic vegetation but must be used very cautiously. Equipment used for dredging should be equipped with weeding forks instead of the normal bucket. Although dredging operations are very effective for removing aquatic vegetation, they are not very advantageous in other aspects. Removing vegetation by dredging also removes mud along with the weeds, therefore enlarging and deepening the water holding area causing a change in capacity.

Drying. Many submersed aquatic weeds, especially those in hot, arid regions may be controlled effectively by drying. This method is often objectionable because it requires complete drainage of the area, which, in most instances, must be done when the water is needed the most.

Burning. Burning is an effective mechanical control measure for controlling young succulent plants along canals and drainage ditches. Burning is most generally done by searing the plants first, then finishing the burn a week or two later.

Mowing. Providing banks are smooth enough, not too steep, and relatively unobstructed, mowing can be used to control aquatic vegetation growing along the sides of canals and drainage systems. Specially designed power-driven weed saws and weed cutters can be used to control rooted submersed plants and emersed plants within bodies of water.

Chemical control. Approved chemicals may be applied in the form of sprays or granules. Porous bags that contain chemicals can be dragged through the water until the chemical has dissolved. Chemicals can even be applied over iced areas in the same manner you would treat a field. As the ice melts, the chemical is released slowly into the water. Copper sulfate, if applied correctly, can be used and is very effective for controlling algae. Aromatic oils are also often used for controlling aquatic weeds in irrigation canals.

Biological control. There are certain fish and snails that feed on many aquatic weeds and, at times, they will virtually eliminate aquatic weeds in ponds and lakes. Carp and sunfish are very important in reducing aquatic vegetation and the *Marisa cornuarietis* snail has shown promise in controlling aquatic weeds in Florida.

Exercises (C52):

1. List the mechanical controls for aquatic vegetation.

2. Which method is more appropriate to use for controlling aquatic vegetation?

3. How can aquatic plants be removed from canals and water systems?

4. How should acquatic plants be removed once they have been detached from the bottom?

5. Removing vegetation by dredging also removes __________ along with the weeds, therefore enlarging the water holding area causing a change in the __________________.

6. Why is drying for control of aquatic vegetation objectionable?

7. How is burning most generally done for ground vegetation control?

8. What method can be used to control aquatic vegetation growing along the sides of canals and drainage systems?

9. What tools can be used to control rooted submersed plants and emersed plants within bodies of water?

10. Approved aquatic herbicides may be applied in what form?

11. How does biological control of acquatic plants work?

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CDC 56650, Volume 7, *Collection, Identification, and Control of Important Vertebrate and Vegetative Pests.* Extension Course Institute, Gunter Air Force Station, Alabama 36118.

Book

Truman, Lee C., Ph.D., Gary W. Bennett, Ph.D., and William L. Butz, Ph.D., *Scientific Guide to Pest Control Operations,* 3rd ed. Cleveland, Ohio: Harvest Publishing Company, 1976.

Periodical

Weidner, Tim. "Pharoah Ants: A Growing Problem in America's Hospitals." *Pest Control Technology,* August 1982, pp. 37–62.

Department of Air Force Publication

Air Force Pamphlet 161–43, *Venomous Arthropod Handbook.*

Answers for Exercises

CHAPTER 1

Reference:

C01 – 1. Homes; hotels; restaurants; bakeries.
C01 – 2. In cracks and crevices provided by buildings.
C01 – 3. On bits of food people scatter where they live and travel.
C01 – 4. Diarrhea, dysentery, typhoid, food poisoning.
C01 – 5. Through the insect's fecal material.
C01 – 6. There are about 55 species in the U.S. Only 5 commonly infest buildings.
C01 – 7. At night, warm; damp; secluded.
C01 – 8. Ootheca.

C02 – 1. (1) d.
(2) b.
(3) a.
(4) e.
(5) c.
(6) d.
(7) c.
(8) a.
(9) e.
(10) b.
(11) d.
(12) a.
(13) c.
(14) b.

C03 – 1. Your list may include any 5 of the following:
(1) Never leave food products exposed.
(2) Keep garbage in enclosed containers.
(3) Eliminate dripping faucets and pipes.
(4) Keep sewer openings cleaned.
(5) Inspect incoming merchandise for cockroaches and eggs.
(6) Store or discard empty drink containers.
(7) Avoid needless trash accumulations.
(8) Exclude roaches by methods such as equipment design, good screening, tight-fitting doors, and filling cracks and crevices.
C03 – 2. Where they would be unsightly or cause contamination problems.
C03 – 3. Make sure it's EPA registered, and read and follow label directions completely.
C03 – 4. In cracks and crevices, under large appliances, and in other suitable harborage areas.
C03 – 5. Because heavy infestation tends to be repellent.
C03 – 6. Place them in small amounts and very close together where they can compete with other food sources.
C03 – 7. Your list may include any eight of the following:
(1) Cracks and crevices.
(2) Under table tops.
(3) Behind sinks.
(4) In cabinets.
(5) In motor compartments of refrigerators and soft drink machines.
(6) Underneath bases of kitchen equipment.
(7) In switch and fuse boxes.
(8) Underneath cafeteria counters.
(9) In cash registers.
(10) In vegetable bins.
(11) Around meat counters and check-out stands.
(12) Anywhere else where conditions are favorable.
C03 – 8. Use ULV applications to supplement residual sprays except in areas where residual pesticide use is prohibited.
C03 – 9. Inside bureaus, shelves in clothes closets, ceiling light fixtures, valances above windows, and any other suspected hiding places.
C03 – 10. Near steam pipes, in sewers, grease traps, damp basements, and similar places.
C03 – 11. a. Under porches and crawl spaces, basements, and floor drains.
b. In abandoned cisterns, valve pits, and in garbage and trash dumps.

C04 – 1. The abdominal pedicel or "node."
C04 – 2. This characteristic will separate ants from all other insects of similar general appearance, and the number of segments and the shape of nodes will help determine the genus and species of ants involved.
C04 – 3. They act as sensory organs for functions such as touch and taste.
C04 – 4. Ant larvae are legless and are more or less translucent. They are gourd or squash shaped with the head at the narrow end.
C04 – 5. Reproductive females (queens), reproductive males (kings), and workers.

C05 – 1. (1) c.
(2) b.
(3) e.
(4) f.
(5) a.
(6) c.
(7) d.
(8) b.
(9) a.
(10) e.

C06 – 1. T.
C06 – 2. T.
C06 – 3. T.
C06 – 4. F; dusts work best when blown into nests and wall voids, or other areas where ants nest or hide.
C06 – 5. F; control can be quite difficult and is only likely to be effective if you can trace foraging workers to the nest's vicinity.
C06 – 6. T.
C06 – 7. T.
C06 – 8. T.
C06 – 9. T.
C06 – 10. T.

C07 – 1. T.
C07 – 2. F; they also attack starched clothing, linen, and rayon.
C07 – 3. T.
C07 – 4. T.
C07 – 5. F; both are wingless.

C07 – 6. F; firebrats prefer hot, dry places.

C08 – 1. Inspection and food reduction (sanitation).
C08 – 2. Basements, attics, closets, around bookcases, behind baseboards, and around steam and water pipes.
C08 – 3. Oven areas, fireplaces, boiler rooms, and other hot, dry areas.
C08 – 4. Apply a space spray to get them moving faster.

C09 – 1. F; Dermaptera.
C09 – 2. T.
C09 – 3. T.
C09 – 4. F; 5 months.

C10 – 1. T.
C10 – 2. T.
C10 – 3. F; they generally aren't effective.

C11 – 1. Five mm long, 3 mm wide, and reddish brown.
C11 – 2. Greatly enlarged and red.
C11 – 3. Both sexes; *Cimex lectularius, Cimex hemipterus*.
C11 – 4. Can lead to nervous and digestive disorders.

C12 – 1. A buggy odor, blood stains on sheets, and fecal stains along crevices.
C12 – 2 At night.
C12 – 3. Gradual metamorphosis.
C12 – 4. It takes 18 to 56 days, depending on the temperature.
C12 – 5. From 6 to 12 months.
C12 – 6. Year.

C13 – 1. F; it is a minor problem.
C13 – 2. T.
C13 – 3. T.
C13 – 4. F; fold mattresses and place at a 45° angle.
C13 – 5. F; open windows for ventilation.
C13 – 6. T.
C13 – 7. T.

C14 – 1. (1) a.
(2) b.
(3) c.
(4) a.
(5) c.
(6) b.

C15 – 1. Apply residuals to floors, walls, around fireplaces and dark crevices, in basements, and behind baseboards.
C15 – 2. Cracks; crevices.
C15 – 3. Baits.
C15 – 4. Congregate.
C15 – 5. Five; 2; 3.

C16 – 1. S.
C16 – 2. P, S.
C16 – 3. P, S.
C16 – 4. P.
C16 – 5. S.
C16 – 6. P, S.
C16 – 7. P, S.
C16 – 8. P, S.
C16 – 9. P, S.

C17 – 1. Physical, cultural, and chemical controls.
C17 – 2. Hot water.
C17 – 3. Removing grass and leaf piles, picking up objects on the ground, and keeping the area free of garbage.
C17 – 4. Dry; ventilated.
C17 – 5. Apply them to entire lawn and turf areas or as a band treatment around a building foundation.

CHAPTER 2

C18 – 1. Neurotoxin.
C18 – 2. Vesicating toxin.
C18 – 3. Hemolytic toxin.

C19 – 1. (1) b.
(2) e.
(3) a.
(4) d.
(5) g.
(6) c.
(7) f.
(8) a.

C20 – 1. C.
C20 – 2. C.
C20 – 3. I. They produce honey and pollenate crop-bearing plants.
C20 – 4. I. It does not harden readily and remains pliable for years.
C20 – 5. C.
C20 – 6. I. They cause serious damage to structures.
C20 – 7. I. Deaths have been reported from bee stings.
C20 – 8. C.

C21 – 1. All bees.
C21 – 2. Honeybees.
C21 – 3. Bumblebees.
C21 – 4. Bumblebees.
C21 – 5. Bumblebees.
C21 – 6. Honeybees.
C21 – 7. Bumblebees.
C21 – 8. Bumblebees.

C22 – 1. If you can handle bees, gently rake them onto a white cotton cloth. When you have collected all the bees, take them to an open field and release them. If you or someone in your shop cannot handle bees, contact a beekeeper to take care of them for you. Beekeepers are usually glad to get the bees and you avoid killing the bees with chemicals.
C22 – 2. Application of insecticide dust, spray, or aerosol will control these bees; however, several applications may be required. Dust is probably the best insecticide to use in this situation.

C23 – 1. Stinging.
C23 – 2. Individual.
C23 – 3. Insects, crops.
C23 – 4. Vegetation.

C24 – 1. T.
C24 – 2. F; it is used for making holes for depositing eggs and for stinging.
C24 – 3. F; some wasps are solitary insects and cause very little trouble to humans.
C24 – 4. T.
C24 – 5. T.

C25 – 1. F; you should treat in the early morning or late evening when most wasps are still on the nest.
C25 – 2. T.
C25 – 3. F; use solutions only if they don't represent a danger to vegetation or treated surfaces.
C25 – 4. T.

C26 – 1. They are beneficial in that they parasitize certain insects and arachnids, but they are far more detrimental because of their visciousness and painful stings to people.
C26 – 2. Baldfaced hornet.
C26 – 3. The white markings on its body.
C26 – 4. They are paperlike as are those of other wasps, but are completely enclosed with a paperlike covering, and may resemble a massive "bloated football" or "inverted teardrop."
C26 – 5. Burning the nest.
C26 – 6. Fire safety and personal protection.

C27 – 1. Get medical attention.
C27 – 2. You must remove the stinger.
C27 – 3. Tweezers.
C27 – 4. Apply a paste of water and baking soda.
C27 – 5. Because it increases the flow of venom into the blood and increases the inflamed area.

C28 – 1. T.
C28 – 2. F; very few species in the United States are poisonous.
C28 – 3. T.
C28 – 4. F; they appear in many parts of the world.
C28 – 5. F; the black widow is more important.
C28 – 6. T.
C28 – 7. F; both sexes are poisonous.

C28 – 8. F; a full bite affects body functions as well as creating a very serious local wound.
C28 – 9. T.

C29 – 1. In temperate and tropical zones.
C29 – 2. To paralyze their prey.
C29 – 3. Humans.
C29 – 4. Mouthparts; skin.
C29 – 5. Instars.

C30 – 1. (1) c.
(2) c, d, e.
(3) a.
(4) b.
(5) c.
(6) a.
(7) d.
(8) b.
(9) a, e.
C30 – 2. 200.
C30 – 3. 2–4 weeks.
C30 – 4. They are laid during the summer and the young reach maturity the following spring.
C30 – 5. On the underside of privy seats, in piles of lumber and trash, and in empty paint cans and buckets.
C30 – 6. Insects; disturbed.
C30 – 7. The dark fiddle-shaped marking on the carapace.
C30 – 8. One; five.
C30 – 9. In houses and associated buildings, boiler houses, schools, churches, libraries, stores, and other such buildings.
C30 – 10. Because they avoid the light and are sedentary.
C30 – 11. Out of doors.

C31 – 1. Under stones, loose bark, in water faucets or wood piles, in rodent burrows, garages, storage buildings, etc.
C31 – 2. Frequent cleaning to remove spiders and their webs.
C31 – 3. Around windows, stairs, closets, and all other spider habitats both indoors and outdoors.
C31 – 4. Inside parts of buildings which are generally dry, littered, and undisturbed for long periods of time; outside, under rocks and loose bark.
C31 – 5. Shake out clothing and bedding before use, eliminate collections of papers and unused boxes, thoroughly clean under and behind furniture, remove spiders, webs, and egg cases from living and storage areas, and properly use appropriate general use insecticides.
C31 – 6. T.
C31 – 7. F; egg sacs must be destroyed along with the adults.
C31 – 8. F; use space treatments indoors only for cleanouts and to control outdoor species found indoors.
C31 – 9. T.

C32 – 1. 1, 2, 4, and 5 are true.

C33 – 1. Four; one.
C33 – 2. Two; unsegmented; segmented.
C33 – 3. Tail; stinger.
C33 – 4. Straw yellow.
C33 – 5. Nocturnal.
C33 – 6. Water.
C33 – 7. House; attics; walls.

C34 – 1. Insects.
C34 – 2. Two to 3 months.
C34 – 3. By cutting down on their hiding places.
C34 – 4. By dampening a burlap sack and spreading it on the ground in the evening.
C34 – 5. Diazinon and Propoxur.

C35 – 1. Immediately place a ligature between the sting and the body.
C35 – 2. Ice.
C35 – 3. 3; 5.
C35 – 4. Antivenins.
C35 – 5. Obtain professional medical assistance as soon as possible.

C36 – 1. (1) f.
(2) h.
(3) c.
(4) b.
(5) a
(6) g.
(7) h.
(8) a.
(9) c.
(10) b.
(11) e.
(12) d.
(13) g.
(14) e.
(15) f.
(16) d.

C37 – 1. Centipedes, millipedes, and conenoses.
C37 – 2. Large centipedes.
C37 – 3. Around doorways, window frames, and around lighting.
C37 – 4. Ornamental and turf pests.
C37 – 5. To prevent prolonged contortions, which cause many hairs and spines to be shed before they die.

C38 – 1. True.
C38 – 2. True.
C38 – 3. False; fatalities are low.
C38 – 4. True.
C38 – 5. False; they can bite under water.
C38 – 6. False; it does not.
C38 – 7. False; people fear snakes because they lack knowledge of snakes and believe fallacies that have been passed down through generations.

C39 – 1. (1) c.
(2) a.
(3) b.
(4) a.
(5) c.
(6) c.
(7) a.
(8) a.
(9) b.
(10) b.

C40 – 1. False; venom is neurotoxic.
C40 – 2. True.
C40 – 3. False; both are from family Elapidae.
C40 – 4. True.
C40 – 5. False; the cobra has a "hood."
C40 – 6. True.
C40 – 7. False; Arizona and New Mexico.
C40 – 8. True.
C40 – 9. False; they are secretive.
C40 – 10. True.

C41 – 1. a. Pain.
b. Nausea.
c. Respiratory difficulty (possibly a sign also).
d. Visual difficulty.
C41 – 2. a. Presence of fang puncture wounds.
b. Drooping of eyelids.
c. Unsteady gait.
d. Slurring or speech.
e. Swelling at puncture point (possibly).
f. Vomiting.
g. Excessive sweating.

C42 – 1. Correct.
C42 – 2. Incorrect; only a doctor or other suitably trained medical personnel may administer antivenin.
C42 – 3. Incorrect. Change "2" to "1."
C42 – 4. Correct.
C42 – 5. Correct.
C42 – 6. Correct.

C43 – 1. Rodent.
C43 – 2. Avoid their natural habitats.
C43 – 3. Hip boots; flashlight.

CHAPTER 3

C44 – 1. Their ability to thrive in cultivated land.

C44 – 2. (1) Underground roots or stems—Permit weeds to persist even if seed production is prevented. Cultivation spreads pieces of roots to other areas.
(2) Abundant seed production—Weeds produce thousands of seeds that can live from 10 to 50 years.
(3) Rapid growth—Seeds form before control measures can be taken.
(4) Competitive ability—Weeds can compete more successfully than desired plants for light and nutrients.
(5) Unpalatability to livestock—Weeds can reproduce and spread without being hindered by animals.

C45 – 1. (1) e.
(2) b.
(3) c.
(4) g.
(5) j.
(6) a.
(7) f.
(8) h.
(9) d.
(10) i.

C46 – 1. T.
C46 – 2. T.
C46 – 3. F; vines climb on other plants or sprawl on the ground.
C46 – 4. T.
C46 – 5. F; some plants have both.
C46 – 6. T.
C46 – 7. T.
C46 – 8. T.
C46 – 9. F; change "polycots" to "monocots."
C46 – 10. F; change "monocot" to cotyledon."
C46 – 11. T.
C46 – 12. F; change "shallow and weak" to "deep and strong."

C47 – 1. I; they separate from the soil and are no longer dependent on the soil.
C47 – 2. C.
C47 – 3. C.
C47 – 4. I; during normal growth these plants will extend above the water surface.

C48 – 1. Identify the weed you want to kill; select the right herbicide to control the weeds without harm to desirable plants; and mix chemicals according to mixing directions.
C48 – 2. When herbicides that affect leaves of plants are used; they are least when low-pressure liquid application are made of nonvolatile herbicides.
C48 – 3. With a high-pressure spray of liquid herbicide.
C48 – 4. Slopes, bare ground, and pavements.
C48 – 5. Downward.
C48 – 6. Wildlife.
C48 – 7. Overdoses and spillage.

C49 – 1. (1) c.
(2) a.
(3) b.
(4) d.
(5) e.

C50 – 1. T.
C50 – 2. F; they are more expensive, but should still be used when possible to protect the environment.
C50 – 3. T.
C50 – 4. T.
C50 – 5. F; it has been used to control the rangeweed; cactus moths have been used against the prickly pear pine.
C50 – 6. T.
C50 – 7. T.
C50 – 8. T.
C50 – 9. T.
C50 – 10. T.
C50 – 11. T.
C50 – 12. T.
C50 – 13. F; burning adds nutrients to the soil.
C50 – 14. T.

C51 – 1. I. Presurface and postsurface treatment is effective in controlling these weeds.
C51 – 2. C.
C51 – 3. C.
C51 – 4. I. Desirable plants may still be damaged by leaching to the roots and runoff from rains.
C51 – 5. I. Wind causes drift which endangers desirable plants.
C51 – 6. I. Only those tall enough to reach the lines.
C51 – 7. C.
C51 – 8. C.
C51 – 9. C.
C51 – 10. I. This could cause erosion; only tall plants should be killed.
C51 – 11. C.
C51 – 12. I. Broad leaves and grasses require different treatments.

C52 – 1. Pulling, chaining, dredging, drying, burning, and mowing.
C52 – 2. It depends on the size of the area, type of terrain, and availability of equipment and operators.
C52 – 3. By dragging a heavy chain between two tractors on opposite banks.
C52 – 4. By raking.
C52 – 5. Mud; capacity.
C52 – 6. Because it requires complete drainage of the area.
C52 – 7. By searing the plants first, then finishing the burn a week or two later.
C52 – 8. Mowing.
C52 – 9. Specially designed power-driven weed saws and cutters.
C52 – 10. Sprays or granules.
C52 – 11. Fish and snails feed on many aquatic weeds and, at times, virtually eliminate weeds in ponds and lakes.

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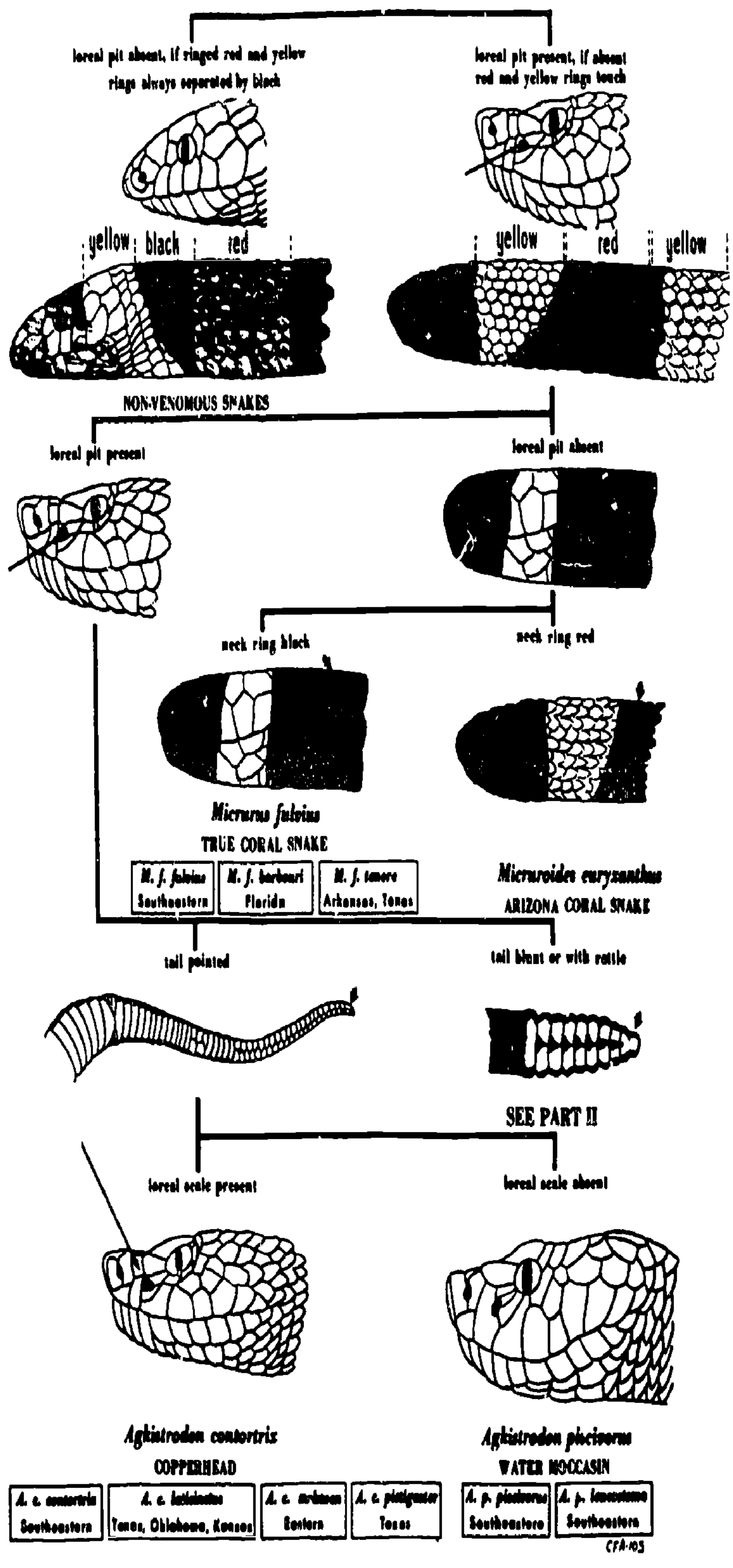
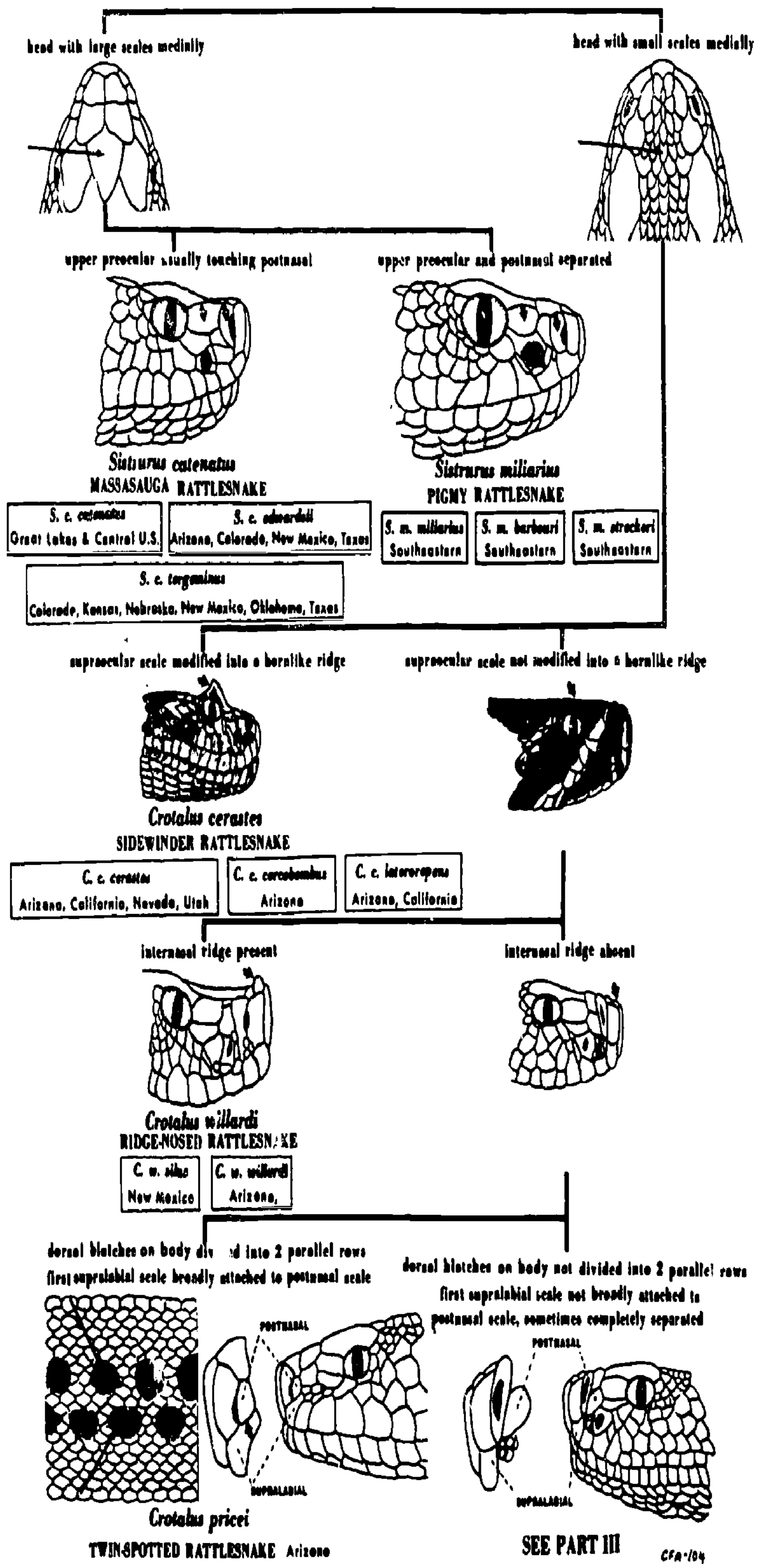
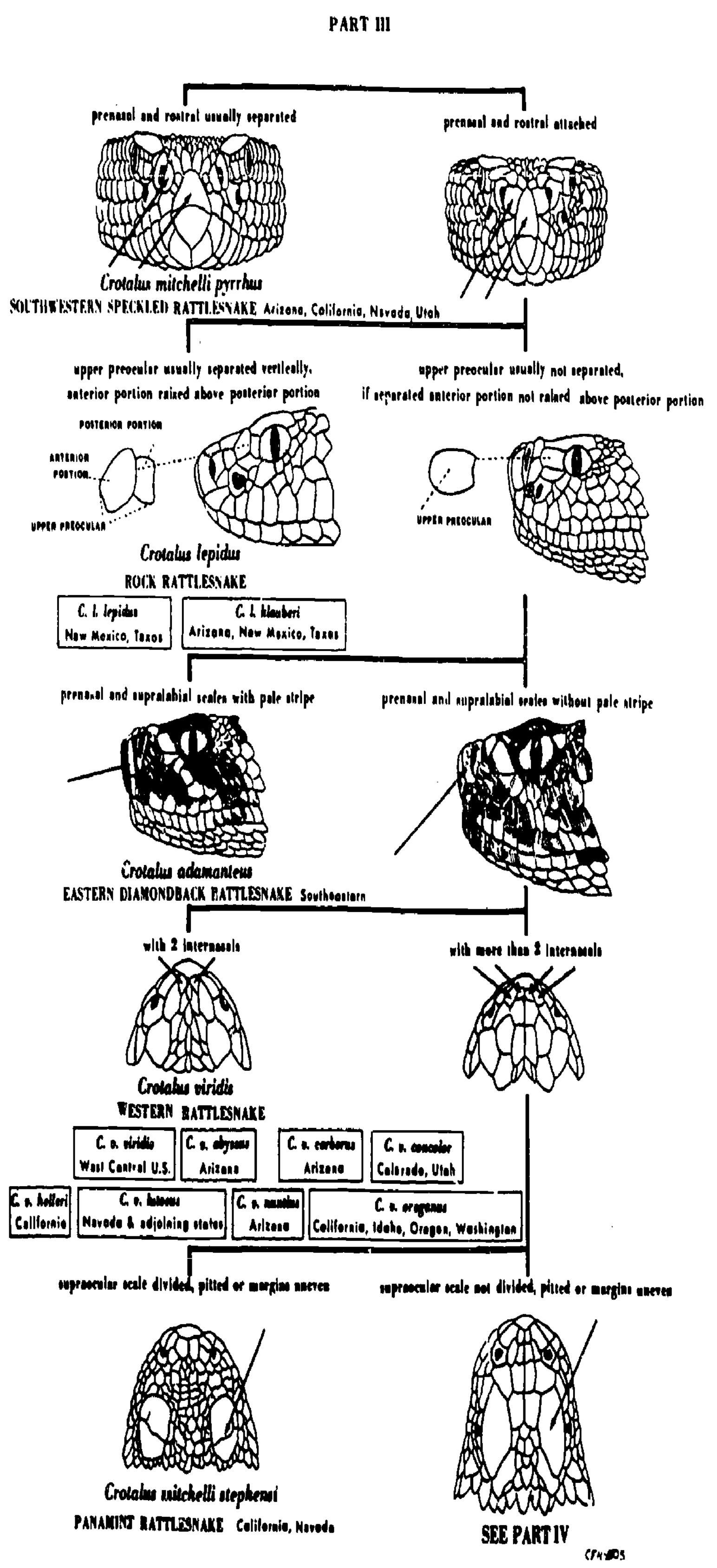
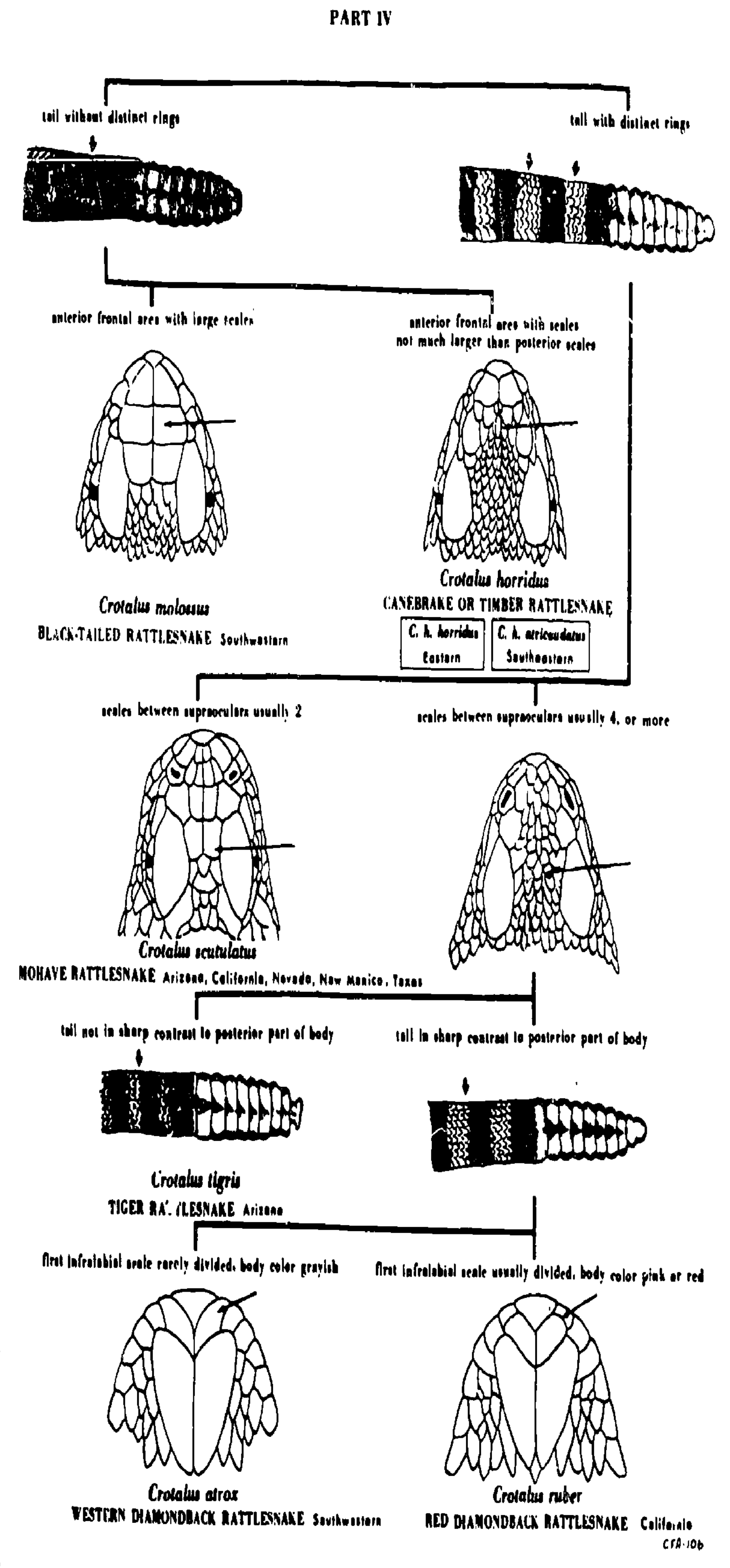
SNAKES: PICTORIAL KEY TO VENOMOUS SPECIES IN UNITED STATES
PART I



PART II




PART III
prenasal and rostral usually separated
prenasal and rostral attached
Crotalus mitchelli pyrrhus
SOUTHWESTERN SPECKLED RATTLESNAKE Arizona, California, Nevada, Utah
upper preocular usually separated vertically, anterior portion raised above posterior portion
upper preocular usually not separated, if separated anterior portion not raised above posterior portion
POSTERIOR PORTION
ANTERIOR PORTION
UPPER PREOCULAR
UPPER PREOCULAR
Crotalus lepidus
ROCK RATTLESNAKE
C. l. lepidus New Mexico, Texas
C. l. klauberi Arizona, New Mexico, Texas
prenasal and supralabial scales with pale stripe
prenasal and supralabial scales without pale stripe
Crotalus adamanteus
EASTERN DIAMONDBACK RATTLESNAKE Southeastern
with 2 internasals
with more than 2 internasals
Crotalus viridis
WESTERN RATTLESNAKE
C. v. viridis West Central U.S.
C. v. abyssus Arizona
C. v. cerberus Arizona
C. v. concolor Colorado, Utah
C. v. helleri California
C. v. lutosus Nevada & adjoining states
C. v. nuntius Arizona
C. v. oreganus California, Idaho, Oregon, Washington
supraocular scale divided, pitted or margins uneven
supraocular scale not divided, pitted or margins uneven
Crotalus mitchelli stephensi
PANAMINT RATTLESNAKE California, Nevada
SEE PART IV
CFA-105


PART IV
tail without distinct rings
tail with distinct rings
anterior frontal area with large scales
anterior frontal area with scales not much larger than posterior scales
Crotalus molossus
BLACK-TAILED RATTLESNAKE Southwestern
Crotalus horridus
CANEBRAKE OR TIMBER RATTLESNAKE
C. h. horridus Eastern
C. h. atricaudatus Southeastern
scales between supraoculars usually 2
scales between supraoculars usually 4, or more
Crotalus scutulatus
MOHAVE RATTLESNAKE Arizona, California, Nevada, New Mexico, Texas
tail not in sharp contrast to posterior part of body
tail in sharp contrast to posterior part of body
Crotalus tigris
TIGER RATTLESNAKE Arizona
first infralabial scale rarely divided, body color grayish
first infralabial scale usually divided, body color pink or red
Crotalus atrox
WESTERN DIAMONDBACK RATTLESNAKE Southwestern
Crotalus ruber
RED DIAMONDBACK RATTLESNAKE California
CFA-106

Foldout Y.

STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 07 23

HOUSEHOLD, VENOMOUS AND VEGETATIVE PESTS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover *your* answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor. If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the *Learning Objective Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Learning Objectives* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual* VRE *items you missed*. Go to the VRE booklet and locate the *Learning Objective Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the *best* answer to each question.

1. (C01) How many species of cockroaches are common pests indoors in the United States?

   a. 5.
   b. 20.
   c. 35.
   d. 55.

2. (C02) Which of these female cockroaches carry the ootheca until the eggs are ready to hatch?

   a. German cockroach.
   b. Oriental cockroach.
   c. American cockroach.
   d. Australian cockroach.

3. (C02) Which cockroach commonly spreads beyond the kitchen and bathrooms in infested homes?

   a. German cockroach.
   b. American cockroach.
   c. Australian cockroach.
   d. Brown-banded cockroach.

4. (C02) Which of these cockroaches is often found in such places as high on walls, behind picture frames, and near motors of appliances?

   a. Oriental cockroach.
   b. Australian cockroach.
   c. Brown-banded cockroach.
   d. Pennsylvania woods cockroach.

5. (C03) For pesticide effectiveness, you should mainly apply pesticides for cockroach control in

   a. ceilings and basements.
   b. roach harborages.
   c. high-humidity areas.
   d. baseboards and drains.

6. (C03) An ideal method for crack and crevice treatments for cockroaches involves

   a. sealing openings, treatment, and inspection.
   b. inspection, sealing openings, and treatment.
   c. treatment, sealing openings, and inspection.
   d. inspection, treatment, and sealing opening.

7. (C04) "Ant egg" is often a term applied to an ant

   a. larva.
   b. pupae.
   c. nymph.
   d. adult.

8. (C04) What type of metamorphosis do ants undergo?

   a. Complete.
   b. Incomplete.
   c. Gradual.
   d. None.

9. (C05) Which ants may be severe pests in hospitals where they can feed on open wounds?

   a. Odorous house ants.
   b. Argentine ants.
   c. Pharoah ants.
   d. Field ants.

10. (C05) Pharoah ant colonies are characterized as having

    a. up to 100,000 workers and many queens.
    b. up to 300,000 workers and many queens.
    c. up to 100,000 workers, but only one queen.
    d. up to 300,000 workers, but only one queen.

11. (C06) When you can't locate or treat ant nests what pesticidal formulation can you use most effectively?

a. Granuals.
b. Sprays.
c. Dusts.
d. Baits.

12. (C06) Broadcast treatments for ant control in large outdoor areas are best accomplished using

a. Dusts.
b. Granuals.
c. Wettable powder sprays.
d. Emulsifiable concentrates.

13. (C07) What is the shape of silverfish and firebrats?

a. Carrot.
b. Beet.
c. Diamond.
d. Hexagon.

14. (C07) Where do silverfish harbor?

a. Duct work for a heating system.
b. Food storage and moist places.
c. Behind stoves or around fireplaces.
d. Under hot, dry conditions.

15. (C08) Chemical controls for silverfish and firebrats are conducted much like control measures for

a. Ants.
b. Cockroaches.
c. Ticks and mites.
d. Stored-food pests.

16. (C08) What type of chemical treatment is normally used to control silverfish?

a. Liquid residual pesticides application.
b. Misting.
c. Fogging.
d. Aerosoling.

17. (C09) Earwigs belong to the order

a. Orthoptera.
b. Cimex.
c. Dermaptera.
d. Domestica.

18. (C09) What type mouthparts do earwigs have?

a. Biting.
b. Sucking.
c. Chewing.
d. Vacuum.

19. (C10) When spraying for earwigs, where would you spray outdoors?

a. In the water area only.
b. In the soil in a 5-foot band around the structures and on the foundation wall to a height of 2-3 feet.
c. Only on the foundation wall to a height of 2-3 feet.
d. Only in a 5-foot band on the soil around the structure.

20. (C10) What indoor areas can you treat by spraying or brushing insecticides for earwig control?

a. Baseboards.
b. Furniture legs.
c. Kitchens and bathrooms.
d. Door and window frames.

21. (C11) To what family does the bedbug belong?

a. Supella supellectilium.
b. Blatella germanica.
c. Cimicidae.
d. Lespisam.

22. (C11) What species of bedbugs is predominate in the temperate regions?

a. Supella supellectimium.
b. Blatella germanica.
c. Cimex hemipterus.
d. Cimex lectularius.

23. (C12) Which of the following characteristics is *not* typical in a bedbug infestation?

a. Buggy odor.
b. Daytime movements.
c. Blood stains on sheets.
d. Fecal stains along crevices.

24. (C12) Depending on the temperature, how long does it take for complete development of a bedbug from egg to adult?

a. 10 to 15 days.
b. 8 to 12 weeks.
c. 18 to 56 days.
d. 1 to 2 weeks.

25. (C13) How long will one application of an approved insecticide emulsion control bedbugs?

a. 30 days.
b. 6 months.
c. 1 year.
d. More than 1 year.

26. (C13) In a bedbug-infested room with a single bed, to what height should you spray the walls?

a. You should treat baseboards only.
b. Two feet.
c. Four feet.
d. Six feet.

27. (C14) To what order does the cricket belong?

a. Orthoptera.
b. Hemiptera.
c. Lespisma.
d. Supella.

28. (C14) What cricket enters the home chiefly in cold weather?

a. House.
b. Cave.
c. Camel.
d. Jerusalem.

29. (C15) Control treatment for crickets in food facilities must be restricted to

a. line area only.
b. cracks and crevices.
c. flat surfaces.
d. the entire room.

30. (C15) How can you prevent crickets from entering buildings?

a. Residuals.
b. Misting.
c. Fogging.
d. Aerosoling.

31. (C16) How can sowbugs be distinguished from pillbugs?

a. Sowbugs roll up into a ball.
b. Sowbugs are longer and have a flat head.
c. Sowbugs cannot roll up into a ball.
d. The sowbug is known as the "roly-poly".

32. (C16) Where are pillbugs and sowbugs usually found indoors?

a. Under kitchen counters and in bathrooms.
b. Around and inside garbage containers.
c. In window sills and door frames.
d. In damp basements and ground level flooring.

33. (C17) Sowbugs and pillbugs congregating under and between outdoor objects can be easily controlled by

a. pouring hot water over them.
b. residual pesticidal solutions.
c. residual pesticidal suspensions.
d. applying a band treatment around nearby buildings.

34. (C17) What is the most appropriate site sanitation method of preventing buildups of sowbugs and pillbugs?

a. Removing grass and leaf piles.
b. Spraying hot water over the area.
c. Applying residual suspension insecticides.
d. Eliminating food and water sources.

35. (C18) Most arthropods and reptiles in the United States produce

a. a neurotoxin.
b. an urticating venom.
c. a hemmorhagic toxin.
d. a hemolytic venom.

36. (C18) Venoms that inhibit reflexes and may cause shock in severe cases are classified a

a. Hemolytic toxins.
b. Urticating toxins.
c. Vesicating toxins.
d. Neurotoxins.

37. (C19) The method of envenomization and the type of venom produced by wasps are

a. stings, hemolytic.
b. stings, neurotoxin.
c. bites, neurotoxin.
d. bites, hemolytic.

38. (C19) The method of envenomization and the type of venom produced by bees are

a. stings, hemolytic.
b. stings, neurotoxin.
c. bites, neurotoxin.
d. bites, hemolytic.

39. (C20) Which of the following bees is the most beneficial to humans in respect to food production?

a. Carpenter bee.
b. Honeybee.
c. Bumblebee.
d. King bee.

40. (C20) Although all bees are of medical importance, which of these is of greater concern because of its economic impact?

a. Carpenter bee.
b. Bumblebee.
c. Honeybee.
d. Italian bee.

41. (C21) Which of the following correctly depicts the habits and appearance of honeybees?

a. Nest in the ground, hairy bodies, no pollen basket.
b. Nest in the ground, hairy faces, pollen basket.
c. Nest above ground, hairy faces, pollen basket.
d. Nest above ground, hairy bodies, no pollen basket.

42. (C21) Which of the following describes a bumblebee?

a. Nest in the ground, hairy bodies, no pollen basket.
b. Nest in the ground, hairy faces, pollen basket.
c. Nest above ground, hairy faces, pollen basket.
d. Nest above ground, hairy bodies, no pollen basket.

43. (C22) Since bees are inactive at night, bee control measures should be taken

a. on a weekly basis.
b. at midday when they are active.
c. when the weather is cool and damp.
d. in the late afternoon or early evening.

44. (C22) Insecticidal dust to control bees should be applied weekly for

a. 1 to 2 weeks.
b. 2 to 3 weeks.
c. 3 to 4 weeks.
d. 4 to 5 weeks.

45. (C23) Wasps are very beneficial to humans in food production because they

a. produce honey.
b. produce beeswax.
c. are parasitizers.
d. are excellent pollinators.

46. (C23) In what way are wasps of the greatest importance in affecting food production?

a. They are parasites of other insects that attack crops.
b. They are better than bees in pollenating plants.
c. They parasitize beneficial plant pollenators.
d. They have no affect on food production.

47. (C24) Which of the following statements describes the wasp?

a. Two pairs of membranous wings.
b. One pair of hairy wings.
c. Two pairs of hairy wings.
d. One pair of membranous wings.

48. (C24) Social wasps of medical importance are commonly attracted by all of the following *except*

a. sweets.
b. flowers.
c. fruits.
d. meats.

49. (C25) You should take measures to control wasps by

a. using a space spray applied with ULV equipment.
b. knocking down and crushing nests in the daytime.
c. treating the nest while most wasps are still on it.
d. using cultural controls that eliminate nesting sites.

50. (C25) For most situations, what chemical formulation should you use to control wasps?

a. Dust
b. Solution
c. Suspension
d. Emulsion

51. (C26) Which of the following statements reflects the habit of the hornet?

a. Construct paperlike nests with exposed cells.
b. Construct completely inclosed paperlike nests.
c. Construct mud nests resembling vases.
d. May burrow into the ground to nest.

52. (C26) One of the most effective ways to control hornet nests is

a. removing the nest and immersing it in water.
b. fumigating the nest.
c. burning the nest.
d. injecting dust.

53. (C27) When you have an embedded sting in your arm, you should

a. carefully remove it with tweezers.
b. carefully remove it with the sharp edge of a knife.
c. seek immediate medical aid.
d. apply a suction cup to remove the venom.

54. (C27) The pain from a wasp or bee sting can be reduced by applying a paste made with

a. rubbing alcohol and flour.
b. water and flour.
c. rubbing alcohol and baking soda.
d. water and baking soda.

55. (C28) The most important spider species in the United States are in the orders

a. *Latrodectus* and *Lycosa*.
b. *Loxosceles* and *Latrodectus*.
c. *Ctenus* and *Loxoccelesi*
d. *Phoneutria* and *Ctenus*.

56. (C28) The most important poisonous spider within the United States is the

a. brown recluse.
b. brown widow.
c. black widow.
d. red widow.

57. (C29) Although spiders are worldwide in distribution, most are found in

a. temperate and tropical zones.
b. tropical and subtropical zones.
c. temperate and meridian zones.
d. meridian and tropical zones.

58. (C29) Spiders belonging to the class Arachnida are identified as having

a. segmented abdomen, eight legs, no wings, and no antennae.
b. segmented abdomen, six legs, no wings, and two antennae.
c. unsegmented abdomen, six legs, no wings, and two antennae.
d. unsegmented abdomen, eight legs, no wings, and no antennae.

59. (C30) Which of these spiders is found only in Florida and is usually brown to grey in color with a red to orange color hourglass?

a. Red widow.
b. Black widow.
c. Brown widow.
d. Brown recluse.

60. (C30) Which of the following statements identifies a brown recluse spider?

a. Dark fiddle-shaped band on the anterior portion of the carapace.
b. The abdomen is dark brown splotched with yellow.
c. Usually brown or grey with red hour glass markings.
d. Not shiny black, but smokey black.

61. (C31) Eliminating all possible breding areas of black widow and other spiders is known as

a. biological control.
b. chemical control.
c. cultural control.
d. physical control.

62. (C31) Insecticide applications used indoors for controlling spiders are best applied as

a. space and repellent treatments.
b. contact and space treatments.
c. residual and contact treatments.
d. space and residual treatments.

63. (C32) The medical importance of a scorpion is determined by its

a. habits and venom potency.
b. size and venom potency.
c. venom potency only.
d. size only.

64. (C32) The scorpions of medical importance are members of genus

a. Tityus.
b. Buthus.
c. Perabuthus.
d. Centruroides.

65. (C33) The scorpion has four pairs of legs and a body with two divisions,

a. unsegmented cephalothorax and unsegmented abdomen.
b. unsegmented cephalothorax and segmented abdomen.
c. segmented cephalothorax and segmented abdomen.
d. segmented cephalothorax and unsegmented abdomen.

66. (C33) The two poisonous species of scorpions in the United States are typically

a. less than 1 inch long and straw-yellow in color.
b. 1-4 inches long and brown to black in color.
c. 2-3 inches long and straw-yellow in color.
d. .5-1 inches long and brown to black in color.

67. (C34) Which of the following is *not* a suitable method of controlling scorpions?

a. Site sanitation.
b. Avoidance.
c. Predators.
d. Trapping.

68. (C34) The two residual insecticides used to control scorpions are

a. propoxur and chlorpyrifos.
b. diazinon and dichlorvos.
c. malathion and pyrethrin.
d. diazinon and propoxur.

69. (C35) In giving first aid treatment to a victim stung by a poisonous scorpion, you would

a. apply a tourniquet between the sting and the body.
b. apply hot compresses or the sting area to draw out the venom.
c. immediately swab the sting area with alcohol.
d. do all of the above.

70. (C35) What is the correct sequence for the following actions when giving first aid for a scorpion sting?

(1) Apply an ice pack to the sting site.
(2) Seek medical assistance for antivenins.
(3) Place a tourniquet between the sting and body.

a. (2), (1), (3).
b. (2), (3), (1).
c. (3), (1), (2).
d. (1), (3), (2).

71. (C36) Which of these lepidoptera larvae has a thick, fleshy body completely covered and hidden by tawny-to-grayish colored hairs?

a. White-marked tussock moth.
b. Puss caterpillar.
c. IO moth.
d. Brown-tail moth.

72. (C36) Which of these moth larvae is considered to be beautiful, with a combination of colors including vermillion, black, and yellow?

a. IO moth.
b. Puss caterpillar.
c. Brown-tail moth.
d. White-marked tussock moth.

73. (C37) Which of the following is a useful preventive control for centipedes, millipedes, and conenoses?

a. Home sanitation.
b. Screening.
c. Yellow light bulbs.
d. Coarse dusts.

74. (C37) For which of these pests should your control measures be particularly swift to reduce pest loss of nettling spines?

a. Centipedes.
b. Millipedes.
c. Caterpillars.
d. Conenoses.

75. (C38) Poisonous snakes within the United States are in the families

a. Viperidae and Colobridae.
b. Elapidae and Crotalidae.
c. Colobridae and Epapidae.
d. Boidae and Crotalidae.

76. (C38) Which one of the following statements is true concerning snakes?

a. A horsehair rope does not stop a snake.
b. Snakes can't bite underwater.
c. Snakes take milk from a cow.
d. A hoop snake chases people by holding its tail in its mouth and rolling over and over.

77. (C39) Which of the following snakes will seek cover quickly when disturbed, except when it is cornered?

a. Moccasin.
b. Copperhead.
c. Horned rattlesnake.
d. Eastern diamondback.

78. (C39) The snake which feeds largely on rabbits and quail is the

a. moccasin.
b. copperhead.
c. horned rattlesnake.
d. eastern diamondback.

79. (C40) The coral snake belongs to the family

a. Bostrichidae.
b. Anobiidae.
c. Lycidae.
d. Elapidae

80. (C40) Where do coral snakes commonly habitat?

a. In rock areas.
b. Around open, hilly regions.
c. Under bark of decaying logs.
d. In bushes or small trees.

81. (C41) Which of the following symptoms describes the envenomization by pit vipers?

a. Excessive salivation and sweating.
b. Slurring of speech and tingling sensation.
c. Prompt and progressive swelling.
d. Drooping of eyelids and unsteady gait.

82. (C41) Which of the following symptoms describes the envenomization by coral snakes?

a. Bruiselike discoloration.
b. Shock, vomiting, and nausea.
c. Local decay of tissue.
d. Excessive salivation and sweating.

83. (C42) No extensive first aid treatment is needed for a snakebite if the victim can receive professional medical treatment within

a. fifteen minutes.
b. thirty minutes.
c. one hour.
d. two hours.

84. (C42) Incision and suction treatment for a snakebite should be started within

a. 10 minutes, but not after 1 hour.
b. 10 minutes, but not after 2 hours.
c. 20 minutes, but not after 1 hour.
d. 20 minutes, but not after 2 hours.

85. (C43) The best method for preventing snakes from using a given area is

a. using chlorinated hydrocarbons as repellent barriers.
b. maintaining an effective rodent control program.
c. trapping and transporting poisonous species.
d. making sure people stay out of the area.

86. (C44) What is the most important growth characteristic of weeds?

a. Competitive ability.
b. Rapid growth ability.
c. Abundant seed production.
d. Ability to thrive in cultivated land.

87. (C44) Some seeds of various weeds can last in the soil for a maximum of

a. 5 years.
b. 10 years.
c. 25 years.
d. 50 years.

88. (C15) What type of plant, propagated by seed only, requires two seasons to complete its reproduction cycle?

a. Annual.
b. Biennial.
c. Perennial.
d. Semiannual.

89. (C15) What type of weed with creeping roots or stems is generally considered to be the most noxious?

a. Annual.
b. Biennial.
c. Perennial.
d. Semiannual.

90. (C16) What are cotyledons?

a. Grasses with fibrous root systems.
b. Tiny leaf-like structures that emerge from germinated seed.
c. The parallel venations of grass leaves.
d. Grasses that are perennial.

91. (C16) Which of the following is *not* a characteristic of herbaceous broadleaf plants?

a. The root system is relatively shallow and extensive.
b. The leaves are relatively wide with netted venation.
c. There are two leaf-like structures that appear upon germination.
d. There are clusters of leaves at the end of branches.

92. (C17) To what group of aquatic plants do algae belong?

a. Emersed.
b. Floating.
c. Suspended.
d. Submersed.

93. (C17) Emersed aquatic plants

a. use the bottom of a body of water for germination only.
b. float on the water surface.
c. are firmly rooted to the soil and will extend above the water surface.
d. complete their entire life cycle below the water surface.

94. (C18) What is the correct sequence of the following steps you should conduct before you apply herbicides?

(1) Select the proper equipment.

(2) Choose the right herbicide.

(3) Identify weeds needing control.

(4) Read the herbicide label.

(5) Plan herbicide applications according to the label.

a. (3), (2), (5), (1), (4).
b. (3), (2), (4), (5), (1).
c. (2), (3), (1), (4), (5).
d. (2), (3), (4), (5), (1).

95. (C19) What type of herbicide is generally used for controlling grasses and herbaceous broadleafs in areas such as storage areas, lumberyards, and parking lots?

a. Contact.
b. Translocative.
c. Soil sterilant.
d. Selective.

96. (C50) What type of control is often the only method available for controlling weeds in inaccessible areas?

a. Mechanical.
b. Biological.
c. Chemical.
d. Natural extinction.

97. (C50) What is the *most* practical mechanical method for controlling annual and biennial weeds from early spring to midsummer?

a. Mowing.
b. Burning.
c. Mulching.
d. Cultivating.

98. (C51) What situation provides the *best* condition for selective control of weedy grasses growing in turf grasses?

a. The weedy grass is perennial and the turf grass is an annual.
b. The weedy grass is an annual and the turf grass is a perennial.
c. The weedy grass is a biennial and the turf grass is an annual.
d. The weedy grass is an annual and the turf grass is semiannual.

99. (C52) What is the *most* popular aquatic weed control measure?

a. Chemical.
b. Biological.
c. Mechanical.
d. Natural extinction.

100. (C52) Which mechanical control measure is equally effective for all types of aquatic vegetation?

a. Mowing.
b. Burning.
c. Dredging.
d. Chaining.

END OF EXERCISE

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012 and EO 9397. PRINCIPAL PURPOSES: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package. It is utilized by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's need. Failure to provide all information would result in slower action or inability to provide assistance to the student.

SECTION I: CORRECTED OR LATEST ENROLLMENT DATA: *(Mail to ECI, Gunter AFS AL 36118)*

1. THIS REQUEST CONCERNS COURSE (1 - 6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7 - 15)	6. GRADE/RANK	7. NAME *(First initial, second initial, last name)* (17) (18) (19-32)
– –		

8. ADDRESS *(OJT Enrollees – Address of unit training office with zip code. All others – current mailing address with zip code.)*	(33-53) (54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33 - 39)

SECTION II: REQUEST FOR MATERIALS, RECORDS, OR SERVICE

(Place an 'X' through number in box to left of service requested)

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1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction (Provide Old or Incorrect data)
4	Request Grade/Rank change/correction.
5	Correct SSAN. (List incorrect SSAN here) (Correct SSAN should be shown in Section I)
6	Extend course completion date. (Justify in REMARKS)
7	Request enrollment cancellation. (Justify in REMARKS)
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 Originals were: ☐ Not received ☐ Lost ☐ Misused
9	Send course materials. (Specify in REMARKS) ☐ Not received ☐ Lost ☐ Damaged
10	Course exam not yet received. Final VRE submitted for grading on ________ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 not yet received. Answer sheet(s) submitted ________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on ________ (date).
13	Previous inquiry (☐ ECI Fm 17, ☐ Ltr, ☐ Msg) sent to ECI on ________ (date).
14	Give instructional assistance as requested on reverse.
15	Other (Explain fully in REMARKS)

6 G	33
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REMARKS *(Continue on Reverse)*

OJT STUDENTS must have their OJT Administrator certify this request.	I certify that the information on this form is accurate and that this request cannot be answered at this station. *(Signature)*
ALL OTHER STUDENTS may certify their own requests.	

ECI FORM 17 OCT 83 (PREVIOUS EDITIONS MAY BE USED)

56650 07 23

SECTION III: REQUEST FOR INSTRUCTOR ASSISTANCE

NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

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Course No ________

Volume No ________

VRE Form No ________

VRE Item No ________

Answer You Chose ________ (Letter)

Has VRE Answer Sheet been submitted for grading?

[ ] Yes [ ] No

REFERENCE

(Textual reference for the answer I chose can be found as shown below)

In Volume No ________

On Page No ________

In [ ] left [ ] right column

Lines ____ Through ____

MY QUESTION IS:

REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

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CDC 56650

ENTOMOLOGY SPECIALIST

(AFSC 56650)

Volume 8

General Contingency Responsibilities

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THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

Preface

THIS VOLUME OF CDC 56650, Entomology Specialist, provides you with general knowledge about the following subjects: first-aid techniques, field sanitation and hygiene, self-protection from extreme weather, work party security, expedient field water treatment, and vehicle equipment qualifications and operations. To become qualified in contingency operations, you must be knowledgeable in these subjects.

Code numbers appearing on figures are for preparing agency identification only.

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Direct your questions or comments relating to the accuracy or currency of this volume to the course author: 3770 Technical Training Group, ATTN: MSgt Robert C. Pletts, Sheppard AFB TX 76311. If you need an immediate response, call the author, AUTOVON 736–2879, between 0800 and 1600 (CST), Monday through Friday. (*NOTE: Do not use the suggestion program to submit changes or corrections for this course.*)

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to a Successful Course, Behavioral Objective Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO as appropriate. If this person can't answer your questions, send them to ECI, Gunter AFS AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 30 hours (10 points).

Material in this volume is technically accurate, adequate, and current as of November 1980.

Contents

NOTE: In this volume, the subject matter is developed by a series of student-centered objectives. Each of these carries a three-digit number and is in boldface type. Each sets a learning goal for you. The text that follows the objective gives you the information you need to reach that goal. The exercises following the information give you a check on your achievement. When you complete them, see whether your answers match those in the back of this volume. If your response to an exercise is incorrect, review the objective and its text.

First Aid Techniques

SOMEDAY YOU may save someone's life—possibly your own-if you know how to give first aid. You've heard similar statements many times before, but don't take such statements lightly. A little effort on your part right now could mean that one of your buddies will not lose a finger, a leg, or his life later.

1-1. Responsibilities

Since your job takes you to so many remote locations around the base, you may be the only one at the scene of an accident or another emergency. One of your first obligations is to render aid to those who are injured. Your actions in treating a casualty must be immediate, thorough, and correct.

E01. State your responsibilities as a first-aider.

Fundamentals of First Aid. As an airman, you have important reasons for learning first aid. Proper first aid may mean a vital mission accomplished, rather than mission not accomplished. Learn how to give first aid; you can't afford not to.

You can easily learn the fundamentals of first aid. Highly technical, involved study is not necessary to become a capable first-aider. You can improve your handling of emergencies just by acquainting yourself with the procedures of first aid.

You should discuss the procedures outlined in this chapter with other airmen. You should use the "buddy method" to practice the various steps outlined. You can learn a lot more by actually applying a splint to an arm than you can by just reading about it.

You should familiarize yourself in first aid measures for injuries such as fractures and chest wounds, for emergencies such as drowning and electric shock, and for common emergencies such as minor wounds and unconsciousness. You should learn as much as you can about first aid measures for sickness and injury resulting from industrial toxic substances.

Very important are procedures dealing with assuring breathing, preventing or treating shock, first aid for electric shock or drowning, poisonous plants, the effects of heat, and the effects of cold. While studying these topics, keep in mind that skin color changes may be too subtle to recognize if the patient is darkly pigmented. Therefore, it is necessary to carefully observe the injured for these changes on the palms, soles, nail beds, mucous membranes of the lips and mouth, and mucous membrane which lines the eyelids and is reflected onto the eyeball.

As you know, first aid refers to the treatment given the sick and injured before a trained individual can administer regular medical or surgical treatment. Personnel in the Air Force medical service have the finest medical equipment available, and they are trained in the most modern methods of saving lives and easing pain. But they can't be everywhere at once, so in an emergency you may have to depend upon your own knowledge of first aid.

The good first-aider deals with the whole situation—the person as well as the injury. When giving first aid, a person who lacks sufficient knowledge could possibly cause even further injury to an injured person. Anyone attempting first aid must use care and skill.

In practicing first aid, your primary duty is to know what to do and what not to do. You must keep calm, use appropriate first aid measures, and seek medical help as soon as possible. Never attempt treatment that is beyond your skill, and never move an injured person unless absolutely necessary.

Exercise (E01):

1. As a first-aider, what areas should you familiarize yourself with?

2. What are alternate methods of determining skin color changes?

3. What is your primary responsibility when practicing first aid?

1-2. Lifesaving Steps of First Aid

When you treat a victim, you must carry out four lifesaving steps. Memorize these steps and learn the simple methods of carrying them out. Bear in mind that prompt and correct first aid not only speeds healing but may also save a life.

E02. Name the four lifesaving steps of first aid, and state why cutting or tearing is usually the best way to remove clothing from the area near a wound.

Four Lifesaving Steps. To treat an injured person, you should carry out what is known as the four lifesaving steps. These steps are: assure breathing, stop the bleeding, protect the wound, and prevent or treat shock. You should memorize these four lifesaving steps and learn the simple methods of carrying them out. Now is the time to learn how to do this. Prompt and correct first aid not only speeds healing but, as emphasized before, may save a life.

To treat a wound, begin by looking carefully at it—but don't touch it. Look to see if there is more than one wound. If the patient has been hit by a flying fragment or other missile, check to see if the missile came out the other side, a condition which would require treatment of a second area.

You must see all of the wound to find out exactly where it is, how large it is, and how much it is bleeding. Usually the best way to remove clothing is by cutting or tearing. Pulling clothing over the wound increases the danger of infection, and moving the wounded part may make the wound worse, as well as cause needless pain.

If possible, cover the wound to prevent further contamination and then treat for shock.

Exercises (E02):

1. What are the four lifesaving steps?

2. Why is cutting or tearing usually the best way to remove clothing from the area near a wound?

E03. From a list of statements about assuring breathing, identify the true statements, and state briefly why the others are false.

Assure Breathing. When a victim can't breathe, any other action you take is of little value because a lack of air can quickly cause a victim's death. Thus, you must see whether the air passageway (airway) is blocked; if it is, you must clear it and keep it clear.

Check for airway obstructions. There are three main causes for airway obstructions. The first is foreign matter, such as false teeth or liquids, in the mouth or throat. The second is caused by relaxation of the jaw. When the victim is unconscious, the jaw muscles relax and sometimes allow the tongue to roll backward and block the throat. This is commonly called swallowing the tongue. The third cause of airway obstruction is the victim's neck position. For example, when a victim's chin is close to the chest, the neck is bent in a manner which "kinks" the throat, thus preventing the passage of air. You must be sure the casualty is able to get air to the lungs. If necessary, you must clear the airway.

Clear the airway. Clear the airway quickly by sweeping your fingers deep into the victim's mouth to remove froth, debris, or any other obstructing matter. Grasp the tongue with your fingers and pull it forward so that it doesn't obstruct breathing. Usually, you have to drive your fingernails into the tongue in order to hold it firmly. Then, look into the mouth to see whether any broken teeth, splintered bone, or other particles are clogging the throat. If so, remove them by any means available: your fingers, a twig, etc. Don't be slow and careful now—the victim's life is ebbiing out. Scratches you might make in the throat are not going to kill the person, and the scratches can always be treated at the hospital. What matters is to get the airway cleared immediately. Anything else is less important at this time.

In some instances, it may be necessary for you to "tie" a victim's tongue in the forward position with a clamping device. For example, if you were alone and had to restore a victim's breathing and heartbeat, you could not possibly hold his or her tongue at the same time. One clamping device you can use is the clip that holds your canteen to your web belt. Another is a safety pin. Clamp the victim's tongue to the lower lip as shown in figure 1-1. When the victim's airway is cleared, it must remain clear.

Keep the Airway Open. You can keep the airway open by placing the victim's head in a position that stretches the throat to what is called the sword-swallowing position (see fig. 1-2). Use the thumb jaw lift method or the two-hand jaw lift method that figure 1-3 illustrates. Even if the victim is on his or her stomach or side, place his or her head so that the throat is stretched away from the chest

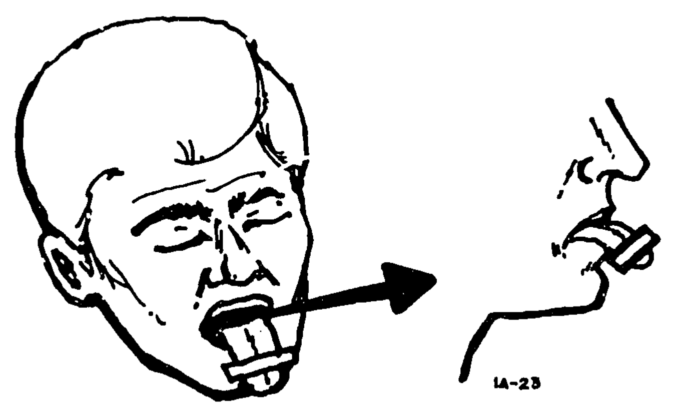

Figure 1–1. Clamping the tongue.

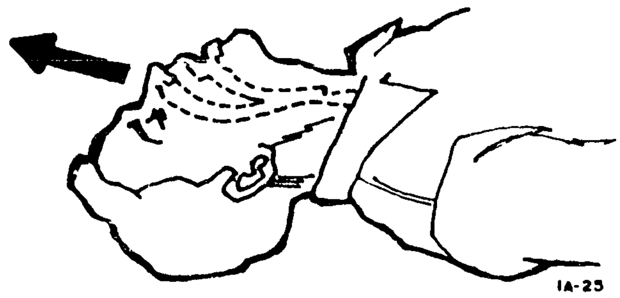

Figure 1–2. Sword swallowing position.

to allow air to pass to the lungs (see fig. 1-4). When someone stops breathing, establish and maintain an open airway at once.

Exercises (E03):

Identify each true statement by writing "true" in the space provided; briefly explain why the others are false.

____ 1. A victim who can't breathe will undoubtedly die in a short period of time.

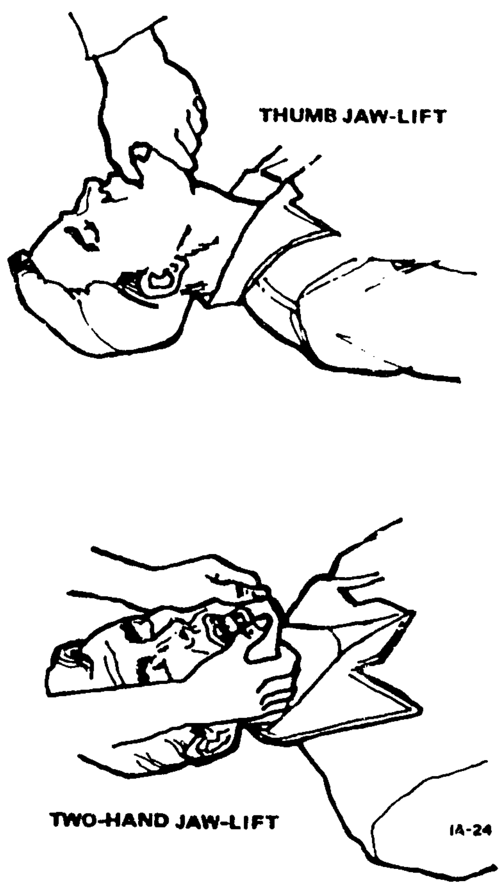

Figure 1–3. Thumb and two-hand jaw-lifts.

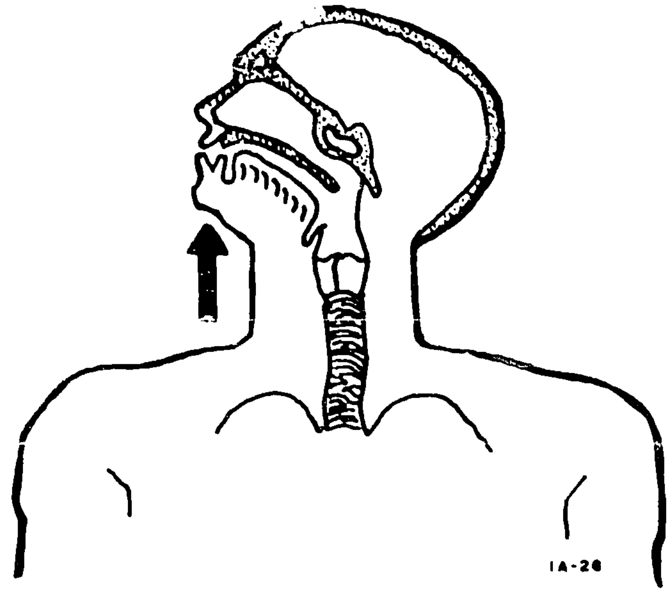

Figure 1–4. Stretch the neck.

____ 2. The main causes of airway blockage in a victim are tongue swallowing, neck bending, and foreign matter in the mouth or throat.

____ 3. Of more importance than how you clear a blocked airway is the fact that it is cleared.

____ 4. In some situations, a victim's tongue must be held in the forward position by mechanical means, such as safety pin or shoe string.

____ 5. Placing a victim's head in the sword-swallowing position means placing his chin close to his chest.

____ 6. There are two variations of stretching the victim's neck: the thumb jaw-lift and two-hand jaw-lift methods.

____ 7. Checking for obstructions and opening and maintaining an open airway are the primary steps of assuring breathing.

E04. Match given statements about a bleeding victim with the types of bleeding and the best methods to control that bleeding.

Stop Any Bleeding. Similar to the need for assuring that a victim can breathe is the need to stop any bleeding—the victim's life is at stake. A person's uncontrolled bleeding can result in severe shock and death. To control or stop any bleeding, you must first know the three main types of bleeding.

Types of bleeding. Types of bleeding are classified by the kind of blood vessel that has been cut. Therefore, they are called arterial, venous, and capillary bleeding. In arterial bleeding, the most dangerous kind, you see a large amount of bright red blood and a spurting or pumping action as the blood leaves the wound. When a vein has been cut, causing venous bleeding, a large amount of dark red blood flows from the wound without the spurting action which characterizes arterial bleeding. In capillary bleeding, the blood oozes or flows very slowly from the wound. Remember these signs. Your doing so may help you select the best method to stop the bleeding of a victim.

Controlling bleeding. Before you treat a bleeding victim, first check to see whether there is more than one wound. It would be senseless to take great pains to stop bleeding from one wound while the victim's life was draining away from another wound. To stop bleeding, you first apply direct pressure to the wound. Preferably, use a surgical dressing from a first aid pack; but if one is not available, use anything you have. Obviously, you want to be sure the dressing is as clean as possible. Place the dressing directly over the wound and press firmly. Continue this pressure as long as necessary, and use additional dressings if required. If the wound is on the arm or leg, you can place the victim on his or her back and elevate the limb. The elevation tends to reduce circulation to that limb and, thus, slow down the flow of blood. However, do not attempt to do this if the victim has other injuries on that limb (for example, broken bones), because moving that limb could cause further injuries and unnecessary pain and increase the danger of shock.

Pressure points. In addition to applying pressure directly on the wound and elevating the wound, you can apply pressure at one of several pressure points. Figure 1-5 shows the location of these point. Place your finger lightly where you think the pressure point is. If you feel a pulse beat similar to a throbbing, you are right on it. Then, use the heel of your hand or fingertips your to press hard. Continue this pressure until any blood gushing from the wound ceases. If you release pressure and bleeding starts again, reapply the pressure. One warning about pressure points: in cases of head wounds, where pressure points are commonly used, be sure NOT to press on both neck pressure points at the same time.To do so will block the flow of blood to the victim's brain and eventually result in death.

Tourniquet. Use a tourniquet only as a last resort, and only after all other methods of controlling the bleeding have failed. Usually, tourniquets are applied only in cases of extreme arterial bleeding. Apply a tourniquet only when you assume that there has been a great loss of blood and that any further loss, even in a small quantity, will be fatal. In other words, act on the assumption that it is better for a victim to lose a limb than a life. As soon as possible after you have applied a tourniquet, get the victim to a hospital. Under no circumstances should the tourniquet be loosened by anyone except a physician, who can stop the bleeding by surgical methods.

When you apply a tourniquet, always place it near the joint (knee, elbow) closest to the wound and between the wound and the heart because the gushing arterial blood is coming directly from the heart. Tighten your tourniquet only as much as needed to stop the spurting blood flow. Place it as close as possible to the wound but above it, except in cases of bleeding below the knee or elbow. In these cases, place a tourniquet just above the knee or elbow. When possible, protect the victim's skin by placing the tourniquet over a smooth sleeve or trouser leg. Figure 1-6 shows the exact procedure for applying tourniquets. If at all possible, stay with the victim, and check the tourniquet frequently to see whether it has slipped and whether there is any sign of further bleeding. Should the bleeding resume, or the tourniquet slip out of place, tighten or readjust it as necessary. In cold weather, because there is a very real possibility of cold injury to a victim's injured limb, protect the limb with anything available: a blanket, jacket, etc.

Again, be sure that the victim gets qualified medical treatment as soon as possible. You must also be certain that medical personnel can see that a tourniquet has been applied. To do this, you could write the information on a piece of paper and attach it to the victim's clothing, or you could write the information on the victim's forehead, face, or other readily seen body part.

Exercise (E04):

1. Match the statements in column A with the types of bleeding in column B, and with the best method to control that bleeding in column C, by writing the column B and column C letters in the space provided. Each item in columns B and C may be used more than once.

Column A

____ (1) A victim has blood spurting from a lower leg wound.

____ (2) A victim has dark red blood coming fro a cut on the forehead.

____ (3) A victim with a wound on the upper right arm is pumping blood past the bone fragments sticking out.

____ (4) Blood is rapidly flowing from a cut at the left side of a victim's head. Your efforts at direct pressure have failed.

____ (5) A victim has a large, ugly open wound in the leg, and blood is slowly coming from the wound.

____ (6) A victim has stepped on a board with a nail in it, and the wounded foot has blood oozing out of it.

Column B

a. Arterial.
b. Venous.
c. Capillary.

Column C

A. Direct pressure.
B. Pressure point.
C. Tourniquet.

Column A

____ (7) Dismounting from the bed of a pickup, an airman slipped and hit hisherchinonthetailgate.Thereisa deepcutonthechin,andbloodisflowingfromthewound.

____ (8) An accident victim has been cut on the left shoulder by a piece of glass, and the blood is flowing slowly from the wound.

____ (9) A CE construction worker has severed three fingers, and blood is vigorously flowing from the wound.

____ (10) You are late for work. While shaving you make a deep cut on your cheek. The blood is running smoothly from your cheek.

E05. State the purpose for protecting wounds, and define "dressing" and "bandage."

Protect the Wound. Protecting a wound from infectionn and from further injury constitutes the third lifesaver step. You must, of course, keep this important first aid measure in mind throughout the treatment of any victim.

A dressing is a pack or padding placed directly on the wound. A bandage is used to hold the dressing in place or create pressure to stop the flow of blood. Bandages should never be placed directly on the wound. Always try to use sterile dressings from a first aid pack; and only as a last resort use other material such as strips torn from a shirt. While dressing a wound, avoid touching it with your

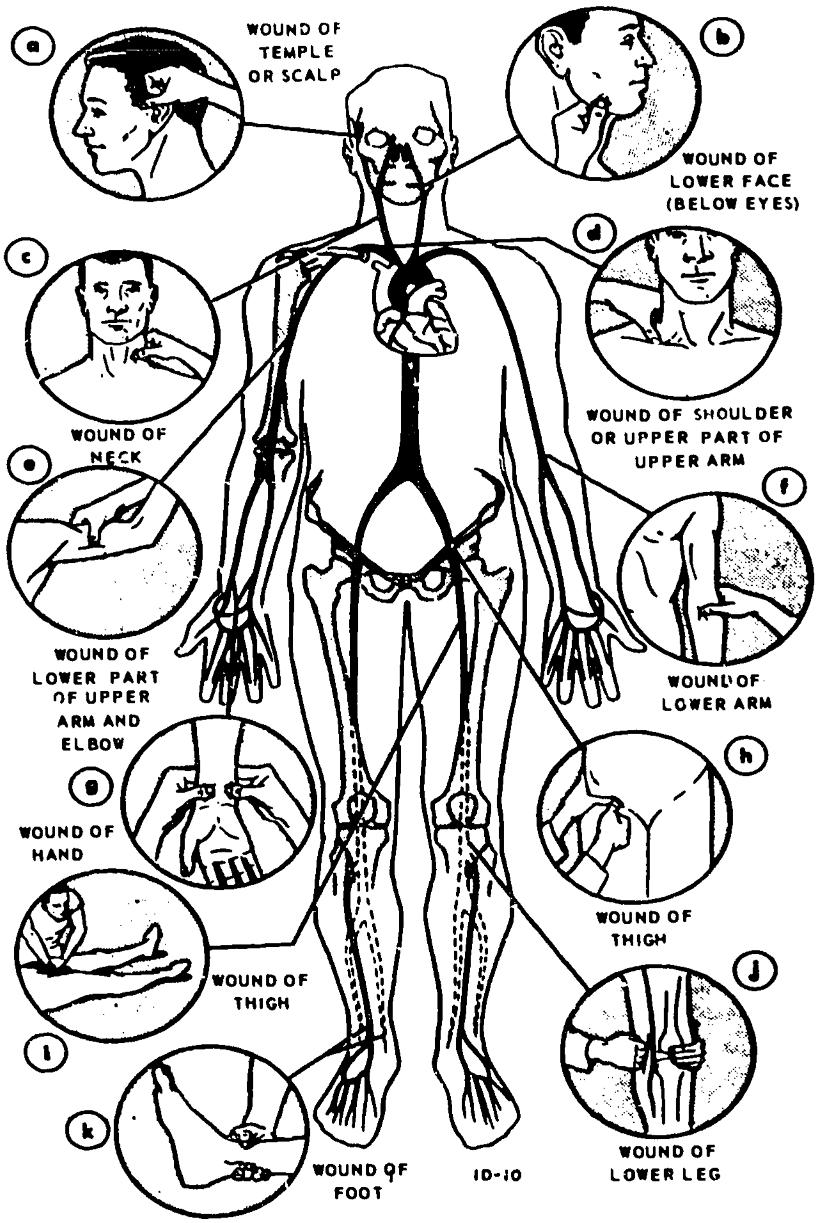

Figure 1–5. Pressure points.

hands and do not handle the side of the dressing that goes next to the wound. Do not pull clothing over the area to be treated because it could infect the wound further. Instead, tear out cut clothing away from the injured area. If you have a regular first aid wound pack available, follow the instructions printed on the back of the package.

Remember, when bleeding is severe, immediately carry out measures to stop the bleeding by applying dressings and bandages; and prevent or treat shock in all casualty situations.

Exercises (E05):

1. What is the purpose of dressing a wound?

2. What is a dressing?

3. What is a bandage?

E06. Specify whether given statements correctly define shock and shock treatment; if any statement is incorrect, briefly state why.

Prevent or Treat Shock. Although treatment of shock is listed as the fourth of the lifesaver steps, you actually begin treating for shock simultaneously with stopping bleeding. Shock exists in several forms, the least dangerous of which is the temporary shock caused by pain, fright, horror, or the sight of blood of other severely injured persons. Such temporary shock may result in fainting, and the victim recovers quickly with no further effects. Far more dangerous is the type of shock caused by severe injuries or bleeding. Unless treated properly and promptly, this type shock is most often fatal. Normally, the severity of shock corresponds to the severity of the injury. Also, delayed shock is not uncommon and may set in several hours after an injury has occurred. Don't be overly concerned with determining the type of shock; just follow the golden rule: treat for shock with any injury. You never hurt a victim by treating for shock, and even if they show no symptoms whatsoever, you have no way of knowing whether delayed shock may set in.

Symptoms of shock. A victim feels shock as a great weakness of the body. The outward symptoms are cold and clammy skin, shallow breathing, lackluster eyes, and apprehension or restlessness. Also, the victim may be

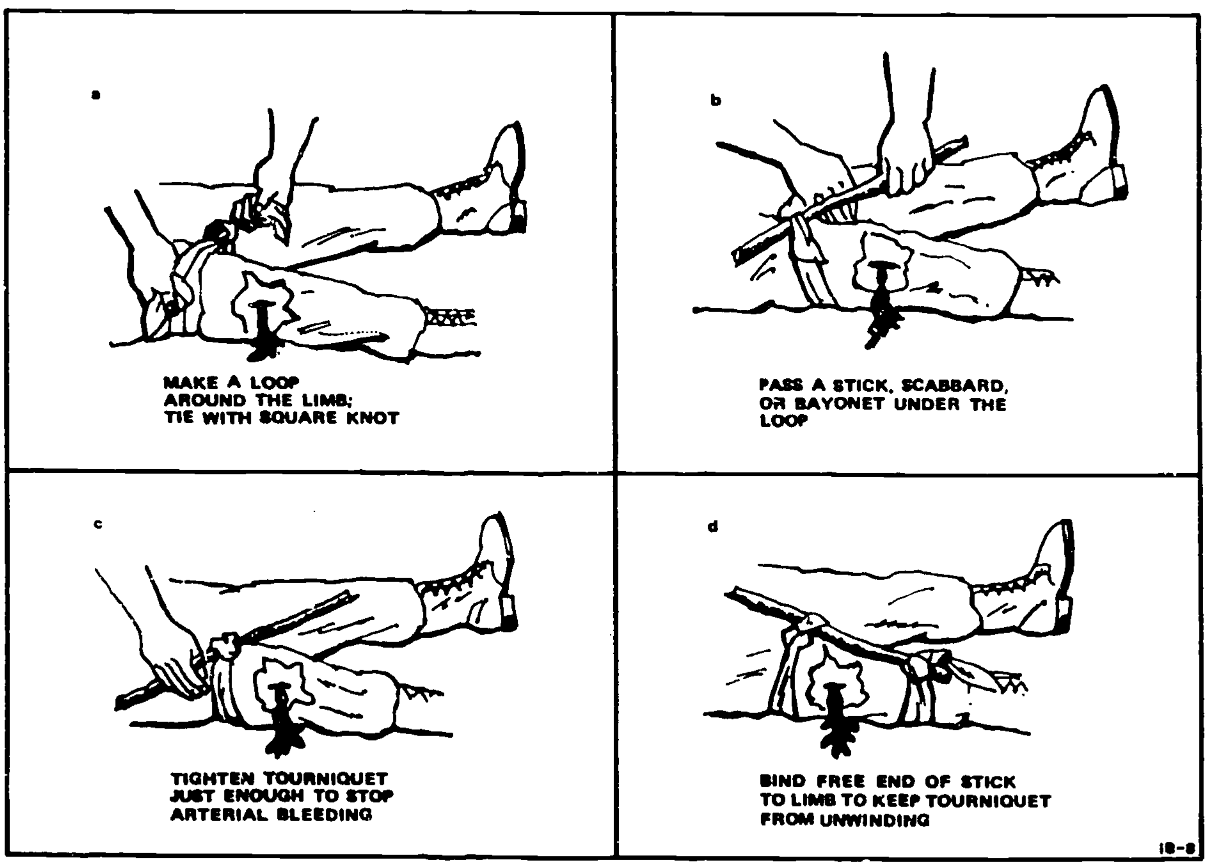

Figure 1-6. Applying a tourniquet.

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excessively thirsty, retching, vomiting, or hiccupping, and be dry around the mouth and lips. The victim is probably going to be pale and wet with perspiration and may gasp for air and lose consciousness. In the final stages, most victims become listless and apathetic and die in deep shock.

Action to take. In case of severe injury, it is imperative that treatment for shock be started immediately. The first steps in shock prevention and treatment are to reassure the injured person and make him or her as comfortable as possible. Place the victim flat on his or her back on a blanket or any other material available. Handle the victim gently, remove all bulky items from his or her pockets, and loosen the belt and clothing. Move the victim as little as possible. You can reassure a victim by being gentle and calm. Nervousness on your part transmits itself to the victim and may increase the degree of shock. Also, do not let the victim see his or her injuries or the injuries of others involved in the same accident. Give the victim as much water to drink as he or she wants, except when he or she has a stomach wound. However, do not give alcohol in any form. When a victim has a stomach wound, you may moisten his or her lips with a damp cloth. An unconscious victim should be placed on his or her stomach, face turned to one side to prevent choking should he or she vomit. This placement is called the shock position. Keep the victim warm by covering him or her with anything available, and be sure to place something under the victim as protection because the ground may be wet or cold. In a hot climate, place the person in the shade, with his or her face away from direct sunlight. Finally, remember that shock is a serious condition and that you should get qualified medical help as soon as possible. You treat for shock in all cases of injury or disaster.

When you have assured the breathing, stopped the bleeding, protected the wound, and treated for shock, you have completed the four lifesaver steps. Your job is not done, however. You must continue to watch the victim, insuring as best as you can that he or she stays alive to be treated by medical personnel. Remember the four lifesaver steps; they are the basis of all your other actions in first aid.

Exercises (E06):

For each of the following statements which is correct, write "true" in the space provided. For each statement which is incorrect, briefly state why.

____ 1. Shock must be treated immediately.

____ 2. When you treat victims for shock when they aren't really experiencing it, you cause little or no additional injury or emotional trauma.

____ 3. Hot, dry skin is indicative of shock.

____ 4. Unconsciousness can be a good indicator that a person is in shock.

____ 5. A victim who is undergoing shock can be given water, or wine with little or no side effect.

____ 6. Any injured person should be protected from the elements of weather and kept warm, particularly if shock is suspected.

____ 7. The shock position means the victim is on his or her stomach with his or her head turned to the side.

____ 8. You begin treating a person for shock after you have assured breathing, stopped the bleeding, and protected the wound.

1-3. Moving and Transporting Injured Personnel

Frequently, a seriously injured person must be moved immediately. Knowing how to move a casualty is one of the most important parts of your first aid treatment. Careless or rough movement can increase an injurt and may cause the victim's death. Unless there is a good reason for immediately moving casualties, such as removing them from a burning aircraft, do not move or transport them until medical help arrives. On the other hand, since there may be situations where you have to move a person yourself, you must know the different ways of moving them. You already know that you always give any necessary first aid, including splinting fractures, before you move a victim. What you must learn now are methods of constructing improvised litters and executing manual carriers. Because movement by litter is most desirable, the section begins with it.

E07. Given hypothetical situations, select the most appropriate methods of transporting injured personnel.

Litters. Transporting of victims is a critical point in evacuating them from the field to medical facilities. Since this movement is critical, you should use a litter (stretcher) whenever possible. Using a litter not only makes it easier for you to carry a victim but also makes the

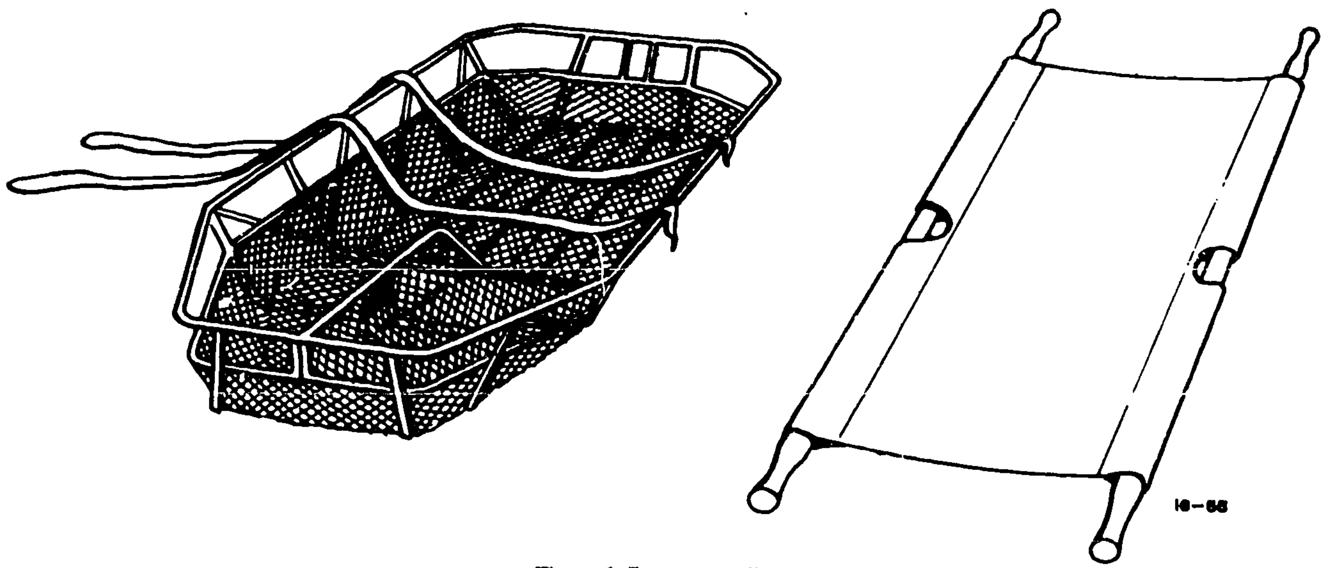

Figure 1–7. Standard litters.

journey safer and more comfortable for the injured. Remember that back and neck fracture casualties must not be moved except on a litter. Basically, there are two types of litters with which you must be familiar: standard and improvised.

Standard litter. A standard litter consists of a frame, a cover, and accessories, such as poles, legs, and securing straps. Generally, such litters as those shown in figure 1-7 are readily available and suited for moving any victim. When a standard litter is available, use it. In situations where no litter is available, you must construct one.

Improvised litter. An improvised litter is simply a substitute for a standard litter. It is constructed from whatever materials are available. Here are four improvised litters that you can construct very easily:

a. Pole and blanket litter. A blanket, poncho, shelter half, tarpaulin, or other material can be used for the bed of a pole and blanket litter. The poles can be made from such objects as strong branches, tentpoles, rifles, etc. Figure 1-8 is a good example of this type of litter. It would be best not to transport back or neck fracture victims on this type of litter unless they are face down.

b. Pole and jacket litter. Illustrated in figure 1-9 is an example of how you can use two or three shirts or field jackets to make a pole and jacket litter. Button up the jackets and turn them inside out so that the lining is

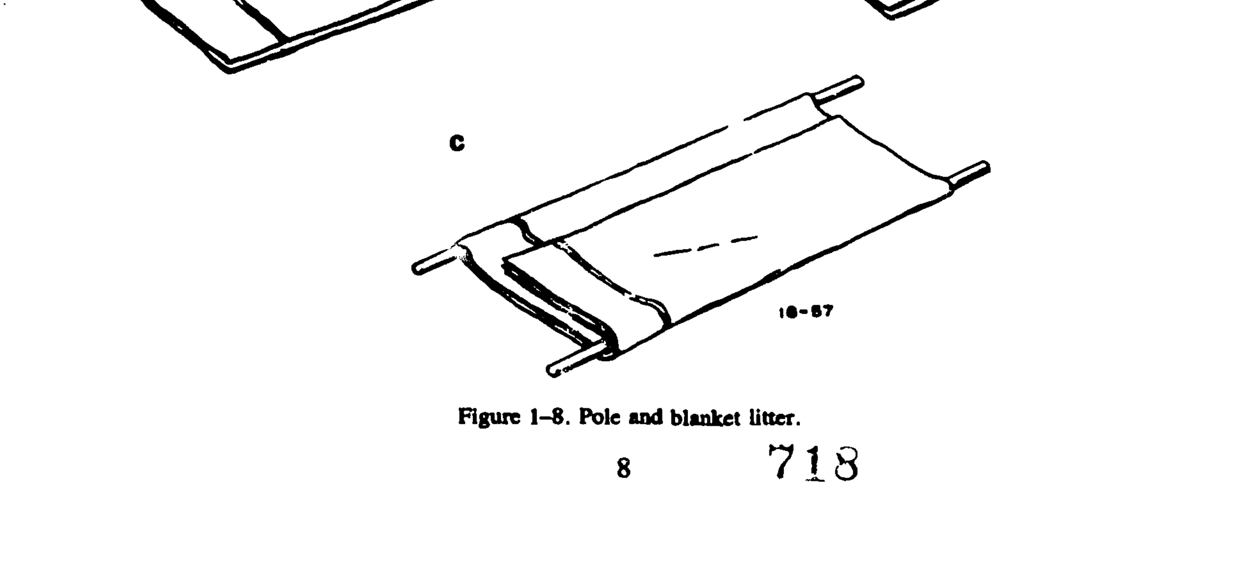

Figure 1–8. Pole and blanket litter.

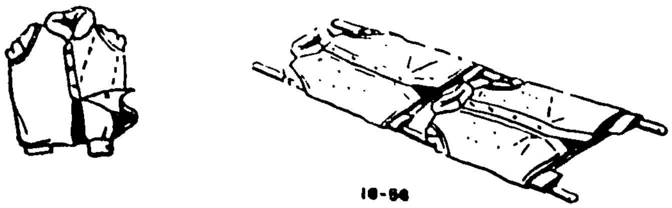

Figure 1–9. Pole and jacket litter.

outside and the sleeves are inside. Then slide the poles through the sleeves. Again, it's best not to use this for transporting back and neck fracture casualties unless they are face down.

c. Door or board litter. To make a door litter, you use any flat surfaced object of a suitable size, such as cots, window shutters, doors, benches, ladders, boards, or poles tied together. Even the hood, door, or windshield from a vehicle will work. You should pad this litter if possible. When you can, use this improvised litter to transport neck and back fracture victims.

d. Blanket roll litter. When you can't find poles or material to make a door litter, you can roll a blanket, shelter half, or poncho from both sides to the center, as shown by figure 1-10. Use the rolled material as grips when carrying the injured. You can use this litter with all victims.

Putting the Injured on the Litter. At this point, you know how to make and use a litter, and, obviously, you know that at least two people should carry a litter. As a minimum, two people are needed to place the victim on a litter. You and another person could move a victim from the ground to a litter (See fig. 1-11) in this way:

a. You and your assistant kneel on one knee on the same side of the victim.

b. You then slide your arms under the victim. Note that one of you slides your arms under the victim's hips and legs and that the other slides his or her arms under the victim's shoulders and back.

c. In a joint effort, you lift the victim to a height even with your knees. Use care, insuring that the victim's head doesn't drop, and keep the victim as straight as possible.

d. The final step is to place the victim on the litter. To do this, you lower the person to the litter by reversing the procedure you used to pick the person up.

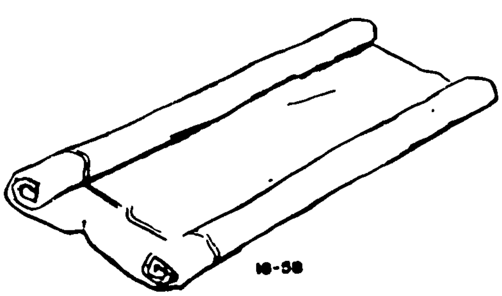

Figure 1–10. Blanket role litter.

Manual Carries. Manual carriers are tiring for the carrier and involve the risk of increasing the seriousness of the victim's injury. The methods of manual carry that are explained here can be used for conscious and unconscious victims. Bear in mind that a victim should be transferred to litter movement as soon as possible and that back and neck fracture injuries must be transported only by litter.

Two-man arm carry. Remember the technique we used to move a victim from the ground to a litter? The first three steps of that technique are the same for the two-man arm carry (fig. 1-12). Once you have the victim at a height

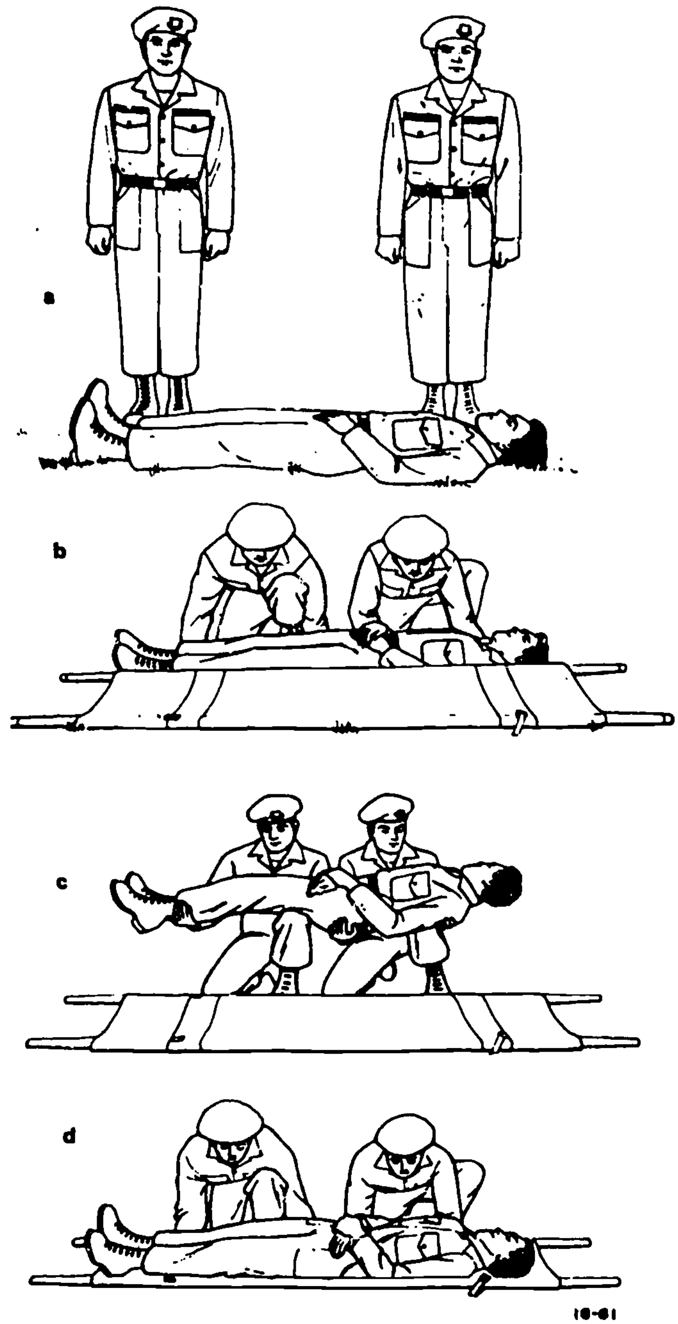

Figure 1–11. Two person litter lift.

equal to your knees, you and your assistant rise to your feet in a smooth, joint effort. As you rise, lift the victim and, by pulling your arms in, roll the individual toward your chest. You can use this technique with just about all types of injuries.

Two-hand carry. This method is ideally suited for for carrying victims with injuries of the head or feet, and it may not be as tiring for the carriers as the two-man arm-carry:

a. With the victim lying on his or her back, you and your assistant kneel on opposite sides of the victim's hips.

b. You both slide your arms under the casualty—one arm goes under the thighs and the other under the arms and behind the back. As you reach through, you and your assistant grasp wrists as shown in figure 1-13.

c. You and your assistant rise together and lift the injured person.

Fireman's carry. This technique is ideal when you must move a victim by yourself and you are not exposed to enemy gunfire. To use it, follow the steps shown in fig. 1-14.

a. Begin by turning the victim face down on the ground. Stand at his or her head and kneel on one knee with his or her head between your legs.

b. Place both hands under the victim's armpits and slide your hands down the his or her side so that they meet at the small of his or her back. This acton raises his or her head to your shoulders.

c. From this position, you now grasp or hug the victim and pull him or her to the kneeling position.

d. Once the victim is in the kneeling position, take a firmer grip across his or her back and lift him or her to the standing position.

e. Once the victim is standing, you support him or her by placing one arm around the waist. You then grasp the wrist farthest away from you and fold the victim's arm across his or her midsection.

f. You are now ready to load the victim to the carry position. Keep your grip on the victims waist and wrist

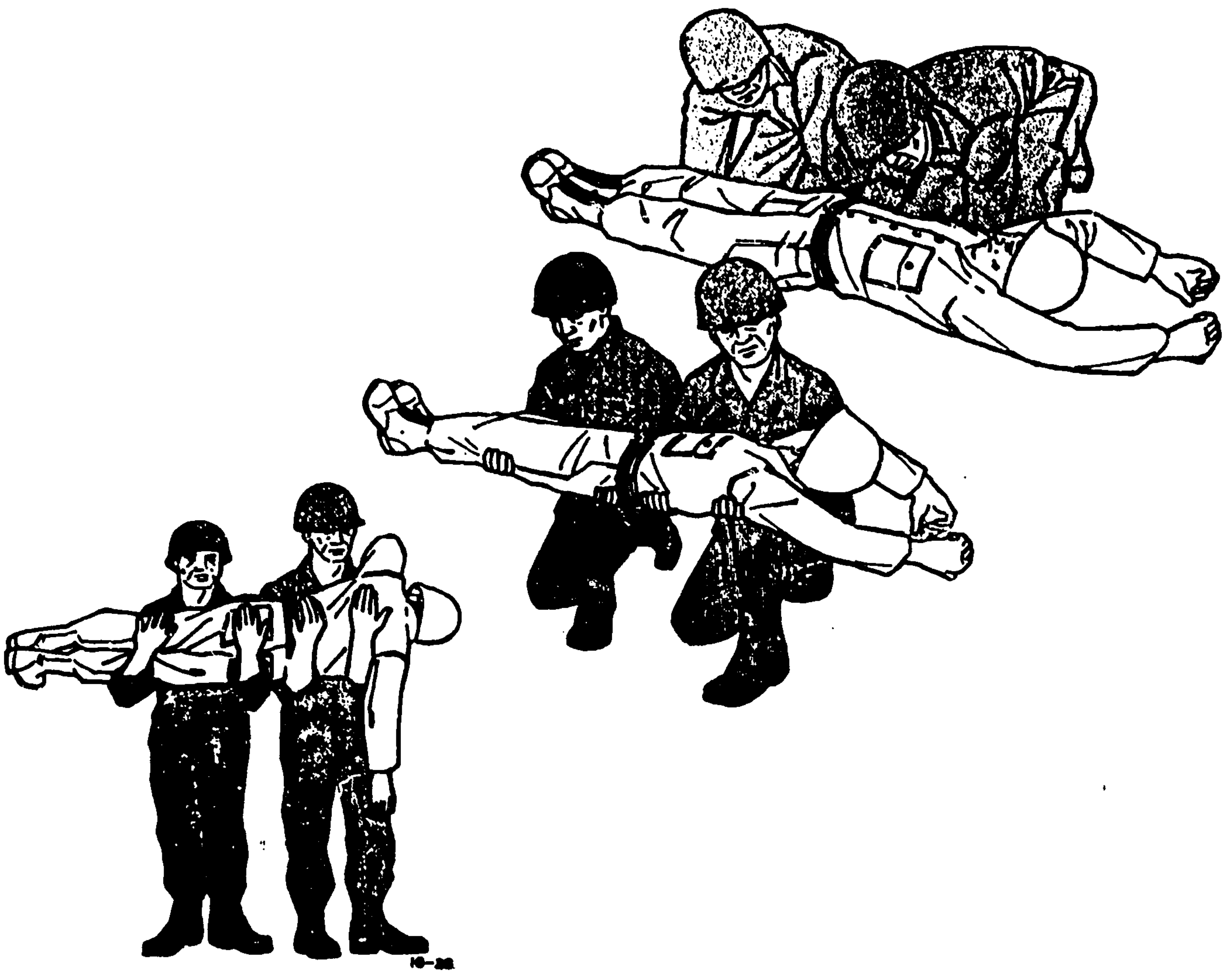

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Figure 1-12. Two-man arm carry.

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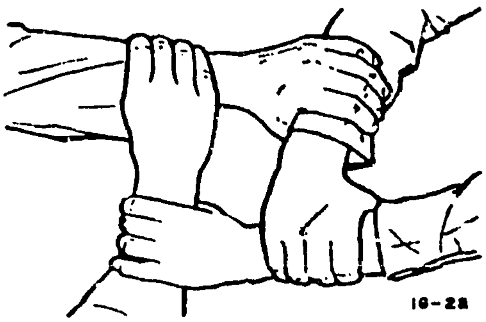

Figure 1–13. Two-hand carry (front view).

and m ›ve slightly to the front. As you move, bend at the waist and pull the wrist you are holding around the back of your neck. Release the victims waist, and with your arm encircle his or her leg.

g. At this point, you must use caution not to strain yourself by lifting. Remember to lift with your legs as you return to the standing position. You maintain your grip on the victims wrist and leg as you lift.

h. After you reach the standing position, you can carry the victim easier by grasping his or her wrist with your hand which encircles his or her legs.

Pistol-belt drag. This method (see fig. 1-15), although only useful for short distances, is ideal to move a victim to a location which offers cover and concealment so that you can use the fireman's carry. To use the pistol-belt drag, follow these steps:

a. Extend two pistol belts to their fullest length. Join them together and lay them on the ground in a straight line next to the victim.

b. Roll the victim to his or her back so that he or she is lying at about the middle of the extended pistol belts.

c. Reach across the victims chest, grasp the free end of the pistol belt, and, by pulling it to you, join the open pistol belts together to form one, large, continuous loop around the victim's chest and back. Be certain the belt goes under his or her armpits.

d. Lying on your side with your back to the victim, slip your upper shoulder through the loop. Roll away from the victim to your stomach. Then crawl away dragging the victim with you.

When transporting the sick and wounded, move a victim as little as possible. You must always be sure to treat any injury before you try to move a victim. Remember your four lifesaving steps throughout the period of movement, and treat symptoms as they occur.

Exercise (E07):

1. Match each hypothetical situation in column A with the best method of transportation in column B by writing the column B letter in the space provided. Column B items may be used only once.

Column A

____ (1) During a severe windstorm at your base, a CE maintenance man is blown off the side of a building. He is lying on his stomach, on the ground next to the building.

____ (2) On a camping trip, one of the two friends that accompanied you falls and break his legs. It is nearly 5 miles to the nearest road.

____ (3) During a base defense exercise, a securitypolic vehicle overturns on the base perimeter. The driver was thrown from the vehicle and landed with his back against a concrete drain. The two passengers are both shaken up but

Column B

a. Standard litter.
b. Improvised litter.
c. Two-man arm-carry.
d. Fireman's carry.
e. Pistol-belt drag.

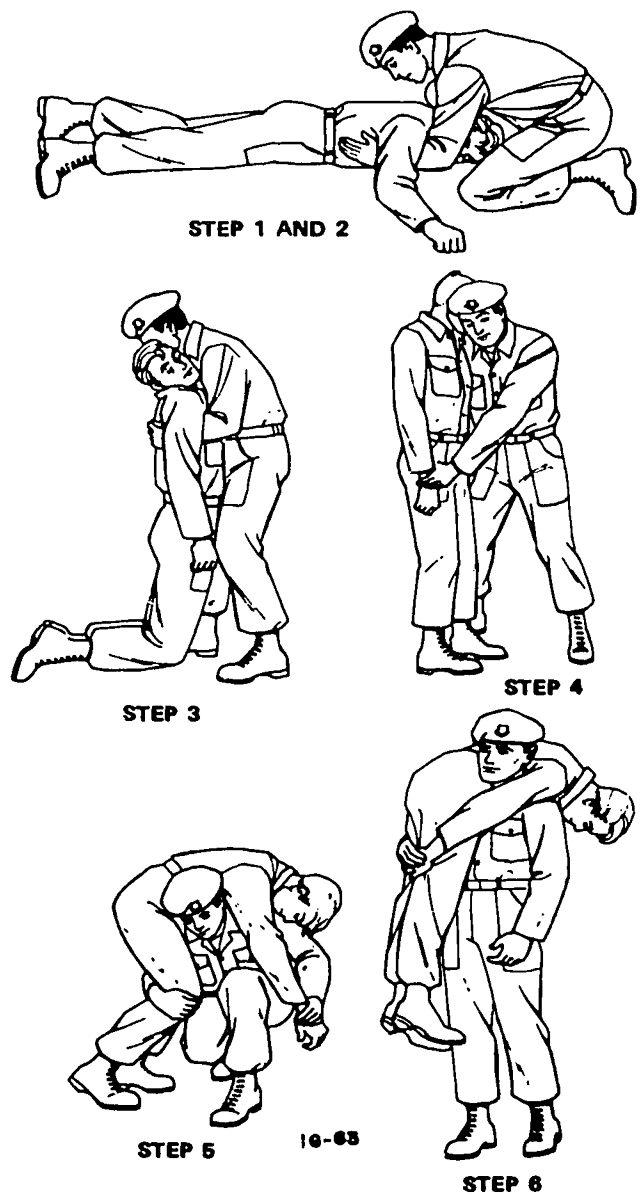

Figure 1–14. Fireman's carry.

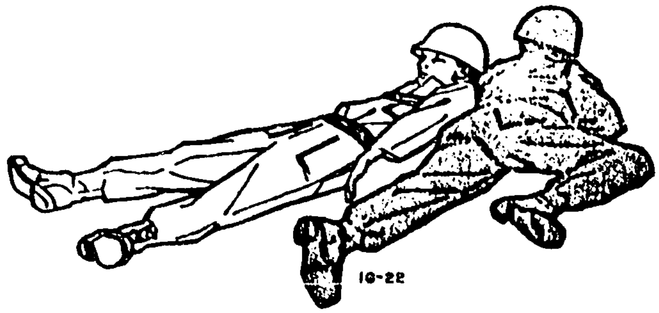

Figure 1–15. Pistol belt drag.

, *Column A*

otherwise uninjured. The vehicle is burning, and the driver must be moved quickly to prevent being burned.

____ (4) In a raid on a missile launch facility terrorists have wounded your team member. The victim is lying on the open about 10 feet from the culvert you are hiding in.

1-4. Extreme Weather Protection

The very nature of your duties exposes you to the extremes of weather. Regardless of where you are now stationed, you undoubtedly have heard how miserable the heat or cold can make a tour of duty. Unfortunately, either of these weather elements can also cause you a very severe injury. In this section, you are presented the actions to take when confronted with an injury caused by the heat or cold.

E08. Given statements about treating conditions caused by heat, identify the true statements, and correct any false statements.

Heat Conditions. Heat cramps, heat exhaustion, and heatstroke are the most prevalent conditions resulting from exposure to heat. These conditions are your body's reaction to both internal and external factors. The harmful effects they create take place because your body becomes overheated and cannot dispose of the excess heat. All three of these reactions are associated with your body's loss of large amounts of water and salt as a result of very heavy perspiration, for instance, vigorous athletic competition, manual labor, or strenuous exercise in a hot atmosphere.

Heat cramps. These are involuntary, painful muscle spasms and pains, similar to those you would experience with a "charley horse." Heat cramps are primarily the result of your body's loss of salt or an insufficient intake of salt. Heat cramps may often be a compounding factor to heat exhaustion; thus, you must watch for their telltale signs and take appropriate first aid measures:

a. Symptoms. Heat cramps most often affect the muscles in the legs and stomach first. A sudden, violent cramp is the main indication.

b. Aid. To relieve the pain of a heat cramp, you take either of the following actions:

(1) Exert firm pressure on the affected area with your hand.

(2) Gently massage the muscle spasm.

When the spasm has reduced, give the victim sips of water containing 1 teaspoonful of salt per 4 ounces of water. This treatment is continued for about an hours.

Heat exhaustion. This condition is a fainting or body weakness due to drinking an inadequate amount of water to replace that which your body loses through perspiration. Heat exhaustion is more severe than heat cramps. Therefore, immediate recognition and treatment are needed:

a. Symptoms. The symptoms of heat exhaustion are headache, excessive sweating, dizziness, and muscle cramps. Also, the skin is pale, cool, moist, and clammy. Heat exhaustion may come on gradually or suddenly.

b. Aid. Give a victim of heat exhaustion the following first aid, immediately:

(1) Lay the victim in a cool, shaded area and loosen his or her clothing.

(2) If the victim is conscious, give the victim cool salt water to drink. Prepare the salt water by dissolving two crushed salt tablets (1/4 teaspoonful of table salt) in a canteen (quart) of cool water. The victim should drink 3 to 5 canteenfuls during a period of 12 hours.

Heatstroke. Heatstroke can be fatal. It is your body's violent reaction to extremely high temperatures and malfunction of the ability to sweat. Heatstroke is the most severe heat condition. Immediate recognition and treatment are essential to life:

a. Symptoms. The first sign of heatstroke may be stoppage of sweating. This causes the skin to feel hot and dry. Collapse and unconsciousness may come suddenly or may be preceded by headache, dizziness, fast pulse, nausea, vomiting, and mental confusion. It is necessary to work fast to save the life of a heatstroke victim. The heat regulators of the body have been damaged, and the body temperature may rise quickly as high as 108° F.

. Aid. Take the following first aid measures for a heatstroke victim, immediately:

(1) Immerse the victim in the coldest water available. If ice is available, add it to the water.

(2) If a cold water bath is not possible, get the victim into the shade, remove his or her clothing, and keep the entire body wet by pouring water over it. Cool further by fanning the wet body.

(3) Transport the victim to the nearest medical treatment facility at once, and continue to cool the body on the way.

(4) When the victim becomes conscious, give him or her cool salt water to drink in the same manner as you would to a heat exhaustion victim.

Exercise (E08):

If one of the following statements about treating heat conditions is true, mark it true in the space provided. If a statement is false, correct it.

_____ 1. Heat cramp victims should be treated quickly to reduce pain.

_____ 2. A gentle squeezing action on the contracted muscle of a heat cramp victim should alleviate the cramp.

_____ 3. A victim suffering from heat exhaustion may first exhibit signs indicative of heat cramps.

_____ 4. A person exhibiting signs of profuse sweating and cool skin should be treated as a victim of heatstroke.

_____ 5. Treating a heat exhaustion victim is simply a matter of reducing the body exposure to heat and replacing body fluids and chemicals lost through perspiration.

_____ 6. A heat exhaustion victim should drink 96 to 160 ounces of mild salt water in the 6 hours following the onset of the condition.

_____ 7. A heatstroke victim is in critical condition and must be treated immediately to prevent death.

_____ 8. Immediate aid for a heatstroke victim could include attempting to reduce body heat by placing the victim in the nearest water or spraying the victim with water from a garden hose.

_____ 9. A victim of heatstroke should be transported to a medical aid facility when he or she regains consciousness, and treatment should be continued en route.

E09. Given statements about treating cold weather injuries, identify the true statements and correct any false statements.

Cold Conditions. The extent or severity of an injury caused by exposure to extreme cold weather generally varies with such factors as temperature, humidity, wind velocity, and wind type. Of the conditions presented here, frostbite is usually considered most severe and most common. Nevertheless, trenchfoot, immersion foot, and snow blindness are not mild conditions.

Trenchfoot. Trenchfoot is an injury that results from fairly long exposure of the feet to cold, wet conditions. Generally this happens at temperatures from freezing to 50° F. If you are also inactive (such as when standing in one spot on your post), the possibility of developing trenchfoot is even greater. Trenchfoot can be very serious; it can lead to a loss of the toes or parts of the feet. A frequent symptom of trenchfoot is numbness. There may also be a tingling or aching sensation or cramping pain. If exposure of the feet has been prolonged and severe, they may swell so tightly that pressure closes the blood vessels and cuts off the circulation. Should you develop trenchfoot, dry your feet thoroughly and get to a medical treatment facility by the fastest means possible. If transportation is available, avoid walking.

Immersion foot. Immersion foot is similar to trenchfoot. It results from immersing the feet in water or constant wetness of the feet for a long time—usually in excess of 12 hours. Immersion foot develops more rapidly if the water is below 50° F. It can occur, however, when the feet are exposed to warm water for a period exceeding 24 hours. In immersion foot, the soles of the feet become wrinkled and white; standing or walking becomes extremely painful. Other portions of the body also may be similarly affected. Should you develop immersion foot, dry your feet thoroughly and get to a medical treatment facility. You should observe the same walking precaution as is observed for trenchfoot.

Snow blindness. Snow blindness is the effect that glare from an icefield or snowfield has on the eyes. For instance, the parking ramp or launch facility may produce such a glare. This condition can occur even in cloudy weather. In fact, it is more likely to occur in hazy, cloudy weather than when the sun is shining. You can recognize the early stages of snow blindness by a scratchy feeling in the eyes when the eyelids are closed. Should you develop snow blindness, cover your eyes with a dark cloth to shut out all light. Then, have someone take you to a medical treatment facility at once.

Frostbite. Frostbite is the injury of skin tissue caused by exposure to cold. The body parts most easily frostbitten are cheeks, nose, ears, chin, forehead, wrist, hands, and feet. Frostbite may involve only the skin, or it may extend to a depth below the skin. Deep frostbite, which is much more serious than skin frostbite, requires different first aid to avoid or minimize the loss of parts of the fingers, toes, hands, or feet. Frostbitten skin is whitish, stiff, and numb, rather than painful. For this reason, you must watch one another's face and hands for signs of frostbite. If a body part has been numb for only a short time, the frostbite probably involves only the skin; otherwise, assume it to be deep:

a. Frostbite of the skin. Take the following actions whenever frostbite of the skin occurs: (NOTE: DO NOT warm or rewarm frostbitten parts by such measures as massage, exposure to open flame, cold water soaks, or rubbing with snow.)

(1) Parts of the face. Cover the frostbitten part with your warm hands until pain returns.

(2) Hands. Place your hands next to your skin in opposite armpits.

(3) Feet. In the most sheltered area available, place your bare feet under the clothing and against the abdomen of another person.

b. Deep frostbite. As we stated earlier, if your body part has been numb for only a short period (5 to 10 minutes), you treat yourself for skin frostbite. Otherwise, take the following actions:

(1) Get to a medical treatment facility by the fastest means possible. If transportation is available, avoid walking.

(2) Protect the frostbitten body part from additional injury, but do NOT attempt to treat it or thaw it in any way.

Thawing increases the possibilities of infection, further damage, and gangrene (rotting skin). There is less danger of walking on your feet while they are frozen than after they have been thawed. Thawing may occur spontaneously during transportation to the medical facility, but this cannot be avoided because your body in general must be kept warm.

Exercises (E09):

Identify the true statements in the following list, and correct any false statements.

_____ 1. Drying your feet and seeking medical aid are about the only measures a first aider can take for trenchfoot or immersion foot.

_____ 2. Trenchfoot is caused by prolonged exposure of the feet to moisture and cool weather.

_____ 3. Snow blindness treatment consists of covering the eyes and seeking medical aid.

_____ 4. Frostbitten skin is whitish, stiff, and numb, rather than painful.

_____ 5. A deep frostbite victim should be protected from further exposure, without thawing the affected body part, and taken to medical aid.

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Field Hygiene and Sanitation

PERSONAL HYGIENE and sanitation are of real importance when an organizational unit is working in the field. When you live in the field apart from modern cleaning facilities, you must give extra care and attention to hygiene activities.

You should already know that untreated psychological injuries can have a serious impact on the effectiveness of an individual and a unit. Lack of personal hygiene and sanitation can have a similar impact on individual and unit effectiveness.

2-1. Hygiene and Health

An efficient military unit is a carefully planned, well-organized, well-trained fighting team. It is a team that carries no substitutes. When any team member is absent or sick, teamwork suffers. Carelessness of one member of the unit in regard to his personal hygiene can lead to disease which incapacitates the entire unit.

E10. Indicate whether given statements concerning personal hygiene are true.

Meaning of Personal Hygiene. Personal hygiene is the practice of health rules by the individual to safeguard his or her own health and the health of others. Personal hygiene is often thought of as being the same as personal cleanliness, but cleanliness of the body is only one of many aspects of all personal hygiene. All personnel actions directed toward maintaining personal health are a part of personal hygiene.

Health. You belong to a group whose physical condition is as carefully guarded as the most vital weapons system. The purpose of this concern is to maintain your effectiveness. Remember— this is group protection. The Air Force can go just so far. Your personal health and welfare still depend upon your own good care and good sense.

Anytime you do not feel perfectly well, or when you believe that you have a disease of any kind, you should report to sick call. Don't wait to see whether the symptoms get worse. Diseases are most readily spread in their early stages. Often, before you feel really sick, you may be a source of infection to your friends. Don't try to treat yourself. Nearly all medicines may be harmful in unskilled hands.

If you have a cold, a headache, diarrhea (loose bowels), sore eyes, a body rash, or a fever, report to sick call immediately.

Diet. Physically, man is the product of what he eats. Great care is exercised to make sure that balanced menus are provided to keep you in good health. An interesting point to understand here is that the C-ration issued to you in most field operations is a balanced, nourishing, and adequate menu. It is your responsibility to eat enough of the various food items to maintain your health and vigor. Proper variety in food is essential to your health. You should know the variety of foods necessary for physical well-being. The human body requires nutrition from each of seven food groups:

- Milk and milk products.
- Leafy green and yellow vegetables.
- Butter or fortified margarine.
- Bread and other cereal products.
- Meat, fish, poultry, and eggs.
- Oranges, tomatoes, and grapefruits.
- Potatoes and other vegetables and fruits.

When possible, you should eat foods from each of these seven food groups daily. This diet should help you to keep alert, healthy, and vigorous. (Eat everything edible in the C-ration for field operations.) Proper diet is extremely important to your body under normal conditions. When you are in the field, proper diet is even more important to maintaining health, because a properly balanced diet helps your body increase resistance to infection.

Mental Health. Mental disorders may be as disabling as are physical diseases. When you are incapacitated by combat fatigue, you are as much a casualty as is the individual with malaria. Both mental health and physical health make up your total health. A sense of well-being, the absence of overpowering fears and anxieties, and a wholesome attitude toward life are essentials of total health.

Exercises (E10):

Indicate whether each of the following statements is true or false.

_____ 1. Personal hygiene includes cleanliness, physical and mental health, and seeking medical treatment when ill.

_____ 2. Maintaining personal hygiene is actually the action of staying clean and healthy.

_____ 3. Personal hygiene could be defined as the everyday personal actions you must take to safeguard your health and the health of others.

_____ 4. Diet can be a major factor in an individual's personal hygiene.

E11. Define "infection"; and list, in order of most to least vulnerable, the body's natural defenses against infection.

Infection (Disease). As you recall, even though you may not feel sick yourself, you may be a source of infection to others. Infection occurs when micro-organisms invade the body, multiply, and produce injury or disease. Micro-organisms which enter the body range from those that produce disease (pathogens) to those that do not produce disease. To understand infection, you must know how the micro-organisms enter the body.

Portals of entry. The principal portals of entry for micro-organisms are abrasions of your skin, mucous membranes of your respiratory system or gastrointestinal and genitourinary tracts, and your eyes. Nevertheless, unbroken skin and mucous membranes are natural defensive barriers against an invasion by pathogenic organisms. Certain organisms require specific routes to infect; others can invade by several routes. Most respiratory diseases are contracted by the inhalation of droplets of contaminated moisture or dust. Intestinal infections usually are produced by the ingestion of contaminated food or drink.

Some organisms invade by penetrating the skin through hair follicles, sweat gland ducts, or abrasions; other organisms must enter through wounds in order to establish themselves. Tetanus spores, for example, may be swallowed without causing harm; but if they are introduced into an open wound, tetanus (lockjaw) may develop. What takes place in your body when these organisms enter is very similar to a battle. If your body has a good defense and wins, you suffer no ill effects. When the pathogens win, you're in trouble—infection has occurred, and you have a disease. Fortunately, your body is usually a tuned fighting machine.

Bodily defense against infection. The ability of your body to fight off or overcome infection is known as resistance. You can better understand this ability when you compare your body's resistance to an active ground defense action using the three-component system and defense in depth:

a. Early warning. Your body's early warning system alerts you to the fact that something is wrong by displaying symptoms. For instance, a sore throat, headache, fever, or sore that won't heal are early warnings to you that your body has been infected.

b. Tactical defense. Your body's first line of defense is provided by the skin and the mucous membranes of your gastrointestinal, tract, respiratory system, and genitourinary tract, along with their secretions. These help to prevent entrance of micro-organisms into the deeper tissues that have little ability to ward off invasion.

c.. Reaction. The second line of defense (blocking force), of which the lymphatic system is a part, is a cellular one not as susceptible to infection as your skin. This defense comes into play when the migrating cells of your body attack and destroy invading organisms. The third line of defense is presented by your blood. Your blood contains neutralizing bodies (counterattacking force) which push the organisms to the liver and spleen where they are destroyed or inactivated. Your blood is about your least vulnerable body defense.

Body preparation. Obviously your body can't employ an active intelligence gathering network. However, because you know your body's enemy is infection, you can take action to prepare (plan) your body in case the pathogens launch a surprise attack.

Your body uses active and passive defensive measures against infection. You have learned the active measures your body uses. The passive defense, like the intelligence capability, must be exercised by you. You can insure that your body has a more then even chance by following these tips:

a. Avoid exposure. Stay away from any person who you know has a disease, or who you think might have a disease, unless it is your assigned duty to take care of him or her. Ask your friends to stay away from you when you think you are becoming ill.

b. Eat properly, and form the habit of having your bowels move regularly.

c. Drink plenty of water at intervals. Depending on climatic conditions, drink three or four full canteens per day.

d. Change wet clothes and shoes for dry ones as quickly as possible.

e. Never borrow cups, pipes, or other personal items that your associates put in their mouths.

f. Keep insects away from food, and don't handle pets before eating.

g. Don't borrow handkerchiefs, towels, shaving brushes, razors, or combs.

h. Take salt as directed to avoid fatigue and heat prostration.

i. Regularly get the proper amount of sleep whenever possible.

Exercises (E11):

1. What is infection?

2. In order of most vulnerable to least vulnerable, what are your body's three natural defenses against infection?

2-2. Personal Cleanliness and Foot Care

This section covers techniques of personal cleanliness as well as measures you can take to have healthy feet.

E12. Given statements about techniques of personal cleanliness, identify the true statements and briefly state why the others are false.

Personal Cleanliness Techniques. Probably no other single habit of hygiene is as important as being clean. An unclean body is not only offensive, it can also be a source of infection to you and your friends.

Clothing.Clothing easily becomes contaminated with disease agents as a result of contact with agents present in stool, urine, and surface garbage. Change your underclothing daily, if possible. If you can't change it daily, rinse your underwear in clean water, and lay it in the sun to dry. The sun's rays act as a purifying agent. Wash outer clothing when it becomes excessively dirty. When it is absolutely impossible to wash your outer clothing, shaking it out and airing and sunning for two hours can greatly reduce the number of disease germs. Any shaking of clothes should always be done out of doors, not in tents or dwellings.

Bathing. It is virtually impossible to take a complete bath while living under field conditions, but even the limited bathing possibilities available to you may make the difference between poor health and keeping fit. Daily washing of your armpits, ears, feet, and crotch with soap and water is a most important part of field hygiene. You should shave every day if possible. If possible, you should wash your hair at least once a week with soap and water. Your helmet can be used as a wash basin. Fill it with water, wash your body, and then shave. You can build simple bathing devices, such as those shown in figure 2-1, if you are going to be in one location for a long time.

Oral hygiene. Regular and proper cleansing of your mouth and teeth prevent tooth decay and gum disease, both of which can cause severe pain and loss of teeth. The most healthful oral hygiene, which should be practiced whenever possible, is to cleanse your mouth and teeth thoroughly and correctly after each meal with a toothbrush and fluoride dentifrice. However, when the situation makes this activity impractical, you should thoroughly cleanse your mouth and teeth at least once each day, using improvised devices if necessary. If a dentifrice is not available, use your toothbrush without one, or use salt. In the absence of a toothbrush, you can use twigs cut from a tree and frayed on the ends to resemble toothbrush bristles. Twigs can also be cut in the form of toothpicks for use in removing material caught between your teeth. If necessary, pieces of clean cloth can be used to wipe away food debris which has collected on your teeth. Rubbing your gum tissue vigorously with a clean finger also stimulates them to better health.

Bedding. At least once a week change your bedsheets. Air and sun the blankets, pillows, and mattresses the same as you do you clothing.

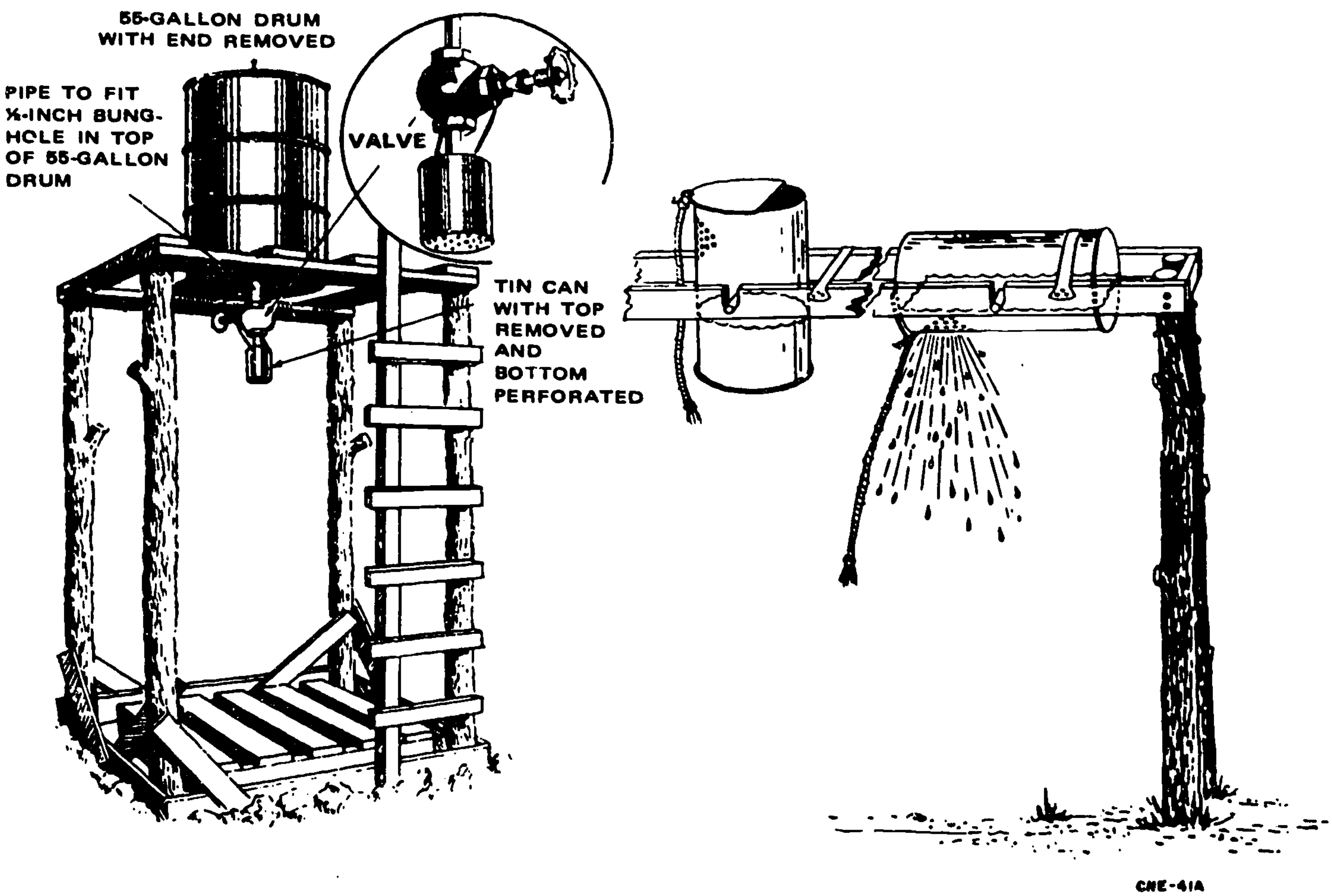

Figure 2-1. Field bathing device.

Hands. Keep your fingernails closely trimmed and clean. Wash your hands (with soap and warm water if available) after any dirty work, after each visit to the latrine, and before touching food or food utensils. As shown in figure 2-2, effective hand-washing devices can be improvised. Such habits as nose-picking, nail biting, and unnecessary scratching can cause contamination of your hands and of the things that you touch later. These habits, which are unpleasant to see and unhealthy for you, should be broken. Coughs and sneezes should be smothered in a tissue or handkerchief or at least directed away from other persons. Keep your fingers and other contaminated objects out of your mouth.

Exercises (E12):

Indicate whether each of the following statements about the techniques of personal cleanliness is true or false. Correct any false statements.

____ 1. An unclean body can be a source of pathogenic organisms to yourself and other members of your unit.

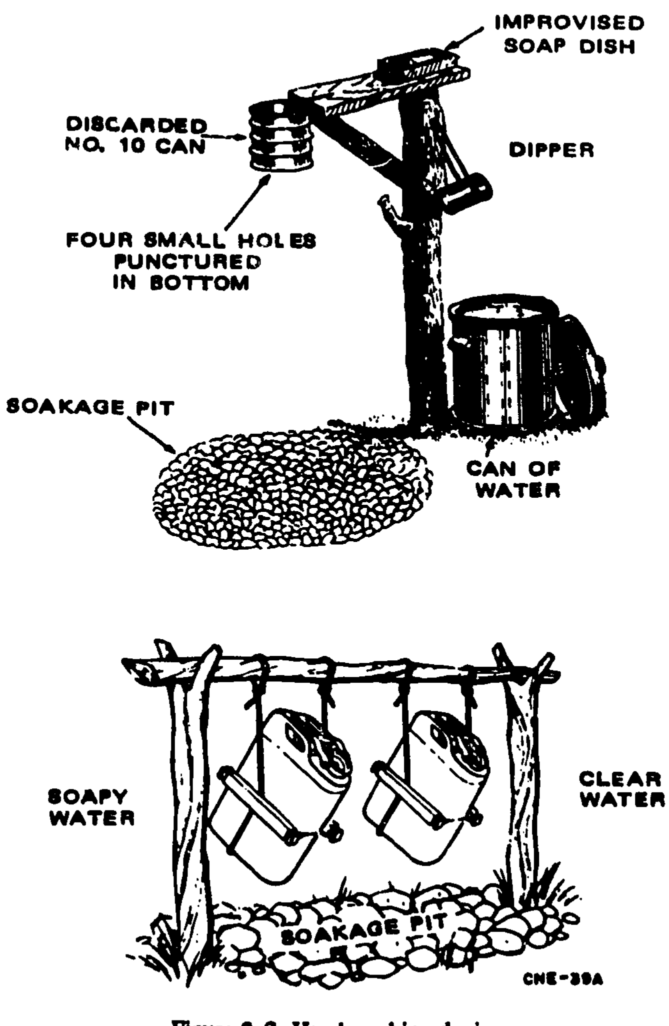

Figure 2-2. Hand-washing device.

____ 2. You should change your underwear at least daily.

____ 3. Exterior clothing that can't be washed can be partially cleaned by shaking, sunning, and airing.

____ 4. When total bathing isn't possible, offensive body odors can be reduced and your health promoted by daily washing of your body creases with soap and water.

____ 5. In the absence of a commercial dentifrice, toothpaste can be used to brush your teeth.

____ 6. When a toothbrush isn't available in the field, a clean cloth can be used to brush your teeth.

____ 7. An individual who practices the techniques of cleanliness in the field should remain relatively disease free.

E13. Associate common foot ailments with their symptoms and the actions needed to correct or prevent these ailments.

Care of the Feet. During sustained field operations, one of the biggest casualty inflictors, and a prime cause for pain, is poor foot care. Proper foot care is essential to the maintenance of physical fitness. Serious foot trouble usually can be prevented by observance of the following simple rules.

Foot hygiene. You should wash your feet daily and dry them thoroughly, especially between the toes. Persons whose feet perspire freely should apply an antifungus foot powder lightly and evenly twice a day. This powder helps retard the growth of some fungi.

Properly fitted shoes. In field operations, only footgear issued for field purposes should be worn. Expert fitting at the time of issue is absolutely essential. There should be no binding or pressure spots; neither should the footgear be so large that it permits your foot to slide forward and backward when you are walking.

Clean, fitted socks. Socks should be changed and washed daily. They should be large enough to allow your toes to move freely but not so loose that they wrinkle. Woolen socks should be at least one size larger than cotton socks to allow for shrinkage. Socks with holes or poorly darned socks may cause blisters. Different types of socks are provided for various footgear; learn their proper uses at the time they are issued to you.

Common Foot Ailments. Blisters, corns, bunions, ingrown toenails, and fungus infections are the most common causes of foot trouble.

Blisters. You can usually prevent blisters by wearing properly fitted shoes and socks. Shoes should be broken in slowly, and socks should be clean and free of holes. If a blister does develop, treat it as shown in figure 2-3.

Bunions and corns. Bunions and corns are painful growths on your feet. Similar to blisters, they are caused by irritation of the foot tissue, such as pinching shoes or rubbing socks. These ailments need medical attention.

Ingrown toenails. Ingrown toenails develop when nails are improperly cut. You should trim your toenails straight across rather than following the contour of your toes. If tenderness develops in the nailbed or along the edge of the nail, report to the medical officer.

Athlete's foot. Athlete's foot is a cracking of the skin between and under the toes, or a general itching of the foot. Athlete's foot is really a misnomer. Generally any fungus that concentrates in the area of the foot is called athlete's foot, which is caused by a fungus that thrives on the warm, moist atmosphere offered in your boots, particularly when you have had them on for a prolonged period. The most appropriate treatment for athlete's foot is to seek medical aid. The reason for this is that the various fungus infections of the feet usually respond differently to treatment. Athlete's foot can be very serious and painful. Don't try to treat yourself.

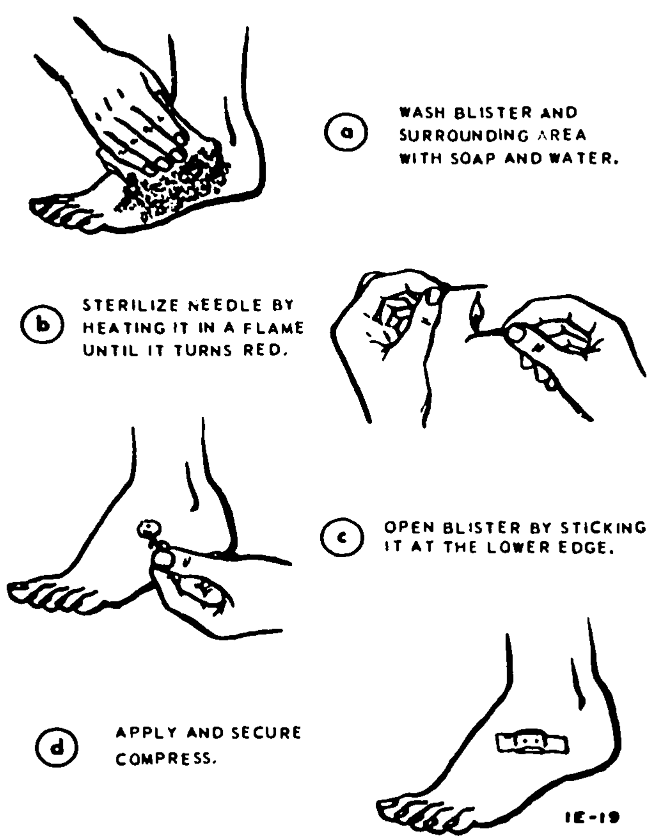

Figure 2–3. First aid for blister.

Immersion foot and trenchfoot. You learned about these ailments earlier. Seek medical aid when you suspect you are suffering from one of these ailments.

Exercise (E13):

1. Match the column A foot ailment symptoms with the types of ailments in column B and the preventive or first aid measures in column C by writing the column B and C letters in the spaces provided. Column B and C items may be used once or not at all.

Column A

____ (1) Cracked skin and itching on sole of foot.
____ (2) Extreme pain and tenderness on top side of corner of toe.
____ (3) Fluid-filled spot on heel of foot.
____ (4) Painful bump on your little toe.

Column B

a. Ingrown toenail.
b. Blister.
c. Fungus infection.
d. Bunion or corn.
e. Immersion foot or trenchfoot.

Column C

A. Properly sized footwear.
B. Keep feet dry.
C. Powder feet.
D. Puncture at lower edge and bandage.
E. Correct cutting.

2-3. Field Sanitation

As you have learned, personal hygiene is your observance of the rules of good health and cleanliness. Even though you follow these rules and maintain perfect health, your body can cope only with a limited number of disease agents.

Under field conditions, unless you and every other member of your outfit follow some basic sanitation rules, practicing personal hygiene is only a temporary stopgap against infection. Three areas of sanitation that must be strictly observed in the field are water, food, and waste sanitation.

E14. Arrange in sequence, of most to least desirable, given statements about water sanitation; state the procedures for purifying water.

Water Sanitation. Impure water may be a means of transmitting such diseases as cholera, dysentery, typhoid fever, paratyphoid fever, and snail fever. All of these can assume epidemic proportions and disable large numbers of people. Getting, purifying, and providing water in the field are usually the responsibilities of base engineer personnel. Nevertheless, we must all be aware of the danger of impure water and must know simple purification procedures to use in field situations. All water must be treated or certified as safe by medical personnel. Water containing organisms that cause disease is contaminated. Water containing substances that are undesirable or that render it unfit for drinking or domestic use is polluted. Water that is free of both contamination and pollution is potable; that is, you can drink it.

Selection of water sources. Water may be obtained in the field from surface water sources (lakes, rivers, streams, ponds), from ground water sources (wells and springs), and sometimes from public water supplies. Public water supplies free from unusual impurities are the best source for drinking water during field operations. In combat, advantage must be taken of whatever water is available if it can be purified with the materials on hand. When time and situation permit, a wider search for a better source may be made. In some locations, it may be necessary to use rainwater, seawater (which must be distilled for drinking), or melted ice or snow.

Individual water purification. When good sources of potable water are not available, you may produce potable water by mixing water purification tablets (iodine) or calcium hypochlorite ampules and water in your canteen. Normally, one iodine tablet is used per canteen of clear water, and two iodine tablets per canteen of cloudy water. You must wait 20 minutes after purifying to drink this water. When using calcium hypochlorite ampules, you should take the following actions:

a. Put one ampule in a canteen of water. Leave a small airspace in the canteen and dissolve the ampule by shaking the canteen thoroughly.

b. Allow the water to stand at least 30 minutes before drinking.

Exercises (E14):

1. Number the following statements about water sanitation in sequence of most to least desirable by writing numbers in the spaces provided.
   ____ a. Using polluted water from a rain puddle in an open field.
   ____ b. Using certified water from a livestock drinking trough.
   ____ c. Using existing potable water supply.
   ____ d. Obtaining uncontaminated water from small, covered, ground sources.

2. Complete the following statements.
   a. Potable water can be produced by using __________ __________ or __________ .
   b. To purify a quart of unclear water, you would use one ampule.
   c. Water purified with iodine is not considered potable until __________ __________ after mixing.
   d. One iodine tablet is used to purify __________ __________ of clear water.

E15. Given statements about food sanitation, select the true statements; if any statements are false, correct them.

Food Sanitation. Food, even the most appetizing, can cause illness if it has become contaminated with disease germs through improper handling or storage. Outbreaks of food poisoning, dysentery, and typhoid fever may result from unsanitary practices in kitchens and dining halls. Thus, persons who handle food must maintain the highest standards of personal hygiene and sanitation.

Stored food must be protected from the sun, heat, dust, insects, rodents, and any other agent that might cause contamination or the growth of disease germs. In operations where you are issued C-rations, you must be alert for signs of possible contamination. You must also prevent your food from being contaminated after you open it. Here are some very basic rules to prevent eating contaminated rations:

a. Look at the metal containers for signs of bulging or leaking. Do not eat the contents if these signs are present.

b. Wipe the top of the cans off with a clean cloth before you open them.

c. Use your own eating utensils, and keep them clean.

d. Do not open the metal containers and let them stand uneaten for long periods.

e. If an unusual odor or color is present after you open the can, do not eat the food.

f. Wash your hands before you eat.

Exercises (E15):

Indicate whether the following statements about food sanitation are true or false. Correct any false statements.

____ 1. Improper handling and storage of food can lead to unitwide sickness.

____ 2. Canned and sealed food is not susceptible to contamination in storage.

____ 3. C-rations that have been opened and left standing for long periods are suitable for eating.

____ 4. Unclean eating utensils can also be a source of contamination of food.

____ 5. Food that is not within a reasonable range of its normal color or aroma should be thrown away.

E16. Associate given situations involving waste to the methods best suited for sanitary disposal.

In war or field conditions, all Air Force personnel are expected to know how to live in the field and how to maintain excellent health and mission efficiency. It is essential, therefore, that you understand the methods of constructing, maintaining, and using field sanitation

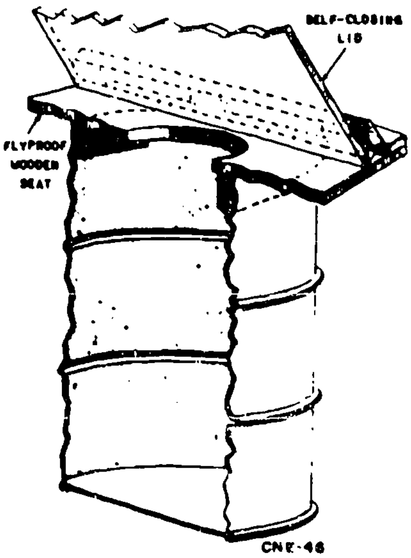

Figure 2–4. Oildrum latrine.

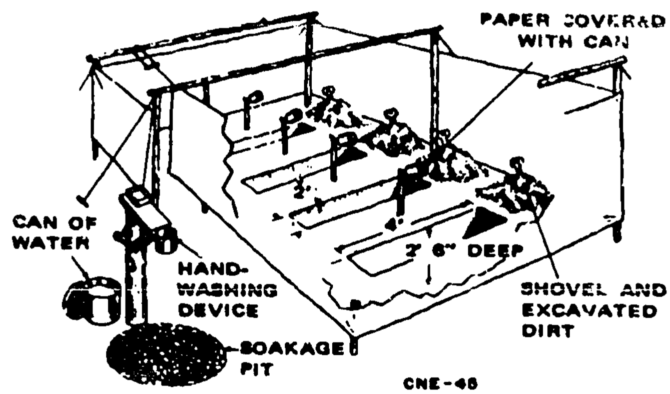

Figure 2–5. Straddle trench latrine.

devices, with emphasis upon the disposal of human and kitchen wastes.

Human Waste. Human waste can cause widespread dysentery and diarrhea among personnel if it is not properly managed. These diseases have cost our airmen more lost time from duty than any other disease. The common method of disposing of human waste in the field is to bury the waste in pit latrines or to burn the latrine contents. Three types of latrines are commonly used in the field: the oil drum latrine, the straddle trench latrine, and the deep pit latrine.

Oil drum. The oil drum latrine, similar to that shown in figure 2-4, is considered the ideal type of latrine for use by small USAF units in the field. To construct an oil drum latrine, you remove the top from a 55-gallon oil drum and fix a flyproof seat with a self-closing lid over the top of the drum. Where the water table is low and the area drains rapidly, the bottom of the drum may be perforated and the latrine set into a flyproof soakage pit. This latrine is intended for long time use; the contents are burned daily, and the resulting ashes are buried.

Straddle trench. The straddle trench latrine (see fig. 2-5) consists of a trench 1 foot wide, 2½ feet deep, and approximately 4 feet long. If available, boards should be placed alongside to provide secure footing. Toilet paper should be placed at the end of the pit and protected from the rain with a wooden covering or tin can. Earth removed from the trench should be piled at each end, and a paddle or shovel should be provided with which each person can immediately cover his excretion and the used toilet paper. This latrine is considered to be inadequate for other than temporary use. It must be closed when abandoned or when filled to within 1 foot of ground level. When this stage is reached, earth should be piled over the pit and tightly packed down. If the soil is sandy, it should be mixed with waste motor oil. The site should be marked with a sign reading "Closed Latrine (date)."

Deep pit. The deep pit latrine is intended for use with a standard latrine box. It is adequate when the water table is low. To construct, you dig a pit approximately 4-foot deep and fit the dimensions to the latrine box. The pit should be surrounded with drainage ditches to direct rainwater away from the latrine box. This type of field latrine is intended for use by large units (squadrons, groups, etc.) that remain in one location for relatively long periods of time. The closing provisions are the same as for the straddle trench.

Kitchen Waste (Garbage). Kitchen waste, if not properly disposed of, becomes the breeding ground for rodents and insects that transmit disease. Consequently, great emphasis must be placed on sanitary disposal of garbage when you are in the field.

There are two classifications of garbage: that which is suitable for animal food and that which is not. Burial is the best method of nonedible garbage disposal in the field where there are areas with low water tables. Incineration is best to dispose of nonedible garbage when units or more than 30 people plan to remain in one location for a period longer than 1 week.

Garbage pits and filled trenches should not be located within 100 yards of any source of drinking or cooking water. They must be located within easy walking distance of kitchens and eating areas, in order to facilitate dumping of garbage. When filled and ready to be abandoned, garbage fills should be marked to indicate the date of closure with a sign reading "Closed Garbage Fill (date)."

What all this means to you is that during field operations you must use the established facilities to dispose of waste. If there are none established, make your own. To neglect personal sanitation or personal hygiene when you are in the field can be as fatal as standing up when you come under enemy fire. When you give pathogens a place to grow, it's only a matter of time until your body's defense system loses the battle.

Exercise (E16):

1. Match the column A statements about waste with the best method of disposal in column B by writing the

column B items in the space provided. Column B items may be used once or not at all.

Column A

____ 1. Human waste of a deployed wing during a 20-day field deployment.

____ 2. Nonedible garbage from a large unit planning to remain in one location.

____ 3. Waste accumulated from cooking and eating during an overnight stop where there is a low-water table.

____ 4. Human waste from four personnel deployed to an off-base plane crash site for 25 days.

Column B

a. Burial.
b. Straddle trench latrine.
c. Deep pit latrine.
d. Inclination.
e. Oil drum latrine.

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Work Party Security

THE RESPONSIBILITY for the defense of an air base rests with those security police specialists assigned to the base ground defense force. As you know, this force comes into being only as a result of hostile actions, as in case of general or limited war actions, or in some cases as the result of a terrorist group's attempt to attack and overcome the base security force. Regardless of the reason for activation, you undoubtedly will become an integral part of the defense force.

Before you can be an effective member of the ground defense force, you must possess and apply certain individual and group defensive skills. These skills can help you close with and capture or eliminate an enemy force. These same skills can also reduce the probability of your being detected by an enemy force. These skills are particularly valuable should the situation be such that you must remain undetected until a significant event occurs. Camouflage, movement, fire control, and field fortification are discussed in this chapter.

3-1. Camouflage Techniques

Camouflage is a French word meaning disguise; it is used to describe actions taken to mislead the enemy by misrepresenting the true identify of an installation, an activity, or an item of equipment. Camouflage, as an element of military deception, permits you to approach unseen and to remain hidden within striking distance of an enemy. It also affords protective concealment for a firing position, materiel, and personnel. Camouflage permits you to see without being seen, thereby enabling you to strike first and at minimum cost.

Although camouflage may be easily described, good camouflage is not easy to attain. Many factors must be considered and remembered. This section addresses the purpose of camouflage, describes the three methods of camouflage, and discusses how you can attain good camouflage for yourself, your equipment, and your position.

E17. Specify the purpose, methods, and factors of camouflage.

Camouflage Objectives. Of a human's five perceptive senses, sight is by far the most useful to the enemy; hearing is second; smell is of only occasional importance. The comparative usefulness of the perceptive senses is primarily a matter of range. For this reason, basic camouflage stresses visual concealment that is relatively long range and protects from direct or indirect observation.

Direct observation. Direct observation is the process whereby the observer looks directly at the object itself, with or without the use of telescopes, fieldglasses, or sniperscopes. Direct observation can be made from ground or air. Direct aerial observation becomes more and more important because of rapid changes in the tactical situation due to greater mobility of troops, weapons, and possible use of guided missiles by enemy forces. Reconnaissance airplanes over enemy lines report locations of troops, vehicles, and installations seen from the air to the ground control stations. Immediate fire can then be brought to bear on targets thus found and reported.

The principal advantage of direct observation is that the observer can readily see movement of troops or equipment in the observed area, and observation can be maintained over relatively long periods of time. The main disadvantage lies in human frailty—that is, the physical condition of the observer can affect his power of observation.

Indirect observation. Indirect observation is the use or study of a photograph or an image of the subject. Photography, radar, and television are examples of indirect observation. Indirect observation is becoming increasingly more varied and rapid, and it may be used from either manned or unmanned positions.

Indirect observation has many advantages: it can be far-reaching, cover large areas, and can be very accurate. It also produces a record of the area observed so that the recorded picture can be studied in detail, compared, to other pictures, and evaluated. The principal disadvantage is that a photograph rarely allows detection movement. However, this disadvantage can be overcome partially by taking pictures of the same area at different times and comparing them for changes.

Camouflage Methods. There are three basic ways of concealing yourself, your equipmment, and your activity. The following paragraphs describe what you must strive to achieve with each method.

Hiding. Hiding is the complete concealment of an object. You must master the act of hiding. You can do this easily if you remember the childhood game of hide-and-seek. Where did you always look first? In the most obvious location, of course. An enemy force will do the same when looking for your position.

Blending. Blending is the arrangement of camouflage materials on, over, and around an object so that it appears to be part of the background. The aim is to prevent detection of the object caused by a change in the natural appearance of the position. Because the works of man are usually geometric in form, they present easily recognized outlines and rectangular shapes and shadows that are very unlike the average terrain features. Blending distinctive, man-made objects into the normal terrain pattern requires that you restore and simulate the normal and natural appearance of the terrain.

Deceiving. Deceiving simulates an object or situation, or disguises it so that it appears to be something else. Deception is intended to mislead an enemy into false identification of strengths, activity, or intentions.

Camouflage Requirements. For camouflage to be successful, three fundamental requirements must be observed; namely, choice of position, camouflage discipline, and camouflage construction. These requirements, and factors inherent in meeting these requirements, are presented in the following narrative.

Choice of position. When choosing a position to gain concealment, a background is chosen that visually absorbs the elements of the position (see fig. 3-1). The appearance of the background must be changed as little as possible by the presence of individuals, weapons, and equipment. Finally, the position selected must not hinder the accomplishment of the mission. With these factors foremost in mind, a natural position is located; that is, a position that can be used almost as it is, such as a natural cover. Isolated landmarks such as individual trees, haystacks, or a house should be avoided because they attract attention to themselves. At times, by making use of background, complete concealment against visual and photographic detection may be gained with no construction. In terrain where natural cover is plentiful, this is a simple task. By taking advantage of terrain irregularities, even though natural cover is scarce, you may gain complete concealment without added camouflage construction.

Camouflage discipline. Camouflage discipline is the avoidance of activity that changes the appearance of an area or reveals military objects to the enemy. A well-camouflaged position is only secure as long as it is well maintained.

a. Daytime. Concealment is worthless if obvious tracks point like directional arrows to the heart of the location or if signs of occupancy are permitted to appear in the vicinity. Tracks, spoil (leftover construction material), and debris are the most common signs of military activity that indicate concealed objects. Therefore, existing tracks, paths, roads, or natural lines in the terrain should be used. Exposed routes should not end at a position, but rather, extend to another logical termination point. If practical, exposed tracks are camouflaged by brushing them out, by covering them with material, or, where time permits, by planting local vegetation. Spoil and debris are covered or placed to blend with the surrounding terrain. Smoke from fires must be controlled and dispersed.

Figure 3–1. Choice of position.

b. Nighttime. Concealment at night is less necessary than in the daytime. Therefore, the enemy can use the cover of darkness to their advantage. They can do this much easier than they can in daylight if given clues to guide them. Camouflage discipline thus becomes doubly important at night. For example, aerial photos taken at night (by light furnished by flares dropped from planes) can pick up breaches of camouflage discipline that are more likely to occur at night than during the day. Consequently, light discipline is very important at night. Sound discipline is always important. Nosies seem magnified at night; clanking gear or snoring may prove fatal. Calling to one another and talking, even whispering, should be kept to a minimum. However, by far the most important phase of night discipline is light discipline. Necessary work lights must be shielded by using them inside an enclosure, such as a lightproof tent or bunker. Even on the darkest nights, your eyes grow accustomed to the lack of light in approximately 30 minutes. Every time a match is lit or a flashlight is used, your eyes must go through the complete process of getting adjusted to the darkness again. Smoking must also be prohibited at night in areas close to the enemy because the light is impossible to conceal. A cigarette light aggravates the situation by creating a reflection that completely illuminates your face.

c. Lessening sound. Sound can be lessened by precautionary measures. Loud orders, talking, calling, and sneezing must be avoided. Walking on hard surfaces should be avoided and full use should be made of soft ground for digging. Hand signals or signs should be used when possible. Individual equipment should be padded and fastened in such a manner as to prevent banging noises. Loading and unloading of vehicles must be accomplished in complete silence; every piece must be carefully lifted and gently set down; and straw, wood shavings, or other muffling agents should be used for packaging. It may even become necessary for you to disconnect vehicle horns and shut off engines. Remember, the noise of engines and tracked vehicles cannot be diminished while they are in movement.

Camouflage construction. Camouflage construction is used for a camouflaged position that requires additional concealment. Camouflage construction is the use of artificial and natural materials to help blend personnel and equipment with the surrounding terrain. Artificial materials are manmade; they and include such items as paint, wire, burlap, chicken wire, fiberglass, garnished nets of various types and sizes, and osnaburg (a cotton cloth more closely woven than burlap).

If artificial materials are used, they must be arranged to blend with the surrounding terrain and must be capable of withstanding local weather conditions. Seasonal changes may require gradual alternation in the color or kind of material used.

Exercises (E17):

1. What purpose is served by camouflage?

2. If you wanted to completely screen a position from enemy observation, which camouflage method should you use?

3. What camouflage method would lead an enemy observer to believe there were more people in a position than there actually were?

4. When using camouflage, what three requirements must be strictly adhered to?

5. What two elements of camouflage discipline are especially important at night?

E18. In given situations, determine what type of camouflage to use.

Individual Camouflage. Individual camouflage is the personal concealment you use to surprise or deceive an enemy. To achieve individual camouflage, you must remember the purpose of camouflage and decide upon the camouflage method to use. The following narrative presents important considerations in camouflage of the individual.

Uniform. Your utility uniform (fatigues) is designed to be as inconspicuous as possible. However, there are occasions when your uniform's appearance or color must be altered to help you blend with the terrain—for instance, for wear on a snow-covered mountain.

Skin tonedown. The contrast in tone between the skin of your face and hands and that of the surrounding foliage and other background must be reduced. Your skin must be made lighter or darker, as necessary, to blend with the surrounding natural tones. The issue facestick may be l whenever natural materials are not available. The al shine areas are the forehead, cheekbones, nose, and these areas should have a dark color. The shadow round your eyes, under your nose, and under your hould have a light color, as shown in figure 3-2.

Your hands, arms, and any other exposed areas of skin must also be toned down to blend with the surroundings. Burnt cork, charcoal, lampblack, and mud can all be used as toning materials. Because soils contain harmful bacteria, a medical officer should determine which soils are safe for use. A mesh mosquito face net, properly toned down, is an effective method of breaking up the outlines of your face and ears. Such a net can be dyed in strong coffee when manufactured dye is not available.

Helmet. The outline of your helmet is a striking characteristic of your equipment. Its curved shape is familiar to the enemy. One of the first steps in individual camouflage is to disrupt the shape of your helmet and thereby eliminate the strong, straight-lined shadow that it casts. The following ways of disrupting the shape of the helmet and reducing its shine or contrast can be used (see fig. 3-3). The choice of method depends on the tactical situation and time and materials available.

a. Paint. A disruptive paint pattern can be used on the helmet. Care must be taken to carry the pattern across the curved lines to the helmet edges, especially those seen from the front.

b. Bands. Rubberbands can be used as holders for garnish of natural materials. A band cut from a discarded inner tube makes a good substitute for the issue band, as do strips of cloth. Bands should not be placed too high on the helmet. When natural materials are not available or not advisable for garnish, the shape of your helmet can also be disrupted with bow ties made of burlap or osnaburg. They should be small enough so that they do not readily catch in bushes or branches and large enough to disrupt the form of the helmet.

c. Helmet covers. An improvised cover can be made for your helmet from a circular piece of osnaburg, burlap, or other coarse-weave cloth. Burlap is best; it helps to tone down the color of the helmet, disrupts its shape, and eliminates shine. The circular piece should be 20 inches in

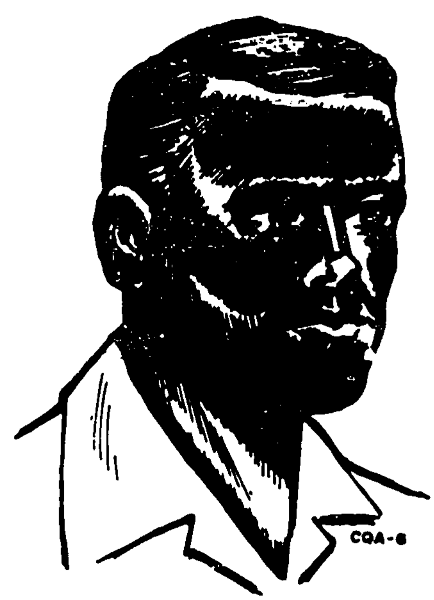

Figure 3-2. Skin tone down.

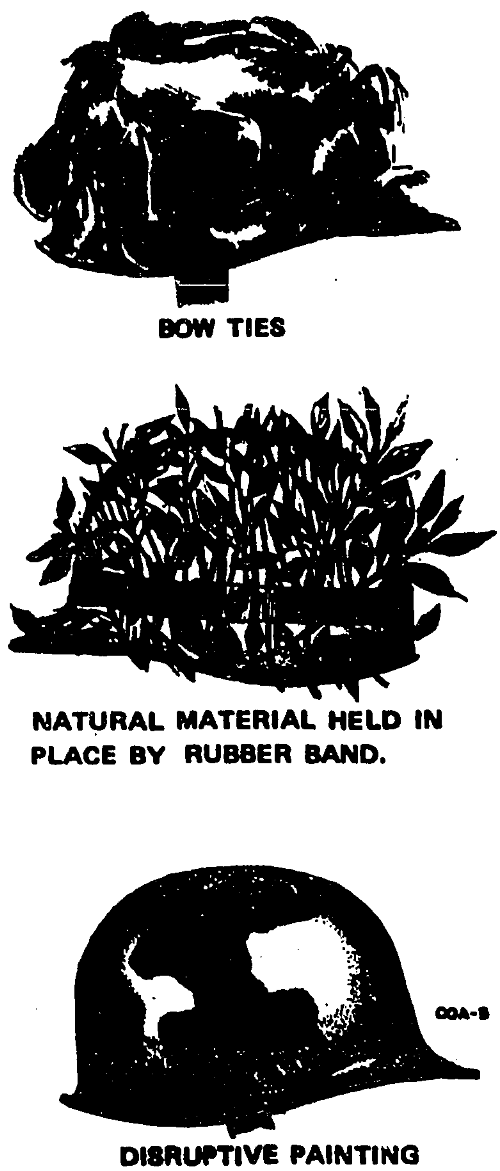

Figure 3-3. Helmet camouflage.

Figure 3-4. Silhouette.

diameter. A 2-inch hem is sewn around the edge, a tape or drawstring is pulled through the hem, and the cover is pulled loosely onto the helmet. It should be painted or smeared with mud to break up the continuous tone. Slits must be cut in the cover to allow for the insertion of foliage. No matter what kind of helmet cover is used, it is incomplete if the shadow underneath the helmet is not broken up by arranging bits of foliage or other garnish so that pieces of it hang over the rim of the helmet. Small irregular fringes of cloth, similarly arranged, can accomplish the same purpose and at the same time keep gnats and mosquitoes away from your face and neck.

Canvas gear. Clean canvas equipment is great for inspections, but in a combat situation such equipment violates the principles of camouflage. Patches of lighter or darker color are easily spotted. One of the first tasks in dressing for the job of fighting is to reduce the tone contrast between your equipment and the surroundings. This requires darkening your equipment in some instances and making it lighter in tone in others. Reducing tone contrast can be done with paint, cloth, mud, charcoal, or any other suitable substance that is available.

Silhouette. Although the airman shown in figure 3-4 blends with the ground, he is sharply silhouetted against the sky. Such clearly defined edges must be avoided. The correct way to look over the bank is from the midst of objects that are irregular in shape and that can conceal. In the illustration, the base of the tree would be a good location to reduce silhouette.

Action at night. As in the daytime, silhouette and background are vital elements in concealment. A silhouette is always black against a night sky. You must take care at night, as in the daytime, to stay away from the skyline (horizontal plane where sky and earth appear to join). On bright moonlit nights, you must use the same precautions as for daylight. You should also remember that the position of an enemy force, not the topographic crest of a hill, fixes the skyline. At night, sound seems amplified and is revealing. Thus, your movement must be careful, quiet, and close to the ground. On the other hand, should you hear the pop of a flare before it illuminates the area, drop to the ground and remain motionless. If you are surprised by the light from a flare, freeze in place, with your face pointed down toward the ground.

Position Camouflage. Proper site selection is the most important consideration in planning field fortifications. However, to serve in their fullest capacity, field fortifications and obstacles must be camouflaged in such a manner that they are a complete surprise to the enemy. The camouflage task is made easier by proper site selection.

Field fortifications are sited to take advantage of the terrain and, at the same time, permit camouflage that is vital for their security and stability. A position should be selected that does not require a change in the appearance of the terrain. Consideration of the camouflage aspect saves time and labor in effecting good concealment. To reduce ground observation, a position should be located with a good background so that occupants are not silhouetted. When proper advantage is taken of the

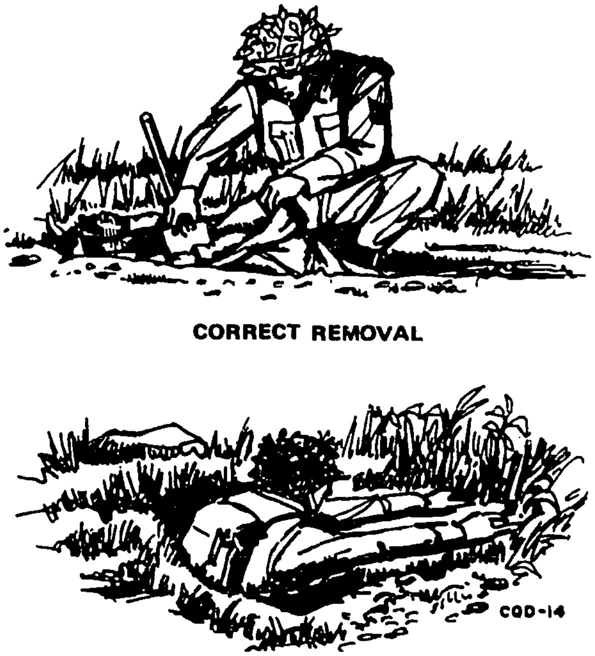

Figure 3–5. Concealing construction spoil.

terrain, positions can be inconspicuous from ground observation. To reduce the possibility of aerial observation, regular geometric layouts of positions must be avoided, and decoys and dummies should be used to confuse the enemy. Positions should be located under trees, under bushes, or in dark areas of the terrain, although your locations should not be isolated to the extent of being a landmark or an aiming point.

Postponing erection and construction of field fortifications is often the best way to camouflage a position. However, where the enemy has nuclear employment capabilities, the erection or construction must not be postponed.

Construction. Before any excavation is started, all natural materials for camouflage construction such as turf, sod, leaves, forest humus, or snow, must be removed. This material is placed or scraped aside so as to not interfere with the digging of the position. It is replaced over the site when the work is completed (see fig. 3-5). Soil (spoil) that is not used must be carried away and dumped in a concealed place, such as under bushes and low trees. Concealment is vital during camouflage construction. To prevent detection of camouflage construction that has little or no overhead cover, camouflage nets can be suspended above the position. The nets are placed so as to permit unhampered excavation work. Workers must then confine their activities to the area beneath the camouflage.

Covers. Camouflage covers are essential for positions that cannot be sited under natural concealment. They are also a valuable aid in preventing detection of the position. Natural materials native to the site must be used to a good advantage. Artificial or manufactured material may be used if garnished or pattern-painted to match terrain features. Covers made from these natural or artificial materials for hasty field fortifications should be light in weight to permit easy removal.

Weapon Camouflage. Your individual weapon must be concealed to complete the camouflage of a position. Weapon outline and shiny surfaces are the two factors involved in concealment of the weapon by camouflage. An M–16 rifle, shotgun, machinegun, and recoilless and antitank weapons have distinctive outlines that are easily identifiable. Concealment of the weapon by digging it in to present a low silhouette and by using nets and natural cover are excellent methods. However, the tactical situation does not always permit sufficient time for these methods. One of the simplest ways to distort the outline of the weapon is to wrap it with standard burlap garnishing or strips of cloth (see fig. 3-6) dyed to match the surrounding terrain. Foliage placed on various parts of the weapon is another field expedient; however, this is difficult to maintain when the weapon is operational.

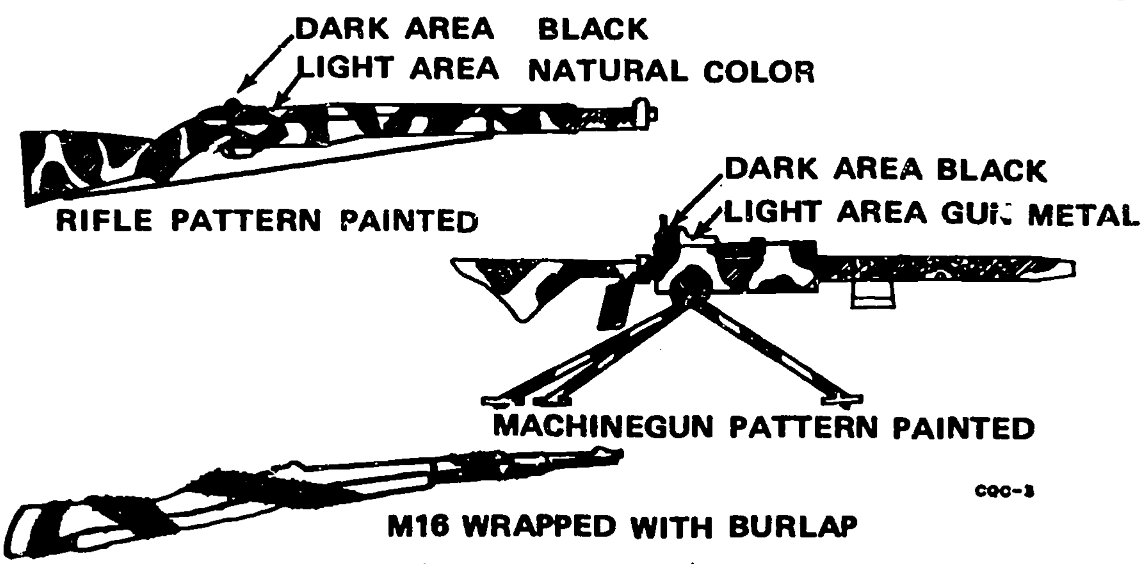

Figure 3–6. Weapon camouflage.

Painting. Pattern painting of a weapon (fig. 3-6), using colors that blend with terrain features, is another excellent method of camouflage used to distort the outline of the weapon. Any type of camouflage used must not interfere with the tactical effectiveness of the weapon.

Other methods. Shiny surfaces of a weapon can be concealed by various field expedients. For instance, cloth and paint, mentioned previously, not only distort outline but can also be used to cover the shiny surfaces of the weapon. Mud or lampblack can also be used to cover these surfaces. The mud used must dry to the desired color. Care must be exercised in application of mud to prevent interference with sighting and firing of the weapon.

Camouflage of other equipment. In a hostile situation, your ability to camouflage yourself and your personal equipment (fig. 3-7) may be excellent. However, even if these efforts are completely successful, their effect can be nullified. This happens when you forget to camouflage other support equipment; for example, vehicles, cooking areas, and sleeping areas. Generally, you do not bear the responsibility for these actions. However, guess who gets smoked when an enemy force has detected your position because of the sunlight shining on a vehicle window? You must do something to prevent this from happening. The same rules apply to camouflaging support equipment that apply to your personal camouflage. Every item in the vicinity of your area must be camouflaged. You can cover equipment with natural or manmade camouflage. The point is that you should cover it, alter the geometrical shape, reduce or eliminate shine, or do whatever else is needed to conceal the equipment.

Exercises (E18):

1. What are some common materials used for skin tone-down?

2. List three ways of disrupting the shape of a helmet and reducing its shine.

3. What fixes the skyline (as opposed to the topographic crest of a hill?

4. How is detection of camouflage construction prevented when there is no overhead cover?

E19. Determine whether cover or concealment is best suited to given circumstances.

Cover. Cover is protection from the fire of enemy weapons. It may be natural or artificial. Natural cover

Figure 3–7. Proper camouflage.

(ravines, hollows, reverse slopes) and artificial cover (foxholes, trenches, walls) protect you from flat trajectory fire and partially protect you from high-angle fire. Even the smallest depression or fold in the ground may provide some cover when you need it badly. As a member of a ground defense force, you should learn how to take advantage of every bit of cover available. You need to do this to achieve maximum protection from enemy fire. In a combat situation, you must learn to select temporary firing or observation positions that take advantage of available cover. Observing and firing around the side of an object, staying low to observe and fire, and selecting a good background when observing over the top of an object are examples of using cover to your advantage (see fig. 3-8).

Concealment. Similar to camouflage, concealment is protection from enemy observation. It, too, may be natural (bushes, grass, shadows) or artificial (burlap, nets, camouflage made from natural materials). Concealment is not protection from enemy fire. Do not make the mistake of believing you are protected from enemy fire merely because you are concealed from enemy eyes. To conceal yourself:

a. Avoid unnecessary movement; movement attracts attention. Remember that movement against a stationary background causes you to clearly stand out.

b. Use all available concealment. Background is important; blend with it to prevent the enemy from detecting you. Select trees and bushes that blend with your uniform and absorb the outline of your figure. Shadows also help hide you.

c. Stay low to observe. Present a low silhouette, making it difficult for the enemy to see you.

d. Expose nothing that shines. Reflection of light on a shiny surface instantly attracts attention and can be seen for great distances.

e. Keep off the skyline. Figures on the skyline can be seen from a great distance, even at night, because a dark outline stands out against the lighter sky. The silhouette formed by your body makes a good target.

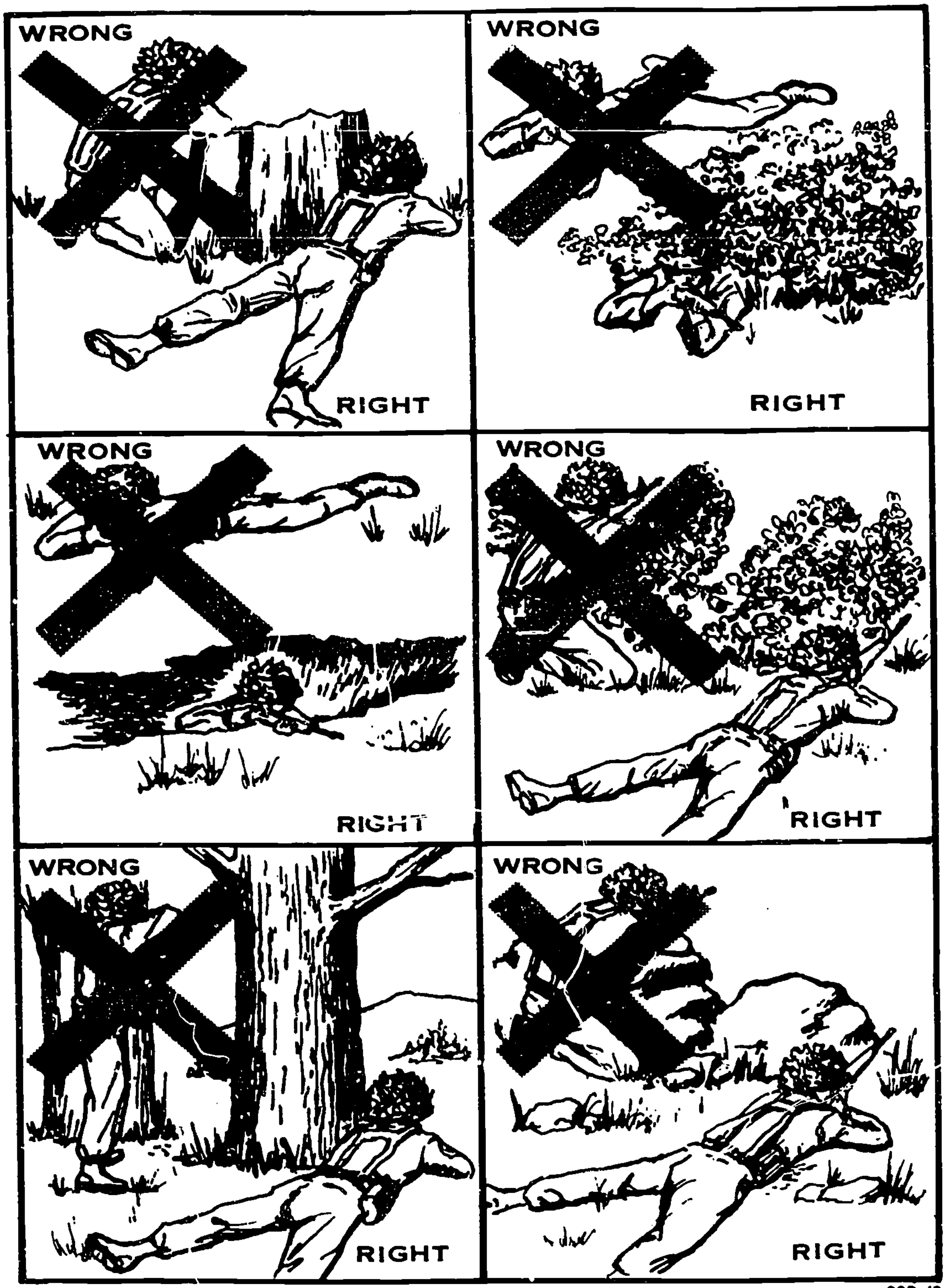

Figure 3-9. Use of cover and concealment.

Exercises (E19):

1. As a member of a response force, you have been ordered to flank an enemy unit attempting to penetrate a restricted area. En route to the scene, you come under fire from a second force no one had reported. Do you use cover or concealment?

2. For the situation in exercise 1 above, what action may have precluded your coming under fire?

3. As a member of a response force, you have been alerted to a possible armed attack and have been positioned in an area between your base's resources and its perimeter. Should you use cover or concealment to await the arrival of the reported enemy force?

3-2. Individual and Force Movement

E20. Specify the methods of individual movement used by a response force member.

Individual Movement. There are several ways of getting from one place to another when you deploy. Depending on the situation, you may decide to use one or more of the following methods.

Rushing. This is a technique for moving quickly from one place to another. You start either from a place of cover or the prone position. You then select the next spot that you want to move to. This new spot should offer you cover or, as a minimum, concealment from observation. To rush to your selected location, you get up quickly, run to the new location, and take cover. While moving, you should be sure to keep alert for enemy fire and for obstacles. You should rush in short bursts, a maximum of 15 meters. Don't try to cover great distances in one rush.

Low crawl. When you must move in on an enemy and there is little or no cover or concealment available, you must use the low crawl. To low crawl, you get into the prone position, lay the stock of your weapon on top of your arm, lay your head as close to the ground as you can, and pull and push yourself along the ground (see fig. 3-9.)

High crawl. The high crawl shown in figure 3-10 is used when some cover and/or concealment is available. To high crawl, you lay your rifle across your arms in front of your body (prone position), and you push and pull yourself along. Your head should be slightly raised so that you can watch things ahead of you.

Figure 3–9. Low crawl.

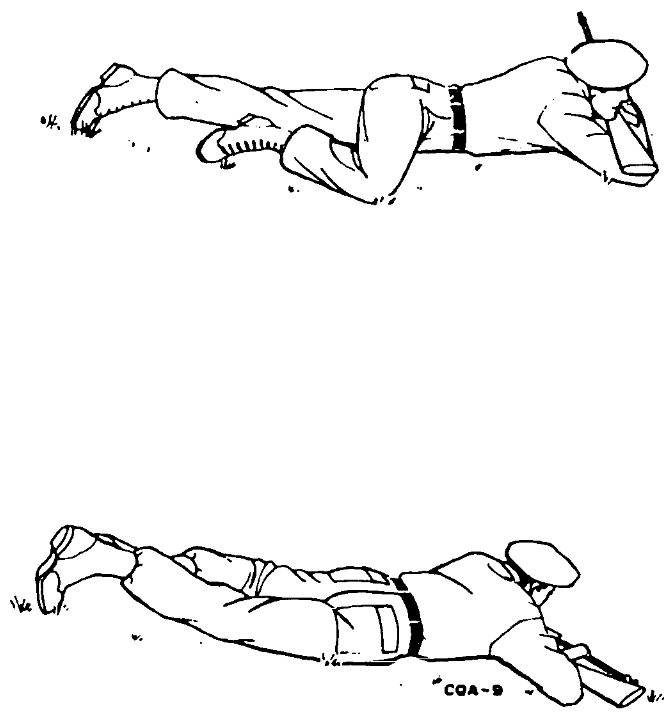

Figure 3–10. High crawl.

Walking at night. The darkness of night offers you some concealment. You can effectively walk at night without being detected by lifting your legs high and stepping down carefully on your toes, as illustrated in figure 3-11.

Stealth. Whenever you are moving, be it day or night, move as quietly and as inconspicuously as possible. When rushing or walking, avoid having loose equipment that bangs against your body; when crawling, don't drag your weapon on the ground or pavement. Silence is necessary to coneal your movement.

Exercises (E20):

1. What is the rushing technique of movement?

2. What are the low and high crawls?

3. What is the best method of walking at night?

E21. Differentiate between the techniques of fire and movement for individuals and for fire teams.

Fire and Movement. Fire and movement is a tactic used for advancing a unit while it is under enemy gunfire. You do this by having a part of your force moving forward while the remainder of the force delivers covering fire to the enemy position.

The number of people who are moving and the manner in which they move depends on the size of your unit, the terrain, and the volume of fire being received.

Figure 3–11. Walking at night.

Individual. Individual movement is usually the safest way for your people to advance under heavy fire. When moving as an individual member, you rush 10 to 15 meters forward to a point of cover. Trying to travel any further than this allows an enemy enough time to take aim with a weapon. After you take cover, you begin to deliver cover fire and another member of the unit begins to move. This leapfrog procedure goes on until all of your unit has reached the desired objective.

Team. The tactic of movement by fire team is similar to the procedure for individual movement. In the team situation, you have a portion of the unit move forward while the remainder of the squad or flight delivers cover fire. You use this type of movement when enemy fire is light. You may start out in individual movement and, as enemy fire decreases, convert to fire team movement.

Exercises (E21):

1. State the techniques of fire and movement.

2. What is the difference between individual and team fire and movement techniques?

E22. Identify the responsibilities of the base-of-fire and maneuver echelons during fire and maneuver.

Fire and Maneuver. Fire and maneuver is a combat tactic in which a squad or flight is divided a maneuver echelon and a base-of-fire echelon. The following narrative illustrates the use of the fire and maneuver tactic.

Let us assume that a hostile armed unit has taken up a position on your base. From this position, the hostile unit directs weapons fire on a number of alert aircraft. In this instance, your task as a member of a defense squad or flight would be to move to the hostile position and neutralize it as soon as possible. In order to do this, your unit would most likely use the fire and maneuver tactic. It is used to permit a portion of your squad or flight (called the maneuver echelon) to get close enough to the hostile force to conduct an assault.

To use fire and maneuver techniques, you divide the squad or flight into a maneuver echelon to advance on the hostile position and a base-of-fire echelon to deliver cover fire for the maneuver echelon. The division of the unit does not have to be equal. For instance, suppose that you find that you need a tremendous volume of fire from your base-of-fire echelon but require only a small maneuver echelon. In this case, you might assign two fire teams as the maneuver echelon and the remainder of the flight as your base-of-fire echelon. Your determination must depend on the situation. It is best to divide your unit so that you do not disrupt the integrity of its elements.

The maneuver echelon moves out under the base-of-fire echelon's cover fire. Depending on the conditions and situation, the maneuver echelon moves by crawling or rushing to a point called the final coordination line, such as that shown in figure 3-12. This point should be as near the enemy position as you can get without being dangerously exposed to friendly gunfire. The base-of-fire echelon may advance its position toward the enemy, providing there is no loss of cover fire.

Often, when long distances must be covered, the maneuver echelon moves to a point midway between its point of departure and the final coordination line and lays down cover fire while the base-of-fire echelon moves forward. This allows the base-of-fire echelon to engage the target area more effectively, whereupon the maneuver echelon resumes their advance toward the final coordination line.

Exercises (E22):

1. What are the responsibilities of the maneuver echelon during fire and maneuver?

2. What are the responsibilities of the base-of-fire echelon during fire and maneuver?

E23. State the mission of each type of reconnaissance patrol, and identify features of each type.

Reconnaissance Patrols. The overall mission of all types of recon patrols is to gather intelligence information and to confirm or disprove the accuracy of previous information. There are three types of reconnaissance patrols, namely: area surveillance, area reconnaissance, and point reconnaissance. Each type has a specific intelligence-gathering function.

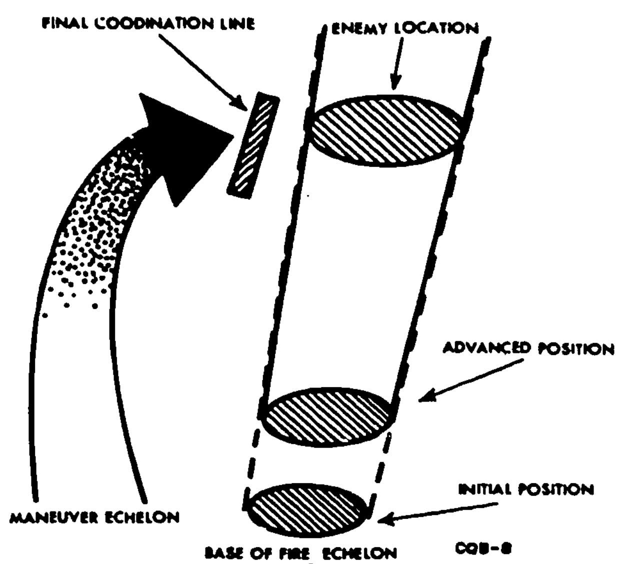

Figure 3-12. Fire and maneuver.

Area Surveillance. Your mission on an area surveillance patrol is to observe a large area, such as the area depicted by a grid square on your map, and locate enemy activity. You mark down enemy locations, places where you observe enemy movement, direction of enemy travel, and especially any changes such as new roads, and built-up areas that are not on your map. Area surveillance patrols provide us with the big picture.

Area Reconnaissance. Your mission on an area recon patrol is to move through an assigned area and locate specific enemy positions. You also confirm data reported by area surveillance patrols. There are many methods of conducting area recon patrols. Figure 3-13 illustrates these methods. Your imagination can produce other methods to use.

Point Reconnaissance. When you go on a point recon patrol, you go to observe one point: a fork in a road or stream, an enemy position, or any point your commander wants to know more about. The time you spend observing a given point is predetermined by your commander; it could be as brief as 15 minutes or as long as several days. Figure 3-14 represents several methods of point reconnaissance.

Exercises (E23):

1. What is the mission of:

   a. Area surveillance patrols?

   b. Area reconnaissance patrols?

   c. Point reconnaissance patrols?

2. Match the descriptions in column A with the types of reconnaissance patrols in column B by entering the column B letters in the spaces provided. If the description does not fit a type of reconnaissance patrol, enter 0 (zero).

Column A	*Column B*
____ (1) Locating enemy positions while moving from one place to another.	a. Point reconnaissance.
____ (2) Provides coverage of your route.	b. Area reconnaissance.
____ (3) Four-man teams observing movement in a valley.	c. Area surveillance.
____ (4) A patrol to deny the enemy control of an area.	
____ (5) A two-man team watching a road junction.	

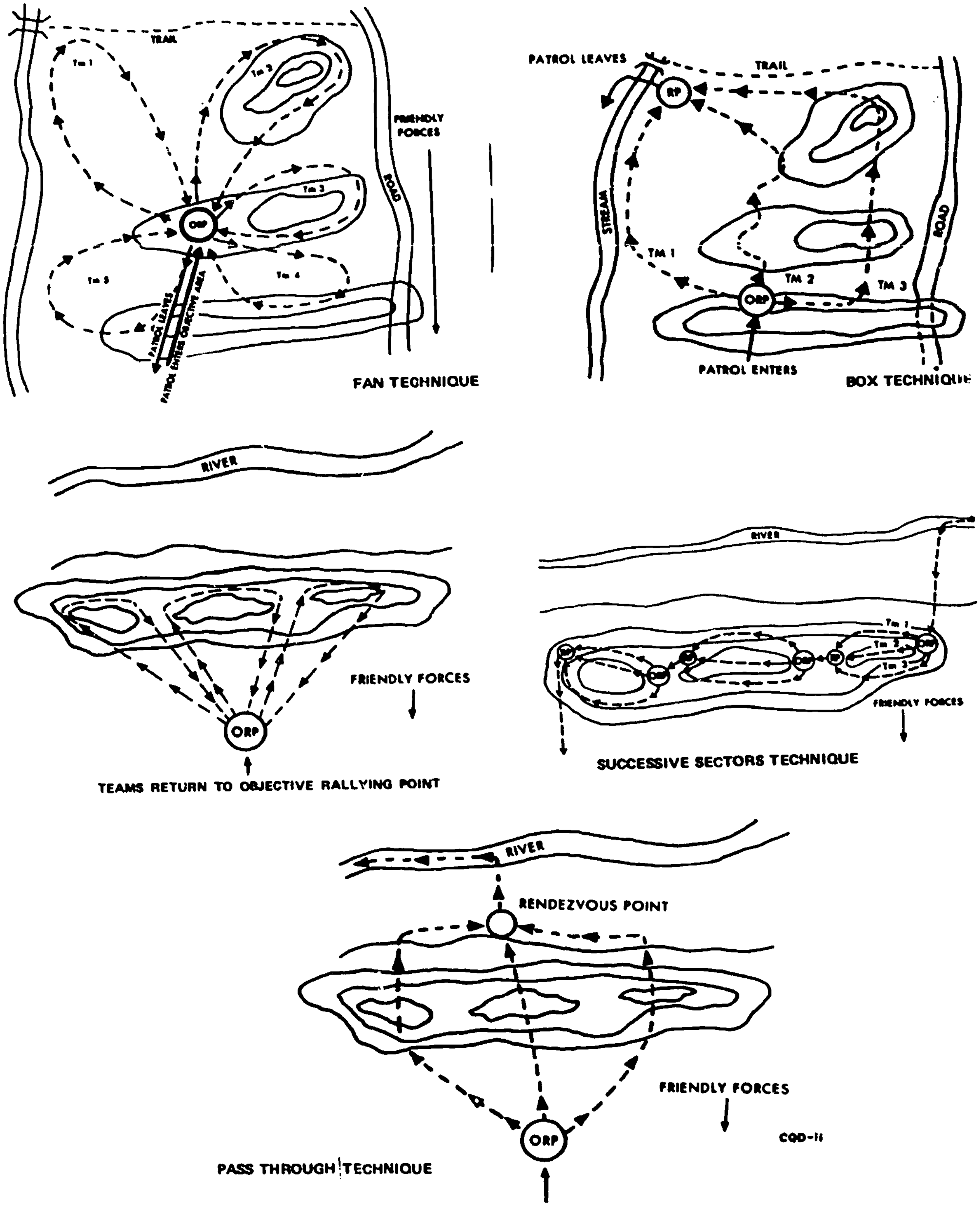

Figure 3–13. Area reconnaissance.

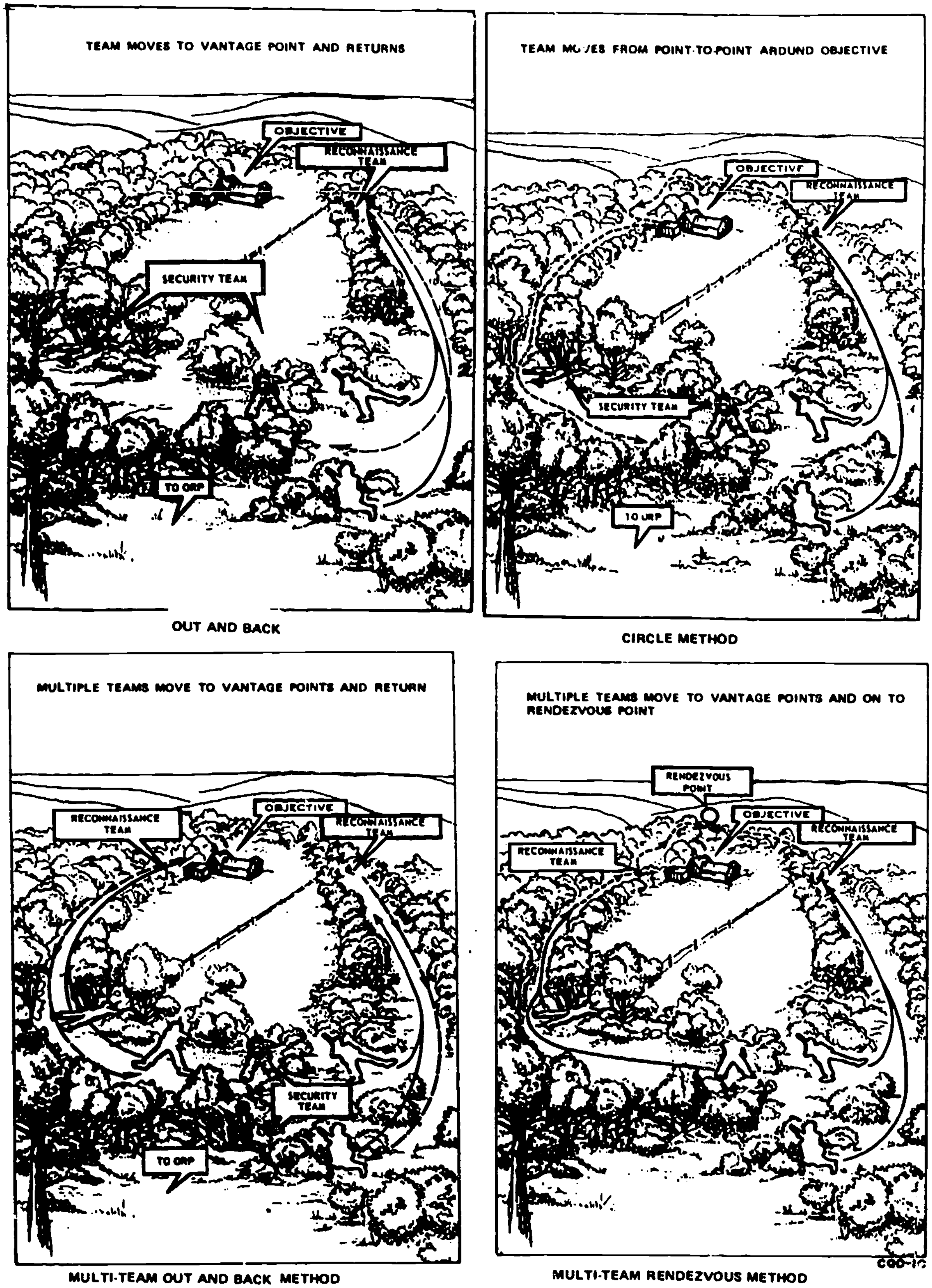

Figure 3-14. Point reconnaissance.

E24. State the mission of each type of combat patrol, and identify features of each.

Combat Patrols. All combat patrols serve basically the same purpose: seek out and destroy, capture, or harass the enemy. They may provide security. They also collect and report information related and unrelated to their mission. There are five types of combat patrols, and each type has a specific goal.

Ambush patrols. Ambush patrols wait in hiding to attack and destroy a moving or temporarily halted target, such as a column of troops or vehicles. There are as many types of ambushes as there are imaginations. Figure 3-15 illustrates only a few of the many forms of ambush.

Raid patrols. When you go on a raid, your mission is to attack and destroy an enemy position and then withdraw. You want to hit the enemy where it hurts and then move on to strike again. Your force is not large enough to hold the position you raid, only strong enough to cause damage, and reduce or eliminate the position.

Search and clear patrols. The mission of a search and clear patrol is to move into an area, destroy the enemy or run them out, and hold that territory for our own use or for use by friendly forces.

Security patrols. These patrols are designed to screen or cover the flanks of your position, area, or route. These screens prevent infiltration and surprise attack. During movements, security patrols prevent ambushes along the way.

Economy of force patrols. Your mission on an economy of force patrol may be to establish a roadblock that prevents enemy movement or reinforcement, seize key terrain to prevent enemy use, cover the withdrawal of a force by deception or delay, or act as a blocking force to allow a major effort to be made without interference at another location.

Exercises (E24):

1. What is the mission of:

   a. Ambush patrols?

   b. Raid patrols?

   c. Search and clear patrols?

   e. Economy of force patrols?

2. Match the descriptions in column A with the types of combat patrols in column B by entering the column B letters in the spaces provided. If the description does not fit a type of combat patrol, enter 0.

Column A	*Column B*
____ (1) Provides coverage for your route.	a. Ambush patrol.
____ (2) Surprise attack.	b. Raid patrol.
____ (3) Four-man team observing movement in a valley.	c. Search and clear patrol.
____ (4) Hit-and-run destruction of an enemy target.	d. Security patrol.
____ (5) A patrol to deny the enemy control of an area.	e. Economy of force patrol.
____ (6) Running an enemy out of an area for our own gain.	

3-3. Weapons Fire Control

Because our operations in a combat environment are generally defensive and our resources are often so inviting to an enemy, we sometimes seem to get more than our fair share of attack by hostile units.

No matter how strong your defense is, if the enemy wants your resources badly enough, they will try to get them. When this happens, your job can become a little bit hectic: you must block the attack before it gets to your resources and then counterattack to destroy the enemy. In this section, we discuss the principles of planning and conducting a counterattack against an attacking hostile force.

E25. Briefly define preparation, fire and maneuver, and assault as they relate to conducting a counterattack.

Preparation. The first step in conducting a counterattack is preparation. You can't just grab a rifle, yell, "Follow me, men," and charge a defended position. Those people in the position have real guns, with real bullets, and lack of preparation could be disastrous.

Plan. The enemy have a plan. If they didn't, they wouldn't be on your base holding one of your positions. And if they didn't want to fight, they wouldn't have come. Consequently, you must plan your actions carefully.

First of all, remember a basic rule of combat: meet force with superior force. To do this, you need to get a reliable estimate of (1) how many people you are facing, (2) how they are armed, and (3) how well protected they are. From this information, you can decide the size of the force you need, how to arm them, and what, if any, support you want to ask for. This support may range from artillery fire to the use of air-to-ground attack by combat aircraft. If that sounds a little heavy, remember that you are the one who has to peek into that position and hope that nobody is peeking back over a gunsight.

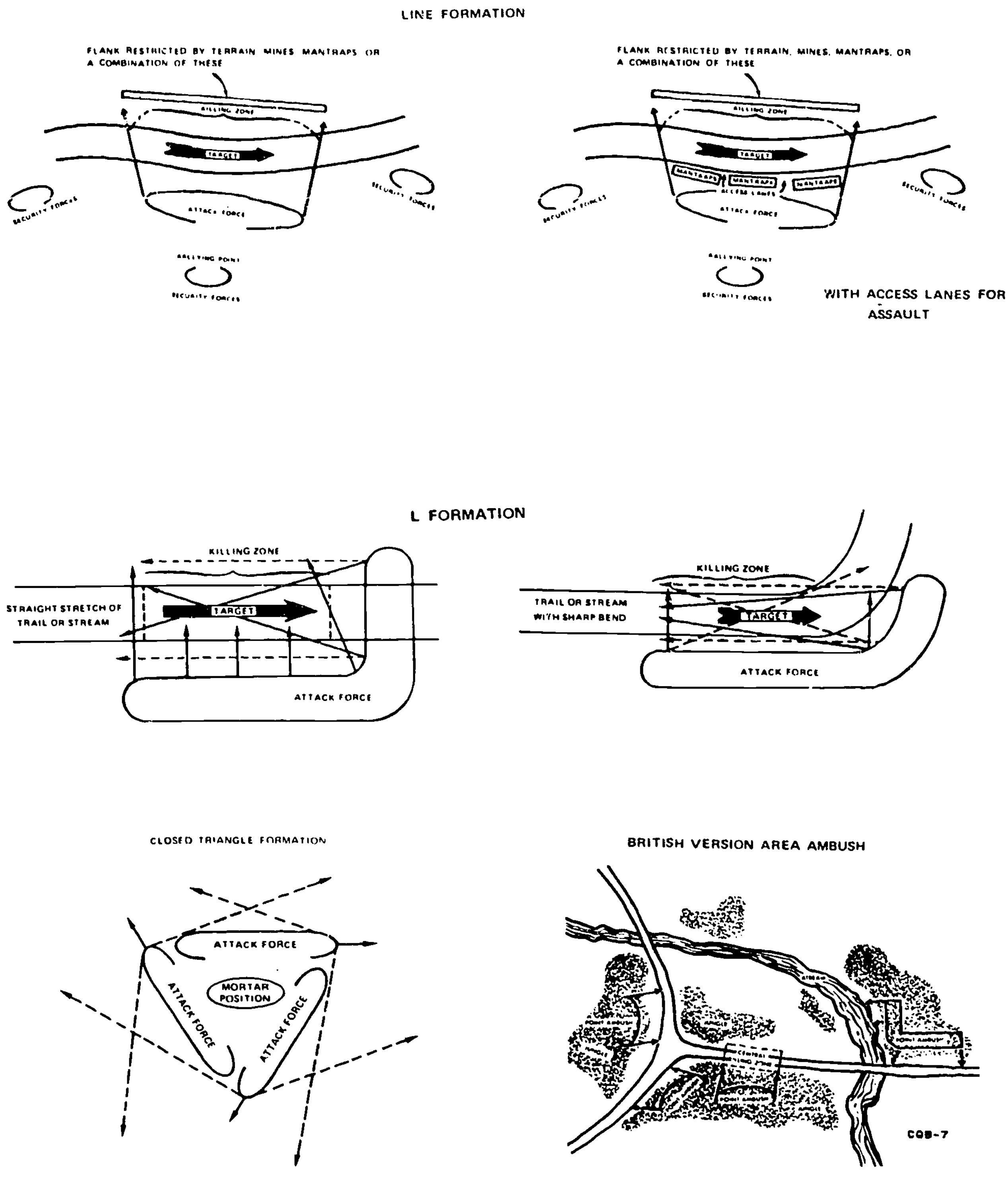

Figure 3–15. Harassing or destructive ambush.

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Next, plan your step-by-step actions through the point where you are again occupying the position. This planning includes two phases: (1) a fire and maneuver operation to get your assault force into the desired position and (2) the actual assault itself.

Assembly. To begin planning the fire and maneuver phase, you select an assembly area. This must be a safe area where final orders can be issued, final supply issue accomplished, and final planning conducted.

Route. Your next step is to carefully plan a route of travel that makes maximum use of all available cover, concealment, and supporting fire. Whenever possible, select a route that allows you to assault the enemy's flank or rear.

Departure Line. Next, you select a line of departure. This is a recognizable physical location that provides cover and that can be safely reached by the assault force (maneuver echelon). If a blocking force has not already established a position for your base-of-fire echelon, you also select that position.

Final Coordination Line. Now select your final coordination line. You must insure that everyone in the maneuver and base-of-fire echelons knows where this point is and knows the time when you plan to begin the actual assault.

Assault. The next step is to plan the assault. Now you must assign specific target areas to each member to avoid bunching your people toward the center of the enemy position. You designate one person as base, and instruct everyone else to stay abreast of the base and guide left or right with him in order to maintain proper spacing. You can then control the entire assault formation by adjusting the speed or direction of the base man. For large-scale operations, you may designate a base team or squad. Finally, you select a limit of advance. This is the point where your assault echelon stops after moving through the objective. You also designate a security element that returns to the objective, checks for boobytraps, and secures the area.

After completing the planning phase, you are ready to proceed to the line of departure. At this point, the base-of-fire echelon begins its suppressive fire. Any other fire support, such as mortar fire, artillery, or air support, is also employed at this time. As the support fire begins, your maneuver echelon starts to move toward the final coordination line. Upon arrival at the final coordination line, everyone reloads his weapon and prepares for the assault.

When the maneuver echelon is ready to begin the assault, the echelon leader gives a prearranged radio or visual signal to the echelon leader of the base-of-fire element. In turn, the base-of-fire leaders instruct their people to shift their fire to a direction different from where the assault will come from, or to cease fire. Now, the maneuver echelon, moving rapidly and maintaining alignment in the line formation, begins the assault. As your people move forward in the assault, riflemen and grenadiers fire a round or a short burst of rounds (as directed by the echelon leader) each time their left foot strikes the ground. To maintain a steady volume of firepower, machinegunners must fire as the right foot strikes the ground. No one in the formation should slow down or stop for anything. Reloading must be done rapidly as you move toward the objective.

When the assault echelon arrives at the objective, they continue moving in formation to your preestablished limit of advance. This is done to push the enemy force further from the objective and to reduce the possibility of a rapid counterattack or ambush.

Your unit then establishes all-around security, and your security element returns to the objective. They check for prisoners and boobytraps and secure the objective. Now your force can return to the objective and, if necessary, prepare to repel an enemy counterattack.

Exercises (E25):

1. Briefly define preparation, fire and maneuver, and assault as they relate to conducting a counterattack?

E26. State counter ambush actions during movement.

Counter Ambush Drills. If your unit is ambushed, you and your entire unit must act immediately with a preplanned course of action. This action, called the counter ambush drill, may vary, depending on whether you are caught in a near or far ambush. In each situation, the success of the counter ambush drill used depends upon being well trained in recognizing the nature of an ambush and well rehearsed in the proper reaction.

Near Ambush. A near ambush is one in which the enemy forces are located within a reasonable assaulting distance of the kill zone (50 meters or less as a guideline). In a near ambush, the kill zone is under very heavy, highly concentrated, close-range fire. There is little time or space for you to maneuver or seek cover. The longer you remain in the kill zone, the more certain your destruction. Therefore, if atta by a near ambush, you should take the following actions (see fig. 3-16).

a. Those in the kill zone, without order or signal, immediately assault directly into the ambush position, occupy it, and continue the attack or break contact as directed by the squad or team leader. This action moves you out of the kill zone, prevents other ambush force elements from firing on the assault without firing on their own men, and provides you positions where you can take other actions.

b. Those not in the kill zone maneuver against the ambush force as directed by the squad or team leader.

c. The assault is continued until the ambush force is eliminated or the order is given to break contact.

Far Ambush. This is an ambush in which the enemy forces are located beyond a reasonable assaulting distance (more than 50 meters). Here, the kill zone is also under very heavy, highly concentrated fire, but from a greater range. This greater range provides those in the kill zone some space for maneuver and some opportunity to seek cover with a smaller risk of destruction. If attacked by a

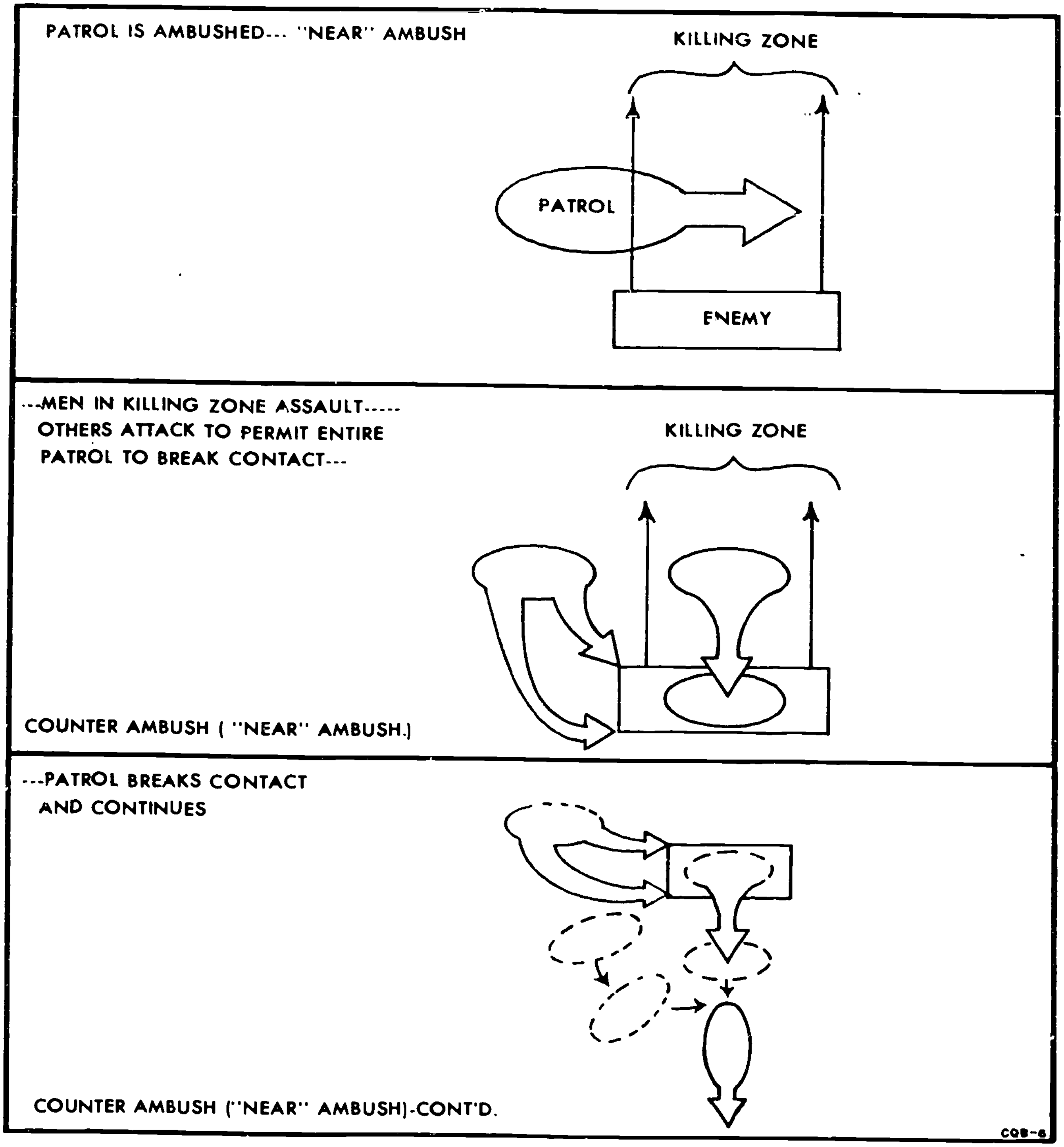

Figure 3–16. Counter ambush for near ambush.

far ambush, you should take the following actions (see fig. 3-17).

a. Those in the kill zone, without order or signal, immediately return fire, take the best positions available, and continue firing until directed otherwise.

b. Those not in the kill zone maneuver as directed against the ambush force.

c. The attack is continued until the ambush force is destroyed or the order is given to break contact.

Exercises (E26):

1. What counter ambush actions do you take when caught in a near ambush?

2. What counter ambush actions do you take when caught in a far ambush?

E27. State the purpose and benefit of search and clear operations. Given hypothetical situations, identify actions taken to search and clear buildings and open areas.

Search and Clear Operation. Whenever a building or area is, has been, or is suspected of being occupied by a hostile force, it must be searched and cleared. The operation is conducted before enemy-held real estate can be occupied by your own forces. This is an absolute must if you are to insure that all hostile forces have fled or been neutralized and that all boobytraps have been found and disarmed. Actions to search and clear a designated locale could take place within friendly or enemy territory.

Buildings. You would normally employ an entire squad to search a building. Two fire teams act as a security element. Their purpose is to seal off all avenues of escape and provide protective fire for the third fire team. The searching fire team is the search party that enters the building and conducts the search. There are three methods of entering and clearing buildings.

(1) Entry at the top. Whenever possible, you should enter and search a building from the top down. Enemies who are forced to the top of a building may be cornered and become physically violent, causing harm to you or forcing you to harm them. On the other hand, enemies who are forced downward to ground level may attempt to escape from the building, making themselves vulnerable to capture by the security element. You may use various means to gain entry to the top of a building; for example, ladders, drainpipes, toggle ropes, grappling hooks, roofs of adjoining buildings, or civil engineering utility vehicles designed for working at heights.

(2) Entry on the middle floor. In many cases, it may be impossible to enter a building at the top. In these instances, you must enter at the highest possible point, using the techniques previously described. Initially, you thoroughly search and secure the floor (level) you enter. Then you move to the top floor and search from the top down.

(3) Entry at the bottom. When you must enter a building at ground level, the security element must take every precaution to insure protection of the search element, up to point of actual building entry. When you have searched the ground floor, move to the top of the building and work down.

Rooms. To search individual rooms, a two-man team is normally used. Depending on the likelihood of an enemy presence in the room, one member may throw in a riot control or fragmentation grenade, wait for it to explode, then enter. After entry, you must place your back against the nearest wall. The second man then follows suit and searches the room in detail.

In an occupied building, when the enemy's location in a building is unknown, all rooms must be searched. In the case of quarters, attempt to have occupants submit voluntarily to the search. At the same time, question them in an attempt to pinpoint the enemy's location. If an occupant will not voluntarily submit and there is any cause to believe that an enemy is located in the room, conduct the search as described earlier.

In a building where the location of the enemy is known, proceed directly to the immediate vicinity of the enemy location. Then, carefully search the rooms near the location in case they have moved. When you pinpoint the enemy, employ riot control or fragmentation grenades in an attempt to force them into the open.

Open areas. The size of the unit you employ to search and clear an open area depends on the size and terrain of the area and size and strength of the enemy force you expect to encounter. Once again, the rule to follow is to meet force with superior force.

Search and clear operations in open areas usually take place outside the defended area of the base. They are really nothing more than the conduct of any of several types of patrolling operations; for instance, operations intended to harass guerrila or terrorist forces, keep them on the move and off balance, and hopefully destroy or capture them. Further, search and clear operations may include offensive tactics, such as raid and reconnaissance in force operations.

Raid. A raid is a swift, small-scale (squad or flight size) penetration of hostile territory. Your objective may be to secure information, harass the hostile force, or destroy their camp or base. A key feature of the raid is that, as soon as your mission is completed, you make an immediate planned withdrawal from the hostile territory.

Reconnaissance in force. A reconnaissance in force operation usually requires a flight-sized unit. Here your purpose is to develop intelligence, locate the hostile force, test their strength, and coordinate or conduct attack on the hostile force or their installation. This form of operation could be considered a large scale, thorough search of the hostile area.

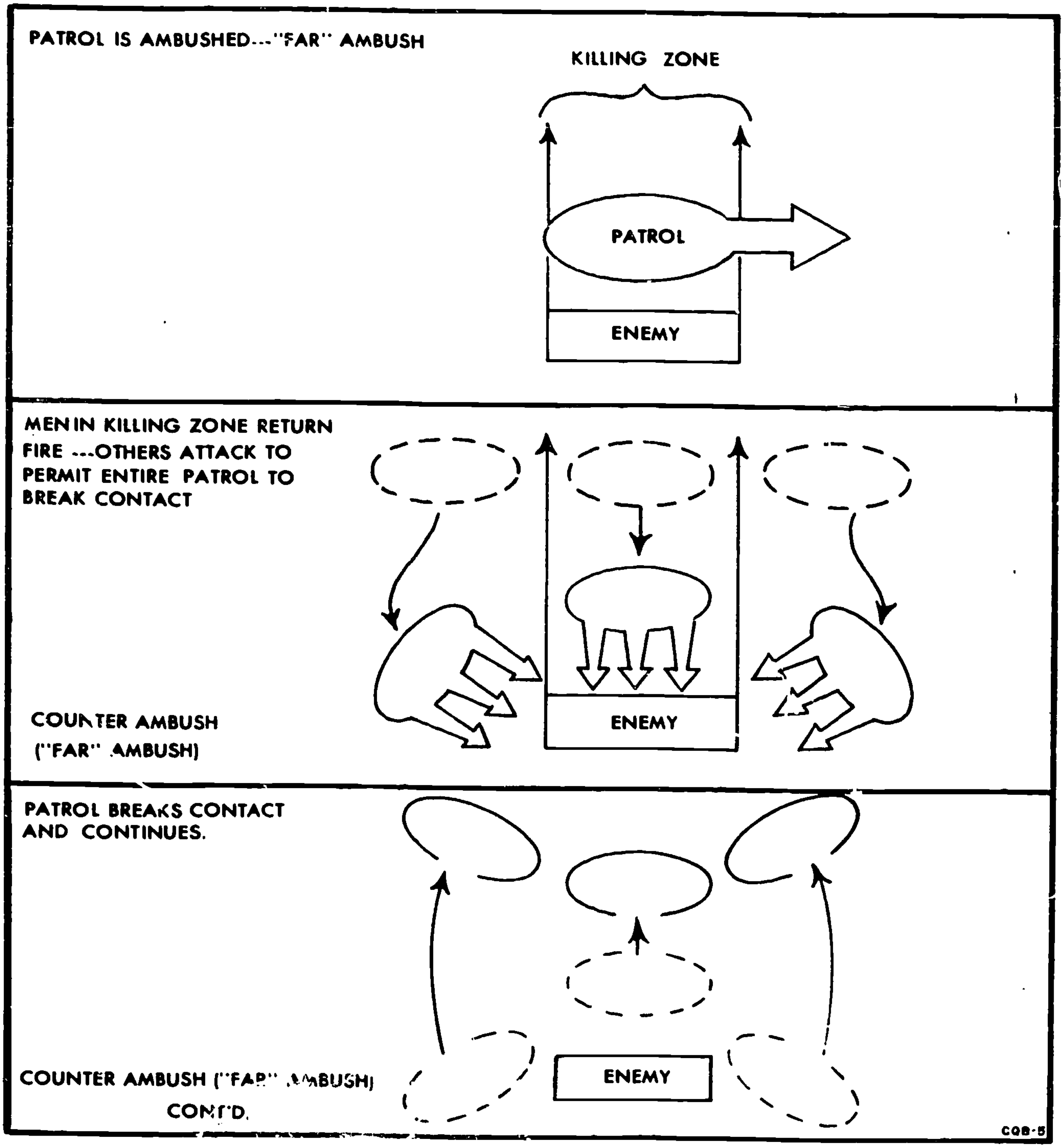

Figure 3–17. Counter ambush for far ambush.

Exercises (E27):

1. Why must an area be searched and cleared?

2. What benefit is realized by a search and clear operation?

Evaluate the situations given below and state the search and clear actions to be taken.

3. A sniper has gotten into a 3-story building just off of the perimeter and is firing at targets on the base. His location inside the building is unknown.

4. Same situation as in exercise 3, but there is no means of entry from the roof or top floor.

5. Intelligence sources indicate that a force of 45 heavily armed terrorists are camped in a densely wooded area somewhere close to your base. They have been harassing your perimeter frequently, and you have been directed to locate them, confirm their strength, and, if possible, attack their camp.

6. Same situation as in exercise 3, but with only 5 terrorists reported.

3-4. Field Fortifications

This section is designed to help you understand the advantages that can be gained through the correct use of field fortifications. Toward this end, we briefly discuss the various factors that must be considered when planning the use of, or building of weapon emplacements and tactical wire barriers. Included are the various types of emplacements and barriers commonly used by our combat forces. Also, we discuss how these fortifications should be used to complement one another and to enhance your overall defense posture.

E28. Given hypothetical situations, determine whether field fortifications must be constructed.

Planning and Use. The opportunity to fight from prepared positions is an advantage that you must exploit. The degree of protection that field fortifications can give you depends on their construction and strength. This protection also depends on (1) how well you distribute them within the tactical defense, (2) how well you adapt them to the terrain, and (3) how well you conceal them from enemy observation. The following are some factors that you should consider when planning the use of, or building of, field fortifications.

Plans. Plans for fortifications not only provide for the desired degree of protection but also for bringing the enemy under the maximum volume of effective fire as early as possible. Fortification plans are usually based on progressive construction; that is, proceeding from open to covered emplacements and shelters. This is done in order to have the best protection possible under the circumstances.

On the offense. During offensive operations, periodic halts may be required to regroup, resupply, or consolidate positions gained. Where the enemy threat is known to include a counterattack capability (or probability), offensive units should seek available cover or should dig hasty emplacements as described later in this chapter.

On the defense. A defensive position is built around a series of organized and occupied tactical positions. Positions are selected for their natural defensive strength and the observation afforded. Fortification measures for these positions include clearing fields of fire, digging weapon emplacements and positions for personnel, strengthening natural obstacles, installing artificial obstacles, and providing camouflage.

Dispersion. The separation of units and individuals is a primary means of increasing protection. Clearly, a unit is less likely to be vulnerable to enemy weapon fire if the area the unit occupies is increased. Proper dispersion, then, can greatly reduce the need for a high level of protection from field fortifications. The extent to which a unit spreads out depends on the mission, the terrain, and the enemy situation. Fortifications, properly employed, can be used in lieu of, or to supplement, dispersion. For this reason, fortifications are particularly important for units that cannot disperse sufficiently to obtain adequate protection.

Alternate and dummy positions. When time and the situation permits, dummy and alternate positions should be built to deceive the enemy and to allow flexibility in your defense.

Exercises (E28):

State whether field fortifications must be constructed in each of the following situations by entering "yes" or "no" in the space provided.

_____ 1. Your unit has just overrun an enemy position and halts to regroup and resupply before proceeding elsewhere on another mission. The decisiveness of your unit's victory assures that the enemy is incapable of mounting a counterattack before your unit leaves the area.

_____ 2. After obtaining the resupply mentioned in exercise 1 above, your unit moves on to its second mission, and it again surmounts an enemy position. This time, however, in the face of your unit's superior strength, the enemy disengages contact and disperses before sustaining any significant casualties. Shortly thereafter, you receive an intelligence report indicating that an additional enemy unit, equal in size to the one that just retreated, is also somewhere in the area. Again, you must wait for resupplies before moving out of the area.

_____ 3. Security forces in your sector recently repelled a ground attack against your base. This attack pointed out some possible weaknesses in your defenses. You find that to strengthen these weaknesses, you must add some weapons and relocate several of those already in place.

E29. Given hypothetical situations, determine the type of weapon emplacement to establish.

Types of Emplacements. Concerning the protection of our bases, we have the advantage of time to prepare defensive positions. As mentioned earlier, you must plan properly and concentrate your defense on what you expect the enemy to do. However, you must also learn to expect the unexpected and be ready to cope with it. Keep in mind that, as is usual with human nature, people do not always act or react as you expect. For this reason, you must be ready for the possibility of having to construct your own on-the-spot defensive position. This situation could arise, for example, when you are reacting as a member of the response force or when you are initially being posted during a ground defense operation. The emplacements you are most likely to use are presented in the following paragraphs.

Hasty emplacements. Hasty emplacements are dug when you have made contact with the enemy, and time and materials are limited. Their purpose is to provide immediate protection from direct fire. They are also used when there is no natural cover available. Examples of hasty emplacements are:

a. Shell crater. If you have time, try to find a crater that is 60- to 90-cm wide (2 to 3 feet). This size offers you immediate cover and concealment and can be quickly made into a hasty position. Any place where heavy weapons rounds have exploded can quickly be expanded to afford you some protection. These craters can later be developed into a foxhole if your stay in the area is extended.

b. Prone emplacements. Initially, you can start with a skirmish trench; this simply involves digging or scraping dirt into piles to place between you and the enemy. As time permits, you can expand this type of emplacement to conform to your body position and arm length. Once improved, you are better protected from small arms or direct fire weapons than if using a shell crater or your initial skirmish trench.

c. Other immediate alternatives. As a last resort, you can pile rocks, hard-packed snow, ice, and dirt in front of your position. A minimum of 30 cm (12 inches) of this material can resist penetration of may small arm projectiles.

Foxholes. Foxholes are the basic defensive positions. They afford you good protection against most forms of enemy small arms fire. They can be developed by expanding the hasty positions discussed earlier, or you can start from scratch. As time permits, you can make improvements by revetting the sides, adding overhead cover, providing drainage, and excavating a grenade sump to dispose of handgrenades thrown into the hole by the enemy. When used in our concept of defense, the two-man foxhole is better than the one-man emplacement.

Machinegun emplacements. Machinegun emplacements should give maximum protection to the crew; however, the main consideration must be the effective use of the weapon. The positions described in the following paragraphs are designed for use in terrain that permits excavation.

a. Horseshoe. The horseshoe-shaped trench, about 3-feet deep, is a trench dug along the rear and sides to form a horseshoe. It has a chest-high shelf in the center to serve as the gun platform. The dirt from this trench is used to form a low protective wall (parapet). The wall should be at least 1-meter wide, and low enough to permit all-around fire. This type of emplacement permits you an easy traverse of the gun through an arc of 180°; but it does not allow you to fire effectively to the rear.

b. Two one-man foxholes. This emplacement consists of two one-man foxholes close to a gun position. The parapet is low enough for all-around fire and offers you good protection. Although 360° fire is possible from this position, fire to the front and rear is most effective because the M-60 machinegun is fed from the left side.

Drive-through fighting positions. In your defensive operation, drive-in revetments, with concealed approach routes, should be constructed on your main line of resistance (MLR). These positions should be as narrow and as short as your vehicle size permits. You can use sandbags or 55-gallon drums filled with sand to construct the drive-in revetments. Individual positions with overhead cover should also be constructed for deployed personnel. These individual positions serve to protect your drive-in positions; also, they give you direct fire support.

Concealment. Concealment is of prime importance in constructing your defensive positions. When and if time permits, you should make full use of all available natural materials; for example, trees, logs, and brush. Manufactured materials such as barbed wire, cement, lumber, sandbags, corrugated metal, and other material that you could use should be obtained from support organizations. To further conceal your positions, make maximum use of surrounding background to break up outlines. A more thorough coverage of camouflage techniques was presented earlier in this text.

Exercises (E29):

Match each situation in column A with the column B type of emplacement that should be constructed by writing the column B letter in the space provided. Column B items may be used once or not at all.

Column A	Column B
____ 1. You are in enemy contract and must seek immediate cover in an area devoid of natural cover and recently bombarded by heavy weapons.	a. Two one-man foxholes.
____ 2. You have the time to expand the initial hasty position you are lying in to make it fit the length.	b. Foxholes.
____ 3. After repelling an initial attack, your unit must hold its present position. You need to improve your present hasty emplacements for better protection against most forms of enemy small arms fire.	c. Prone emplacement.
____ 4. You must set up a machinegun emplacement that allows you a 180° arc of fire to the front. Firing to the rear is not needed.	d. Shell crater.
____ 5. You must set up a machinegun position that allows for all-around fire.	e. Horseshoe.
	f. Drive-through fighting position.

E30. Determine how tactical barriers are used, and state how they enhance defensive positions in given situations.

Tactical Barriers. Wire barriers (entanglements) are used to break up enemy formations and to hold the enemy in areas covered by your defensive fire. They also protect you by preventing close-in surprise attacks on your defensive positions. When you construct these barriers, place them close enough so that you can observe them both day and night. At the same time, however, be sure to place the barriers far enough from your position to keep the enemy beyond handgrenade throwing range.

As you can see, selecting the proper position for barriers is important. Equally as important, however, is selecting the proper type of barrier. To help you do this, barriers have been classified according to their use and their depth.

Use. Entanglements are classified by use as tactical, protective, or supplementary.

a. Tactical. Tactical wire entanglements are sited along and parallel to the friendly side of your final protective line. You use them to break up enemy attack formations and to hold or channel the enemy in areas covered by your most intense defensive fire. You can extend this type of entanglement across the entire front of your position. Remember, however, that it doesn't necessarily need to be continuous.

b. Protective. This type is located to prevent surprise assaults from points close to your defensive area. Remember to place it to keep the enemy beyond handgrenade range.

c. Supplementary. You can use this type to conceal the exact line of your tactical wire. Also, you can use it to inclose your defensive position by connecting protective wire entanglements. If used to break up the line of your tactical wire, it should be identical to the tactical wire entanglement and should be constructed at the same time.

Depth. The following are the three classifications of depth:

a. Belt. A belt is an entanglement that is one fence in depth.

b. Band. This consists of two or more belts with no intervals between them. You may construct a band by using different types of fences.

c. Zone. This is two or more bands or belts with intervals between them.

Types. Now that you are familiar with the classifications of entanglements, let us look at the types of barriers and their uses (see fig. 3-18).

a. Four-strand cattle fence. This fence may be used to designate the legal base boundary. It is also used as the center section of a double-apron fence.

b. Double-apron fence. This fence combines the four-strand cattle fence with aprons of barbed wire at the front and rear. Its effectiveness can be increased by installation of tripwires.

c. Standard concertina. The triple-strand concertina fence is usually a better obstacle than the double-apron fence. Concertina fences are held down by stakes placed at intervals of not more than 2 meters. These stakes are used on the single concertina fence and on the front strand of the double and triple types. There are three types of concertina fence you can use:

(1) Single. This single line of concertina is erected quickly and easily, but it is not an effective obstacle.

(2) Double. This consists of a double line of concertina with no interval between lines. The two lines are installed with staggered joints. Also, double concertina is less effective than a double-apron fence. It is used to supplement other obstacles in a band or zone.

(3) Triple strand. This consists of two lines of concertina serving as a base, with a third line resting on top. All lines are installed with staggered joints. Each line is completed before the next is started so that a partially completed concertina entanglement will present some obstruction. It is erected quickly and is difficult to cross or crawl through.

Portable barbed-wire obstacles. Concertina wire is an effective obstacle that can easily be moved, used to temporarily close gaps or lanes, or used for adding obstacles to already established barriers. Other portable barbed-wire obstacles you can use are:

a. Spirals of loose wire. By filling open spaces in and between your wire entanglements with spirals of loose wire, the obstacle effect is substantially increased. Men are tripped, entangled, and temporarily immobilized by the loose wire.

b. Knife rest. The knife rest is a portable wooden or metal frame strung with barbed wire. It is used when you need a readily removable barrier; for example, at lanes in wire obstacles or at roadblocks. Knife rests are normally constructed with 3 to 5 meters between crossmembers. They should be approximately 1 meter high, and the crossmembers must be firmly lashed to each horizontal member with plain wire. Insure that you firmly secure the knife rest in its position.

c. Tripwires. Immediately after a defensive positon is occupied, tripwires should be placed just beyond grenade range. The wires should stretch about 8 inches above the ground and be fastened to pickets at not more than 5-meter intervals. They can be concealed in long grass, or on a natural line, such as the side of a path or the edge of a field. Tripwires should be placed in depth, in an irregular pattern, to enhance their disguise.

d. Tanglefoot. Tanglefoot is used where concealment is possible. The obstacle should be used in a minimum depth of 10 meters. Space your holddown pickets at irregular intervals from 1 to 3 meters, with the height of the barbed wire varying from 8 to 30 inches. Tanglefoot should be sited in scrub, if possible, using bushes as supports for part of the wire. In open ground, short pickets may be used.

Exercises (E30):

Determine how barbed-wire barriers are being used by matching the column A situations with the appropriate classification listed in column B by writing the column B letter in the space provided. Column B items may be used once or not at all. Briefly state how the barriers enhance your defensive positions.

Column A	*Column B*
____ 1. Barriers are positioned along and parallel to the friendly side of your final protective line.	a. Protective.
____ 2. Barriers are used to complement and/or joinother wire barriers.	b. Tactical.
____ 3. Barriers are installed around your defensive positions at distances designed to keep the enemy beyond handgrenade throwing range.	c. Supplementary.

E31. Given hypothetical situations, determine how weapon emplacements and tactical barriers are used in base and sector defense.

Weapon Emplacements. Base and sector defense weapon emplacements are located to cover a selected area with fire, taking advantage of any natural cover and concealment. The most commonly used emplacements were discussed earlier in this chapter. One main point to keep in mind when planning or constructing weapon emplacements is that, in defensive firing positions, maximum fields of fire and observation in the direction of the enemy should not be sacrificed for elaborate overhead cover. Obviously, then, weapon emplacements must be built to coincide with your fire plans.

Fire plans. Fire plans must be prepared for each defended locality (whether occupied by a fire team, squad, or flight) and must be consolidated at sector level before coordination is attempted with adjacent sectors.

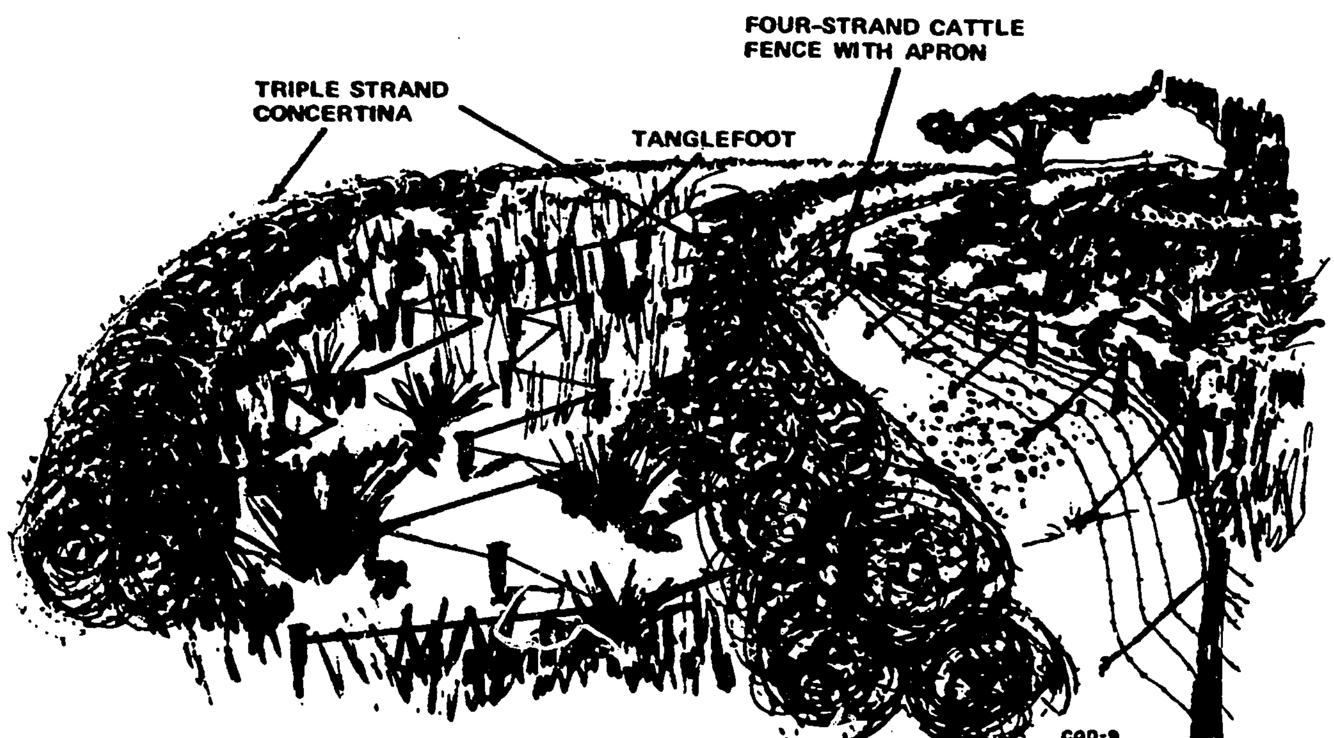

Figure 3-18. Entrapments.

Basically, a sector fire plan must provide for (1) placing long-range fire on enemy personnel as soon as they come under observation, (2) subjecting enemy personnel to an increasing volume of fire as they approach the tactical defenses, (3) breaking up the attacking force with close defensive fire, and (4) stopping an enemy assault with final protective fire.

Defense in depth, interlocking fires, and mutual support between defended localities and between defense sectors are essential. For instance, machineguns should be positioned to provide maximum grazing fire between the frontage of adjacent localities. Individual rifle positions are selected to support and protect machinegun positions, provide supplemental fire for the unit area, and add depth to the defense. Weapon emplacements, as we stated previously, must be built to directly support your fire plans.

Emplacement considerations. The following considerations affect the type and location of weapon emplacements:

a. Employment of weapons. Emplacements must permit effective use of the weapons for which they were designed. This requirement may limit the protection that can be provided and may influence the design and depth of adjacent shelters.

b. Protection. As far as possible, protection should be provided against all hazards except a direct hit by heavy artillery. This means that excavation should be as small as possible, consistent with space requirements, in order to obtain maximum protection from the walls against airbursts and to limit the effective target area for high trajectory weapons. Some of the main methods used to obtain this protection are presented later in this section.

c. Simplicity and economy. The emplacement or shelter should be strong and simple, require as little digging as possible, and be constructed, when possible, with materials that are immediately available.

d. Progressive development. Your plans for defensive work should allow for progressive development. This improves the usefulness of emplacements. You can develop emplacements in three steps:

(1) Digging in quickly where speed is the principal consideration, and no special tools or materials are required.

(2) Improvising with local materials.

(3) Refining, using stock materials.

e. Concealment. Weapon emplacements should be built so that the completed work can be concealed. It may not be practical to conceal a defensive position completely, but it should be concealed sufficiently to prevent the enemy from spotting the defensive position by casual ground observation. If possible, you should build dummy positions at the same time that the primary and alternate positions are built.

Protection. The most predominant hazard during ground defense operations is fire from conventional weapons. Therefore, the construction of weapon emplacements must be geared primarily toward obtaining protection against this hazard. This is done by digging in, providing overhead cover, and erecting standoff fencing.

a. Digging in. Protection against conventional weapons is best provided by constructing a thickness of earth and other materials. This is done by digging into the ground so that personnel and equipment can offer the smallest possible target. Digging in also provides some protection against artillery, infantry, heavy weapons, bombs, and other aerial weapons.

b. Overhead cover. Overhead protection is especially important in forward areas where the threat includes airburst shelling. Covered firing positions must be built for individual riflemen. Small, readily accessible shelters adjacent to weapon emplacements are also necessary. Available materials may be used, but cover must be kept low or the outline modified to blend with its surroundings.

c. Standoff fencing. Standoff fencing is intended to cause point detonating or inertial-impact-fused rounds to explode before hitting the defensive position. Chainlink fencing is used for this purpose, and it should be located 10 to 25 feet from the position.

Tactical Barriers. Basically, in base or sector ground defense operations, tactical barriers are used to complement fire plans. They consist of a coordinated series of natural and artificial obstacles that are used to channel, restrict, delay, or stop enemy ground movement.

An important point to remember is that an obstacle may constitute either an advantage or a disadvantage. For example, an obstacle perpendicular to the direction of attack favors the defender; it slows or channels the attacker. Conversely, an obstacle that is parallel to the direction of the attack may help to protect the flank of an attacking force. For this reason, you must look at each obstacle or barrier closely, determine what you want it to do, and insure that this job is being done. Above all, make sure that each barrier is working for you, not against you.

Natural obstacles. Natural obstacles, such as ravines, streams, marshes, and forests, can be used to advantage in a barrier plan. These obstacles, when supported by artificial barriers (such as barbed wire), often make the most effective tactical barriers. For this reason, good use should be made of available natural or seminatural obstacles. For example, waterlogged ground and large watershed drains (pools or ponds), supported by wire entanglements, can present a formidable barrier to aggressors.

Perimeter barriers. Fences are used to delay the enemy and compound the problems they face in negotiating the perimeter. Vegetation, ravines, buildings, debris, and any other form of concealment should be removed or destroyed. Wire entanglements, roadblocks, and minefields can be used to cover likely avenues of approach and vulnerable parts of the base perimeter. Remember that no matter what fence system is used, it must have depth, the sentries maintaining surveillance over it must be alert, and it must be effectively covered by defensive fire.

Lighting. Lights should be installed to provide for maximum night visibility. Use of such lighting, however, depends on tactical considerations at the time. Additional devices, such as trip flares, antipersonnel mines, ground radar, and sensors, are also used to enhance the effectiveness of barriers.

Interior barriers. Tactical wire barriers are used within the perimeter to limit and channel penetrations by enemy groups or individuals. These interior barriers can be as simple as a single strand of wire, 3- to 4-foot high. Generally, they are placed in a manner that prevents a direct approach to vital areas.

Provisions must be made to cover these barriers by automatic weapons fire teams, by assignment as an alternate mission for such weapons teams. The barriers are constructed as inconspicuously as possible, and are relocated periodically to prevent counterplanning by the enemy.

It is important to insure that interior barriers do not preclude the reserve force's freedom of movement. For this reason, conterattacking forces, as well as all other personnel who work within areas reinforced with barriers, must be thoroughly familiar with the location of all barriers.

Lanes and gaps are provided for the passage of reserve forces, patrols, work parties, and counterattacking forces. When not in use, they are sealed by the use of portable obstacles covered by weapons fire. In barbed-wire zones, lanes and gaps are staggered in a zigzag pattern.

Exercises (E31):

You are tasked with evaluating weapon emplacements and tactical barriers on your base to insure that they effectively support fire plans and protect personnel. During your evaluation, you must insure that the specific criteria listed in column A are met. Match the column A item with the column B type of weapon emplacement, related protective action, or tactical barrier that would most likely achieve the result described by writing the column B letter in the space provided. Column B items may be used once or more than once.

Column A	Column B
____ 1. Provide grazing fire across the frontage of adjacent areas.	a. Overhead cover.
____ 2. Cause point detonating rounds to explode before hitting defensive positions.	b. Perimeter barriers.
____ 3. Should be covered by defensive fire.	c. Machinegun emplacements.
____ 4. Should be relocated periodically to prevent counterplanning by the enemy.	d. Dug-in positions.
____ 5. Provide the means for personnel and equipment to offer the smallest target possible.	e. Interior barriers.
____ 6. Must not hinder the ovement of response forces.	f. Individual rifle positions.
____ 7. Provide supplementary fire for the unit area and add depth to the offense.	g. Standoff fencing.
____ 8. Limit or channel the movement of enemy penetrators to areas covered by your most intensive fire.	
____ 9. Provide protection of personnel against airburst shelling.	
____ 10. Must be supported and protected by individual rifle positions.	
____ 11. Increase the problems the enemy faces in trying to penetrate your outer defenses.	

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Convoy Techniques

A MILITARY FORCE must be able to get from one place to another with the necessary men and supplies if it is to perform its mission. The outstanding ability of U.S. Forces to do this today makes them the most mobile force that the world has ever known. A great deal of this mobility depends upon the transportation of many people and large quantities of materials by military vehicles. This movement of people and material can be maintained only so long as vehicle operations personnel are qualified in all phases of motor transportation. One of these phases is convoy operation. This chapter provides you with knowledge of the kinds of convoys, coordination required with civil authorities, planning and control of convoys, and the field and mechanical expedients you are required to know as a supervisor of convoy operations.

4-1. Convoy Terms

The techniques of organization and management of convoys have been developed by the U.S. Army to a very high degree. This has been the result of the Army's heavy reliance upon military vehicles for its ground transportation. Transportation within the Air Force has been directed toward the use of air transport whenever practical. However, Air Force motor transportation is particularly well-suited for short hauls and supply distribution. Another exceptionally useful advantage of motor transportation is its ability to reach an unlimited number of points which cannot be serviced otherwise. This makes it necessary for Air Force vehicle operations personnel to have a working knowledge of convoy techniques.

E32. Define terms used in convoy operations.

Convoy Defined. A convoy is the movement of a group of motor vehicles under the control of a designated individual. Its purpose is to facilitate the coordinated movement of personnel and materiel; it is also used for the practical training of personnel responsible for such operations. The individual designated to control the movement is the convoy commander. He may be either an airman or an officer—this depends on the size and purpose of the movement.

In many cases, a convoy is called a motor march. Actually, the two terms are synonymous and are used interchangeably. A motor march is quite formalized, with very rigid controls applied. Small convoys are more informal and controls are inclined to be more flexible.

Terms Used in Convoy Operation. There are several terms peculiar to convoy operation that you should know. The more commonly used terms are defined in the following paragraphs.

Control vehicle. The vehicle which precedes a convoy (motor column) or one of its elements (serial) and sets the pace or rate of march.

Fixed column. A motor column (convoy) in which a prescribed space between vehicles is maintained regardless of the speed.

Governed column. The spacing between vehicles is governed by a speedometer multiplier or by some other means.

Lead. The linear spacing between the heads of successive vehicles, march units, serials, or columns.

March graph. A time-distance diagram used in planning and controlling motor marches.

March unit. A subdivision of a serial which moves and halts on the command or signal of the march unit commander.

Rate of march. The average speed of a motor column over a period of time, including short, periodic halts.

Serial. A major subdivision of a motor column which consists of elements moving from one area to the same destination. These elements are grouped under a serial commander.

Speedometer multiplier (SM). Any number by which the speedometer reading in miles per hour is multipled to determine the vehicle distance in yards. At 20 mph, with an SM of 2, the distance between vehicles would be 40 yards.

Time-distance. The time required for a motor column, or one of its elements, to move from one point to another at a given rate of speed.

Traffic density. The number of vehicles that pass a given point within a given period of time; e.g., 500 vehicles per lane per hour. It can also be defined as the number of vehicles occupying a mile of roadway at any given time.

Types of Convoys. We can separate convoys into three kinds: normal convoys, hazardous convoys, and convoys transporting classified equipment.

Normal convoys. These are convoys consisting mainly of general-purpose vehicles that do not exceed legal limitations of maximum overall length, width, height, weight, or axle loadings permitted by the states through which the movement is made. They are also capable of maintaining normal speeds on the highway.

Hazardous convoys. These are convoys composed of large, bulky motorized equipment. One or more vehicles may be extra wide, having overhanging or projecting obstacles to traffic; may be overlength; or may travel at unusually slow speeds. For all practical purposes, overweight vehicles can be put in this category, since most overweight vehicles have one or more of the preceding characteristics.

Convoys transporting classified equipment. These convoys may consist of normal transport vehicles or they may involve hazardous-type vehicles. Oversize vehicles are required for transporting specialized missile equipment. Usually, convoys with classified equipment are comparatively small and often have only one transport vehicle with the necessary escorts.

Exercises (E32):

1. Define the following terms.
   a. Fixed column.

   b. March graph.

   c. Serial.

   d. Speedometer multiplier (SM).

   e. Time-distance.

   f. Traffic density.

   g. Normal convoy.

   h. Hazardous convoy.

4-2. Planning and Coordination.

E33. State factors to be considered, sources and kinds of information, and the importance of route reconnaissance in planning convoy movements.

General Planning Factors. There are a number of factors that determine the amount of planning needed when a convoy movement is to be made. When convoy movements are being formulated, you must find out the purpose of the convoy, quantity and type of cargo to be hauled, loading point, destination, and arrival time. This information is usually obtainable from orders and instructions issued by higher authorities.

Next, determine the number and type of vehicles which are necessary. This can be decided after the amount and type of cargo are known. The number of personnel necessary depends to a great extent upon the number and type of vehicles needed.

Now, determine the supplies that are required. The number of vehicles, distance to travel, and personnel involved are the factors to be considered. When all this has been done, you should answer the following questions:

- What is the best route?
- What are the halts to be made?
- At what speed will the convoy travel?
- Where will fuel, oil, and other supplies be obtained?

However, if you are not familiar with the area of movement, do not attempt to answer these questions until you have made a route reconnaissance. You will then be able to answer the preceding questions regarding the route. After answering these questions, decide which type of march you will use and arrange the convoy accordingly. You must also arrange for convoy control.

Finally, most movements within the continental United States or its territories must be coordinated with the civil traffic authorities before they are started. Be sure to get all the necessary permits and clearances required from the civil authorities as early as possible.

Route Reconnaissance. Route reconnaissance simply means to survey a route over which a convoy movement will be made. This survey is used to gather needed information concerning the route and adjacent areas for planning the move. Reconnaissance should be made before and during any motor move.

You may obtain basic information from maps (either standard highway or military), personal knowledge, and reports furnished by engineers, state police, and weather forecasters. Within the continental limits of the United States and in most oversea areas, you will find well-marked routes and traffic personnel available. But even so, you may make a limited reconnaissance to prevent accidents or delays. In combat areas, you must make a more thorough reconnaissance—lack of information there may prove disastrous both to personnel and equipment.

If your reconnaissance is thorough, it should provide you with the following information:

a. The location and nature of major routes in the area.

b. The location and characteristics of major road junctions.

c. The location and characteristics of detours or bypasses.

d. The time and distance measurements between major points.

e. The types of road surface and the condition of roadway and shoulders.

f. The width of each roadway and the number of traffic lanes available for movement in each direction.

g. The maximum grades (percent).

h. Limiting physical features of the available routes (clearances, heights, loads, and widths).

i. Facilities providing fuel; repairs, rations, water, and other supplies.

j. Availability of medical facilities in the area.

k. The traffic density at critical points.

l. The variations in traffic density.

m. The location of critical points (bottlenecks, points needing traffic control, or highway regulation).

n. Availability and type of communications facilities.

o. Traffic control devices and their locations.

p. Types of traffic controls that are or can be used.

q. The locations of potential hazards (lack of roadways, ice and snow, steep grades, etc.).

r. The locations and characteristics of fords.

s. The routes which afford maximum protection from hostile ground or air attack.

t. Road and bridge construction that may be required.

u. Sites that may be adequate for dumps or depots.

Exercises (E33):

1. How are the number and type of vehicles determined in a convoy move?

2. Why is route reconnaissance important in a move?

3. What factor determines the number of personnel needed for a convoy?

4. Complete the following statements (one word in each blank): Basic information to be used in route reconnaissance may be obtained from highway __________, personal knowledge, and reports furnished by engineers, state police, and weather __________. A thorough reconnaissance usually reveals information concerning the location of __________ supply facilities and critical __________ en route.

E34. State responsibilities, procedures, and sources of information in the coordination and application of control measures, escort requirements, and permits for convoy movements.

Coordination/Escort Requirements for Normal Convoys. Normal convoy movements outside the local area consisting of 10 or more vehicles organized as a column are coordinated with civil traffic authorities by higher headquarters. This also applies to movements of 10 or more vehicles dispatched over the same route to the same destination during a 1-hour period. Arrangements with civil authorities for local movements are handled by the base transportation officer in coordination with the security police officer.

Special Procedures and Escort Requirements for Hazardous Convoys. Normal convoys are protected in both the front and the rear by escort vehicles. These escort vehicles should be equipped with red warning lights, flares, and other emergency equipment. These vehicles travel far enough in front of and behind the convoy to give adequate warning to all approaching traffic.

Hazardous convoys require special markings, red flags, and lights to make them readily identifiable and to reduce their danger to other traffic. Special markings and procedures also apply to all vehicles transporting explosives. Each truck carrying explosives or ammunition is properly marked with explosive warning signs. The word "explosives" or "dangerous," as determined by the class of explosives, is exhibited in letters at least 6-inches high on reflectorized placards. These placards are posted on the front, rear, and both sides of every vehicle. When 2 or more trucks carrying explosives are traveling together, a minimum distance of 300 feet is maintained between vehicles. Department of Transportation regulations govern the transportation of explosives on public highways. Specific safety precautions for the transportation of explosives are given in AFR 127–100, *Explosive Standards*.

Escort vehicles lead and follow these convoys. Normally, escort vehicles are equipped with and display rotating red flashing beacons and also keep their headlights on. Suitable signs (preferably luminous) are displayed, indicating that a convoy follows or is ahead. Radio communications are used, when available, to facilitate normal communications and the immediate adoption of emergency procedures.

Other vehicles in the convoy will have headlights and running lights turned on at all times. All overhanging and projecting equipment is marked with red flags during daylight when visiblity is good; red and amber lights are used during periods of poor visibility and at night.

The vehicle operations officer and the convoy commander are responsible for insuring that these convoys are equipped for all conditions expected. The coordination with civil authorities for the movement of hazardous convoys is carried out by higher headquarters.

Special Procedures/Requirements for Classified Convoys. Small classified convoys of vehicles not exceeding legal limitations on size or weight can be coordinated locally. However, oversize classified equipment requires the same coordination as any other hazardous convoy.

Convoys with classified equipment are under the direct control of a security officer, who may also act as convoy commander. Also, escorts leading and following the convoy are security guards. The number of guards and their locations in the convoy are determined by the commander ordering the movement. Driver personnel must have security clearances.

Procedures in Coordination and Obtaining Permits for Convoys. The first thing is to determine whether or not the vehicle is oversize or overweight, thereby requiring a clearance. Each state has established its own limitations on vehicle widths, heights, lengths, weights, and axle loadings. Since these limitations vary considerably from state to state, you must be familiar with those for all the states in which your vehicles operate. You can get this information by checking state laws or by asking the appropriate highway officials. However, there is a simpler method. The American Trucking Association, Inc., publishes a consolidated chart that shows current information on vehicle sizes and weights and other related matters for highway carriers. This is not an official Air Force publication but, it is used for military vehicle movements and commercial carriers.

The Director of Transportation and Supply of the appropriate air logistics center (ALC) is the representative designated to secure permits for military vehicle movements. The Director determines whether or not the movement by highway is essential to national security and, when appropriate, makes all the necessary requests and certifications to the authorities of the states involved.

In some cases, there is a recurring need for oversize, overweight, and special movements of military vehicles within a limited area. The director (mentioned above) coordinates and arranges for formal agreements with state and local civil authorities for such movements. Copies of these agreements are furnished to state officials, local military officials, and the Director of Transportation, Headquarters USAF. When a movement is to be made under an agreement, the local base transportation officer notifies the civil authorities of the move and obtains the necessary permits.

When an essential movement which is not covered by an agreement must be made, the local base transportation officer will request the appropriate ALC Director of Transportation and Supply to negotiate for the required permits. The request should be prepared on DD Form 1265, Request for Convoy Clearance, or on DD Form 1266, Request for Special Hauling Permit. These forms furnish all the information normally needed for negotiation. The information to be furnished for oversize or overweight vehicles includes, as a minimum, the following:

a. Type of equipment with the manufacturer's name, if available, and pertinent accessories; gross weight; axle or track loads and spacing; and the height, width, and length of the vehicle, both loaded and unloaded.

b. Origin and destination of the movement.

c. Proposed date and time of the movement.

d. Nature of the cargo (within security limitations).

In addition, reasons must be given why oversize or overweight vehicles or loads cannot be reduced. Also justification must be given as to why highway movement, as opposed to another mode of transportation, is essential.

In urgent cases, applications for permits can be made by electrical communications means. These message requests should give the required information in the numerical order given on the DD forms and should be confirmed through the submission of the applicable form.

Except in an emergency, all permits and clearances necessary for convoy movements should be obtained at least 24 hours before the movement. Also, if civil police escorts or traffic personnel are needed, arrangements for them must be made at least 24 hours ahead of time.

Exercises (E34):

1. You have a movement which involves 19 vehicles. All the vehicles will reach the same destination within a 1-hour period. Who is responsible for the initial coordination?

2. Who has the direct control of vehicles transporting classified equipment?

3. What is the best source for information pertaining to state laws concerning overweight or oversize vehicles for movement over highways?

4. Name the officials that are given a copy of a written formal agreement for oversize, overweight, and special movement of military vehicles.

5. What forms are used for requesting permits for essential oversize convoy movements not covered by formal agreements with appropriate civil authorities?

E35. Specify the chief difference, the advantages, and the disadvantages, in the three types of motor marches.

After gaining the necessary information concerning the route or routes, you should determine the type of motor march to use. Three general types of marches may be employed—close column, open column, and infiltration. The difference between these marches is largely vehicle spacing. Densities and speeds will vary with such factors as weather, tactical situation, enemy capability, condition and type of road, vehicular maintenance, types of vehicles, etc. The following descriptions are accepted values for average conditions.

Close Column March. Close column is the formation generally used in moves under blackout conditions or in movements through congested areas. For planning purposes, figure that vehicles move at a rate of 10 miles in the hour ("in the hour" refers to distance covered and not miles-per-hour speedometer readings) with a density of

67 vehicles per mile of road. In other words, elements of the column are grouped as compactly as possible to reduce road space to a minimum. Vehicles in close column follow each other at the minimum distance which safety, traffic conditions, and the tactical situation will permit.

Advantages. The full traffic capacity of the road, or traffic lane, can be used since road space is reduced to the minimum required for safe driving. Column control and intracolumn communications are better in such compact columns and fewer guides, escorts, and markers are needed.

Disadvantages. Close column formations do not provide dispersion for passive protection against enemy observation and attack. The strength and type of organization are readily apparent to hostile observation. Vehicles may arrive at loading and unloading terminals more rapidly than they can be handled. Careful scheduling and rigid control of traffic are necessary to avoid blocking intersections. Greater driver fatigue is generally experienced in close column than in other marches. Use of the highway by other traffic is severely limited.

Open Column March. An open column march is generally used during daylight moves. The distance between vehicles is increased to gain a greater degree of protection from hostile action and to permit concurrent use of highways by other traffic. For planning purposes, figure that vehicles in open column move at the rate of 15 miles in the hour with a density of 20 vehicles per mile of roadway.

Advantages. Open column formations offer some passive protection from enemy observation and action, allow greater speeds with more safety, permit greater flexibility in planning moves, and reduce driver fatigue.

Disadvantages. In comparison with close columns, open columns are more difficult to command and control. Abnormal gaps make it hard for drivers to maintain prescribed spacing. Open column formations also permit less traffic volume on a road than more compact formations. In comparison with infiltration, open columns have less secrecy and are not as well adapted to passive defense.

Infiltration. Infiltration is used when maximum secrecy, deception, and dispersion are needed. This type of movement involves the dispatch of vehicles, individually or in small groups, to a predetermined destination over one or more routes, at irregular intervals and at irregular rates of march. To an observer, an infiltration move looks like ordinary casual traffic. Vehicles should normally be dispatched so as to produce an average density not to exceed eight vehicles per mile. It is suitable for daylight moves, movements in congested areas, and on routes which cross heavily traveled roads.

Advantages. Infiltration provides the best possible defense against hostile observation and attack. Under light traffic conditions, movement of the individual vehicle is not materially affected by other vehicles in the move but is limited only by orders, road capability, vehicle mobility, and the training, experience, and physical condition of the drivers. Higher speeds by individual vehicles may be used with this type of movement. Since traffic density is light, cross traffic may move without excessive interference. A unit may be moved by infiltration over a route on which traffic is too heavy to permit movement in a single unit or column.

Disadvantages. It takes longer for the vehicles in an infiltration march to complete a move than for those in any other movement formation. Thus, in spite of a higher rate of march, the total road clearance time for a move may be longer. More important, because of extended distances between vehicles, internal control of the column is difficult. Drivers are usually unable to regulate their movements by the vehicle ahead, and careful marking of the route is necessary to prevent drivers from getting lost. If drivers operate alone, a more detailed briefing is required. Maintenance, refueling, and messing are sometimes difficult to arrange. There is a danger that vehicles may bunch up. Due to relaxed control, tactical employment of the unit may be difficult until the march is completed.

Exercises (E35):

1. What is the main difference between the different types of marches?

2. In what type of march are fewer guides, escorts, and markers required?

3. Which type of march—open column or close column—offers passive protection from enemy observation?

4. Why is an infiltration march used when maximum secrecy is involved?

5. List three disadvantages of an infiltration march.

E36. Given a march graph, determine distance and time factors concerning a convoy movement.

March Graphs. A march graph is a time-distance diagram used in planning, controlling, and recording the progress of a convoy over a given route. It gives a visual picture of a movement and thus shows possible conflicts and congestion before they occur.

March graphs may be used for an individual vehicle, a small unit, or a large motor movement. They may show the movement of one or several columns traveling at different speeds over one or more routes.

Before preparing a march graph, determine the following information concerning the route and movement:

a. Distance from starting point to destination.

b. Route characteristics such as road surface, curves, populated areas, intersections, number of lanes, etc.

c. Reasonable speed for the convoy to travel.

d. Where halts will be made, and the time spent for each.

e. Checkpoints along the route.

f. Rate of march.

g. The time required to make the move by dividing the distance by the rate of march.

When you have the required information, you are ready to prepare a march graph. As we cover the preparation of a march graph, refer to figure 4-1 and check each item as we discuss it.

The first requirement is that the graph paper contain enough squares to plot the distance and time involved in the move. Across the bottom of the graph paper, starting at the left and progressing to the right, a time scale is inserted. A scale of distance, usually in miles, is then placed up the left side of the paper starting at the bottom.

After the time and distance scales are established, the selected route is added on the side of the graph. The names of towns, intersections, highway regulation points, and traffic control posts along the route are shown at their proper locations on the route. This is done by the use of a diagrammatic strip map.

Next, the movement is plotted on the prepared graph. For example, in figure 4-1, a unit is to march from Mt. Royal to a point 5 miles beyond Travistock. Scheduled departure time is 0700, and the column is planned to proceed at the rate of 15 miles per hour.

A dot is placed on the graph at the point where the line representing the place of departure intersects the line representing the hour of departure. Another dot is placed on the graph at the point where the line representing the destination intersects the line representing the hour the head of the column is scheduled to arrive. A straight line is drawn to connect these two dots. This line represents the schedule on which the head of the column travels and indicates when it should reach any point en route.

In addition to scheduling the head of a column, the end of the column (the trail) may also be scheduled on a march graph. For example, in figure 4-1, the head of the column was scheduled to leave Mt. Royal at 0700 hours and the last vehicle of the convoy was scheduled to leave Mt. Royal at 0730.

After the head and trail of a column have been scheduled on a march graph, the length of the column can be determined. This is done by drawing a vertical line connecting the head and trail lines. This vertical line is measured and applied to the scale of miles, thereby giving the overall length of the column.

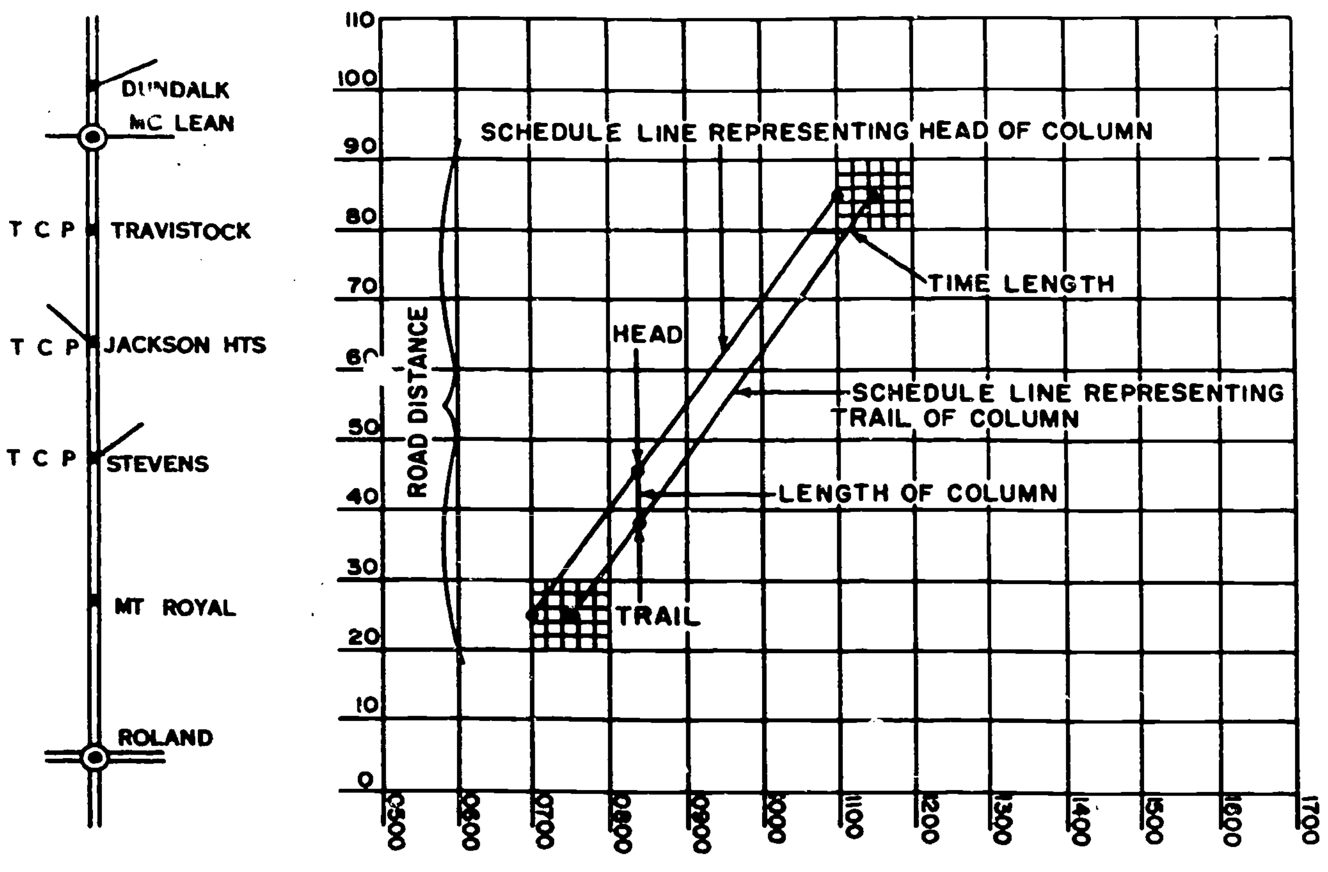

Figure 4-1. March graph.

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Exercises (E36):

Using the march graph in figure 4-1, determine the following planning (distance and time) factors.

1. What is the distance the convoy will travel?

2. When should the convoy head arrive?

3. When should the convoy trail arrive?

4. How long (miles) is the convoy column?

5. Where should the convoy head be at 0930?

4-3. Convoy Organization and Control

E37. Specify the internal composition of convoys and the responsibilities of various elements.

Internal Composition of Convoys. Every convoy is made up of three internal elements or parts: head, main body, and trail. In the case of small columns, the functions of the three parts may be combined. For example, a convoy may be as small as two vehicles moving together under one commander. In such a small movement, both vehicles are usually task vehicles carrying loads and constitute the main body. The first vehicle also contains the persons who perform the functions of the head, and the second vehicle contains trail personnel.

In addition to the above elements, large convoys often make use of detached parties. These detached parties, advance and followup, are not a part of the main column and operate apart from it. They are detailed to perform special duties when the situation requires their use. The functions of the various elements are discussed in the following paragraphs.

Head. The head is the first element of the column in the order of march. The lead vehicle should contain the convoy commander or an officer or noncommissioned officer who represents the commander. He or she is there to handle any problems that occur at the head of the column. This would consist of such things as correctly following the prescribed route, checking in at scheduled points, receiving any orders or change in orders, and issuing such instructions as may be required. He or she may also contact and coordinate with civil authorities along the route of the movement.

A lead vehicle should also contain a pace setter. The pace setter sets the pace to comply with the rate of march. The maximum pace is usually controlled by the speed that can be maintained by the slowest vehicle in the column.

Main body. The main body of the column follows the head and consists primarily of vehicles carrying troops, equipment, and supplies. This part of the convoy may be subdivided into serials and march units for easier regulation and control. For example, the commander can divide the vehicles into serials of vehicles and then subdivide the serials into march units. The convoy commander commands the entire motor march; he or she names serial commanders and march unit commanders. Each serial (and march unit when desirable) may be organized with a head, main body, and trail. Each separate element should have its own pace setter.

Once the vehicles have been organized into a suitable march column, each vehicle must be labeled to indicate its position in the column. Normally, vehicles are identified numerically. For example, the first vehicle in the column is numbered "1," the second "2," etc. If there are two or more serials, the serials are identified alphabetically, such as "A," "B," "C," etc. The designation "A-1" on a vehicle would indicate the 1st vehicle in the first serial; "B-27" would indicate the 27th vehicle in the 2d serial. Placards or some easily removed substance (chalk or tape) should be used to label the vehicles.

If all vehicles in a convoy are to remain together from origin to destination, slower vehicles should be placed near the head of the column. This arrangement serves as a governor on the faster vehicles and prevents large gaps from developing between elements within the column. It may be desirable for the column to move in small segments because small units create less disruption of traffic over the routes used. In this case, vehicles are grouped with the faster ones at the head. As the column progresses, gaps between serials or march units become progressively greater.

Trail. The trail is the last element of a motor column. The trail officer or noncommissioned officer represents the commander in such functions as preventing straggling and maintaining discipline. Usually, maintenance and possible medical personnel included in the trail are under the supervision of the trail officer. The final clearance of designated points by the column is checked by the trail officer, and he or she takes such action as may be required. He or she also makes sure that traffic from the rear is warned of the convoy ahead, and he or she picks up guides and markers. In case of breakdowns, the trail personnel make repairs, arrange for towing, or see that the vehicle is properly attended until disposition of vehicle and cargo can be effected.

Detached parties. Advance parties may be provided by a higher headquarters or detailed from the convoy. Their mission is to locate and arrange for bivouac areas; for quarters or billets; for loading and parking facilities; and for supplies, rations, water, fuel, and medical attendance before the convoy arrives. The advance parties are responsible also for traffic reconnaissance except when the movement is made over an already reconnoitered route. The advance parties also post guides, traffic control personnel, and route markers as needed.

The followup detachment is designated to inspect bivouac areas and other halt sites after they are vacated by the convoy. They must correct and report to the commander of the convoy any undesirable conditions noted. During operation in peacetime, the followup party completes the necessary paperwork in connection with leased camp sites and with claims arising from damage. On the road, this party may pick up guides, guards, and markers which have been placed by the advance party. Providing for the disposition of dead or wounded and of disabled vehicles is also a responsibility of the followup parties.

Exercises (E37):

1. Explain how a convoy of two vehicles can have all three elements of a convoy.

2. What is a detached party?

3. List five things for which the head of the column is responsible.

4. Which unit determines the rate of march for a convoy?

5. How is internal control maintained in a large convoy?

6. What does the sign or chalk designation "D–19" on a vehicle in a convoy indicate?

E38. State convoy communications methods; given situations involving the need for communication within a convoy, determine the possible methods.

Intracolumn Communication. Intracolumn communications help provide convoy control. Sign messages from the front of the column may be written on a board and posted on the driving side of the road or displayed by a guide. Such messages are then noted by the drivers as they pass the signboard.

Written messages directed to a unit or vehicle in the column may be delivered by a messenger or given to a guide stationed along the route who will transfer it to the proper vehicle.

Two-way radios may be located in the control cars of the commander and at the head and trail. When supplemented by receivers in other vehicles in the column, they provide the best intracolumn communications and afford maximum control of a column.

Whistles and other audible signaling devices (horn, siren, etc.) can be used as a means of tranmitting a command to a column when a code has been established.

Visual hand and arm signals constitute another means of march communication. Column control signals may be given from the cab of a vehicle or by a person standing on the road. The meaning of the standard hand and arm signals used for convoy control is contained in AFM 77–2, *Manual for the Wheeled Vehicle Driver*.

Exercises (E38):

1. List four methods of communicating between personnel within a convoy.

2. A message for the driver of the vehicle B–3 could be delivered by what means?

3. Serial B is to be rercuted a short distance. There is no radio communications within the convoy. How could the drivers of this serial be notified?

E39. State the purpose of, and considerations in scheduling, halts during convoy operations.

Halts. Halts are made for purposes of rest, personal comfort and relief, messing, refueling, maintenance and inspection of equipment, and allowing other traffic to pass.

Short halts. Routine short halts will be made at the discretion of the commander. Short halts, when specifically ordered, should normally be made for 10 minutes after every 110 minutes of driving time.

Long Halts. Long halts (messing, refueling, and bivouacking) should coincide and must always be specifically ordered and plotted on road movement graphs. The locations for scheduled halts should be selected in advance. They may be prescribed by higher authority, located tentatively by map references, or selected by the reconnaissance party.

Comfort of personnel and servicing facilities for vehicles are important considerations in selecting sites for long halts. If a column starts from a populous area, its first halt should be delayed, when practical, until a rural area is reached to facilitate relief of personnel. Columns should be halted at points providing a minimum of 200 yards of clear visibility to the front and rear of the column. Guards, warning flags, caution lights, or flares should be posted in the front and to the rear of the column if it presents a hazard to passing traffic.

During halts, all personnel have certain responsibilities. Officers and noncommissioned officers check the welfare of personnel, the security of loads, and the performance of operator maintenance. Control personnel make necessary inspections and give instructions to insure resumption of the movement with a minimum of confusion at the end of the halt. Mess, medical, and maintenance personnel perform such special duties as the purpose and duration of the halt permits. Drivers inspect their vehicles and security of loads and make necessary corrections.

Exercises (E39):

1. Why are halts made during a convoy movement?

2. How often should shorter halts be scheduled for a convoy?

3. What are two important things to consider when scheduling long halts?

Expedient Field Water Treatment

HAVE YOU EVER been in a situation or location where you had to drink any water that was available? If you have, it isn't hard for you to appreciate the clear, pure water that you can get by opening a water faucet or by pressing the pedal on a water cooler.

Your water supply affects your health and general welfare, your normal work output and combat efficiency, as well as your morale. Without water, you are out of action in a day or two. In extremely hot areas, or in cases of extreme physical exertion, your limit is 16 hours. Since water must be potable and palatable, as well as available, the Air Force's field water purification equipment must be highly efficient and, at the same time, highly mobile.

Potable water in sufficient amounts is essential to contingency operations. Water which is not treated properly can spread diseases, such as typhoid and paratyphoid fevers, bacillary dysentery, cholera, leptospirosis, and common diarrhea. In certain areas, water may also tramsmit infectious hepatitis, schistosomiasis (a prevalent disease in the tropics) and amoebic dysentery. The latter diseases are caused by organisms which are highly resistant to the water disinfection methods normally used. Standards of quality require that drinking water be free of harmful contaminants, objectionable color, odor, and taste. No untreated water is considered safe until approved by the medical services.

You cannot afford to endanger your health and the health of the people in your unit; therefore, when required, you must use portable and mobile water purification units (diatomite field units) to purify water to make it safe for human consumption and use.

This chapter contains the information you will need to procure, protect, and treat water from water points and from other sources. Furthermore, we will lead you through the steps to use and maintain mobile water purification units.

5-1. Protection of Treated Water

To procure and protect treated water, a knowledge of water characteristics is essential. This section presents information concerning the quantity of water required, method of treating water from water points, and how to protect the water once it is treated. We have included some terms that you need to know.

E40. Define given terms.

Definition of Terms. The following terms are used in relation to field treatment of water.

a. Brackish water. Highly mineralized water that contains dissolved solids in excess of 500 ppm (parts per million). Both alkalinity and salinity range from very high to very low. Brackish water is found in many regions throughout the world but most frequently in arid or semiarid climates as ground water and along sea coasts.

b. Chlorination. Disinfection of water by the addition of a chlorine compound, such as calcium hypochlorite.

c. Chlorine demand. The amount of the chlorine dosage which reacts with and is consumed by organic material, bacteria, and other materials in the water.

d. Chlorine dosage. The amount of chlorine added to a given quantity of water.

e. Chlorine residual. The amount of the chlorine dosage remaining after the demand has been satisfied. Dosage minus demand equals residual.

f. Contaminated water. Water which is unfit for human consumption even though it may be palatable. Contaminated water contains disease-producing organisms or excessive amounts of mineral and organic matter, toxic chemicals, or radioactivity.

g. Disinfection. Treatment with a chemical or by boiling to destroy disease-producing organisms.

h. Palatable water. Water which is pleasing to the taste but which may be unsafe (contaminated).

i. Parts per million. A unit of measurement for expressing the number of units of a substance in one million units of water by weight.

j. Potable water. Water which is safe for human consumption. Potable water is free from disease-causing organisms and excessive amounts of mineral and organic matter, toxic chemicals, and radioactivity.

k. Water treatment. Removal of undesirable constituents in water through such means as coagulation, sedimentation, filtration, and disinfection.

Exercise (E40):

1. Match given definitions with the appropriate term. NOTE: Some terms may not be defined, and there is only one "best" match for each definition.

Column A	Column B
____ (1) Water containing disease-producing organisms.	a. Brackish water.
____ (2) Chlorine added to a given quantity of water.	b. Chlorination.
____ (3) Water which may be contaminated.	c. Chlorine demand.
____ (4) Water which is free from disease-causing organisms and excessive amounts of mineral and organic matter.	d. Chlorine dosage.
____ (5) The addition of a chlorine compound to disinfect water.	e. Chlorine residual.
____ (6) Using coagulation or sedimentation as a means of removing undesirable constituents in water.	f. Contaminated water.
____ (7) The amount of the chlorine dosage remaining after the demand has been satisfied.	g. Disinfection.
____ (8) The number of units of a substance in one million units of water by weight.	h. Palatable water.
	i. Parts per million.
	j. Potable water.
	k. Water treatment.

E41. Identify appropriate quantities of water required for field operations.

Quantity of Water Required. The quantity of water required varies with the season of the year, the geographical area, and the tactical situation. Dehydration may be a problem in both extremely hot and extremely cold climates. In extremely hot climates, large quantities of potable water are needed to replace body fluid losses. In extremely cold climates, water must be available for reconstruction of dehydrated foods. A guide for planning to meet the water requirements in a temperate zone is 5 gallons per person per day for drinking and cooking. When shower facilities are to be available, the water requirement increases to at least 15 gallons per person per day.

Exercises (E41):

Place a T in front of each correct statement and an F in front of each false statement; correct false statements.

____ 1. The quantity of water that will be required will vary with the season of the year, the geographical area, and the tactical situation.

____ 2. In extremely hot climates, small quantities of potable water are required in order to replace body fluids.

____ 3. In extremely cold climates, consideration must be given to requirements for potable water in the reconstruction of dehydrated foods.

____ 4. The water requirement in a tropic zone is 5 gallons per person per day.

____ 5. When shower facilities are to be made available, the water requirement decreases.

E42. State how to protect treated water obtained from established water points.

Treated Water from Established Water Points. Obtain water that has been treated (for drinking) at designated water points. This treated water must not become recontaminated as you are transporting it to the unit area.

Water trailers, tank trucks, and water cans must be clean on arrival at a water point. To the maximum extent possible, they should be used for hauling potable water only. When they are used to haul nonpotable water, *they must be so marked*. If they are to be used thereafter for hauling potable water, you must clean and disinfect them with a 100 ppm chlorine solution. New trailers, tank trucks, and water cans should also be disinfected before initial use. The disinfecting solution can be prepared by adding one ampule of calcium hypochlorite to 1 gallon of water. For trailers and tank trucks, it will be more convenient to obtain calcium hypochlorite in 3½-pound cans. Use 2 ounces or five level messkit spoonfuls per 100 gallons of water.

The interior surfaces of trailers, tanks, and cans must be properly maintained. You should inspect them periodically for rust and chips in interior enamel, tightness of seals and seams, and cleanliness.

Water purification bags (Lyster bags, 36-gallon canvas containers) are ordinarily issued to units on the basis of one bag per 100 people. These bags permit seepage of water, and provide cooling by evaporation. They are set up before they are filled with water (fig. 5-1). The weight of the water may cause the supporting ropes to stretch, creating a gap between the cover and the bag. Should this occur, the ropes should be adjusted so that the cover again fits snuggly around the upper part of the bag and, thus, prevents contamination of the water by dust and insects. Inspect Lyster bags frequently for cleanliness. If you find them dirty, scrub them, treat them with a strong solution of chlorine (1 ampule of calcium hypochlorite to 1 gallon water), and rinse them several times with potable water. A soakage pit must be provided under each Lyster bag to prevent water from collecting.

In case of extreme emergency, you may use gasoline cans for holding potable water. Use the newest and cleanest cans, and clean them as follows:

a. Drain the can thoroughly (for 10 to 15 minutes).

b. Fill the can half full of water and add 1 ounce of powdered detergent; close the can and shake it for 5 minutes; discard this water.

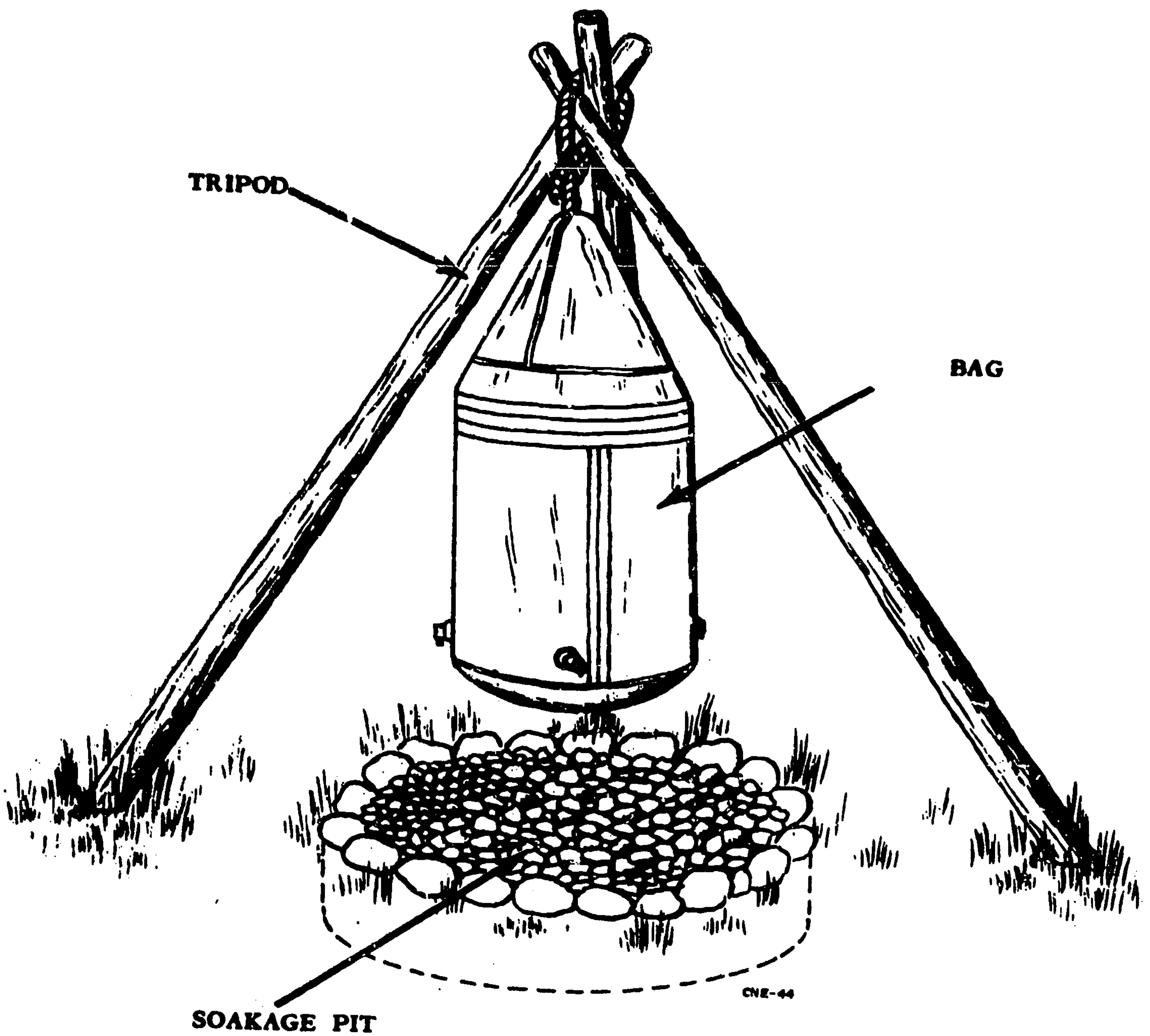

Figure 5–1. Water purification bag setup.

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c. Rinse the can with water three or four times; then fill it to overflowing and discard this water.

d. Fill the can with water and add the contents of five calcium hypochlorite ampules; close the can and shake it to mix the calcium hypochlorite with the water.

e. Let the can stand for 1 hour, empty it, and use it.

Test to determine the chlorine residual of treated water must be made periodically. If the residual is below the level prescribed by regulations, calcium hypochlorite ampules must be added until the prescribed residual is reached.

Exercises (E42):

1. When water cans are used to haul nonpotable water, what must you do?

2. Water purification bags are ordinarily issued to units on the basis of how many bags per 100 people?

3. How do Lyster bags provide cooling?

4. If you find dirty Lyster bags, after you should scrub the bags, what should you do?

5. Why should a coakage pit be provided under each Lyster bag?

6. If you find that the residual is below the level prescribed by regulation, what should you do?

5-2. Purification of Contaminated Water

Isolated units may not be able to obtain water from water points. In this case you must obtain and treat your own water whether it is in large quantities or for an individual. Select the source that appears to be the cleanest. Water taken from any source, except a public water supply system approved by the Air Force Medical Services, must be properly treated before use, as all other sources are presumed to be contaminated.

E43. Classify of water sources in terms of surface water, ground water, and other water.

Selection of Water Sources. The possible sources of water are surface water (lakes, rivers, streams, and ponds), ground water (wells and springs), rain collected from roofs or other catchment surfaces, ice or snow, and distilled sea water.

Surface water source. Although surface water is ordinarily more contaminated than other water sources, it is commonly selected for use in contingency operations because it is generally more accessible in the quantity required. You should draw water as distant from known sources of contamination as possible. When a stream is used, you should locate the intake upstream from any source of contamination. In lakes and ponds, it is generally desirable to locate the intake as far from the shore as practicable, as the amount of contamination usually decreases with the increase in distance from the shore. When surface water is used, you should take care to avoid getting mud from the bottom or picking up floating sticks, leaves, or other debris. Muddy or cloudy water should be settled before it is used. Water from muddy streams can be improved in quality by digging a hole on the bank and permitting water to seep slowly into it. Another method is to dig a shallow trench so that water can flow into it from the stream and stand quietly. After the dirt has settled, the clean water may be taken and disinfected by methods that will be discussed later in this unit.

Ground water source. Ground water is usually less contaminated than surface water and is, therefore, a more desirable water source. The use of ground water by contingency operation units, however, usually is limited unless existing wells are available. You should locate a ground water source at least 100 feet from all possible sources of contamination, and surface drainage should be away from it. A well that is selected as a water source should have a casing or lining, an impervious platform or apron, a cover, and a device for drawing water from it in a sanitary manner.

Other water sources. Rain, melted snow, or melted ice may be used in special instances where neither surface nor ground water is available. Water from any of these sources must be disinfected before drinking. Sea water cannot be used for human consumption until the salt has been removed by distillation or until other demineralizing processes have been performed.

Exercises (E43):

1. Match each classification of water in column A with the appropriate source in column B.

Column A	*Column B*
____ 1. Melted ice.	a. Surface water source.
____ 2. Pond.	b. Ground water source.
____ 3. Rain catch.	c. Other water source.
____ 4. River.	
____ 5. Sea water.	
____ 6. Spring.	
____ 7. Stream.	
____ 8. Well.	

E44. Identify the compound used to treat field water supplies and state how it generally is used.

When you or other individuals are involved in the treatment of field water supplies, you must place complete reliance on the disinfection process. The compound you normally will be using to chlorinate water in the field is calcium hypochlorite. Add it to the water in the amount (dosage) necessary to destroy the disease-producing organisms (chlorine demand) with some remaining to indicate that the demand has been satisfied and to serve as a continuing disinfectant (chlorine residual).

Exercises (E44):

1. What compound should you normally use to chlorinate water in the field?

2. In general terms, how much of this compound should you use?

E45. Specify structural and functional aspects of a water purification unit and specify bulk treatment requirements and procedures.

Purification Unit. In order for you to make water potable in field operations, you should use the following method. The knapsack filter unit is a hand- or foot-operated water purification unit (fig. 5-2). It is designed for use by small groups of individuals. It can treat water at the rate of 1/4 gallon per minute. Two filter pads used simultaneously can clarify approximately 5 gallons of muddy water before becoming plugged and replaced. The filter pads can remove amoebic cysts from water, but smaller bacteria and viruses pass through the filter pads. The filtered water must, therefore, be disinfected to make it safe for drinking. The filtering process greatly improves the taste of the water. The unit weighs 7 pounds and comes with extra filtering pads and a knapsack (carrying case).

Chlorination Requirements. Sufficient chlorine must be added to water to produce a required chlorine residual after a 30-minute contact period. A 5 ppm residual is the standard requirement for field water supplies. Higher or lower concentrations, however, may be prescribed by the medical services on the basis of their knowledge of local diseases and environmental conditions.

Chlorination kit. A chlorination kit (fig. 5-3) is available for all contingency operations for use in

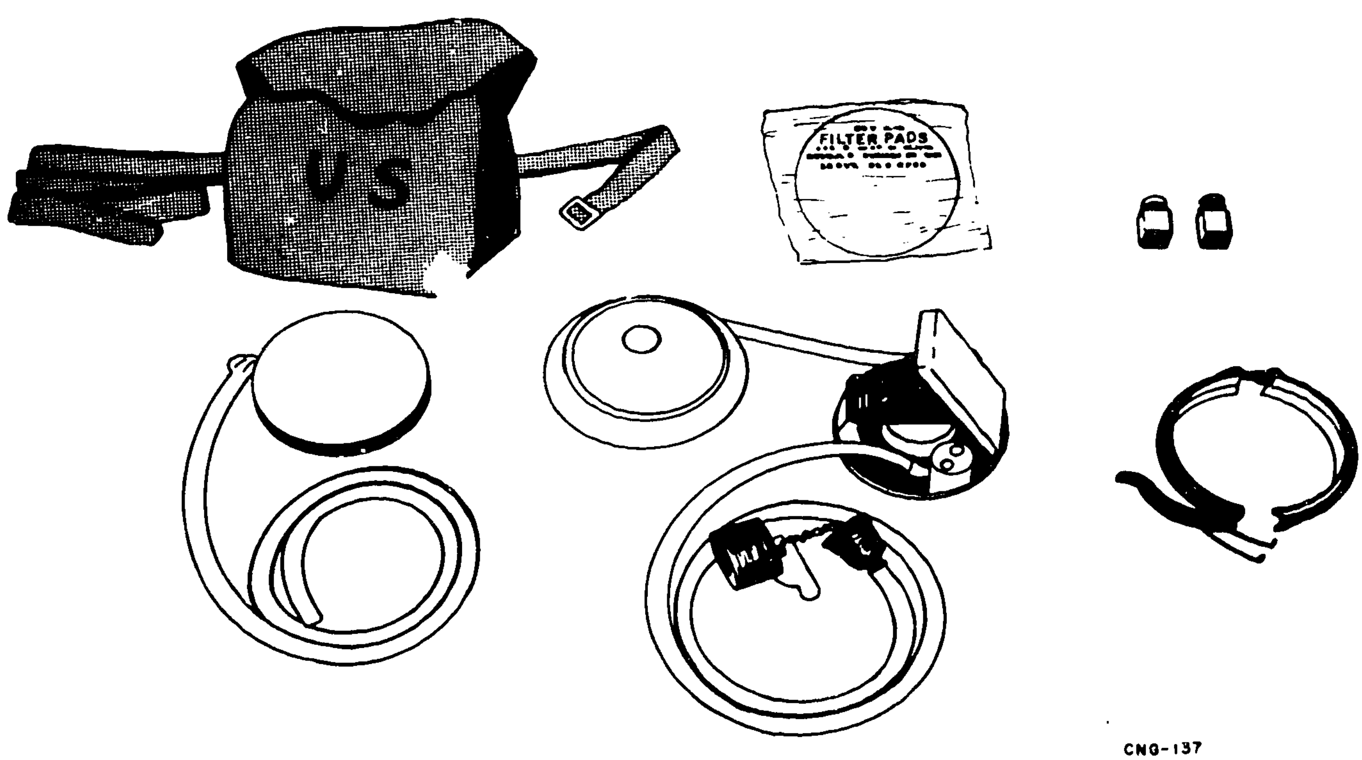


Figure 5–2. Water purification filter unit (knapsack type).

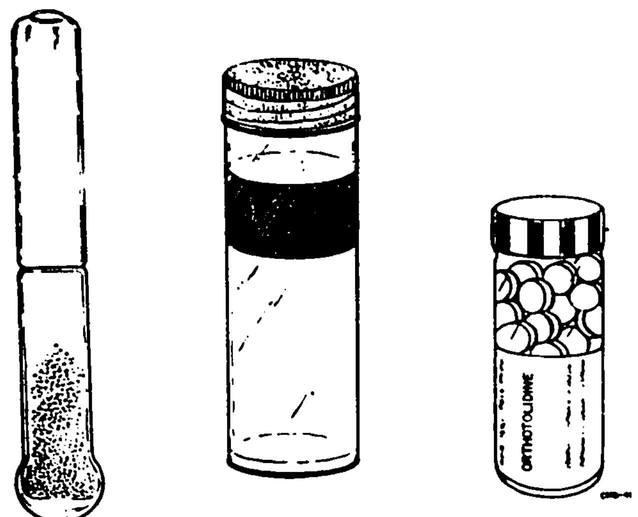


Figure 5–3. Items in chlorination kit.

chlorinating water and testing it for the proper chlorine residual. The kit contains calcium hypochlorite ampules (.5 gram each) for disinfecting water together with three plastic tubes and three vials of orthotolidine tablets for use in determining the chlorine residual. The vials of orthotolidine tablets are packed inside the plastic tubes. Each of the plastic tubes has a band of a different shade of yellow around it; the lightest shade of yellow indicates 1 ppm; the medium shade, 5 ppm; and the darkest shade, 10 ppm. These figures are printed on the tubes.

Disinfection Procedures. Water is disinfected at the unit level by using the Lyster bag (fig. 5-1) or other suitable containers.

Lyster bag. The procedure for the chlorination of water using a Lyster bag is as follows.

a. Clean the Lyster bag and hang it by the supporting ropes as illustrated in figure 5-1. The supports must be sturdy, as the bag filled with water weighs approximately 300 pounds.

b. Fill the bag with water to the 36-gallon marks which is 4 inches from the top of the bag. If possible, use settled, clear water.

c. Put the contents of at least three calcium hypochlorite ampules into a canteen cup; add a small amount of water from the Lyster bag and stir with a small stick until a thick mixture results; then fill the cup one-half full of water and stir again.

d. Empty the prepared solution slowly into the Lyster bag, stirring the water with a clean stick.

e. Cover the bag and flush the faucets by running a small quantity of the water through each of them.

f. After the disinfecting solution has been mixed with water for 10 minutes, flush the faucets again; then collect a sample of water from one of the faucets in the 5 ppm plastic tube for testing.

g. If the test shows a chlorine residual less than 5 ppm, add the contents of an additional calcium hypochlorite ampule and after 10 minutes repeat the test.

h. If the test shows the chlorine residual to be at least 5 ppm, wait an additional 20 minutes, because a total disinfection time of 30 minutes is required. Check the residual again before drinking the water.

Other water containers. When you treat water in containers other than a Lyster bag, it's important for you to remember that you must use, different amounts of calcium hypochlorite depending on the capacity of the container.

a. Five-gallon can of water. Use one-half of the contents of one calcium hypochlorite ampule initially.

b. Fifty-five gallon drum of water. Use four or five ampules initially.

c. Four-hundred gallon trailer of water. Use 30 ampules initially. With any of the three examples listed above, if you find that the chlorine residual is low, add small amounts of clacium hypochlorite. Remember, as stated earlier, a 5 ppm residual is the standard requirement for field water supplies.

Chlorine residual testing procedure. Determine chlorine residual of water by use of the plastic tubes and the orthotolidine tablets provided in the chlorination kit (fig. 5-3). The procedure is as follows:

a. Select the appropriate plastic tube from the three tubes in the kit. The appropriate tube is the one on which is printed the number of ppm chlorine residual required by the medical services.

b. Flush the faucets of the Lyster bag and fill the plastic tube to a point just below the yellow band.

c. Take one orthotolidine tablet from the vial in the kit and add it to the tube of water.

d. Place the cap on the tube of water and shake the tube until the orthotolidine tablet is thoroughly dissolved.

e. Compare the yellow shade of the water with the yellow shade of the band on the tube. If the color of the water is the same shade or darker than the band, the chlorine residual is equal to or greater than that printed on the tubes. If a lighter color or no color is formed, the water does not have a sufficient chlorine residual; therefore, additional chlorination and testing are required.

Exercises (E45):

1. At what rate is the knapsack filter unit capable of treating water?

2. When two filter pads are used simultaneously, how many gallons of muddy water can they clarify before being replaced?

3. What must be done to filtered water to make it safe for drinking?

4. What chlorine residual is the standard requirement for field water supplies?

5. How much does the Lyster bag when properly filled with water weigh?

6. How many calcium hypochlorite ampules added to water in a [illegible] cup are needed to disinfect a Lyster bag of water.

7. Before water is considered safe to drink from a Lyster bag, how much disinfection time is required?

8. What kind of tablest are provided in the chlorination kit?

9. When the yellow shade of water is the same as the yellow shade on the plastic shade of the tube, how does the chlorine residual compare to that printed on the tube?

E46. Classify given procedures as to the method of treating individual water supplies.

Individual Water Treatment. When safe water is not available in large quantities, each person must produce potable water by using a canteen and iodine purification tablets, calcium hypochlorite supplied in .5 gram ampules, or by boiling the water.

Iodine tablets. Before you use iodine tablets, check them for physical changes, as they lose their disinfecting ability in time. Do not use tablets that are not steel gray in color, which are stuck together, or that are crumbled. Use the following procedure in treating water in a 1-quart canteen (or any suitable 1-quart container), with iodine tablets.

a. Fill the canteen with the cleanest, clearest water available.

b. Add one iodine tablet to your canteen of a clear water; add two tablets if the water is cloudy. Double these amounts for a 2-quart canteen.

c. Place the cap on the canteen loosely; wait 5 minutes then shake the canteen well, allowing leakage to rinse the threads around the neck of the canteen.

d. Tighten the cap and wait an additional 20 minutes before using the water for any purpose.

Calcium hypochlorite. Use the following procedure is used to purify water in a 1-quart canteen with calcium hypochlorite ampules.

a. Fill the canteen with the cleanest, clearest water available, leaving an air space of an inch or more below the neck of the canteen.

b. Fill a canteen cup half full of water and add the calcium hypochlorite from one ampule, stirring with a clean stick until this powder is dissolved.

c. Fill the cap of a plastic canteen half full of the solution from the cup and add it to the water in the canteen; then, place the ca[illegible] canteen and shake it thoroughly.

NOTE: If an aluminum 1-quart canteen is being used, add at least three capfuls of the calcium hypochlorite solution to the canteen, as this cap is much smaller than the one on the plastic canteen.

d. Loosen the cap slightly and invert the canteen, letting the treated water leak onto the threads around the neck of the canteen.

e. Tighten the cap on the canteen and wait at least 30 minutes before using the water for any purpose.

Boiling of water. Use this method when disinfecting compounds are not available. It is a good method for killing disease-producing organisms; however, it has several disadvantages: (1) fuel is needed; (2) it takes a long time for the water to boil and then cool; (3) there is no residual protection against recontamination. Water must be held at a rolling boil for at least 15 seconds to make it safe for drinking. If there is evidence that a 15-second boiling period will not make it safe, the medical services will prescribe the longer period required.

Exercises (E46):

1. Classify each treatment procedure in column A by placing in the appropriate blank the letter code of the method shown in column B. Some procedures may be used in two methods.

Column A	*Column B*
____ (1) Used to purify water in a 1-quart canteen.	B. Boiling of water.
____ (2) Used when disinfecting compounds are not available.	C. Calcium hypochlorite.
____ (3) A good method for killing disease-producing organisms.	I. Iodine tablet.
____ (4) Used in treating water in a 1-quart canteen.	
____ (5) Total elapsed time is 25 minutes.	
____ (6) Canteen must be shaken thoroughly.	
____ (7) Total elapsed time is 30 minutes before water is usable.	
____ (8) Leaves no protection against recontamination.	

2. What are the three disadvantages of boiling water for human consumption?

3. What conditions should iodine tablets meet in order to be effective?

4. How long must water be held at a rolling boil before it is safe for drinking?

5. Who will prescribe a longer boiling period if the required time is not considered safe?

5-3. Mobile Water Purification Units

Mobile water purification units are available for use during contingency operations, and they can be installed a base or remote site on a permanent or semipermanent basis. The primary purpose of these mobile units is to produce safe, germ-free water for human consumption and use in any area or situation. There are several types of mobile water purification units. Their output capacities range from 600 gallons of water per hour to 3000 gallons of water per hour. These units are often referred to as diatomite purification units, and they are designed to be used only with fresh water.

This equipment requires three phases of water treatment: pretreatment, purification, and filtration. You pretreat water to remove the suspended matter and dissolved gases. You purify water by adding chemicals to the water for specific periods of time to disinfect the water by killing disease organisms and bacteria. You filter the water through a diatomaceous earth type of filter, which not only removes residue that may be harmful, undesirable, or objectionable because of appearance, taste, or odor but also removes certain waterborne, disease-causing bacteria. Keep in mind that you will be working with three types of water as it passes through the unit: raw, treated, and filtered.

All units, regardless of type, have similar components. They operate on the same principles. Differences in the units exist when equipment or components manufactured by different companies are used on the water purification units. Since these units operate on the same principles, you can transfer your knowledge of how one unit operates to another. Operating and maintenance instructions, furnished by the manufacturer of the unit, and similar instructions in Air Force technical orders, are available. Follow the instructions in these publications when you operate and maintain a diatomite water purification unit. In this section, we discuss the operation and maintenance of a trailer-mounted water purification unit that has a water-producing capacity of 600 gallons per hour.

E47. Identify those components required to make up a field purification unit.

Description. The 600-gallon-per-hour water purification unit is furnished in a special-purpose cargo body mounted on a 2½ ton two-wheel trailer. The erdlator assembly, diatomite filter, filter pump, chemical feed equipment, with the necessary piping and valves, and the electrical controls are mounted in the cargo body. These components are designed to be operated without removing them from the trailer body. The supporting equipment includes a 3-kilowatt gasoline-engine-driven generator set, gasoline-engine-drive pump, a portable electric-drive pump, two 500-gallon collapsible water tanks, necessary hoses and fittings, a disk comparator, and a supply of chemicals.

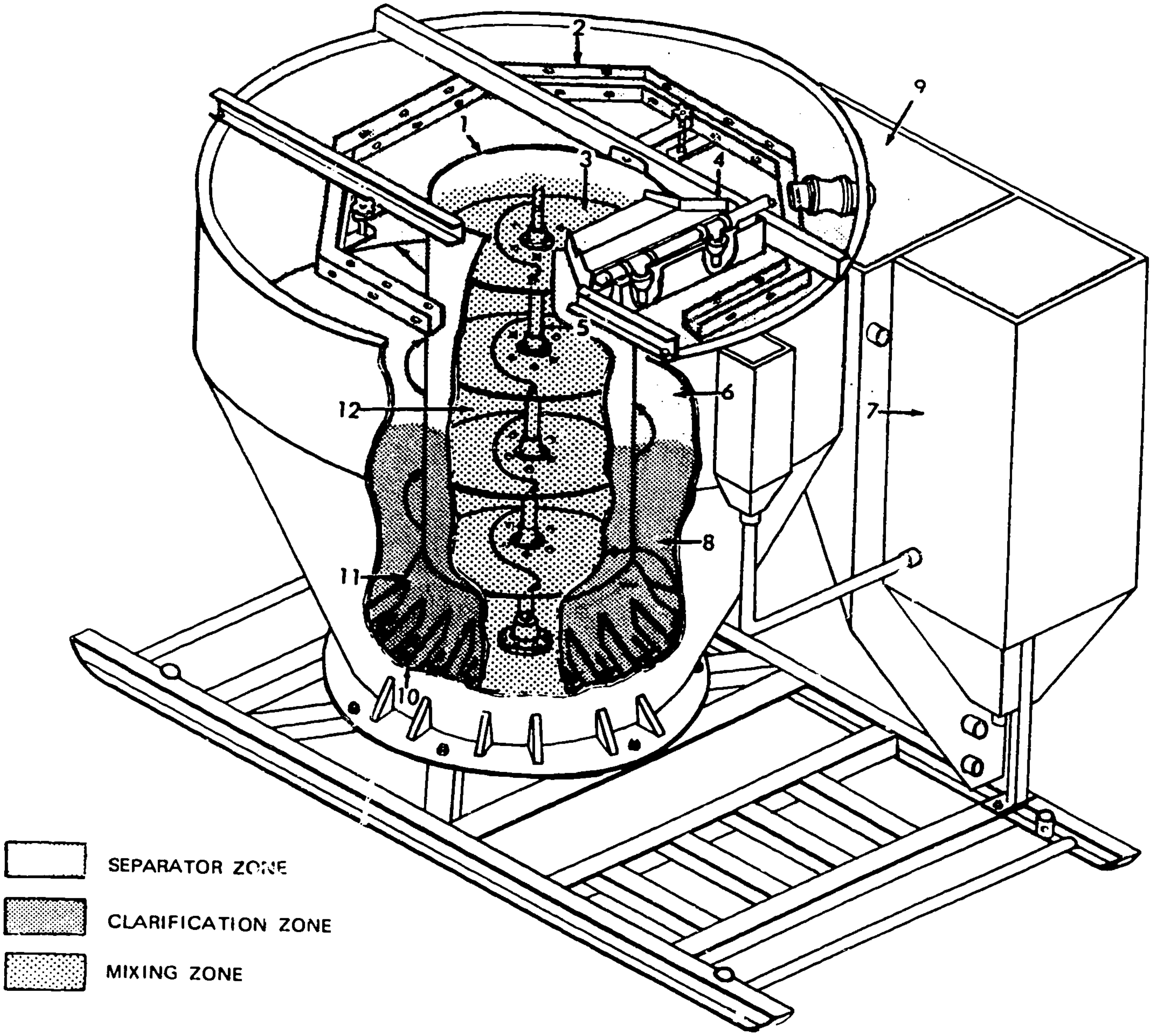
Exercise (E47):

1. Place a checkmark in the spaces provided below to identify components required to make up a field purification unit.

____ (1) 2 ½ ton two-wheel trailer.
____ (2) Farm tractor.
____ (3) Erdlator assembly.
____ (4) Portable steel building (10 x 10).
____ (5) Diatomite filter.
____ (6) Filter pump.
____ (7) Chemical feed equipment.
____ (8) 1000-gallon steel tank.
____ (9) Piping, valves, and electrical control.
____ (10) 3-kilowatt, gasoline-engine-drive generator set.
____ (11) Portable elevated water tower.
____ (12) Gasoline-engine-driven pump.
____ (13) Pontoon bridge.
____ (14) Portable electrically driven pump.
____ (15) Two 500-gallon collapsible water tanks.
____ (16) Field laboratory.
____ (17) Disk comparator and a supply of chemicals.

E48. Label on a diagram the major components of an erdlator assembly, and state how the erdlator operates.

Erdlator Assembly. The erdlator assembly (cross section in fig. 5-4) reduces the organic and suspended matter content of the water and produces an effluent suitable for application to the diatomite filter. Raw water is introduced to the influent launder (4) at the top of the erdlator tank through the aspirators; this action aerates the raw water. The water overflows from the influent launder to the mixing zone (12) where it is thoroughly mixed with ferric chloride, pulverized limestone, calcium hypochlorite and, when necessary, activated carbon. As



1. DOWNCOMER TUBE
2. EFFLUENT LAUNDER
3. CIRCULAR DISK (4 REQUIRED)
4. INFLUENT LAUNDER
5. AGITATOR SHAFT
6. SEPARATOR ZONE
7. SLUDGE CONCENTRATOR TANK
8. CLARIFICATION ZONE
9. WET WELL TANK
10. BAFFLE
11. BAFFLE RING
12. MIXING ZONE

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Figure 5–4. Cross section of erdlator.

the liquid descends through the mixing zone, it is mixed by the flat circular disks (3) equally spaced on the shaft.

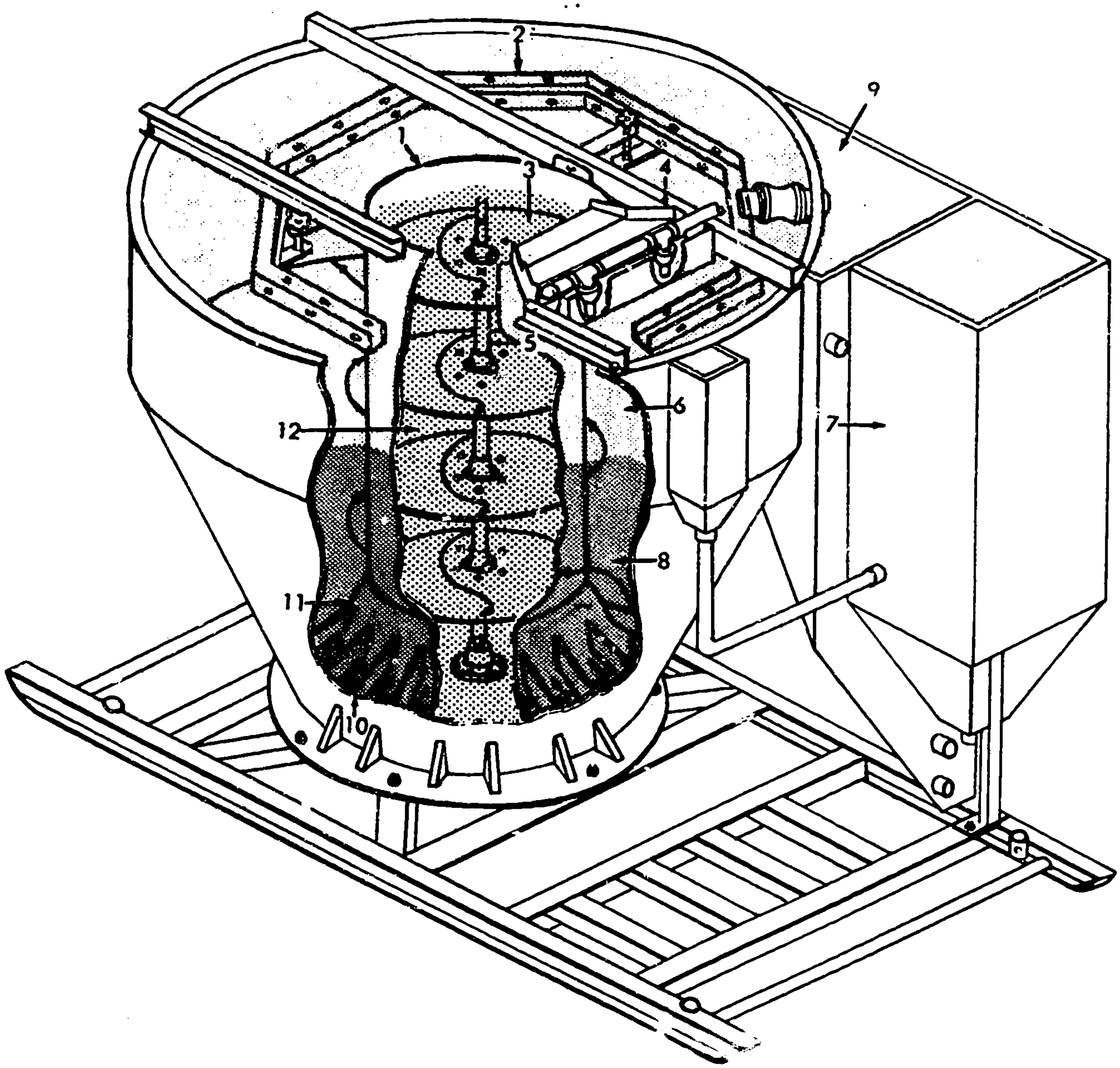
The flow through the mixing zone is a downward rotation and is deflected by a series of shallow baffles (10) in the bottom of the erdlator tank and directed in a counter rotation into the clarification zone (8). The resulting counter rotation is reduced but continues at a sufficient velocity to keep the slurry pool rotating. The slurry is separated from the clear water in the upper section of the erdlator tank in the separator zone (6). The clear water is collected by the effluent launder (2) and discharged into the wet well tank (9) where it is stored until it is delivered into the filter. The slurry level in the erdlator tank is controlled by means of an exterior sludge concentrator tank (7). A portion of the slurry from the top of the slurry pool in the separator zone is continuously withdrawn by gravity flow to the sludge concentrator tank.

Wet well. The wet well (9) is a tank welded to the front quadrant of the erdlator for the collection of the effluent from the erdlator. It provides limited storage of coagulated water and serves as a sump for the suction of the filter pump. An overflow pipe to waste in the wet well permits operation of the erdlator at rated capacity when the filter is stopped. A float switch, operated from the wet well, sounds an alarm and lights a red signal light when the filter pump pumps water from the wet well at a rate greater than the incoming supply. A drain in the bottom of the wet well permits complete drainage of the tank to waste when water unsuited for filtering is obtained from the erdlator.

Sludge concentration tank. The sludge concentrator tank (7) is attached externally to the erdlator and, through a pipeline arrangement, receives, by gravity flow, the flocculent slurry from the erdlator. The sludge concentrator functions as a small auxiliary erdlator. It provides a longer holding period for slurry concentration and a reduced upflow water-rise rate for separation of clear water from the slurry. The concentrator permits settling of the slurry in the bottom of the tank for continuation of intermittent drainage to waste and skimming of a clear coagulated water at the top of the tank for return to the wet well and eventual pumping to the filter. The drainage of slurry to waste and the return flow to the wet well is manually controlled by the operator, depending upon the amount of a slurry produced in the erdlator.

Exercises (E48):

1. Using the illustration below (fig. 5-5), label the major components of the erdlator assembly.



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________

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Figure 5-5. Objective E54, exercise 1.

Complete the following statements that describe the operation of the erdlator.

2. The erdlator assembly reduces the organic suspended matter content of the water and produces an __________ suitable for application to the __________ filter.

3. Raw water is introd[illegible]e at the top influent launder at the top of the erdlator tank through the __________, which __________ the raw water.

4. The water overflows from the influent launder to the mixing zone, where it is thoroughly mixed with __________ __________, pulverized __________, __________ __________, and, when necessary, __________.

5. As the liquid descends through the mixing zone, it is mixed by the __________ __________ disks equally spaced on the shaft.

6. The flow through the mixing zone is a downward rotation and is deflected by a series of __________ in the bottom of the erdlator tank and directed in a __________ rotation into the __________ zone.

7. The resulting counter rotation is reduced but continues at a sufficient velocity to keep the __________ pool rotating.

8. The slurry is separat[illegible] from the clear water in the up[illegible] of the erdlator tank in the __________ zone.

9. The clear water is collected by the effluent launder and discharged into the __________ __________ tank, where it is stored until it is delivered to the __________.

10. The slurry level in the erdlator tank is controlled by means of an exterior __________ __________ tank.

11. A portion of the slurry from the top of the slurry pool in the separator zone is continuously withdrawn by __________ flow to the sludge concentrator tank.

12. An overflow pipe to waste in the wet well pe[illegible] operation of the erdlator at rated capacity when the filter is __________.

13. A float switch, operated from the wet well, sounds an alarm and lights a red signal light when the filter pump pumps water from the wet well at a rate greater than the __________ __________.

14. The sludge concentration tank receives, by gravity glow, the __________ slurry from the erdlator.

15. The sludge concentrate functions as a small __________ erdlator.

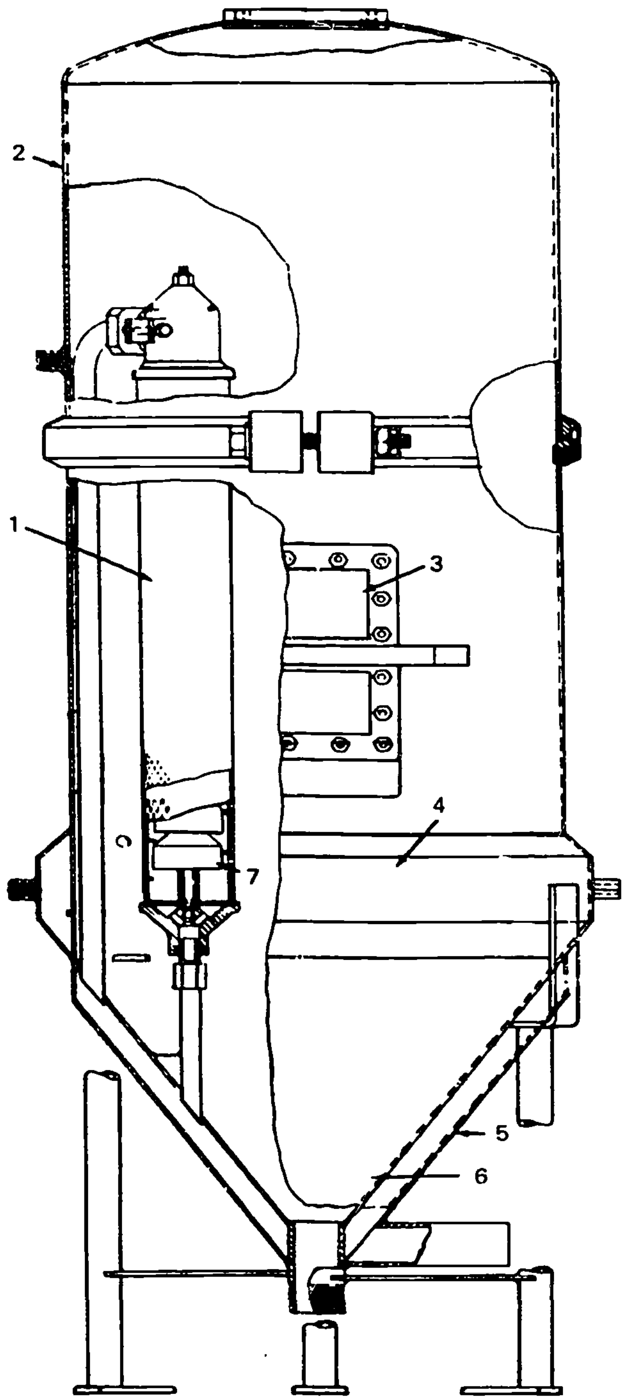
16. The concentrator provides a longer holding period for slurry concentration and a reduced __________ water rise rate for separation of clear water from the __________.

17. The drainage of slurry to waste and the return flow to the wet well is __________ controlle[illegible] the operator.

E49. Specify the operation and construction of the filter section of the erdlator assembly.

Filter Section. The filter section permits precoating of the filter elements with a concentrated diatomaceous earth slurry, filtration at a constant rate, and backwashing by the air pump method. The diatomite filters are divided into three sections: effluent, influent, and wash ring. Notice these sections and the other parts of the filter shown in figure 5-6.

The effluent section (5) is the conical base of the filter. The filter waterline is connected to the effluen[illegible] section and contains the 1½-inch effluent plug valve, [illegible] flow controller valve, and gate valve in the filter discharge line, and the 1/2-inch drain gate valve. Inside the effluent section is another conical section separated from the first.



1. FILTER ELEMENT (4 REQUIRED)
2. FILTER HOUSING COVER (AIR DOME)
3. FILTER WINDOW
4. WASH RING
5. EFFLUENT SECTION
6. INFLUENT SECTION
7. PLASTIC CUP (32 REQUIRED)

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Figure 5–6. Diatomite filter.

The latter conical section and the cylindrical section above it comprise the influent section. This is the section that can be seen by looking through the filter window or by removing the filter shell dome.

The filter elements are inside the influent section. Each element is connected to the effluent section by two pipes, one at the base and one other at the top of the element. Water in the influent section cannot reach the effluent section except through the filter elements. The filter element consists of a perforated metal tube covered by a plastic membrane sleeve. Inside the tube are inverted plastic cups. The upper and lower ends of the tube are connected to the two pipes. The top of the influent section is inclosed by the filter shell dome and the air release valve.

The wash ring is separated from the influent section by a cylindrical baffle. At the base of this baffle are small wires. Water entering the wash ring through the upper line from the influent plug valve is forced to swirl by the baffle and is directed downward along the conical section of the influent section by the wires. The influent pressure line is connected to the wash ring. It contains the pressure gage, the 1/4-inch draincock, and the 1/8-inch draincock. The effluent pressure line is connected to the filtered line. It contains the pressure gage, the 1/4-inch draincock, and the 1/8-inch draincock.

The precoat funnel is used when precoating the filter element before going into normal operation. The flow controller controls the flow of water through the filter. Two pressure gages indicate the amount of pressure on the influent and effluent sides of the filter.

The air release valve releases air in the dome of the filter. When the air release valve is opened, the air pressure under the filter dome is suddenly released. The air in the filter element inverted plastic cups expands with the effect of a blast. The plastic sleeves around the filter elements also expand following the air blast and cause the coating of filter aid and accumulated foreign matter to fall off.

Exercises (E49):

1. With what does the filter section permits precoating of the filter elements?

2. The diatomite filters are divided into what thr sections?

3. The filter elements are inside what section?

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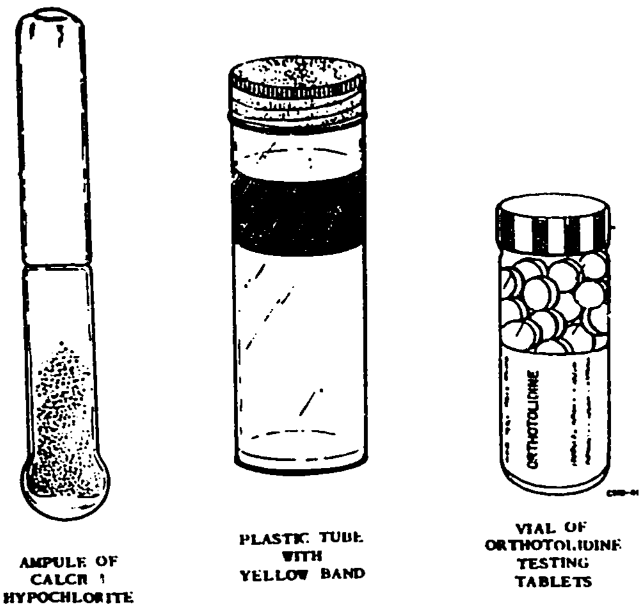


Figure 5–3. Items in chlorination kit.

chlorinating water and testing it for the proper chlorine residual. The kit contains calcium hypochlorite ampules (.5 gram each) for disinfecting water together with three plastic tubes and three vials of orthotolidine tablets for use in determining the chlorine residual. The vials of orthotolidine tablets are packed inside the plastic tubes. Each of the plastic tubes has a band of a different shade of yellow around it; the lightest shade of yellow indicates 1 ppm; the medium shade, 5 ppm; and the darkest shade, 10 ppm. These figures are printed on the tubes.

Disinfection Procedures. Water is disinfected at the unit level by using the Lyster bag (fig. 5-1) or other suitable containers.

Lyster bag. The procedure for the chlorination of water using a Lyster bag is as follows.

a. Clean the Lyster bag and hang it by the supporting r s as illustrated in figure 5-1. The supports must be sturdy, as the bag filled with water weighs approximately 300 pounds.

b. Fill the bag with water to the 36-gallon marks which is 4 inches from the top of the bag. If possible, use settled, clear water.

c. Put the contents of at least three calcium hypochlorite ampules into a canteen cup; add a small amount of water from the Lyster bag and stir with a small stick until a thick mixture results; then fill the cup one-half full of water and stir again.

d. Empty the prepared solution slowly into the Lyster bag, stirring the water with a clean stick.

e. Cover the bag and flush the faucets by running a small quantity of the water through each of them.

f. After the disinfecting solution has been mixed with water for 10 minutes, flush the faucets again; then collect a sample of water from one of the faucets in the 5 ppm plastic tube for testing.

g. If the test shows a chlorine residual less than 5 ppm, add the contents of an additional calcium hypochlorite ampule and after 10 minutes repeat the test.

h. If the test shows the chlorine residual to be at least 5 ppm, wait an additional 20 minutes, because a total disinfection time of 30 minutes is required. Check the residual again before drinking the water.

Other water containers. When you treat water in containers other than a Lyster bag, it's important for you to remember that you must use, different amounts of calcium hypochlorite depending on the capacity of the container.

a. Five-gallon can of water. Use one-half of the contents of one calcium hypochlorite ampule initially.

b. Fifty-five gallon drum of water. Use four or five ampules initially.

c. Four-hundred gallon trailer of water. Use 30 ampules initially. With any of the three examples listed above, if you find that the chlorine residual is low, add small amounts of clacium hypochlorite. Remember, as stated earlier, a 5 ppm residual is the standard requirement for field water supplies.

Chlorine residual testing procedure. Determine chlorine residual of water by use of the plastic tubes and the orthotolidine tablets provided in the chlorination kit (fig. 5-3). The procedure is as follows:

a. Select the appropriate plastic tube from the three tubes in the kit. The appropriate tube is the one on which is printed the number of ppm chlorine residual required by the medical services.

b. Flush the faucets of the Lyster bag and fill the plastic tube to a point just below the yellow band.

c. Take one orthotolidine tablet from the vial in the kit and add it to the tube of water.

d. Place the cap on the tube of water and shake the tube until the orthotolidine tablet is thoroughly dissolved.

e. Compare the yellow shade of the water with the yellow shade of the band on the tube. If the color of the water is the same shade or darker than the band, the chlorine residual is equal to or greater than that printed on the tubes. If a lighter color or no color is formed, the water does not have a sufficient chlorine residual; therefore, additional chlorination and testing are required.

Exercises (E45):

1. At what rate is the knapsack filter unit capable of treating water?

2. When two filter pads are used simultaneously, how many gallons of muddy water can they clarify before being replaced?

3. What must be done to filtered water to make it safe for drinking?

4. What chlorine residual is the standard requirement for field water supplies?

5. How much does the Lyster bag when properly filled with water weigh?

6. How many calcium hypochlorite ampules added to water in a canteen cup are needed to disinfect a Lyster bag of water?

7. Before water is considered safe to drink from a Lyster bag, how much disinfection time is required?

8. What kind of tablest are provided in the chlorination kit?

9. When the yellow shade of water is the same as the yellow shade on the plastic shade of the tube, how does the chlorine residual compare to that printed on the tube?

E46. Classify given procedures as to the method of treating individual water supplies.

Individual Water Treatment. When safe water is not available in large quantities, each person must produce potable water by using a canteen and iodine purification tablets, calcium hypochlorite supplied in .5 gram ampules, or by boiling the water.

Iodine tablets. Before you use iodine tablets, check them for physical changes, as they lose their disinfecting ability in time. Do not use tablets that are not steel gray in color, which are stuck together, or that are crumbled. Use the following procedure in treating water in a 1-quart canteen (or any suitable 1-quart container), with iodine tablets.

a. Fill the canteen with the cleanest, clearest water available.

b. Add one iodine tablet to your canteen of a clear water; add two tablets if the water is cloudy. Double these amounts for a 2-quart canteen.

c. Place the cap on the canteen loosely; wait 5 minutes then shake the canteen well, allowing leakage to rinse the threads around the neck of the canteen.

d. Tighten the cap and wait an additional 20 minutes before using the water for any purpose.

Calcium hypochlorite. Use the following procedure is used to purify water in a 1-quart canteen with calcium hypochlorite ampules.

a. Fill the canteen with the cleanest, clearest water available, leaving an air space of an inch or more below the neck of the canteen.

b. Fill a canteen cup half full of water and add the calcium hypochlorite from one ampule, stirring with a clean stick until this powder is dissolved.

c. Fill the cap of a plastic canteen half full of the solution from the cup and add it to the water in the canteen; then, place the cap on the canteen and shake it thoroughly.

NOTE: If an aluminum 1-quart canteen is being used, add at least three capfuls of the calcium hypochlorite solution to the canteen, as this cap is much smaller than the one on the plastic canteen.

d. Loosen the cap slightly and invert the canteen, letting the treated water leak onto the threads around the neck of the canteen.

e. Tighten the cap on the canteen and wait at least 30 minutes before using the water for any purpose.

Boiling of water. Use this method when disinfecting compounds are not available. It is a good method for killing disease-producing organisms; however, it has several disadvantages: (1) fuel is needed; (2) it takes a long time for the water to boil and then cool; (3) there is no residual protection against recontamination. Water must be held at a rolling boil for at least 15 seconds to make it safe for drinking. If there is evidence that a 15-second boiling period will not make it safe, the medical services will prescribe the longer period required.

Exercises (E46):

1. Classify each treatment procedure in column A by placing in the appropriate blank the letter code of the method shown in column B. Some procedures may be used in two methods.

Column A	*Column B*
____ (1) Used to purify water in a 1-quart canteen.	B. Boiling of water.
____ (2) Used when disinfecting compounds are not available.	C. Calcium hypochlorite.
____ (3) A good method for killing disease-producing organisms.	I. Iodine tablet.
____ (4) Used in treating water in a 1-quart canteen.	
____ (5) Total elapsed time is 25 minutes.	
____ (6) Canteen must be shaken thoroughly.	
____ (7) Total elapsed time is 30 minutes before water is usable.	
____ (8) Leaves no protection against recontamination.	

2. What are the three disadvantages of boiling water for human consumption?

3. What conditions should iodine tablets meet in order to be effective?

4. How long must water [illegible] at a rolling boil before it is safe for drinking?

5. Who will prescribe a longer boiling period if the required time is not considered safe?

5-3. Mobile Water Purification Units

Mobile water purification units are available for use during contingency operations, and they can be installed at a base or remote site on a permanent or semipermanent basis. The primary purpose of these mobile units is to produce safe, germ-free water for human consumption and use in any area or situation. There are several types of mobile water purification units. Their output capacities range from 600 gallons of water per hour to 3000 gallons of water per hour. These units are often referred to as diatomite purification units, and they are designed to be used only with fresh water.

This equipment requires three phases of water treatment: pretreatment, purification, and filtration. You pretreat water to remove the suspended matter and dissolved gases. You purify water by adding chemicals to the water for specific periods of time to disinfect the water by killing disease organisms and bacteria. You filter the water through a diatomaceous earth type of filter, which not only removes residue that may be harmful, undesirable, or objectionable because of appearance, taste, or odor but also removes certain waterborne, disease-causing bacteria. Keep in mind that you will be working with three types of water as it passes through the unit: raw, treated, and filtered.

All units, regardless of type, have similar components. They operate on the same principles. Differences in the units exist when equipment or components manufactured by different companies are used on the water purification units. Since these units operate on the same principles, you can transfer your knowledge of how one unit operates to another. Operating and maintenance instructions, furnished by the manufacturer of the unit, and similar instructions in Air Force technical orders, are available. Follow the instructions in these publications when you operate and maintain a diatomite water purification unit. In this section, we discuss the operation and maintenance of a trailer-mounted water purification unit that has a water-producing capacity of 600 gallons per hour.

E47. Identify those components required to make up a field purification unit.

Description. The 600-gallon-per-hour water purification unit is furnished in a special-purpose cargo body mounted on a 2½ ton two-wheel trailer. The erdlator assembly, diatomite filter, filter pump, chemical feed equipment, with the necessary piping and valves, and the electrical controls are mounted in the cargo body. These components are designed to be operated without removing them from the trailer body. The supporting equipment includes a 3-kilowatt gasoline-engine-driven generator set, gasoline-engine-drive pump, a portable electric-drive pump, two 500-gallon collapsible water tanks, necessary hoses and fittings, a disk comparator, and a supply of chemicals.

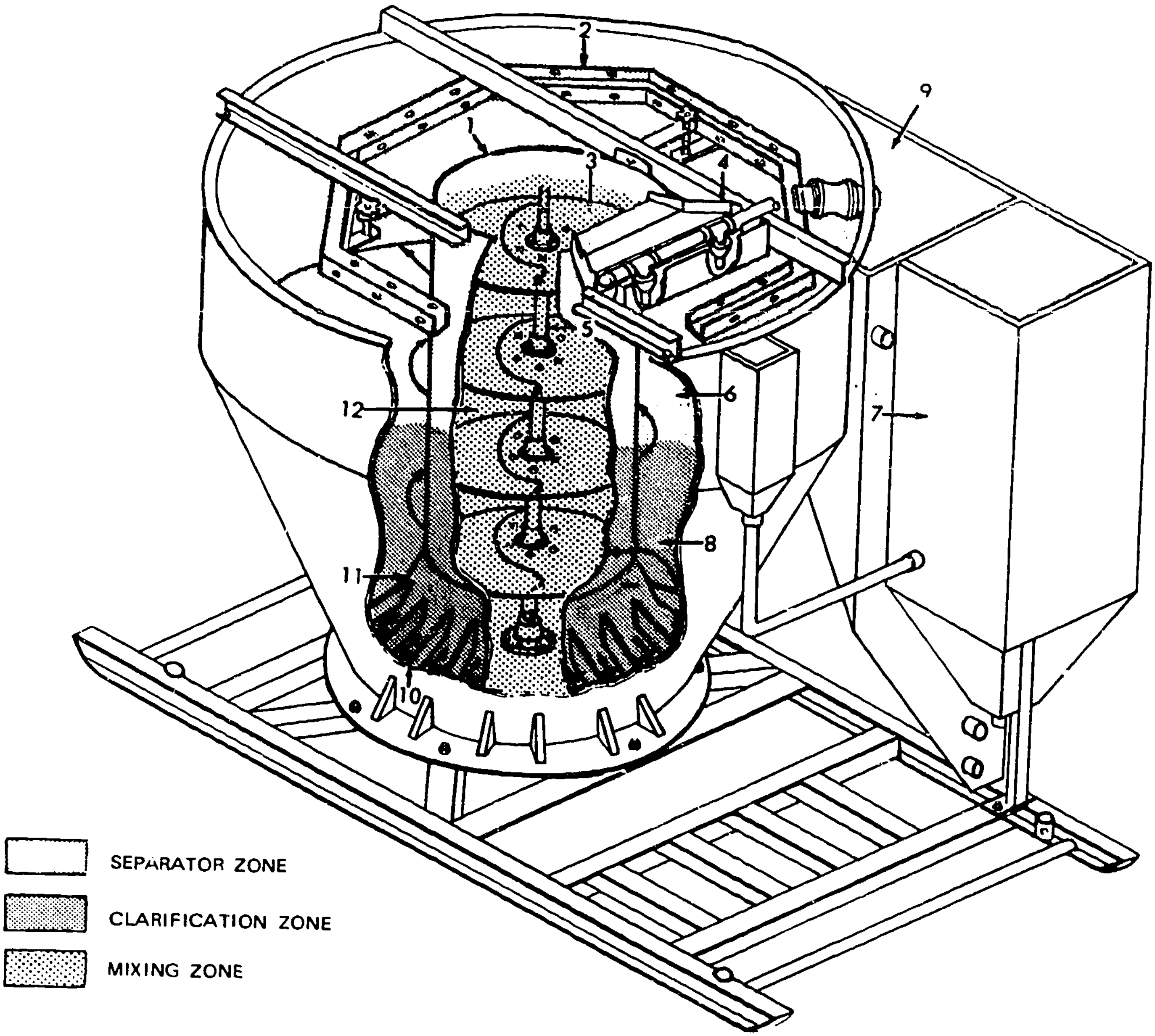
Exercise (E47):

1. Place a checkmark in the spaces provided below to identify components required to make up a field purification unit.

____ (1) 2 ½ ton two-wheel trailer.
____ (2) Farm tractor.
____ (3) Erdlator assembly.
____ (4) Portable steel building (10 x 10).
____ (5) Diatomite filter.
____ (6) Filter pump.
____ (7) Chemical feed equipment.
____ (8) 1000-gallon steel tank.
____ (9) Piping, valves, and electrical control.
____ (10) 3-kilowatt, gasoline-engine-drive generator set.
____ (11) Portable elevated water tower.
____ (12) Gasoline-engine-driven pump.
____ (13) Pontoon bridge.
____ (14) Portable electrically driven pump.
____ (15) Two 500-gallon collapsible water tanks.
____ (16) Field laboratory.
____ (17) Disk comparator and a supply of chemicals.

E48. Label on a diagram the major components of an erdlator assembly, and state how the erdlator operates.

Erdlator Assembly. The erdlator assembly (cross section in fig. 5-4) reduces the organic and suspended matter content of the water and produces an effluent suitable for application to the diatomite filter. Raw water is introduced to the influent launder (4) at the top of the erdlator tank through the aspirators; this action aerates the raw water. The water overflows from the influent launder to the mixing zone (12) where it is thoroughly mixed with ferric chloride, pulverized limestone, calcium hypochlorite and, when necessary, activated carbon. As



1. DOWNCOMER TUBE
2. EFFLUENT LAUNDER
3. CIRCULAR DISK (4 REQUIRED)
4. INFLUENT LAUNDER
5. AGITATOR SHAFT
6. SEPARATOR ZONE
7. SLUDGE CONCENTRATOR TANK
8. CLARIFICATION ZONE
9. WET WELL TANK
10. BAFFLE
11. BAFFLE RING
12. MIXING ZONE

CNC–031

Figure 5–4. Cross section of erdlator.

the liquid descends through the mixing zone, it is mixed by the flat circular disks (3) equally spaced on the shaft.

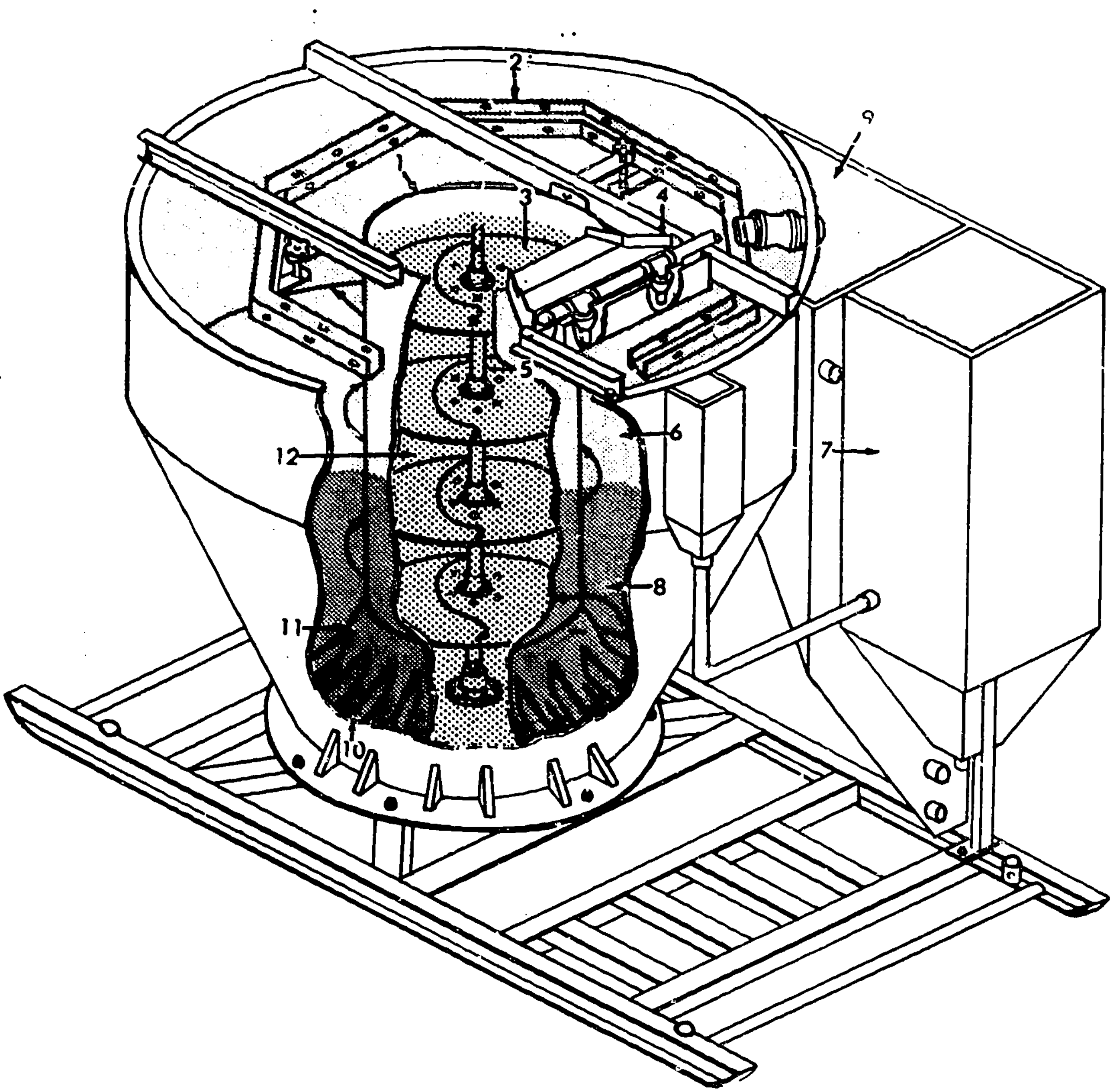
The flow through the mixing zone is a downward rotation and is deflected by a series of shallow baffles (10) in the bottom of the erdlator tank and directed in a counter rotation into the clarification zone (8). The resulting counter rotation is reduced but continues at a sufficient velocity to keep the slurry pool rotating. The slurry is separated from the clear water in the upper section of the erdlator tank in the separator zone (6). The clear water is collected by the effluent launder (2) and discharged into the wet well tank (9) where it is stored until it is delivered into the filter. The slurry level in the erdlator tank is controlled by means of an exterior sludge concentrator tank (7). A portion of the slurry from the top of the slurry pool in the separator zone is continuously withdrawn by gravity flow to the sludge concentrator tank.

Wet well. The wet well (9) is a tank welded to the front quadrant of the erdlator for the collection of the effluent from the erdlator. It provides limited storage of coagulated water and serves as a sump for the suction of the filter pump. An overflow pipe to waste in the wet well permits operation of the erdlator at rated capacity when the filter is stopped. A float switch, operated from the wet well, sounds an alarm and lights a red signal light when the filter pump pumps water from the wet well at a rate greater than the incoming supply. A drain in the bottom of the wet well permits complete drainage of the tank to waste when water unsuited for filtering is obtained from the erdlator.

Sludge concentration tank. The sludge concentrator tank (7) is attached externally to the erdlator and, through a pipeline arrangement, receives, by gravity flow, the flocculent slurry from the erdlator. The sludge concentrator functions as a small auxiliary erdlator. It provides a longer holding period for slurry concentration and a reduced upflow water-rise rate for separation of clear water from the slurry. The concentrator permits settling of the slurry in the bottom of the tank for continuation of intermittent drainage to waste and skimming of a clear coagulated water at the top of the tank for return to the wet well and eventual pumping to the filter. The drainage of slurry to waste and the return flow to the wet well is manually controlled by the operator, depending upon the amount of a slurry produced in the erdlator.

Exercises (E48):

1. Using the illustration below (fig. 5-5), label the major components of the erdlator assembly.



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________

CNC–031A

Figure 5–5. Objective E54, exercise 1.

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Complete the following statements that describe the operation of the erdlator.

2. The erdlator assembly reduces the organic suspended matter content of the water and produces an __________ suitable for application to the __________ filter.

3 Raw water is introduced to the at the top influent launder at the top of the erdlator tank through the __________, which __________ the raw water.

4. The water overflows from the influent launder to the mixing zone, where it is thoroughly mixed with __________ __________, pulverized __________, __________ __________, and, when necessary, __________.

5. As the liquid descends through the mixing zone, it is mixed by the __________ __________ disks equally spaced on the shaft.

6. The flow through the mixing zone is a downward rotation and is deflected by a series of __________ in the bottom of the erdlator tank and directed in a __________ rotation into the __________ zone.

7. The resulting counter rotation is reduced but continues at a sufficient velocity to keep the __________ pool rotating.

8. The slurry is separated from the clear water in the upper section of the erdlator tank in the __________ zone.

9. The clear water is collected by the effluent launder and discharged into the __________ __________ tank, where it is stored until it is delivered to the __________.

10. The slurry level in the erdlator tank is controlled by means of an exterior __________ __________ tank.

11. A portion of the slurry from the top of the slurry pool in the separator zone is continuously withdrawn by __________ flow to the sludge concentrator tank.

12. An overflow pipe to waste in the wet well permits operation of the erdlator at rated capacity when the filter is __________.

13. A float switch, operated from the wet well, sounds an alarm and lights a red signal light when the filter pump pumps water from the wet well at a rate greater than the __________ __________.

14. The sludge concentration tank receives, by gravity glow, the __________ slurry from the erdlator.

15. The sludge concentrate functions as a small __________ erdlator.

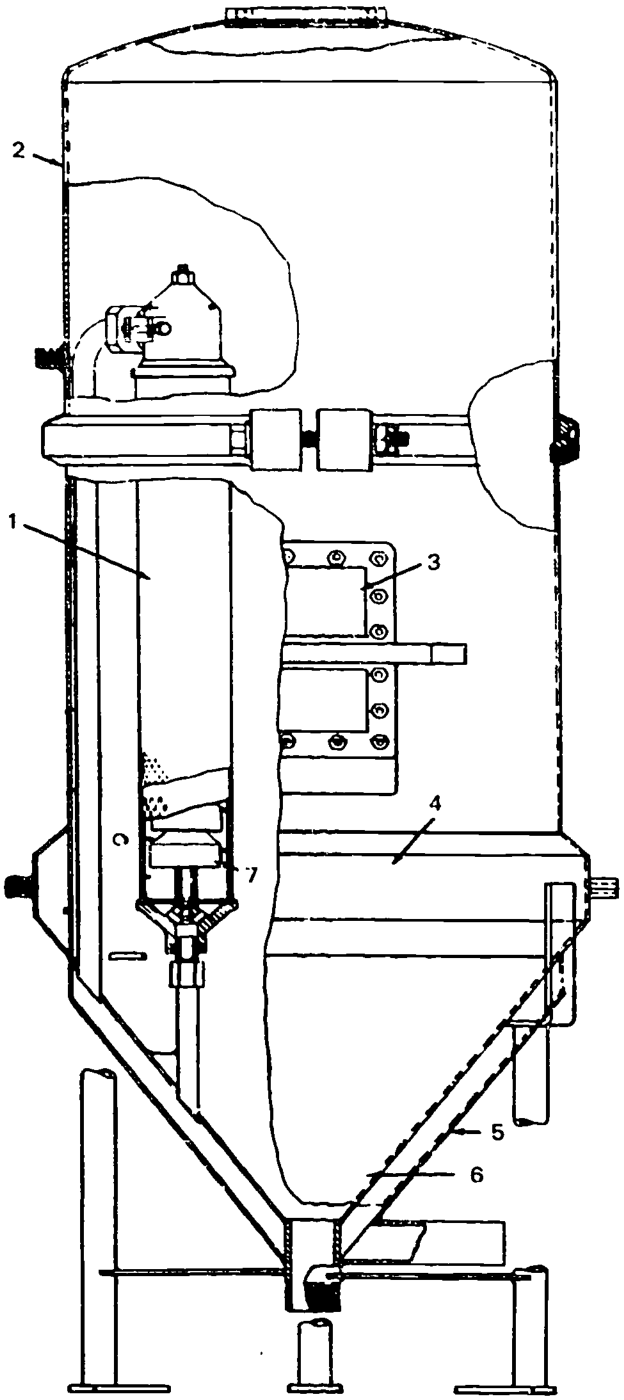
16. The concentrator provides a longer holding period for slurry concentration and a reduced __________ water rise rate for separation of clear water from the __________.

17. The drainage of slurry to waste and the return flow to the wet well is __________ controlled by the operator.

E49. Specify the operation and construction of the filter section of the erdlator assembly.

Filter Section. The filter section permits precoating of the filter elements with a concentrated diatomaceous earth slurry, filtration at a constant rate, and backwashing by the air pump method. The diatomite filters are divided into three sections: effluent, influent, and wash ring. Notice these sections and the other parts of the filter shown in figure 5-6.

The effluent section (5) is the conical base of the filter. The filter waterline is connected to the effluent section and contains the 1½-inch effluent plug valve, the flow controller valve, and gate valve in the filter discharge line, and the 1/2-inch drain gate valve. Inside the effluent section is another conical section separated from the first.



1. FILTER ELEMENT (4 REQUIRED)
2. FILTER HOUSING COVER (AIR DOME)
3. FILTER WINDOW
4. WASH RING
5. EFFLUENT SECTION
6. INFLUENT SECTION
7. PLASTIC CUP (32 REQUIRED)

CNG–088

Figure 5–6. Diatomite filter.

The latter conical section and the cylindrical section above it comprise the influent section. This is the section that can be seen by looking through the filter window or by removing the filter shell dome.

The filter elements are inside the influent section. Each element is connected to the effluent section by two pipes, one at the base and one other at the top of the element. Water in the influent section cannot reach the effluent section except through the filter elements. The filter element consists of a perforated metal tube covered by a plastic membrane sleeve. Inside the tube are inverted plastic cups. The upper and lower ends of the tube are connected to the two pipes. The top of the influent section is inclosed by the filter shell dome and the air release valve.

The wash ring is separated from the influent section by a cylindrical baffle. At the base of this baffle are small wires. Water entering the wash ring through the upper line from the influent plug valve is forced to swirl by the baffle and is directed downward along the conical section of the influent section by the wires. The influent pressure line is connected to the wash ring. It contains the pressure gage, the 1/4-inch draincock, and the 1/8-inch draincock. The effluent pressure line is connected to the filtered line. It contains the pressure gage, the 1/4-inch draincock, and the 1/8-inch draincock.

The precoat funnel is used when precoating the filter element before going into normal operation. The flow controller controls the flow of water through the filter. Two pressure gages indicate the amount of pressure on the influent and effluent sides of the filter.

The air release valve releases air in the dome of the filter. When the air release valve is opened, the air pressure under the filter dome is suddenly released. The air in the filter element inverted plastic cups expands with the effect of a blast. The plastic sleeves around the filter elements also expand following the air blast and cause the coating of filter aid and accumulated foreign matter to fall off.

Exercises (E49):

1. With what does the filter section permits precoating of the filter elements?

2. The diatomite filters are divided into what three sections?

3. The filter elements are inside what section?

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4. Water in the influent section cannot reach the effluent section except through what?

5. What separates the wash ring from the influent section?

6. The filtered waterline is connected to the effluent section and contains the 1½-inch effluent __________ valve, the __________ controller valve, the __________ valve in the filter discharge line, and the 1/2-inch __________ __________ valve.

7. Inside the effluent section is another conical section which is separated from the first; this conical section and the cylindrical section above it comprise what section?

8. The influent section can be seen by looking through the filter window or by removing what device?

9. How is each element is connected to the effluent section?

10. The filter element consists of a perforated metal tube covered by a membrane sleeve of what kind of material?

11. By what is the top of the influent section inclosed?

12. Water entering the wash ring through the upper line from the influent plug valve is foced to swirl by the baffle and is directed downward along the conical section of the influent section by the __________ .

13. The precoat funnel is used when precoating the __________ element before going into normal operation.

14. Two pressure gages indicate the amount of pressure on the __________ and __________ sides of the filter.

15. The plastic sleeves around the filter elements also expand following an air blast and cause the coating of __________ and accumulated __________ to fall off.

E50. List the chemicals or materials used in the chemical feeders; state their function and where they are applied.

Chemical Feeders. The chemical slurry feeder is an aluminum tank unit, mounted to brackets welded to the erdlator tank, (3, fig. 5-7). It has two identical chemical compartments and water collection troughs and two weirs; one of which contains a float-operated needle valve. One compartment supplies pulverized limestone slurry (coagulant aid) and activated carbon to the erdlator. The other compartment supplies diatomite slurry to the suction inlet of the filter pump. A dial-indicated timer (4, fig. 5-7) is mounted on the lower part of the feeder.

The chemical solution feeder, which is a different component and not shown in figure 5-7, is mounted to the erdlator mounting base. It consists of two diaphragm pumps. The pumps operate from one electric motor by means of a gear reduction mechanism. The chemical solution feeder pumps ferric chloride and calcium hypochlorite solution from two rubber pails into the mixing zone or downcomer of the erdlator.

Exercises (E50):

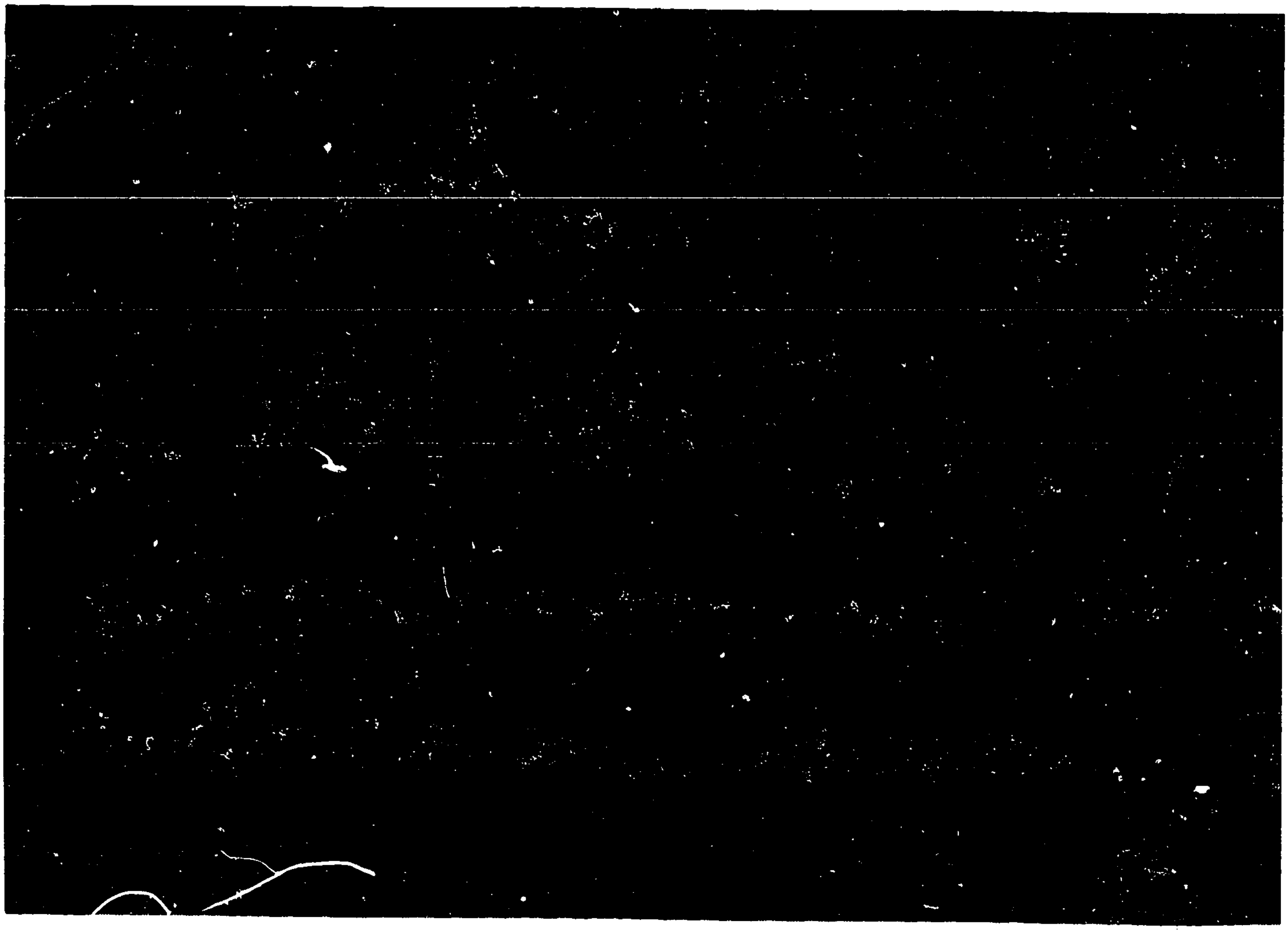
1. List the chemicals or materials used in the chemical feeders.

2. State the function of the chemicals and where they are applied.

E51. Identify the functions of given minor components of the field purification unit.

Minor Components. In addition to the erdlator, diatomite filter, and chemical feeders, the field water purification unit consists of several minor components. Some of these components are separate and some are attached to the other major assemblies.

Raw water and filter pumps. The filter pump and the raw water pump are identical; both are centrifugal pumps.



1. ERDLATOR TANK
2. INFLUENT LAUNDER
3. CHEMICAL SLURRY FEEDER
4. DIAL INDICATED TIMER
5. EFFLUENT LAUNDER
6. WET WELL TANK
7. SLUDGE CONCENTRATION TANK
8. ELECTRICAL CONTROL BOX

CNC-037

Figure 5–7. Chemical feeders.

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The raw water pump is used to pump the raw water to the erdlator. It is mounted in a tubular frame designed to mount on the erdlator base when the pump is not in use. The filter pump is used for pumping coagulated water from the wet well tank to the filter.

Distribution pump. The distribution pump is a centrifugal type. It is driven by a gasoline engine and is mounted in a tubular frame. It is used to distribute the filtered water to the user.

Electrical control box. The electrical control box (8, fig. 5-7) is mounted on the front of the sludge concentrator tank. It contains the circuit breakers, transformer, receptacle connectors, switch, signal lamp, alarm buzzer, and the necessary controls and wiring to operate the components of the water purification unit.

Water storage tanks. Two collapsible synthetic rubber-coated nylon tanks are furnished with the basic issue items for storing the filtered water. Each tank has a capacity of 500 gallons.

Generator. A gasoline-engine-driven, 120-volt AC generator is furnished with the basic issue items. The generator can provide all the electrical power required for the operation of the water purification unit.

Hoses and fittings. Sufficient hoses and fittings are furnished with the basic issue item to equip the water purification unit for pumping raw water from the source to the erdlator, filtered water from the filter to the storage tanks, finished water from the storage tank to the user, and waste water from the erdlator and filter to waste.

Piping and valves. The valves and pipes of the unit are color coded as follows:

- Black—raw water
- Yellow—coagulated water
- Red—waste water
- Green—filtered water

Exercise (E51):

1. Match each minor components in column A, to its function in column B.

Column A	*Column B*
____ (1) Raw water and filter pumps.	a. Used to store filtered water.
____ (2) Distribution pump.	b. Used to connect the various major components together temporarily.
____ (3) Electrical control box.	c. Provides all electrical power to unit.
____ (4) Water storage tanks.	e. Pumps coagulated water to filter and raw water to the erdlator.
____ (5) Generator.	f. Distributes filtered water.
____ (6) Hoses and fittings.	g. Permanent connections in units and are color coded.
____ (7) Piping and valves.	

E52. Identify preparations for operation of a field purification unit.

Preparation for Operation. Selecting a raw water source may or may not be your responsibility. This selection may be made by the advance party or by the medical services. If you are a member of the advance party or if you have to select the site on which the water purification unit is to operate, be sure that you:

a. Locate the water purification unit as close to a raw water source as is practicable, preferably not more than 50 feet away.

b. Do not select a raw water source that is adjacent to a sewer outlet, latrine, bathing area, refuse pile, or drainage area.

c. Select relatively level terrain with firm footing.

d. Allow sufficient space for locating and installing the component items. There must be adequate roads for vehicles to transport purified water.

e. Take advantage of natural camouflage and of existing roadways, powerlines and suitable contingency operation areas for personnel.

f. Position the distribution pumps at the selected location accessible for distributing purified water to the transporting vehicles. Provide a suitable, firm, drained, level foundation to insure proper operation of the pump. Use planking or timbers to prevent settling and shifting when in operation.

The layout of one water purification unit is similar to other units. Notice the arrangement of the different components in figure 5-8. This unit is set up to accomplish the following operations.

a. Raw water intake.
b. Clarification and purification.
c. Filtration.
d. Storage of filtered water.
e. Distribution.
f. Discharge of waste water. Notice that the discharge hoses are located downstream from the raw water intake.

Exercises (E52):

From the list of statements below, select those that indicate correct procedures for preparing the field purification unit for operation. Place an X by true statements and correct any statements that are not true or that are only partly true.

____ 1. Select a raw water source.

____ 2. Locate the purification unit 50 feet or farther away from source of raw water.

____ 3. Select relatively level terrain with firm footing.

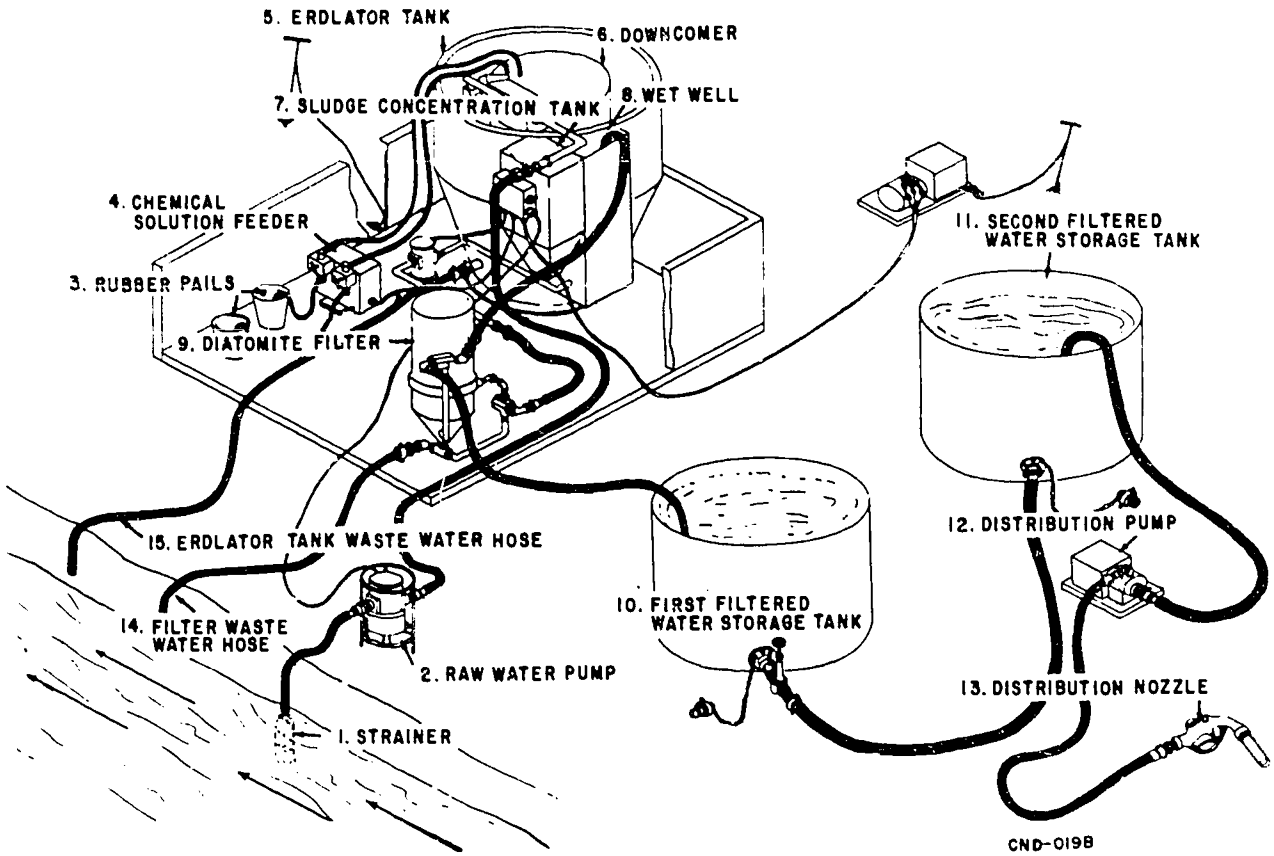


Figure 5–8. Layout of water purification unit.

____ 4. Allow sufficient space for locating and installing component items.

____ 5. Locate in an area where roads can be provided.

____ 6. Locate near kitchens and latrines for convenient water supplies to them.

____ 7. Take advantage of existing powerlines, roads, and natural camouflage.

____ 8. Set distribution pump on ground.

____ 9. Discharge waste water upstream from raw water intake.

E53. Identify services as occurring before operation, during operation, or after operation.

Operation, Maintenance, and Servicing. To insure that the equipment is ready for operation at all times, it must be inspected systematically before, during, and after operation. The equipment is inspected so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance services are performed before operation. Defects discovered during operation of the unit are noted, and they are corrected as soon as operation has ceased. Stop operation immediately if you note a deficiency that would damage the equipment if operation were continued. The operator performs after-operation services after every operating period or at intervals based on the normal operation of the equipment. If you operate under abnormal conditions, reduce the interval. Report to organizational maintenance defects or unsatisfactory characteristics beyond the scope of your capabilities at the earliest opportunity. The items to be inspected and serviced and the service and inspection intervals are shown in table 5-1.

Preventive Maintenance. The systematic care, service, and inspection of equipment for the purpose of maintaining it in a serviceable condition and for detecting and correcting pending failures is preventive maintenance and is the responsibility of all echelons.

Maintenance. Any action taken to keep materiel in a serviceable condition or to restore it to serviceability when it is unserviceable is maintenance. Maintenance of equipment includes the following:

a. Service. To clean, to preserve, and to replenish fuel and lubricants.

b. Adjust. To regulate periodically to prevent malfunction.

c. Inspect. To verify serviceability and to detect pending mechanical failure scrutiny.

d. Test. To verify serviceability and to detect pending mechanical failure by use of special equipment, such as gages, meters, etc.

e. Replace. To substitute serviceable assemblies, subassemblies, and parts for unserviceable components.

f. Repair. To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes, but is not limited to, inspecting, cleaning, preserving, adjusting, replacing, welding, riveting, and straightening.

Preoperation services. The following services must be performed to determine whether the condition of the equipment has changed since it was last operated as well as to make sure the equipment is ready for operation. Any deficiencies must be corrected or reported to your supervisor before the unit is put into operation.

a. Leaks, general. The hoses, hose connections, tanks, and valves are visually inspected to determine if they are leaking.

b. Visual inspection of equipment. The hoses and filter unit are inspected for evidence of possible damage. The hoses should not be kinked. The raw water strainer should be clean and covered with water, and the tank guy ropes and supports should be secure.

During-operation services. You should report any unusual sounds or odors, deficiencies in performance, or other signs of abnormal operation:

a. Instruments. While the unit is being operated, you should watch the pressure gage on the filter unit. You also should test the water for chlorine residual.

b. Unusual operation and noises. It is necessary to watch for possible overflow of the slurry feed aparatus and tanks. If you notice that the pump motor is overheating, it is an indication that the filter run should be stopped. A surge of water into the storage tank and a rapid decrease in pressure on the gage indicates that the filter-aid cake has dropped off the elements.

After-operation services. After operating the equipment, and during halts, if only for short periods, you should make a general check of the equipment and correct or report any deficiencies you noted. The purpose of the after-operation service inspection is to make sure that the equipment is ready to operate at any future time. For the equipment to be ready for immediate operation, you must perform the following services at the end of any operating period of whatever duration:

a. Leaks, general. Inspect the hoses, hose connections, tanks, valves, and filter unit for leaks.

b. Visual inspection of equipment. You will find that it is necessary to backwash the filter when flow through the elements is stopped. Again, it is necessary to make sure that the raw water strainer is clean and submerged. In addition, the guy ropes and supports are inspected, the pump and engine sets are checked, and hoses are inspected to determine that there are no kinks in them.

c. Cleaning equipment. The settling tanks should be filled so that the water can settle overnight. The filter should be backwashed and the water drained from the filter shell. Mud and dirt should be removed from all equipment.

Exercises (E53):

In the spaces provided below, place a B for before-operation, a D for during-operation, and an A for after-operation services required on field purification units. Some of the operations may require more than one entry.

____ 1. Publications. See that a copy of TO 40W4–9–1, and the operator's manuals for the generator set and distribution pump are on or with the equipment and in serviceable condition.

____ 2. Visual inspection. Inspect for water, oil, and fuel leaks; loose or missing bolts, screws and nuts; loose wiring connections; and broken wires. Inspect for any damage that may have occurred since the equipment was last operated.

____ 3. Tires. If the trailer is to be operated, check the air pressure in the tires. Correct tire pressure is 45 psi.

____ 4. Supplies. See that the required maintenance and operating supplies are available.

____ 5. Fuel. Check the fuel supply in generator and distribution pump engines. Add fuel if necessary.

____ 6. Oil. Check the oil level in engine crankcases. Add oil if necessary.

____ 7. Brake hoses, light cable. If the trailer is to be operated see that the brake hoses and intervehicular electric cables are securely connected.

____ 8. Lubrication. Lubricate according to the instructions in TO 40W4–9–1.

____ 9. Lights and reflectors. If trailer is to be moved, check the lights after connecting to the towing vehicle. See that the lamps and reflectors are clean and serviceable.

TABLE 5–1
SERVICE AND INSPECTION REQUIREMENTS

Intervals: Before-operation	During-operation	After-operation	PROCEDURES
X	....	....	Publications. See that a copy of TO 40W4–9–1, and the operator's manuals for the generator set and distribution pump are on or with the equipment and in serviceable condition.
X	....	X	Visual inspection. Inspect for water, oil, and fuel leaks; loose or missing bolts, screws and nuts, loose wiring connections, and broken wires. Inspect for any damage that may have occurred since the equipment was last operated.
X	....	....	Tires. If the trailer is to be operated, check the air pressure in the tires. Correct tire pressure is 45 psi.
X	....	....	Supplies. See that the required maintenance and operating supplies are available.
X	....	X	Fuel. Check the fuel supply in generator and distribution pump engines. Add fuel if necessary.
X	....	X	Oil. Check the oil level in engine crankcases. Add oil if necessary.
X	....	....	Brake hoses, light cable. If the trailer is to be operated see that brake hoses and intervehicular electric cables are securely connected.
X	....	....	Lubrication. Lubricate in accordance with the instructions in TO 40W4–9–1.
X	....	....	Lights and reflectors. If trailer is to be moved, check the lights after connecting to the towing vehicle See that the lamps and reflectors are clean and serviceable.
X	....	....	Generator. See that the electric generator and distribution pump (if pump is to be used) are serviced and ready for operation. Refer to operator's manual. Start the generator and check to see if the water purification unit is receiving electric power.
X	....	....	Drain lines. See that all drain lines are securely connected and not damaged. Make sure the waste water is disposed of so it will not interfere with the operation of the unit.
X	....	....	Fire extinguisher. Check the fire extinguisher for insufficient charge by shaking it and judging by sound and weight if it is full. Do not discharge any of the contents. Check for corrosion and insecure mounting.
	X	....	Unusual noises or operations. Inspect the electric motors for overheating; usually indicated by smoke or odor. Inspect the speed reducer drive belt for slipping. Check for any unusual noise that may indicate a clogged strainer, strainer sucking air, or debris in the pump. A surge of filtered water into the storage tank indicates that the filteraid cake has dropped off the elements. Watch for overflow of storage tanks.
	X	....	Brakes. Any time the brakes are used, consider it a test and note unsatisfactory performance, such as not holding or grabbing.
	X	....	Leaks, water purification unit. Inspect hoses, connections, fabric tanks, pumps, piping, and pipe fittings for leaks.
		X	Tools and equipment. See that all tools and equipment assigned to the water purification unit are in serviceable condition, clean, and properly stowed or mounted.
X	....	X	Trailer body. Inspect the trailer body, racks, gates, and paulin for damage or missing hardware. See that the paulin is tied down securely.
		X	Clean equipment. Remove any oil, mud, grease, chemical, or other foreign matter from the external parts of the water purification unit with clean cloths. Use coagulated water for washing the trailer.
		X	Filters and tanks. Backwash the filters when flow through the elements has stopped. See that tank guy ropes and supports are secure and that tanks are covered.
		X	Water treatment equipment. Drain and clean the erdlator, slurry feeder, chemical solution feeder, filter, and all pumps and hoses.

C-ND-027

_____ 10. Generator. See that the electric generator and distribution pump (if pump is to be used) are serviced and ready for operation. Refer to operator's manual. Start the generator and check to see if the water purification unit is receiving electric power.

_____ 11. Drain lines. See that all drain lines are securely connected and not damaged. Make sure the waste water is disposed of so it will not interfere with the operation of the unit.

_____ 12. Fire extinguisher. Check the fire extinguisher for insufficient charge by shaking it and judging by sound and weight if it is full. Do not discharge any of the contents. Check for corrosion and insecure mounting.

_____ 13. Unusual noises or operations. Inspect the electric motors for overheating, usually indicated by smoke or odor. Inspect the speed reducer drive belt for slipping. Check for any unusual noise that may indicate a clogged strainer, strainer sucking air, or debris in the pump. A surge of filtered water into the storage tank indicates that the filter-aid cake has dropped off the elements. Watch for overflow of storage tanks.

_____ 14. Brakes. Any time the brakes are used, consider it a test and note unsatisfactory performance, such as not holding or grabbing.

_____ 15. Leaks, water purification unit. Inspect hoses, connections, fabric tanks, pumps, piping, and pipe fittings for leaks.

_____ 16. Tools and equipment. See that all tools and equipment assigned to the water purificaiton unit are in serviceable condition, clean, and properly stowed or mounted.

_____ 17. Trailer body. Inspect the trailer body, racks, gates, and paulin for damage or missing hardware. See that the paulin is tied down securely.

_____ 18. Clean equipment. Remove any oil, mud, grease, chemical, or other foreign matter from the external parts of the water purification unit with clean cloths. Use coagulated water for washing the trailer.

_____ 19. Filters and tanks. Backwash the filters when flow through the elements has stopped. See that tank guy ropes and supports are secure and that tanks are covered.

_____ 20. Water treatment equipment. Drain and clean the erdlator, slurry feeder, chemical solution feeder, filter, and all pumps and hoses.

E54. Identify the components of a water purification unit and specify the operation or function of each unit.

Operating the Equipment. It is essential that you know how to operate properly the equipment so that you can produce germ-free water that is pleasing to the taste. You will become proficient in operating the equipment as you work with specialists and technicians and accomplish all equipment operations required to purify water. We discuss, in general, the water treatment process. Look at figure 5-8 again so that you will be familiar with the arrangement of the equipment.

Chemical requirements. The following chemicals are required in the treatment and filtration processes.

- Ferric chloride as a coagulant.
- Calcium hypochlorite as a disinfectant.
- Pulverized limestone as a coagulant aid.
- Diatomaceous earth as a filter aid.
- Activated carbon as an absorber to control objectionable tastes and ordors.

The chemicals are mixed proportionally with water in according to an established base charge. The base charge is the concentration of mixture of solution expressed as the amount of chemical in a measured quantity of water prepared for the chemical feeder.

Water treatment process. The water treatment process reduces the organic and suspended matter of raw water to a minimum and produces coagulated water suitable for application to the diatomite filter. Raw water is pumped from its source by the raw water pump (2) through the aspirator nozzles to the influent launder from where it overflows into the downcomer or mixing zone (6) inside the erdlator tank (5). The aspirator nozzles aerate the water; process that improves the sludge formation. The flow of water to the influent launder is regulated by a control valve preset for a flow rate of 10 gallons per minute.

A coagulant (ferric chloride), a coagulant aid (pulverized limestone), a disinfecting agent for prechlorination (calcium hypochlorite solution), and, when necessary, an absorber for objectionable taste or odors (activated carbon) are added to the mixing zone. As the liquid descends through the mixing zone, it is mixed by the agitator. The flow is deflected by a series of shallow baffles in the bottom of the erdlator tank and directed in a counterrotating direction into the outer compartment of the clarification zone. The resulting rotation is reduced but it continues at a velocity sufficient to keep the slurry volume, together with the clear water above the slurry pool, rotating.

The slurry is hydraulically separated from the clean water in the upper cylindrical section of the erdlator tank in what is termed "the separator zone." The slurry level is controlled by a continuous withdrawal of a small amount of slurry from the top of the slurry pool, through the slurry weir box to the sludge concentration tank (7).

Clear water is collected at the water surface in the effluent launder, which acts as a double-edged weir. The effluent launder is adjusted manually by the leveling rods to permit leveling and skimming of the water surface. The clear water is discharged across the slurry pool to the wet well tank (8) through the effluent launder tube. The wet well tank provides limited storage of coagulated water and serves as a sump for the filter pump.

An overflow pipe in the wet well tank permits operation of the erdlator at rated capacity when the filter is stopped. A switch, operated by a float in the wet well, activates an alarm bell and a red signal light when the float valve is open. The float valve is activated through a lever connected to the float located in the wet well tank. This float valve allows additional raw water to enter the system whenever the amount of water in the wet well falls below a preset level. A drain in the bottom of the wet well tank permits complete drainage of the tank to waste when water unsuited for filtering is obtained from the erdlator tank.

The flocculent slurry flows by gravity from the erdlator tank to the sludge concentrator tank (7). The sludge concentrator tank functions as a small auxiliary clarifier. It provides a longer holding period for slurry concentration and reduces the water-rise rate for separation of clear water from the slurry. The sludge concentrator tank permits settling of slurry in the bottom of the tank for continuous or intermittent drainage to waste. It also permits the skimming of clear coagulated water from the top of the tank for return to the wet well from which it is pumped to the filter. The drainage of slurry to waste and the return flow to the wet well is manually controlled, depending on the amount of slurry produced in the erdlator tank.

The chemical solution feeder (4) pumps ferric chloride and calcium hypochlorite solutions into the downcomer or mixing zone (6). Remember that ferric chloride is used as a coagulant and calcium hypochlorite is used as a disinfectant. The pump's discharge rate is adjustable, butthe pump delivers a fixed, constant rate of feed with each pump stroke at any one setting.

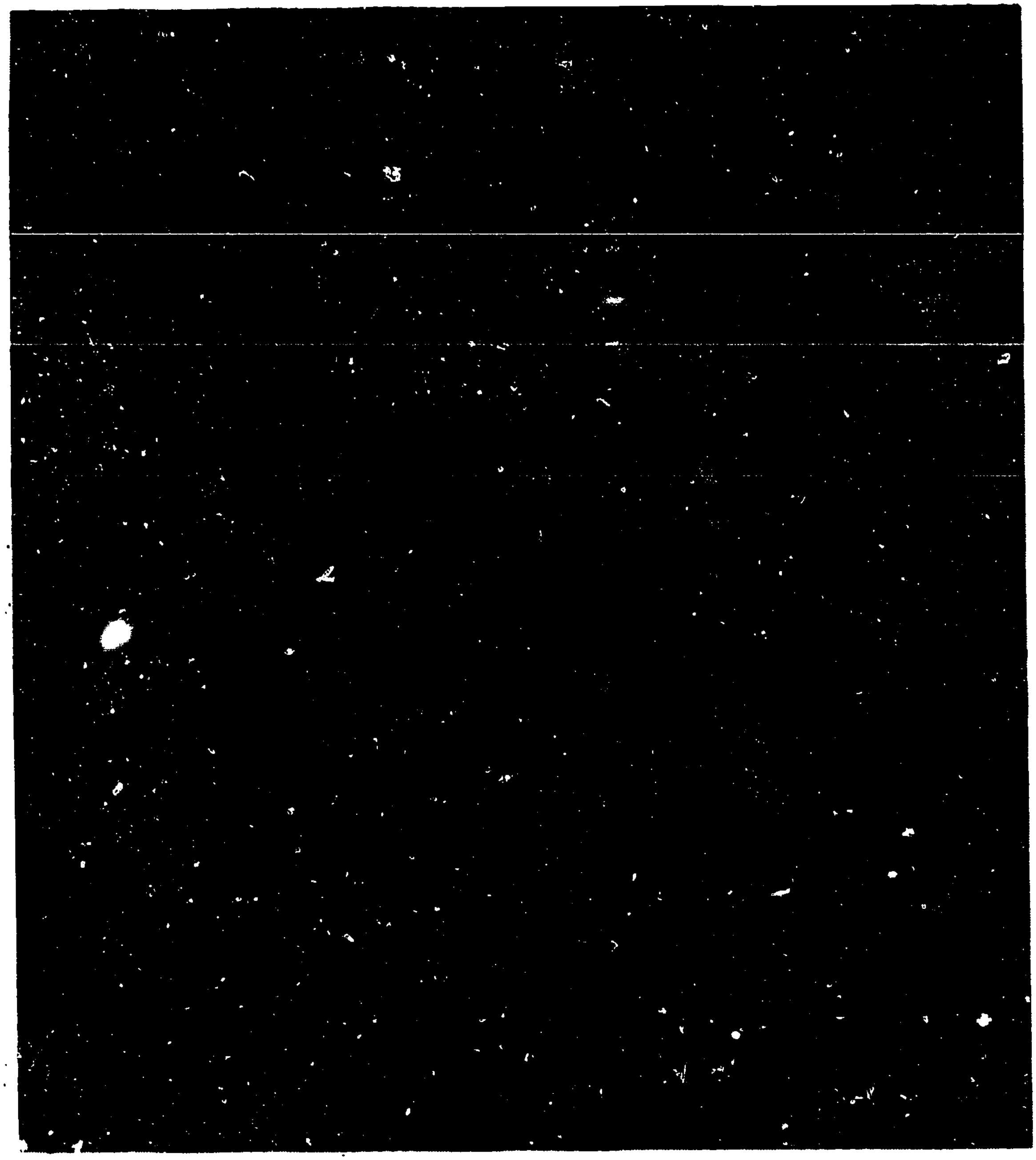
The chemical slurry feeder limestone compartment supplies pulverized limestone (coagulant aid) to the mixing zone of the erdlator tank. Raw water is continuously added to a collector trough on the back of the compartment. A portion of this water flows through a constant head-fixed orifice into the limestone slurry compartment, and the remainder overflows to a weir for dilution of the slurry discharge from the feeder. This diluted slurry flows by gravity into the downcomer. The limestone slurry is kept in suspension by introducing air at the bottom of the tank. The feeder operates on a dilution principle whereby 65 percent of the initial charge of slurry is fed during a 1-hour period; therefore, the feeder requires recharging with dry chemical every hour. The limestone compartment remains full of liquid slurry but becomes more diluted during the hour until recharged with the dry chemical.

Filtering process. The filtering process further reduces suspended matter by use of diatomaceous earth filter aid. The filtering process consists of precoating, filtering, and backwashing. Before the water can be filtered, it is necessary to precoat the filter elements with diatomaceous earth. To precoat the filter, you add diatomaceous earth slurry to the coagulated waterline through the precoat funnel (1, fig. 5-9) and valve CV 2.

The coagulated water is pumped from the wet well tank through the filter influent control valve (which is in the FILTER position) into the influent of the filter. The influent control valve is not shown. The water rises in the filter until it starts escaping through the control valve (3, fig. 5-9), which must now be closed. Air is trapped and compressed in each of the plastic cups of the filter elements and in the dome of the filter housing cover. The air is prevented from escaping through the air release (7) valve, on top of the cover, because it is closed in the FILTER position. As the water is filtered through the element membranes, the diatomaceous earth and suspended matter are deposited on the elements. After the water is filtered, it enters the effluent section of the filter through the two pipes from each element. The water then goes through the filter effluent control valve (5, fig. 5-9), which is in RECIRCULATE position, and back to the wet well tank. The water is recirculated through the filter until it appears clear when viewed through the filter window (4).

Filtering removes the remaining suspended matter and organisms from the coagulated water. The flow of water from the wet well and through the filter is the same as during precoating, until it reaches the filter effluent control valve. During filtering, the filter effluent control valve is in FILTER position to allow the water to flow through the filtered water hose to the storage tanks. Diatomite slurry is discharged from the diatomite slurry compartment of the chemical slurry feeder to the coagulated waterline at the suction side of the filter pump. The flow of coagulated water carries the diatomite slurry to the filter, where it is deposited on the filter elements. The continuous feed of diatomite slurry maintains the porosity of the filter cake and permits longer filter runs. As coagulated water is pumped through the filter cake, the suspended matter will gradually plugs the filter cake and increases the pressure differential across the filter elements. When the effluent pressure gage (6, fig. 5-9) indicates a pressure of 5 psi, the filter is ready to be backwashed. The filter cycle is the length of time the filter is in operation, from the time the precoat has been added, until the filter elements must be backwashed.

The filter elements are backwashed to remove accumulated suspended matter and the filter-aid cake whenever the filter run is stopped. The elements must also be backwashed (and the filter shell drained) at the end of each day's operation so that any contamination and organisms are removed quickly and not allowed to multiply. When the air release valve is placed in the BACKWASH position, it allows some of the air compressed in the dome of the filter housing cover to bypass the main air valve. This action opens a valve releasing the air in the dome to the atmosphere. The sudden release of air allows the air compressed in the cups in each element to expand and force water back thorugh the element filter cake. The rapid reversal of the water usually dislodges all the suspended matter from the elements. If it does not, the elements must be removed and cleaned. Most of the removed suspended matter and the water in the influent section will drain to waste through the filter drain valve (8). However, some of the suspended matter will settle on the conical bottom of the influent pipe and must be washed away. When the filter



1. PRECOAT FUNNEL
2. CONTROL VALVE
3. CONTROL VALVE
4. FILTER WINDOW
5. FILTER EFFLUENT CONTROL VALVE
6. EFFLUENT PRESSURE GAGE
7. AIR RELEASE VALVE
8. FILTER DRAIN VALVE
9. INFLUENT PRESSURE GAGE

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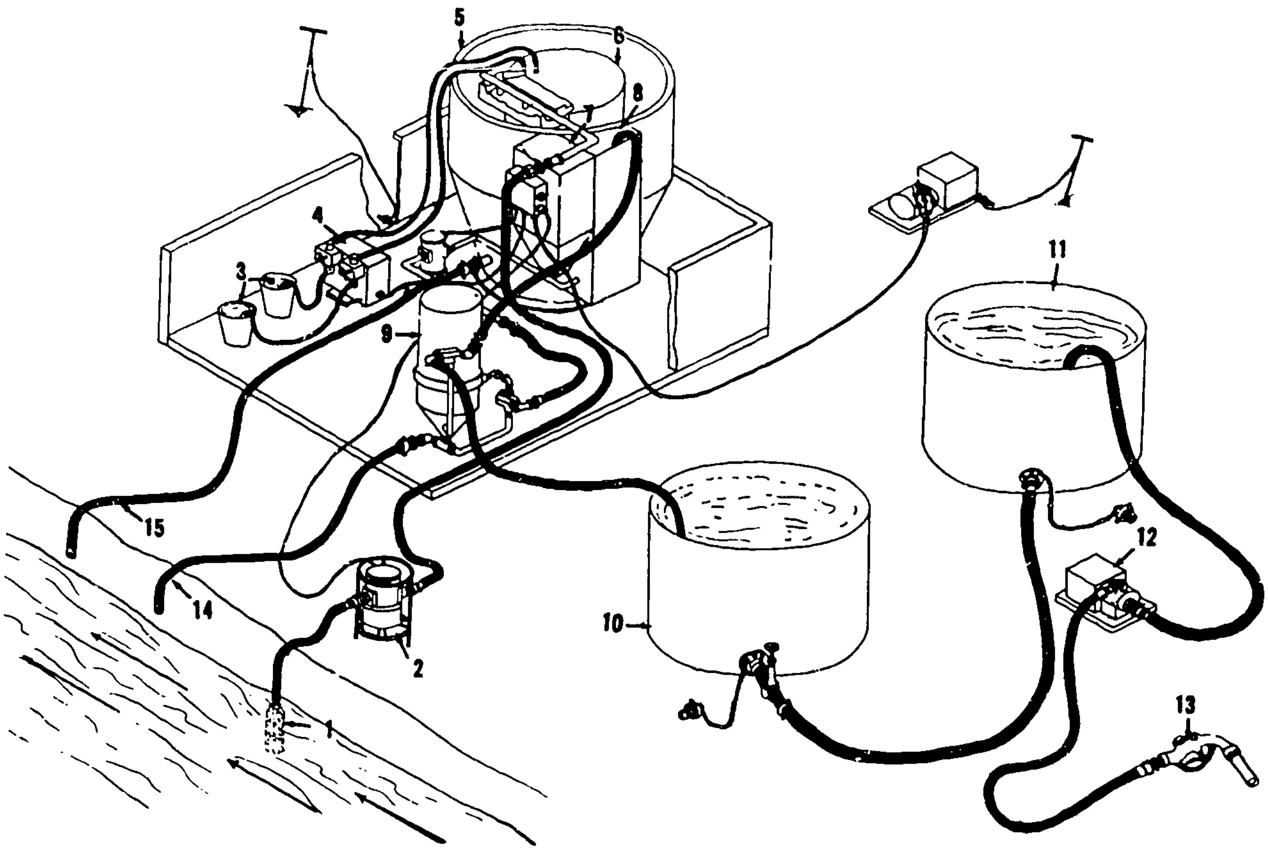
Figure 5–9. Filter.

influent control valve is in WASH position, it allows the water to enter the wash ring and wash the sediment from the bottom of the filter. After washing, the filter is ready for precoating.

Exercises (E54):

1. On the diagram below (fig. 5-10), label each numbered unit.



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
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9. ______________________
10. ______________________
11. ______________________
12. ______________________
13. ______________________
14. ______________________
15. ______________________

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Figure 5–10. Objective E59, exericse 1.

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2. Write a brief statement to describe the operation or function of each unit labeled on the diagram above.

E55. Identify safety precautions that specifically apply to the operation of the field purification unit.

Safety Precautions. Under average conditions, there are not many hazards to cope with while operating this unit. However, you will be called on to operate this unit in emergencies and during unusual operating conditions. Therefore, you are cautioned to be guided by the fundamental rules of safety. A good operator is the best assurance against accidents. The following safety precautions are general in nature for most types of operation.

a. Use care in selecting a raw water source. Avoid water adjacent to a latrine, sewer outlet, bathing area, oily area, refuse pile, or camp drainage area.

b. Keep chemicals away from the eyes. Be careful when opening the chemical containers. Keep your head turned so that chemical dust will not fly up into your eyes. Wash your hands thoroughly with soap and water after handling chemicals.

c. Never mix the two chemicals (calcium hypochlorite and ferric chloride), because the mixture gives off a greenish-yellow chlorine gas which is irritating, disagreeable, and has a suffocating odor.

d. Keep raw water away from hands and clothing as much as possible. The raw water may contain pathogenic organisms that will enter the body through the pores, or through skin abrasions, causing bacteriological infection. Infection may also result unless the same precautions are taken when working with the erdlator or sludge concentrator.

e. Do not place your hands in the erdlator tank or in the sludge concentrator tank during operation.

f. Keep storage tanks covered to prevent entry of debris, rain, or foreign matter that may contaminate the water.

g. Never add unfiltered water to the filtered water storage tank. Before any water is distributed to personnel, it must be chlorinated.

h. Do not use raw water, gasoline, or oil to wash the water purification equipment. When backwashing, always use filtered water; clean up all spilled water and chemicals immediately.

i. Before connecting to the external power source, be certain that all power controlling switches have been set in the OFF position. Never handle "live" electric wiring. High voltage may cause serious injury or death.

j. Never work on electrical equipment unless the power controlling switches are in the OFF position and the power cables disconnected.

k. Never operate ungrounded equipment.

Exercise (E55):

1. From the list of safety precautions below select those that apply specifically to the operation of the field purification unit. Place a checkmark by applicable statements.

____ (1) Use care in selecting raw water source.
____ (2) Watch your step or ladders.
____ (3) Keep chemicals away from eyes.
____ (4) Never mix calcium hypochlorite and ferric chloride.
____ (5) Never pour water into acid.
____ (6) Keep raw water away from hands and clothing as much as possible.
____ (7) Keep trailer tires inflated to the proper pressure.
____ (8) Do not place your hands in erdlator tank or sludge concentrator tank while operating.
____ (9) Keep vehicle lights in good working order.
____ (10) Keep storage tanks covered.
____ (11) Never add unfiltered water to filtered water.
____ (12) Do not wash equipment with gasoline or unfiltered water.
____ (13) Make sure all power switches are off before connecting power to unit.
____ (14) Never handle live electric wiring.
____ (15) Never operate ungrounded equipment.

Vehicle Operation

AN IMPORTANT part of your contingency duties is the operation of a number of vehicles in the Air Force inventory. Some of these vehicles are utility trucks, cargo trucks of 1 to 2½ ton capacity, dump trucks, tractor/trailers, forklifts, water distributors, front-end loaders, and farm tractors.

This chapter will acquaint you with these vehicles and their operation. You will receive hands-on training in any vehicle you will be required to operate at your normal duty assignment.

6-1. Utility and Dump Trucks

Utility trucks are pickups, stake and platform, and other general-purpose trucks. In the CONUS, most of these trucks are commercial trucks because they are less expensive than military design vehicles (M-series). In some places overseas, they, or at least part of them, are military design vehicles. Because of their construction they are more expensive. They have all-wheel drive for off-road operation and are built to withstand more rugged treatment. Dump trucks are used primarily to haul loose material, such as dirt, sand, gravel, crushed rock, etc. They are used to transport such material to the construction site, especially when the haul distance is great. They are always used to haul asphalt. The Air Force has both M-series and commerical dump trucks, but most of them are commerical dump trucks.

E56. Complete given statements pertaining to the use of utility and dump trucks.

Pickups. Pickups are one of the most widely used vehicles within CE for hauling small amounts of light materials. They are also widely used to transport personnel to and from jobs and as transportation for supervisors to keep check on work progress.

You can haul most anything that is small and weighs less than 1500 pounds in a pickup. However, be careful about hauling such materials as long pipe and long lumber in a pickup. Each state has specific laws concerning how far the load can project beyond the truck bed. Therefore, when you are using state highways, your load should conform to these laws. You should haul such materials as 12-foot lumber and long lengths of pipe on a truck with a long bed. Also, you should haul such materials as dirt, sand, gravel, and cement in a truck larger than a pickup unless you keep the amounts small. The weight carrying capacity of a pickup is 1000 to 1500 pounds on good roads and 500 to 700 pounds on bad roads or off the road. For the specific weight carrying capacity of a pickup, check the data plate riveted to the dash.

Let's say that you have 20 bags of cement (94-pound bags) to haul 3 miles on good roads from a storage point to where they are to be used. What should you do? Get a larger truck if one is readily available. If not, haul one-half of the cement in each of two loads.

One-Ton to 2½-Ton Trucks. You should use these trucks to haul medium loads. Such materials as large timers, kegs of nails, cement, reinforcing rods, prefabricated concrete, and concrete forms are examples of materials hauled on these trucks. What you haul, however, is not nearly so important as how you haul it. Suppose, for example, you are to haul some cement that is stacked on pallets. Each pallet has 20 bags of cement on it. To haul one pallet (1880 pounds) on a 1-ton stake and platform truck, you should remove the sideboards and use a forklift to set the pallet directly over the rear wheels. To haul two pallets on a 1½-ton stake and platform, you should set one pallet fore and one aft of the rear wheels. In other words, always distribute the load properly over the truck bed—neither too far forward nor too far rearward. If you put the load too near the front, the load will put a strain on the front wheels and cause the truck to be hard to steer. If you put the load too near the rear, the load will raise the front wheels slightly and you will lose some steering control. Again, it is important to consult the data plate. It shows the empty vehicle weight, the gross vehicle weight, and the net or maximum payload. The plate may also show the off-the-road payload and the on-the-road payload. In addition to distributing and sizing a payload by weight, you should size it by dimensions and tie it when necessary. Let's consider hauling some prefabricated concrete forms for example. If you were to haul 8-foot by 12-foot forms on an M-series cargo truck, you should lay them flat inside the cargo bed. The bed should allow the forms to lay flat. The bed has sidewalls about 18 inches high. If you haul enough forms to rise above the sidewalls, install the removable sideboards after you load the forms, or securely tie the forms. In some cases, you can use stakes in the holes where the sideboards fit instead of the sideboards themselves. Stakes are especially useful when you have to make several loads. If you choose to tie the forms, run the ropes completely around the bed and forms in two or three places. Pull the ropes tight and tie them securely.

Let's say that you are going to haul some 10-foot by 10-foot forms on a stake and platform truck that has an 8-foot by 12-foot bed. You should remove the sideboards and load the forms. Tie the forms with rope. Be very careful while driving from the loading to the unloading point. If you have to drive through an area of heavy traffic, get a Security Police escort. Why all this caution? Because your load is wider than your truck bed.

Dump Trucks. The difference between a truck that will dump and one that will not dump is the way it is equipped. This equipment includes a dump box, or body; a power take off (PTO); and a hydraulic pump and cylinder. The cylinder is similar to a large hydraulic jack supported on frame members under the dump box.

There are two levers in the floor of the truck cab, just to the right of the gear selector lever, for controlling the raising and lowering of the dump box. Let's call these lever A and lever B. Lever A is the PTO lever, and B is the hydraulic control lever. A is the one nearer the transmission gear selector lever. It has two positions, neutral and engaged. Forward is neutral, and back toward the seat is engaged. Lever B has three positions: forward to raise the dump box, center to hold the dump box, and back toward the seat to lower the dump box.

You have to push the clutch pedal down to engage the PTO with lever A. However, lever B positions can be changed without pushing the clutch in. A word of caution here: pull lever B back slowly. If you pull it back too fast, with a load, or part of a load, the dump box will come down too fast. If you keep doing this, you will eventually damage the truck.

Let's look at figure 6-1. As far as we are concerned, this rear view of the truck is the "business end" where we carry our payload. This is the part that dumps the load. Wouldn't you hate to unload it with a hand shovel? Figure 6-1 shows the chains on the tailgate and the way they are adjusted to spread gravel. Adjusting the tailgate opening allows gravel to be spread in layers instead of being dumped in piles. The small hook on the rear corner of the dump bed is the tailgate latch. There is another one on the other rear corner. These latches hold the tailgate closed when the lever on the left-front corner of the bed is pushed up. Always push this lever up and latch the tail gate before you leave the dump area. If you don't, you may forget to latch it until after the truck is loaded. If this happens, you will have to shovel part of the load out of the way so that you can latch the tailgate.

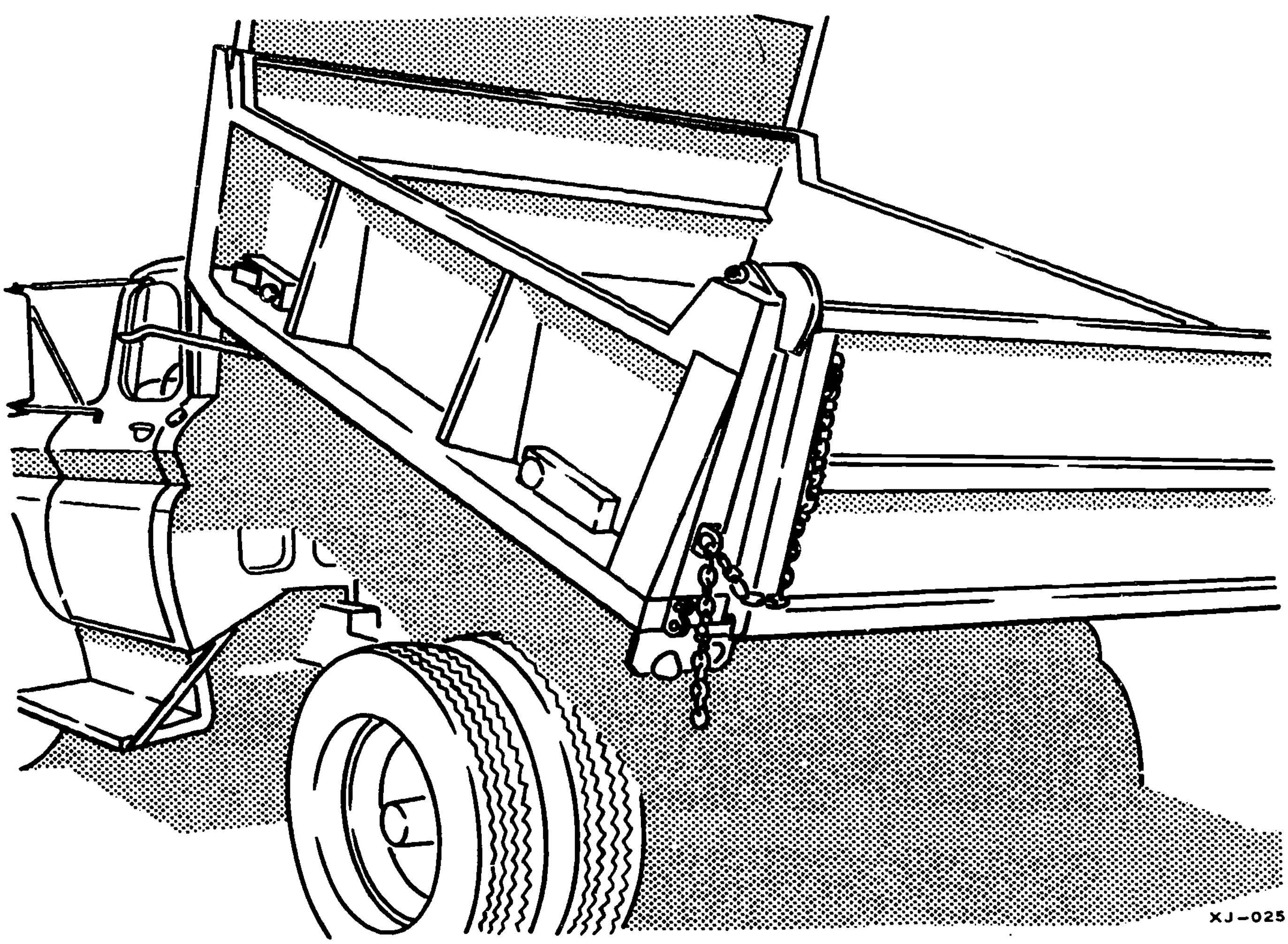


Figure 6-1. Dump truck with tailgate adjusted to spread load.

Exercises (E56):

1. A pickup can carry loads of how many pounds when operating on bad roads?

2. To determine the weight carrying capacity of a pickup, what should you do?

3. To engage the PTO on a dump truck what must you do?

4. The mechanism that raises the box of a dump truck is similar to a what?

6-2. Truck Tractors and Semitrailers

Truck tractors and semitrailers are commonly referred to as tractors and trailers. Because their operation varies considerably from other equipment, we will cover them seperately in this section.

E57. Specify the structure and operation of tractors and trailers.

Tractors and Trailers. A tractor and a trailer are separate units joined together by a fifth wheel. The fifth wheel consists of two metal plates, one on the tractor, as shown in figure 6-2,A, and one on the trailer, as shown in figure 6-2,B. The upper fifth wheel and the lower fifth wheel form a flexible coupling which permits both rotational and vertical movement between the tractor and trailer. The upper fifth wheel has a kingpin. The lower fifth wheel has locking jaws that lock around the kingpin to couple the tractor and trailer together. When not attached to the tractor, the front end of the trailer is supported by a retractable two-legged landing gear. The landing gear may be equipped with either wheels or pads (flat pieces of heavy metal).

Tractors normally range in size from 2½ to 10 tons. Each tractor has a data plate attached to the dash. Refer to the data plate to determine the load capacity of the tractor.

Trailers range from about 18 to 40 feet long and from about 8 to 10 feet wide. There are several types of trailers, but the ones you are interested in are general cargo and equipment trailers. Cargo and equipment trailers look much the same. The major differences are that equipment trailers (commonly called lowboys) are lower (about 3 feet high) and stronger. Both types have data plates that you can look at to determine their load capacity.

Coupling and Uncoupling the Tractor and Trailer. Let's go through the procedure of coupling a tractor and

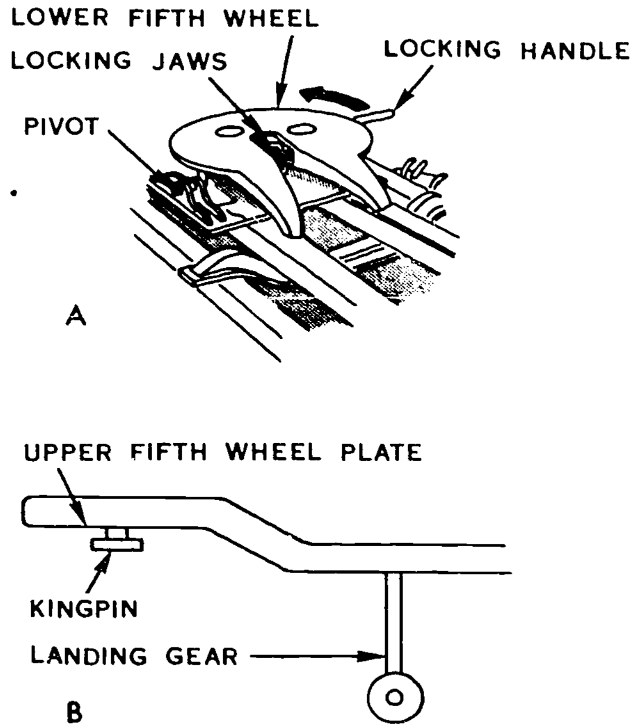


Figure 6-2. Fifth wheel (upper and lower).

trailer together. The procedures are the same for cargo and lowboy trailers. Block the trailer wheels with woodblocks. Position the tractor ahead of, and in line with, the trailer. Back the tractor slowly to the nose of the trailer. Make sure that the kingpin is in line with the locking jaws. Just before the upper fifth wheel starts to ride over the lower fifth wheel, stop the tractor. Check the height of the trailer fifth wheel to insure that it is in the proper height to align with the tractor fifth wheel. If not, raise or lower the front end of the trailer by raising or lowering the landing gear.

Connect the brake lines of the tractor to the trailer. The coupling of the tractor line marked "SERVICE" must be connected to the coupling having a like tag on the trailer. This is also essential in connecting the emergency line. If you connect the airbrake lines properly, they will be crossed. Open the shutoff valves on the tractor air lines. (On some new commercial tractors, you change the position of a switch in the tractor cab to turn the air on or off.) Then, lock the trailer brakes by applying the steering column brake lever in the tractor cab. This helps to prevent the trailer from moving when the tractor is backed under it.

Be sure that the lower fifth wheel locking handle is in the OPEN position. Normally, this is insured by pulling the handle forward until it is approximately 45° from the centerline of the tractor. Back the tractor until the fifth wheel picks up the front of the trailer and the landing gear wheels are off the ground. Back the tractor under the trailer with a fast and forceful motion until the jaws of the lower fifth wheel automatically lock around the kingpin on the trailer. This will throw the lower fifth wheel locking handle into the CLOSED position. Make certain that the coupling is secure by trying to pull the tractor forward with the trailer brakes set.

Insert the electric jumper cable into the receptacle on the trailer and secure it in position. Operate the lights from the towing vehicle to make certain that all are in working order. Remove the chock blocks. Release the landing gear crank from its clip. This crank is usually located underneath the edge of the trailer near the landing gear. Engage the crank and rotate it to raise the landing gear. Raise the landing gear as high as possible to afford maximum clearance. Place the crank back in its clip.

Before we move on to operating a tractor and trailer, let's go through the procedure of uncoupling them. Block the wheels on both sides of the trailer. If you park on an upgrade, place the blocks behind the wheels; if you park on a downgrade, place them in front of the wheels. Close the shutoff valves on the brake lines at the rear of the tractor. Uncouple the shutoff valves on the brake lines at the rear of the tractor. Uncouple the airbrake lines from the couplings on the nose of the trailer. The trailer brakes will set automatically when the emergency air line is uncoupled. Disconnect the electric jumper cable from the receptacle on the nose of the trailer. Remove the landing gear operating crank from its clip and engage it on its shaft. Turn the crank to lower the landing gear feet until they contact the ground. Replace the crank in its clip.

Place the lower fifth wheel handle in the OPEN position. Drive the tractor forward until the semitrailer is free and rests on the landing gear. Take it easy and pull the tractor out slowly. This prevents dropping the weight of the trailer suddenly on the landing gear if it is not in full contact with the ground.

Operation. Operation of the tractor and trailer is much more difficult than that for most other vehicles. You must make allowances for the added length when turning, backing, and passing other vehicles. You must also consider space for maneuvering this larger unit into position for loading and unloading. There are special techniques for turning, backing, and stopping the tractor and trailer combination.

When you make a turn with the tractor and trailer, you must allow for the overall length of the unit. Also, keep in mind that this unit is "hinged" in the middle and the trailer has a tendency to cut the corners rather than follow the tractor. For this reason, it is necessary to make a wider turn than when you are turning with a straight truck. However, on a right turn, keep the unit close enough to the road edge to keep a following vehicle from making an attempt to pass on the right. (CAUTION: It is extremely important that the turn signals be turned on well in advance of starting the turn. This will warn other drivers that a turn will be made and allow them to drive accordingly.) When preparing for the turn, pull straight ahead into the intersection and continue until you can make the turn without the trailer wheels running over the curb or off the road on the inside corner.

When you back a tractor-trailer combination, reverse the procedures you use to back a straight truck. For example, if you want the trailer to go to the left, turn the steering wheel to the right. After the trailer is headed in the desired direction, turn the steering wheel slowly to the left. This puts the tractor in the same line of travel as the trailer and prevents the tractor and trailer from jackknifing. (The term "jackknife" means a condition where the tractor and trailer become jammed together at an acute angle.) Backing the trailer to the left is known as *"sight side"* backing and is the method recommended whenever possible. When backing to the left, you have a better view of the area into which you are backing, as you can see in figure 6-3.

Reverse these procedures to back a trailer to the right. This is called *"blind side"* backing and should be done only when it is absolutely necessary. As you can see in figure 6-4, you cannot see the rear of your trailer or the area into which you are backing. For this reason, a guide is mandatory for blind side backing.

In normal operation, apply the brakes of the tractor and those of the trailer simultaneously. This is done with the tractor brake pedal which controls both the tractor and trailer brakes. This procedure is not recommended when driving on steep grades or slippery surfaces. The safest way to stop a tractor on slippery roads or steep grades is to apply the trailer brakes first. Then apply the tractor brakes. This procedure reduces the possibility of the trailer jackknifing or swinging out of the line of travel. You apply the trailer brakes independently of the tractor brakes with a lever mounted on the steering column. Be careful not to pull the lever too far and lock the trailer wheels. Do not use the trailer brakes for parking.

Exercises (E57):

1. If the airbrake lines are properly connected they will be ________ .

2. What is the range in size for tractors?

3. On which fifth wheel are the locking jaws?

4. What is the first step in the uncoupling procedure?

6-3. Load Distribution

Each vehicle is designed to carry a maximum load. In carrying this load, the truck has a front suspension system (axle, springs, wheels, etc.) and a similar rear suspension system, each of which is designed to carry a certain

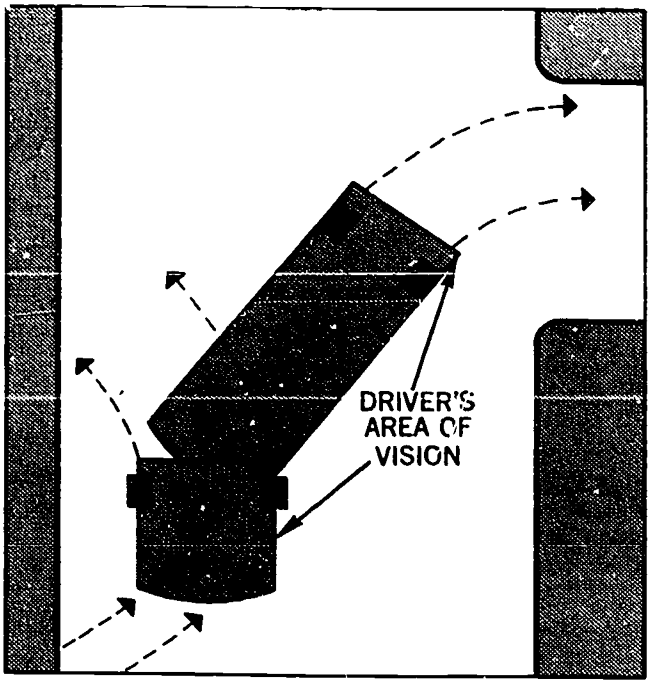


Figure 6–3. Backing trailer left (sight side).

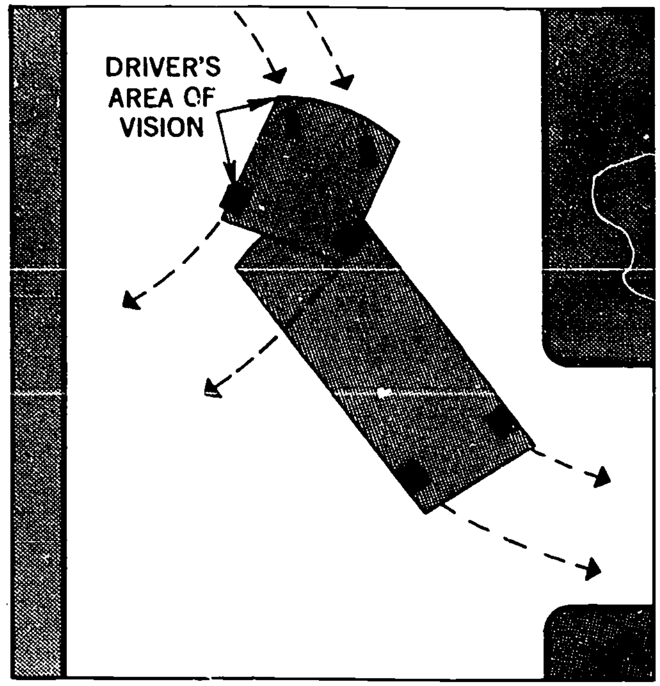


Figure 6–4. Backing trailer right (blind side).

maximum load. It is important that you adhere to these load limits when loading and unloading the vehicle.

E58. State how load distribution affects truck operation.

Manufacturer's Specifications. Suppose, for example, we consider a 1-ton truck. Let's say the truck is to be operated on smooth roads and the manufacturer's specifications read as follows.

a. Empty truck:
(1) Weight 4500 lbs.
(2) Front axle 2500 lbs.
(3) Rear axle 2000 lbs.
b. Maximum load 3000 lbs.
c. Maximum gross weight 7500 lbs:
(1) Front axle (maximum) 3000 lbs.
(2) Rear axle (maximum) 4500 lbs.

(NOTE: Weights shown are not that of an actual truck. They are, however, reasonable values that have been selected to simplify calculations.)

Load Placement. Suppose we have 32 bags of cement at 94 pounds each to haul to the job site. Also, let's say the cement is stacked on two pallets (16 bags per pallet). Now, if both pallets are loaded on the front of the truck bed, the front axle will be overloaded. If they are placed on the back of the bed, the rear axle will be overloaded. Such loading will place excessive strain on the frame and respective suspension system (axle, springs, shocks, wheels, wheel bearings, and tires) and, the steering will be affected by improper load placement. Thus, to avoid such a condition, you should insure that the load is distributed so that each axle carries only its share of the load. When operated as such, the truck will have proper balance, good vision, and normal steering characteristics. Suspension parts will have a normal lifespan and the truck can be operated safely.

Balance. You may recall from your childhood days some experiences on the seesaw (see fig. 6-5). As you can see, the board is supported by a bar. The length of the board extending on either side of the bar can be adjusted. This adjustment provision can be used to compensate for children of different weights.

Detail A of figure 6-5 shows a balanced condition. Why? To answer this we must understand some basic properties of balance. Then we will extend these properties to your vehicle, the truck. The seesaw is balanced because the two weights are equal and their distances from the supporting beam are equal. Let's apply some simple arithmetic to analyze this balanced condition. First, let's consider the left side of the seesaw. The force applied is the product of weight and distance. Distance, in this case, is measured from the center of the supporting beam. Such distance is commonly referred to as a moment arm. The moment ($75 \times 100 = 7500$ inch-pounds) is a force that tries to rotate the left end of the board downward about the pivotal point (beam) as shown in detail B. This force, as you can see, is opposed by an equal force trying to rotate the right end of the board downward about the same pivotal point. The two opposing forces are equal; consequently, the board is balanced.

The mathematical analysis is somewhat involved. You will be expected to perform only limited calculations as a 5 level airman. As you progress up the career ladder to the 7 level, however, you should have a better understanding of load placement and its effect on the truck operation.

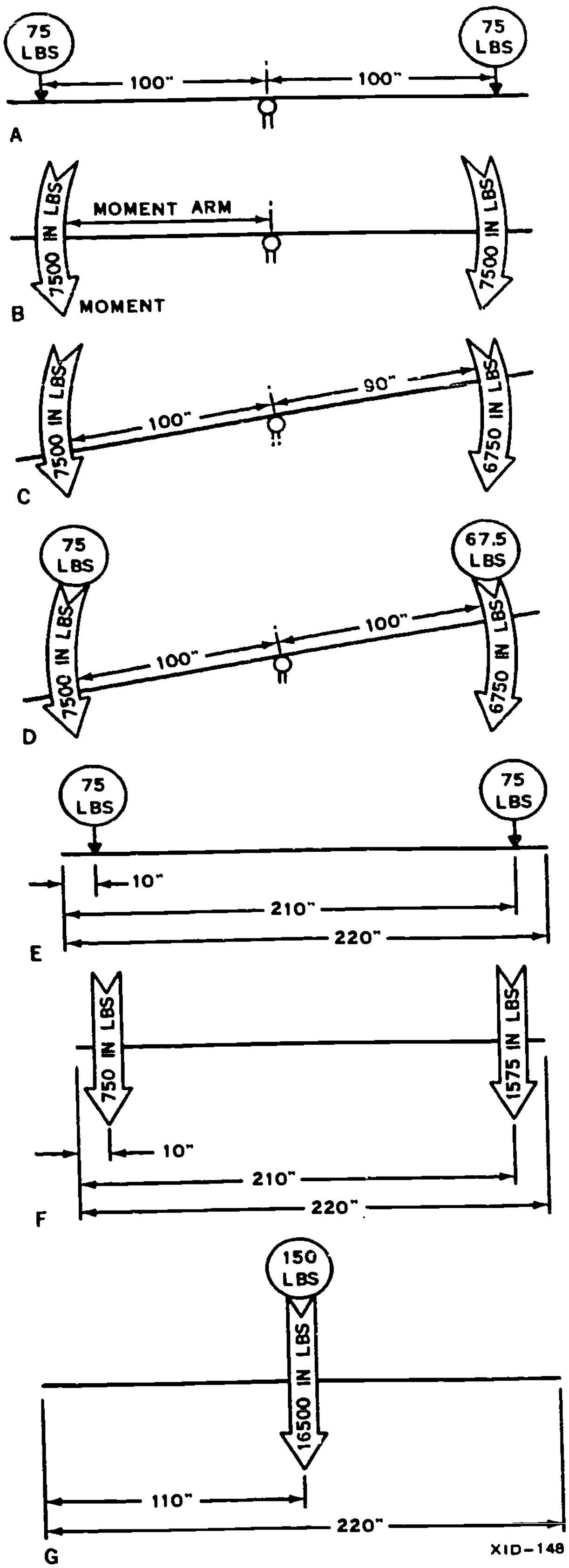


Figure 6-5. Seesaw board.

A serious accident could result from improper loading. For example, suppose you are driving a truck that has a heavy load on the back of the truck bed. Further, suppose you encounter rain and turbulent winds on an asphalt road. As you probably know, this type of road can become very slick when wet. Let's suppose you approach a familiar turn at a speed that would be slow under ordinary conditions. However, the light load on the front tires, slick and wet pavement, and turbulent winds could cause loss of control in the turn. The vehicle could veer off the pavement and overturn. The results could be severe damage to the truck and possible loss of life—your life!

Exercises (E58):

1. When a truck is overloaded to the rear, how does it affect steering characteristics?

2. What determines which portion of the load is to be carried by each axle?

6-4. Rough Terrain Forklifts

During contingency operations the movement and handling of materials and equipment is often difficult because of the unimproved surfaces where these operations take place. Because of this, the material handling equipment (MHE) must be specially designed to operate over these surfaces. The rough terrain (RT) forklifts in the Air Force inventory are designed for this specific purpose.

E59. State how to use rough terrain forklifts.

Rough Terrain Forklift Attachments. The rough terrain forklift used by the Air Force is a multi-purpose piece of equipment. By removing or adding attachments it can be used as a forklift, dozer, scraper, scoop shovel or front-end loader. Two experienced technicians can remove the bucket and install the forklift mechanism in about 4 hours.

Operation. To load material stacked on pallets, approach the pallet and check the forks to make sure that they are far enough apart to insure stability. Pull forward and slide the forks under the pallet. Tilt back and raise the forks. If you are stacking material, raise the load to the proper level, tilt forward, and place the load in position and back out slowly. As you back out, check the forks for clearance.

To load material not on pallets, depending on the shape of the object to be moved, you can first tilt the forks forward and try to slide the forks under the load, or you can raise one end of the load and block it and then raise and block the other end. Four by fours make ideal blocks. After you have the load blocked, you can then slide the forks under the center of the load. Before you lift the load, you should tilt the forks back to prevent the load from tipping forward. When transporting a load, raise it just high enough to clear the ground. To insure stability, travel slowly, avoid sharp turns, and do not attempt to stop suddenly.

Hauling Construction Materials. Let's say that you are going to haul a large quantity of prefabricated airfield landing mats. The mats are 12 feet long and 2 feet wide. There are 12 mats per bundle. Let's assume that you are going to use a forklift to load and unload the mats, because it is the most likely piece of equipment to use.

Place the trailer beside the mats. Leave enough room between the trailer and stack of mats to allow forklift working space. Place 4 x 4s, or other suitable blocking, across the trailer floor. Set the mats on the 4 x 4s. If the forklift will reach far enough, you can load from one side. If not, load from the middle out on each side. After you get the first tier loaded, place 4 x 4s on top of it and load another tier. Load as many mats as the tractor and trailer will haul without overloading. Check the data plates for the maximum load. When you have the vehicle loaded, place two chains across each row of mats. Tie the chains securely and tighten them with load binders.

Load binders are chain tightening [illegible] that are made of iron with swivels, two chain hoo[illegible], and a lever, as shown in figure 6-6. You hook one binder hook on the chain near the trailer and the other higher up and tighten the chain by pulling the lever down. The lever will stay in place as long as the chain is tight. To release the load binder, push the lever up and away from the chain.

After you drive from the loading point to the unloading point, park the tractor and trailer so that there is sufficient forklift working room. Release the load binders and remove the chains. Place 4 x 4s on the ground where you are to stack the mats. The 4 x 4s will serve three purposes: they will allow the forklift forks to slip out easily, keep the mats out of mud and water in wet weather, and allow forklift forks to be easily slipped under the mats in the future. You may use the 4 x 4s that are under the mats on the truck. This example is only one type of construction material that you may haul. With minor variations in the procedure, you can haul most types of construction materials in the same manner.

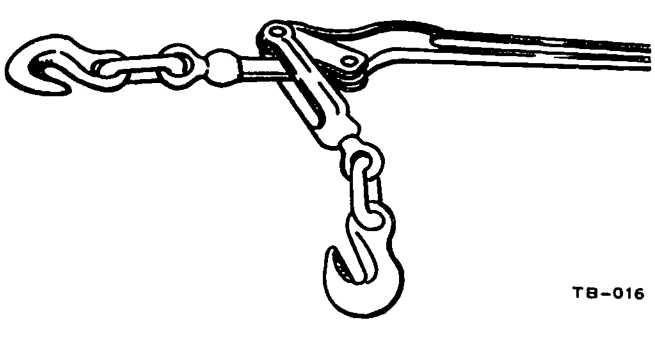


Figure 6-6. Load binder.

Exercises (E59):

1. How far apart must the forks be?

2. Chains are tightened by the use of what device?

3. A front-end loader may be converted to a forklift in approximately how many hours?

6-5. Front-End Loaders

The front-end loader is a self-contained unit. It can be mounted on pneumatic wheels or on tracks. Since you are more apt to operate wheel-mounted loaders than track-mounted units, we will concentrate on this type. Because of the different types of attachments that can be mounted on the loader, such as a traction-type bucket or a forklift mechanism, it is a very versatile machine. Its versatility is further enhanced by its ability to operate over rough terrain. You can see why it is a very important piece of equipment to the CE equipment inventory.

E60. Specify the techniques of operating front-end loaders and the types of operations they perform, and state the functions of the controls.

These loaders are available in various sizes and capacities, and they have buckets holding up to 3 cubic yards. The Air Force loader generally falls in the 1½- to 2½-cubic yard range. They are usually diesel engine powered and are equipped with a transmission of the power-shift type providing four speed ratios forward and reverse. On older models of the 2½ cubic yard units, the frame is hinged midway between the front and rear axles. This construction is referred to as an "articulated" frame. On this type of machine, the front axle provides the steering. A hydraulic system provides power for operating mounted attachments and assists in steering.

Versatility of the loader is depicted in figure 6-7. Detail A shows the loader equipped with a multi-purpose bucket. Equipped as such, it may be used to scoop up and load loose material into a truck; or, it may be used to dig earth out of a bank. This heavy duty, all-welded, steel bucket has replaceable cutting edges and bolt-on replaceable teeth. This durable bucket has the strength to perform excavation of medium-type materials. Equipped with this bucket, the loader can perform clamshell, dozer, scraper, and scoop-shovel functions. The machine in detail B of this illustration is poised for dozer operation. Detail C shows the machine converted to a forklift. As such, it can be used to load equipment or supplies onto a truck or flatbed. It may also be used to move machinery and packaged or crated material over a short distance.

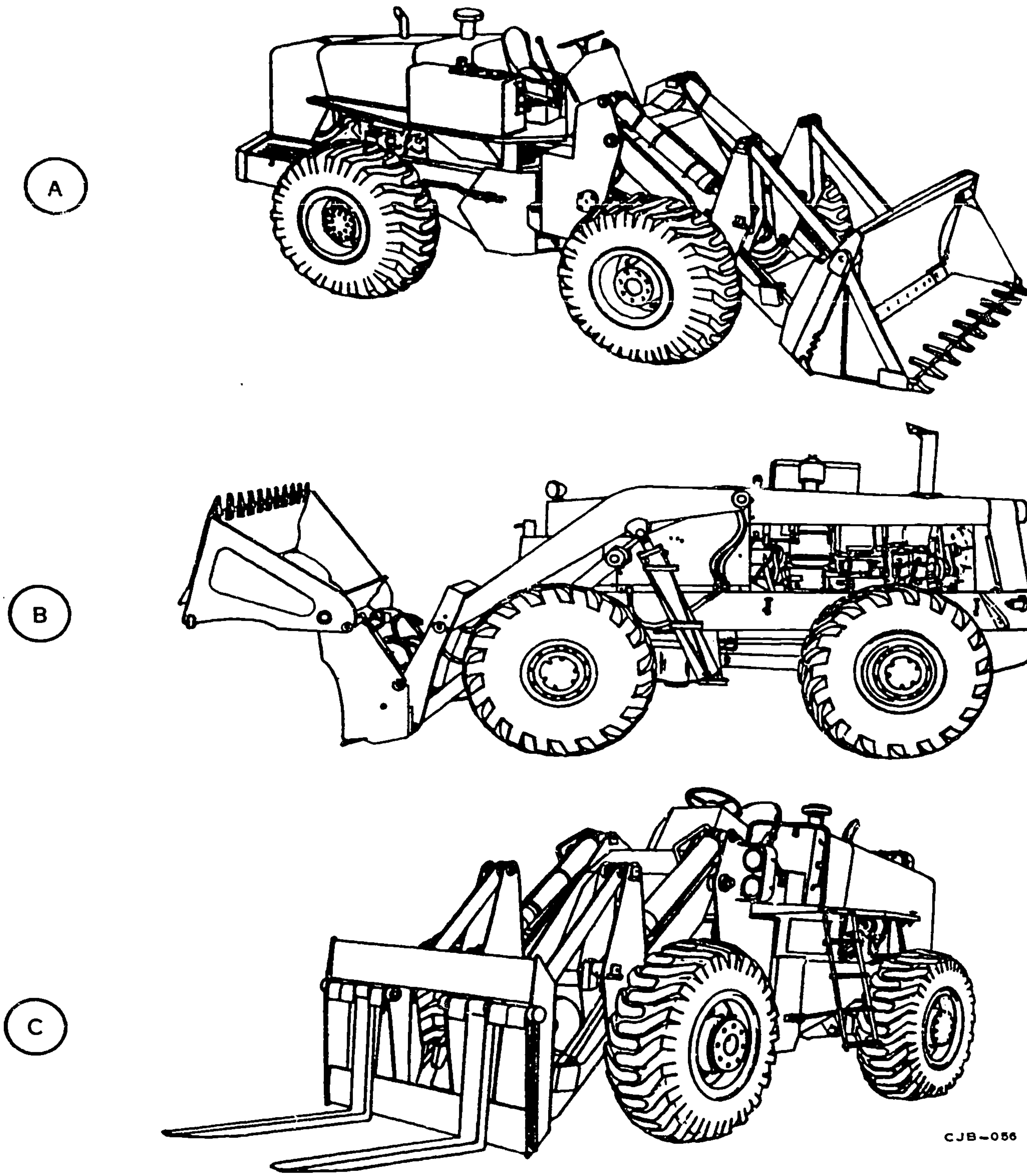


Figure 6–7. Loader attached with bucket and forklift attachments.

Other attachments available, but of limited military use, include the crane hook and snowplow.

As we discuss loaders, there will be areas where it is necessary to cover a specific piece of equipment. We will refer to the International Hough (pronounced huff) 90 in this chapter where the information is specific. This loader is shown in figure 6-8. It is a versatile machine that can be used as a loader and as a forklift. The typical wheel-mounted loader is equipped with large rubber tires that give it a relatively low-ground-bearing pressure. With this characteristic, this type of machine can perform a variety of jobs and is capable of speeds approaching 30 miles per hour. The loader has good traction on unstable surfaces and can perform on side slopes of 15 percent and on straight slopes up to 30 percent in the direction of travel.

Operating Controls. Refer to figure 6-9. Notice that the Hough 90 loader is equipped with numerous controls, each of which has a specific function in the control of the loader. We will consider these controls as two sets and review their functions briefly. One set controls the bucket, while the other set controls the engine, transmission, and brakes.

Bucket controls. As shown in figure 6-9, the three levers located on the right side of the operator's seat are used to control the bucket. Lever number one is used to raise, hold, lower, and float the bucket. Lever number two is used to tilt the bucket or forks. Lever number three is used to open and close the clamshell.

Other controls. The remaining controls pertain to speed, direction, transmission, and brakes.

The two levers located on the left of the steering wheel (fig. 6-9) are used to control the direction and the speed of the loader. The direction shift lever (5) has three functions. In its forward position the loader moves forward; the center position is neutral; and the downward position is reverse. Speed shift control (6) has three positions; i.e., up is first speed, center is neutral, and down is second speed. Since the loader has a 4-speed power shift transmission, this combination provides low speed ratios.

Controls (4), (7), and (10) are self-explanatory from their titles in figure 6-9. Control (7), however, has a dual function. It disconnects the transmission and applies the brakes when the pedal is depressed.

A bucket position indicator, shown in figure 6-10, is affixed to the boom. It indicates the operating mode of the bucket. Position indications include bulldozer, scraper, bucket, and clamshell.

Operation of Front-End Loader. Now that you are familiar with the loader controls, let's discuss operation of the loader. For an example, let's consider loading a dump truck from a stockpile. The loader is equipped with a regular bucket. Refer to figure 6-11. You should begin with the bucket leveled with the ground (approach). Then drive forward into the stockpile (thrust). As the bucket fills, tilt backwards and raise the bucket. Back away from the pile keeping the loaded bucket low (loaded). Always

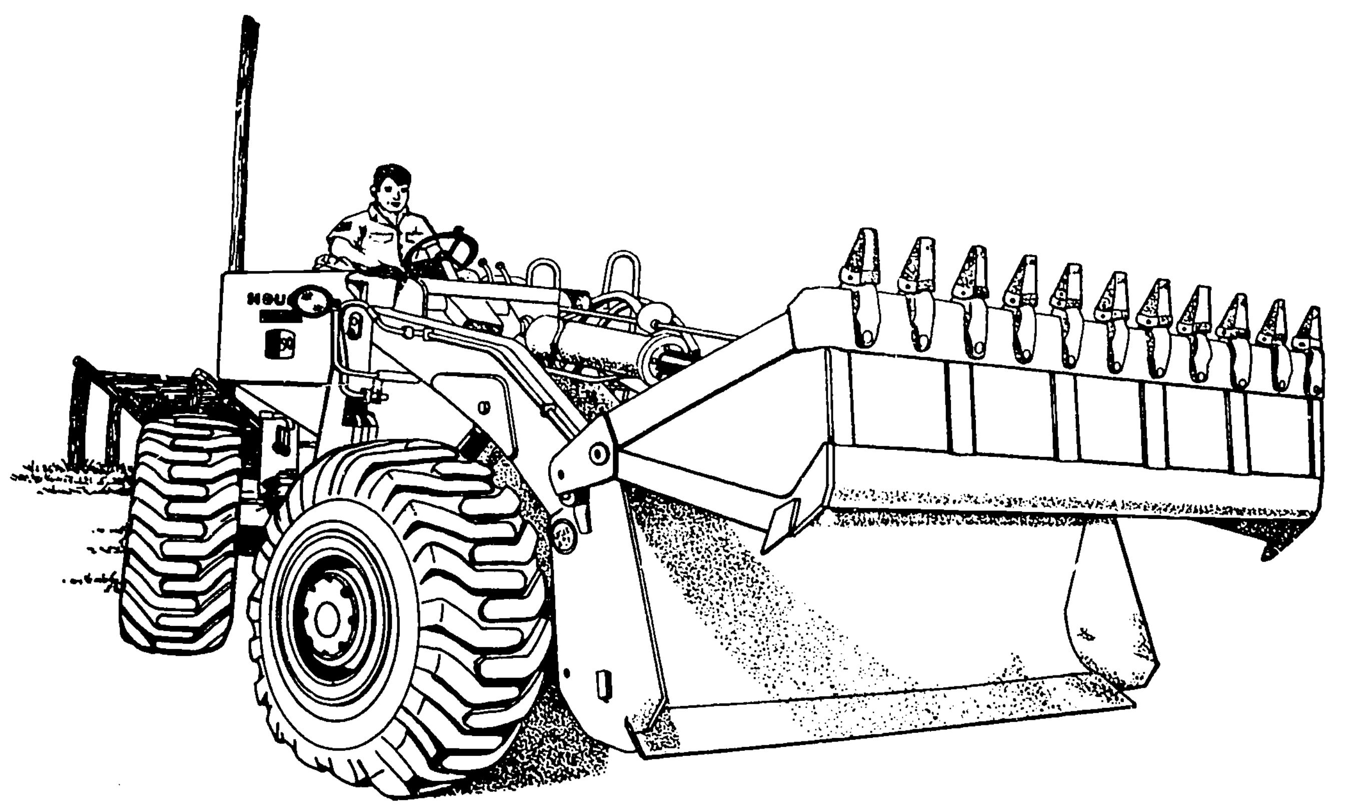
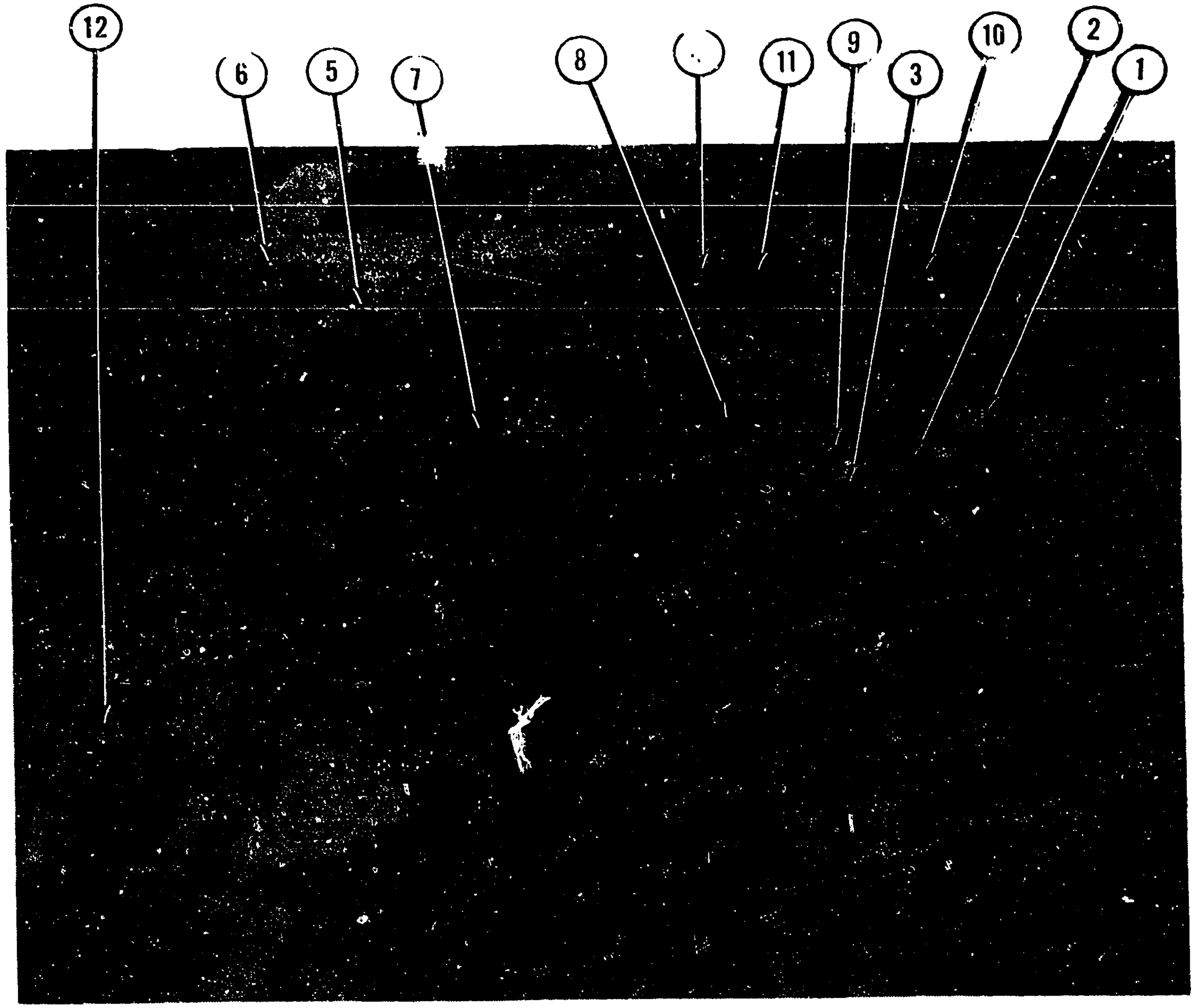


Figure 6-8. Front-end loader with clamshell-type bucket.



(1) Bucket raise and lower lever
(2) Bucket tilt lever
(3) Clamshell lever
(4) Hand throttle lever
(5) Direction lever
(6) Speed shift lever
(7) Transmission disconnect pedal
(8) Brake pedal
(9) Foot throttle
(10) Parking brake
(11) Parking brake warning light
(12) Instrument panel

Figure 6–9. Front-end loader controls.

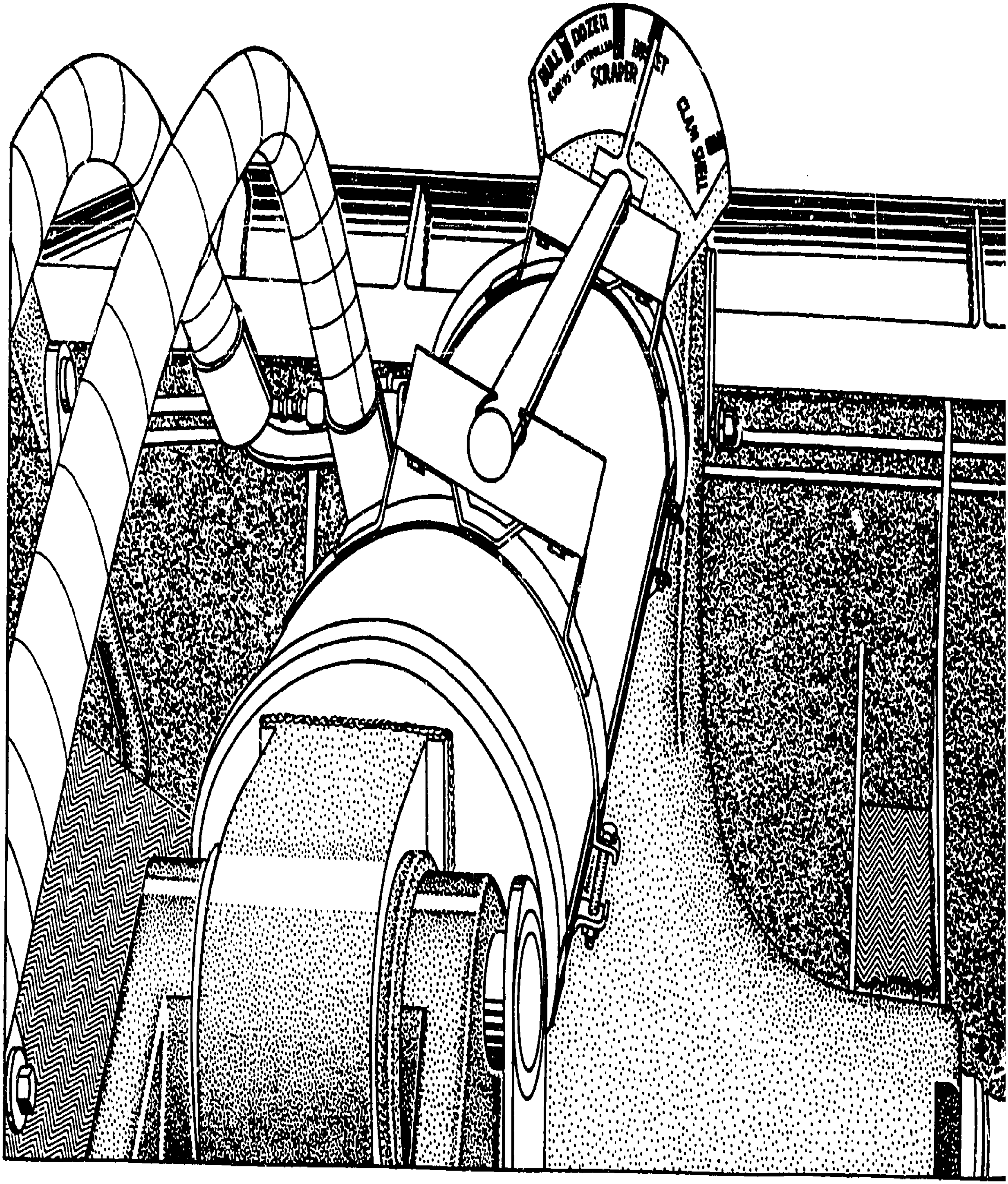


Figure 6-10. Bucket position indicator.

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travel with the loaded bucket as low to the ground as possible. Then, raise the bucket to the desired height as you approach the dump truck. To prevent damage to the dump body, dump the first load a little at a time. To increase production, keep the travel distance as short as possible. Spotting the trucks where you want them is a big help.

Another method of loading is by use of the clamshell: you should engage the bucket to the dozer position, push the material ahead, and, when you have a pile, close the clamshell (see fig. 6-12). You can then use the scraper position to spread the load. Set the bucket to the desired height. Then, as you back up, open the clamshell. As the material flows out, regulate the clamshell opening to maintain the desired depth of spread. The speed of the loader and the type of material normally governs the clamshell opening. You can also use the clamshell to dump the load in a dump truck, as shown in figure 6-12.

Excavating. The loader may also be used to dig or excavate. You should start by leveling the bucket with the ground. Then drive forward and tilt the bucket forward. When the bucket has penetrated the ground to the desired depth, level off and continue until the bucket is full. Then tilt the bucket back and raise it approximately 12 inches from the ground. Carry the load to the desired dumping site. Remember, always carry a full bucket close to the ground to insure maximum stability.

The loader can excavate for basements, personnel shelters, weapon revetments, etc. If the loader is used for this purpose, you must construct a ramp into the excavation in order to bring the material out (see fig. 6-13). A combination of the loader and haul trucks increases the efficiency more than threefold.

Backfilling. The loader can be used in other operations, such as backfilling ditches or trenches. By lowering the bucket to grade level, the forward movement of the machine pushes the stockpiled earth into the trench (see fig. 6-14). This work is ideal for the scoop loader, provided the bucket is as wide or wider than the tracks or wheels, for it insures cleanup in the least number of passes. Narrow buckets cause the tracks or wheels to ride up the stockpile. This raises one corner of the bucket and reduces the area for cleanup.

Techniques of Operation. You can use certain operating techniques to improve the production of scoop loaders. For example, when you load the bucket, move it parallel with the ground, with the cutting edge skimming the surface being traveled. This action removes ruts, obstacles, and loose material during the forward pass of the machine. Move the loader at slow speed, increasing power as the cutting edge contacts the bank or stockpile. On penetration of the material, raise the bucket. Crowd the material into the bucket and roll the bucket back. This procedure prevents the spilling of the material.

Proper positioning. Proper positioning of equipment to receive material from the loader is necessary for maximum production, to minimum maneuvering time, and protection of the traveled surface.

Handling of difficult material. To maintain efficiency when handling a sticky m[illegible]l that has a tendency to cling to the bucket, use the multisegment bucket with its clam-type opening instead of the solid bucket. For material that is medium to hard, first break up or loosen the material with a rooter, ripper, or explosives.

Selection Factors. Certain factors should enter into your selection of a loader or other item of equipment to perform a task. One of these factors is the volume of material to be excavated. Loaders are excellent machines to use in soft to medium material, such as that found in stockpiles. When the material is medium to hard, the production rate of the loader is greatly reduced. Further, a loader attains its highest production rate when it works in flat, smooth-surfaced areas and has proper space to maneuver. If there are poor underfoot conditions and lack of space to operate efficiently, some other items of equipment may be more effective. The height to which the material must be placed or dumped is another factor which must be considered. Other items of available equipment may construct a stockpile faster or load a hopper or grizzly more efficiently.

Exercises (E60):

1. What techniques should be used to operate a sc[illegible]p loader on a bank or stockpile?

2. Name two operations the front-end loader can perform and briefly explain each operation.

3. State the functions of the two sets of controls.

4. There [illegible]e three levers used to control the bucket. State the function of each.

5. In what positions should you engage the bucket to push the material in a pile?

6. Which bucket do you use when you want to spread the load?

7. Under what condition does a loader perfo[illegible]n best?

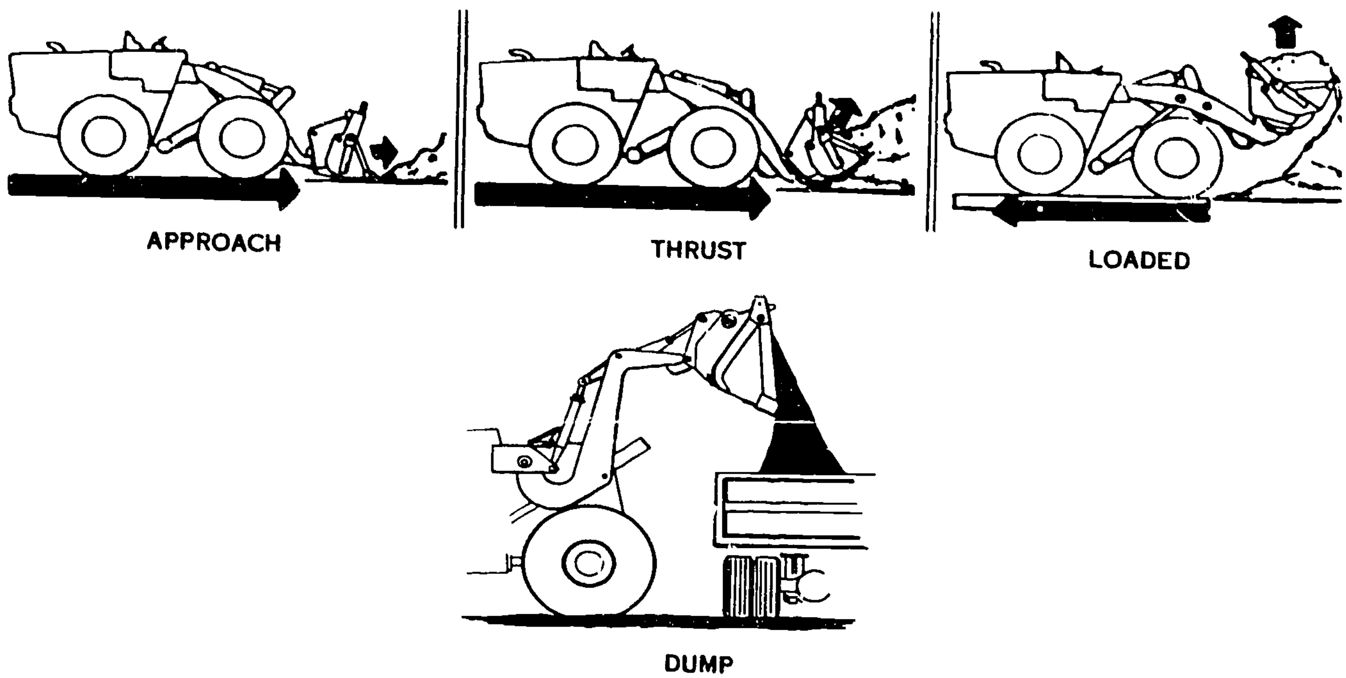

Figure 6–11. Loading a dump truck.

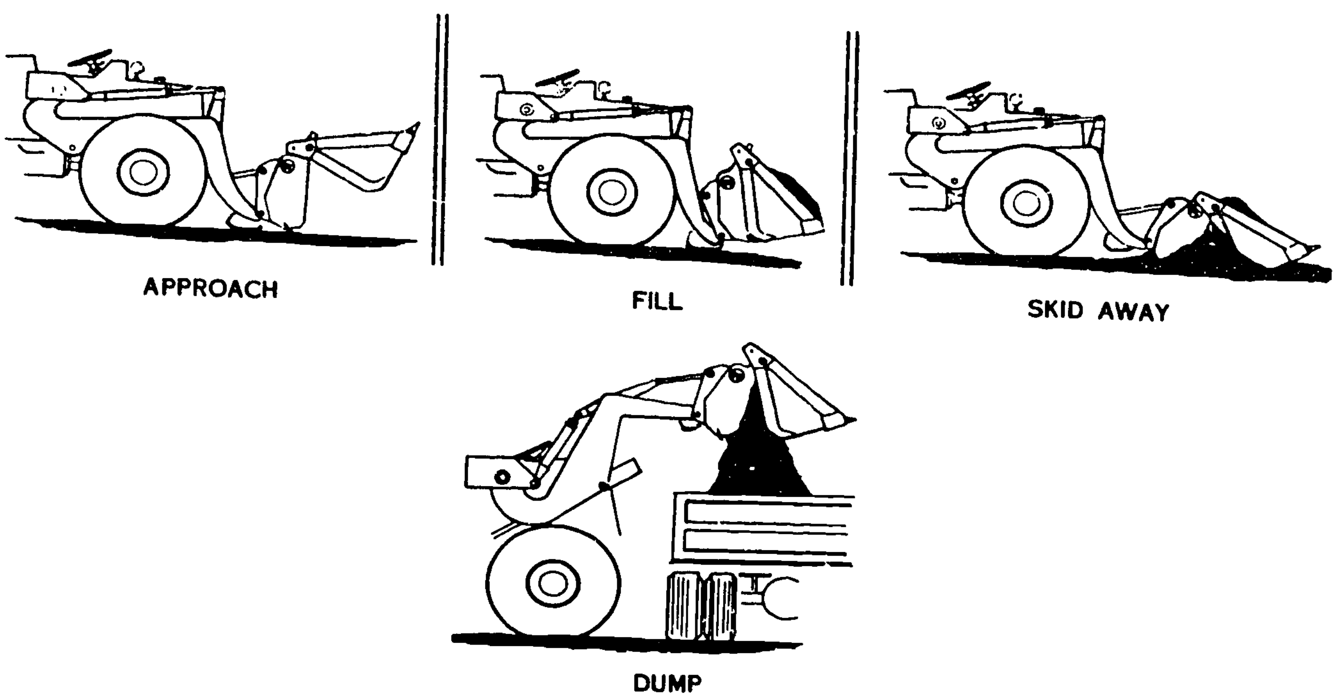

Figure 6–12. Loading and unloading a clamshell.

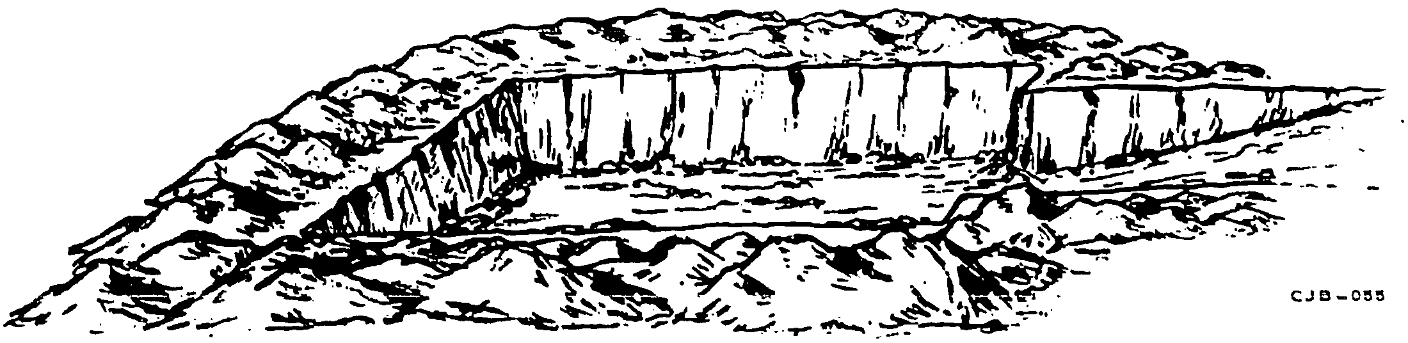

Figure 6–13. Loader excavation project.

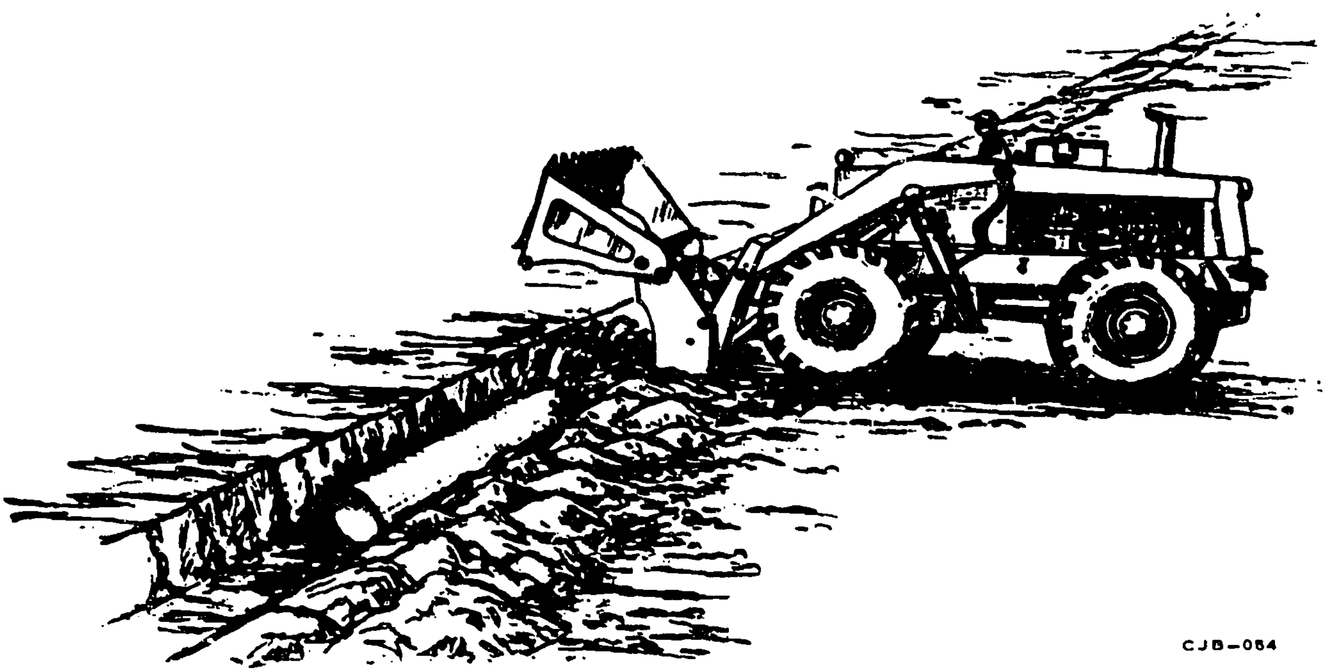

Figure 6–14. Backfilling with a loader.

8. Where is the bucket position indicator located?

6-6. Industrial Tractors

The most common vehicle found in a civil engineering organization is the industrial tractor. An industrial tractor is used constantly on a wide variety of light jobs in both construction and maintenance. Much work can be done with an industrial tractor with one or more attachments connected to it.

In a contingency operation you may be required to operate either a farm tractor, or an industrial tractor, or both. For all practical purposes, they are both operated in essentially the same way. The only difference is in the number and type of attachments available. Since the two are very similar in operation, and the industrial tractor will accept more attachments, we will discuss only industrial tractors in this unit.

E61. State the method for mounting equipment and the purpose of the PTO; and name the hydraulic controls and three of the attachments used.

Industrial tractors must be of sturdy construction and be relatively free from maintenance problems. For example, to withstand the pressures exerted by a front-end loader, the front axle of an industrial tractor must be heavier and stronger than the front axle on a farm tractor. Because of the heavier loads it must control, the clutching mechanism is sturdier; and for more traction, industrial tractors are equipped with larger rear tires than farm tractors.

The engine of an industrial tractor is usually in the 60-horsepower class. It may be either gasoline or diesel operated. The engine provides the pressure to the hydraulic system that gives the operator "fingertip" control of all mounted or attached equipment. Through the use of the hydraulic controls, all mounted equipment and attachments, or attached equipment with remote cylinders, can be controlled from the operator's seat. In addition, the hydraulic system provides power steering at all operating speeds.

Mounting of Equipment. Several methods have been devised to mount equipment on, or attach them to, industrial tractors. The most modern and convenient method is the three-point hitch, shown in figure 6-15. This hitch provides three separate points at which an attachment is connected. It consists of two lower (outside) links and one upper (center) link. The lower links support the weight of the attachment and apply the direct pulling power to it. The upper link provides a means by which the attachment can be positioned or leveled.

The right lower link is also equipped with a leveling adjustment (see fig. 6-15). By using both the upper link adjustment and the right lower link adjustment, an attachment can be leveled or positioned as desired. Once the attachment is positioned, you have complete control over it (raising, lowering, etc.) through the hydraulic system controls.

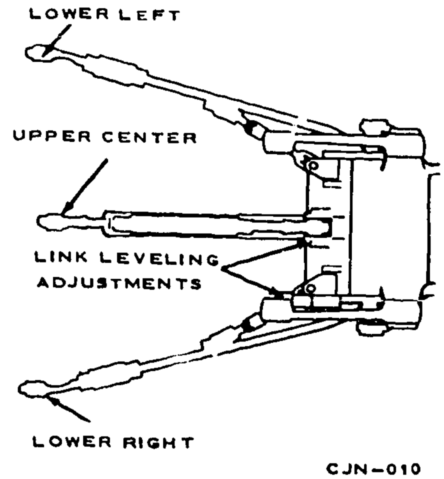

Figure 6-15. Three-point hitch.

Many types of equipment simply are pulled behind the industrial tractor. This trailing type of equipment is attached to a drawbar. This may be a swinging drawbar, a fixed drawbar, or a floating drawbar.

Floating drawbar. This device is nothing more than a crossbar fastened to the lower links of a three-point hitch. It has the advantage of being adjustable (up or down) to match the height of the equipment hitch.

Swinging drawbar. This drawbar (fig. 6-16) consists of a drawlink hinged at the tractor end so that the opposite

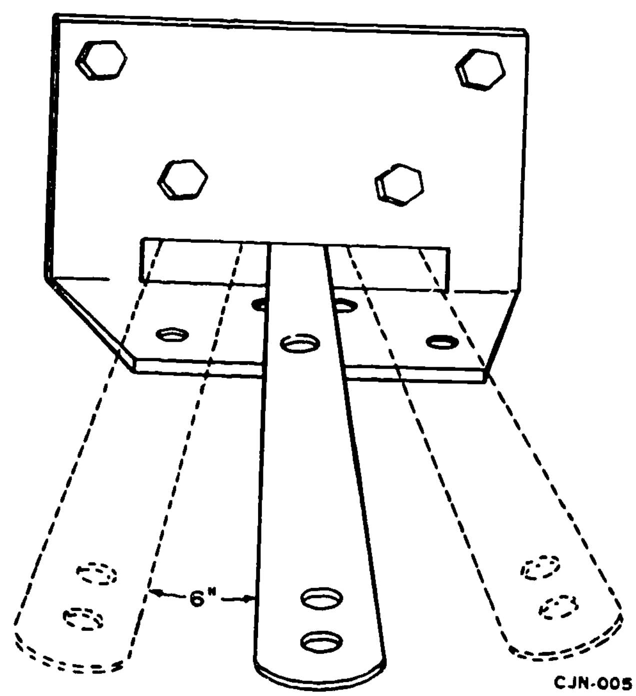

Figure 6-16. Swinging drawbar.

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end is free to pivot across a supporting bar that is attached rigidly to the tractor housing. The swinging drawlink is free to swing the entire width of the support bar or, when desired, it can be locked in place. When pulling trailing-type equipment that does not require close positioning, steering is easier if the swinging drawbar is left free to swing. If a three-point hitch is on the tractor, place the lower links in the UP position to prevent interference when the drawbar swings from side to side. When you want the pull on a load to be centered, bolt the swinging drawlink in its center position to the support bar.

Fixed drawbar. This device (fig. 6-17) is found on many older model tractors, but it can be used in many modern towing situations. It consists of a flat, U-shaped drawlink fixed rigidily to the tractor housing. Steel rod braces support the drawlink and increase its load-carrying capabilities. The fixed drawbar has holes spaced along its length. On pin-type equipment tongues, the pin simply is dropped through one of the holes. When the ball and socket type of trailer hitch is used, the ball can be mounted readily in one of the holes.

Power Takeoff. All industrial tractors are equipped with a PTO located on the rear-end tractor housing. Through a system of reduction gears, the PTO provides operating power from the tractor engine to the mounted or attached equipment. A PTO shaft and its housing are shown in figure 6-18.

You can operate the PTO independently when the tractor is in any forward, reverse, or in neutral gear. In other words, if the forward motion of the tractor is stopped, the PTO will continue to operate until it is disengaged. Its operation is independent of the tractor clutch and is controlled with the lever on the tractor frame.

When you use the power takeoff equipment, it is essential that the PTO shaft is the proper length. If the equipment is attached to the drawbar, you may have to use an extension adapter on the power takeoff shaft to make up the connection. A PTO extension adapter (fig. 6-19). has a female spline on one end that mates to the PTO splined shaft. The exposed end of the adapter has a male spline that can be mated to a female spline on the attachment or equipment. All splined ends are drilled so that they can be keyed if necessary. Keying prevents the splined ends from separating during operation.

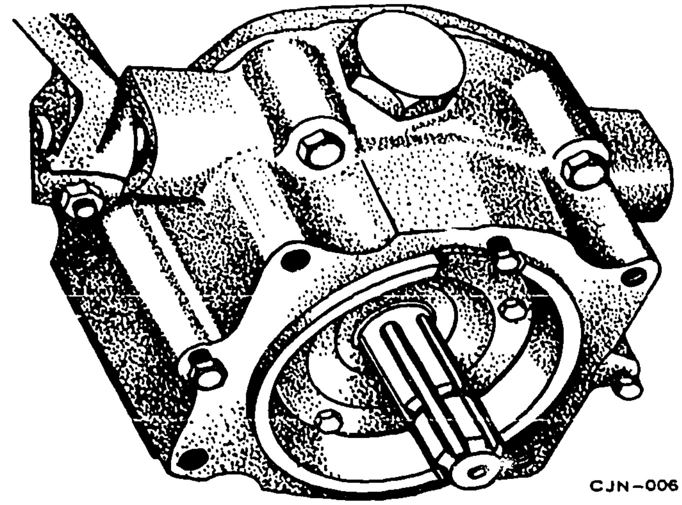

Figure 6-18. PTO.

Unless you take safety precautions, operating the PTO can be hazardous. Never engage the power takeoff unless PTO-driven equipment is mounted or attached to the tractor. Never step down from the tractor until after you disengage the PTO. When you remove equipment, remove the extension adapter and cover the PTO shaft.

Hydraulic Controls. The hydraulic controls used to control the three-point hitch are illustrated in figure 6-20. Although some manufacturers may locate or position the controls differently on their tractors, basically, there are three controls: (1) the draft (or load) control, (2) the position (up and down) control, and (3) the response (or action) control.

Draft control. Use the draft, or load, control when a three-point hitch attachment is of the soil engaging type,

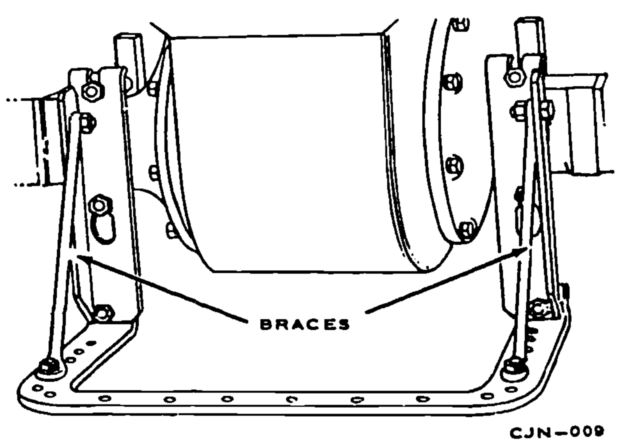

Figure 6-17. Fixed drawbar.

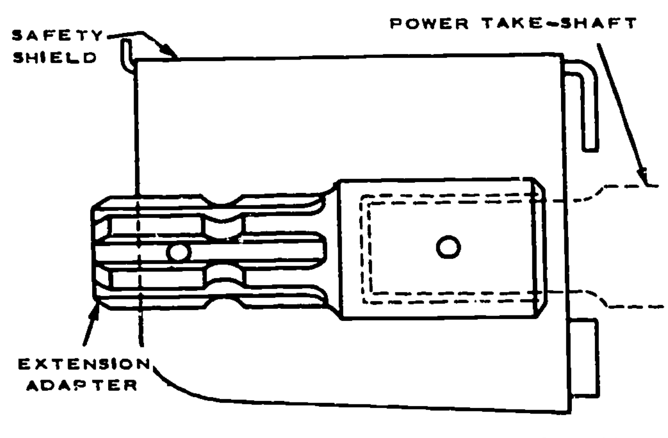

Figure 6-19. PTO extension bar.

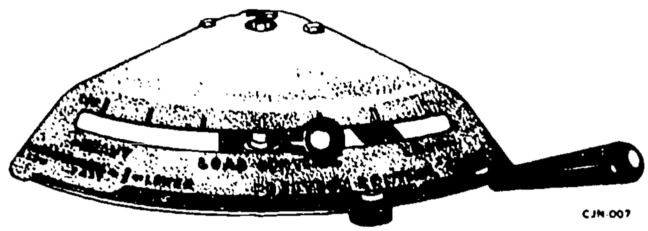

Figure 6-20. Hydraulic controls.

and when you need the attachment to maintain a uniform working depth to follow the contour of the ground. When you use a draft-controlled attachment, such as a ripper or plow, the draft system automatically maintains the attachment at an even working depth and transfers weight to the tractor's rear wheels to provide traction, regardless of soil irregularities. When you are working in an area that has various soil textures, uyou can keep a uniform depth by making minor adjustments to the draft control lever.

To lower a draft-controlled attachment from the upper position to the ground, move the draft control lever down. If the attachment is running too shallow, continue to move the draft control lever down until you have the depth you want. If the attachment is running too deep, move the draft control lever up until you reach the depth you want. After you get the desired depth, set the adjustable locator in line with the draft control lever to use as a reference. This procedure will allow you to lower the attachment to the same selected working depth.

Position control. Use the position control for operating three-point hitch mounted attachments that are not draft controlled, such as scoops or earth augers. You can hold attachments of this type at a fixed height, depth, or intermediate position regardless of draft loads. Moving the position control lever toward the RAISE position raises the attachment. Moving the lever toward the LOWER position lowers the attachment. Locating the position control lever at intermediate positions within the position control range locates the lower three-point hitch links at the corresponding intermediate positions. The position control lever has an adjustable stop that lets you return the lever from RAISE to the same desired operating position.

Response control. The response control is used in direct conjunction with the load control. The response control governs the rate at which three-point hitch attachments are lowered to the ground from the RAISED position and also governs the rate at which the load control system responds to various draft loads. The response control is used with the position control to regulate the attachment lowering rate.

Certain attachments are very active in the soil and cause rapid changes to the draft load because of aggressive attachment penetration. You can smooth out these rapid changes by moving the response control toward the SLOW position. If the attachment tends to "float" on the soil, the draft response may be too slow. You can corrected this condition by moving the response control toward the FAST position until the draft control system responds properly.

Attachments. The industrial tractor is used more often than any other item of equipment in the pavements and grounds section because of the many different jobs it can perform when the right piece of equipment is attached to it. The tractor alone is worth very little to the equipment operator. It becomes a working unit capable of most light construction and maintenance jobs when attached equipment is controlled by the hydraulic system and driven by the PTO.

Plows. A plow (see fig. 6-21) is used to break up unimproved grounds and turn under undesirable vegetation. You can use it to turn under organic material on improved or semi-improved grounds where sod is to be established. Some AF installations use the plow to turn under dry grass and create vegetation-free strips to prevent fires from spreading onto such areas as ammo storage areas and airfields. Plows can be of any size, from one to six moldboard plows. There are a wide variety of manufactured plows. Some are wheel mounted and are towed by industrial tractors with a fixed drawbar. Others are mounted to industrial tractors by a three-point hitch.

When attaching the plow to a three-point hitch, it is essential that the plow be leveled. You can level it by extending or retracting the upper link, and by raising or lowering the right lower link. If the plow is not leveled, the plow may tend to ride out of the ground, go deep into the ground, or drag to one side. The plow is controlled, once the cutting depth is set, with the hydraulic system. The main control used is the draft control lever. The position control lever is placed in the RAISE position and the response control is placed at the desired speed. Once these two levers are set, the plow can be controlled by using the draft control lever only. To raise the plow, place the draft lever in the UP position. To lower the plow, place the draft control lever at the desired digging depth. Once you may have the desired depth, you set the adjustable locator. This procedure insures that each time the plow is lowered it automatically goes to the desired cutting depth.

Harrows. Three types of harrows are in general use at Air Force installations: (1) disk, (2) spring-tooth, and (3) spike-tooth harrows. A disk harrow (fig. 6-22) is used primarily for pulverizing soils. It can be used to chop weeds and light brush in areas too rough for mowing. A disk harrow is often used to pulverize plowed ground during seedbed preparation where sod is to be established. The two sets of disks are arranged to throw dirt in opposite directions, leaving a loose, relatively smooth, surface.

Older model disk harrows are attached to the tractor drawbar and are raised and lowered mechanically with a lever or crank located on the top of the frame. Pulverizing soil to the desired depth with this type of harrow often requires that additional weight be placed on top of the harrow frame. Later models are attached to the three-point hitch and are controlled hydraulically. You adjust the depth position of the hydraulically controlled disk from the tractor seat. You can reach the correct depth

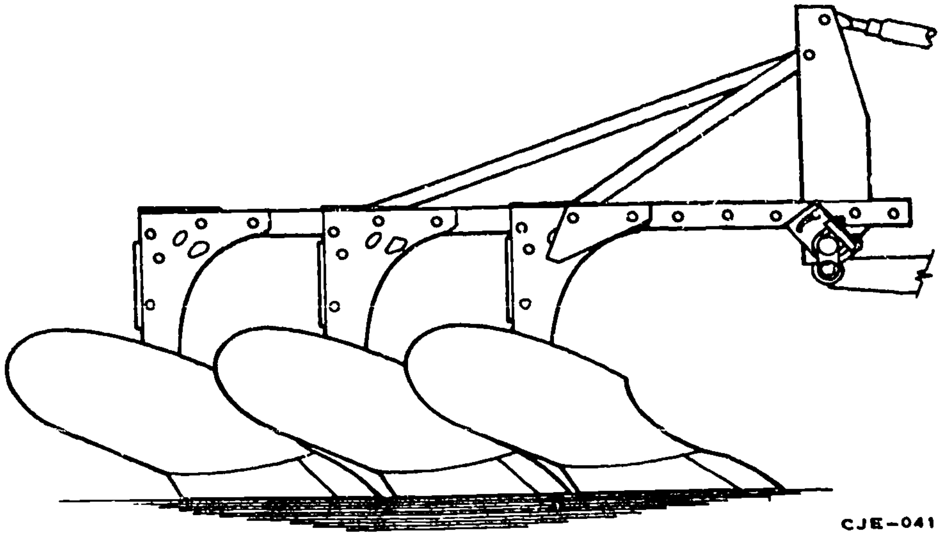

Figure 6-21. Plow attachment.

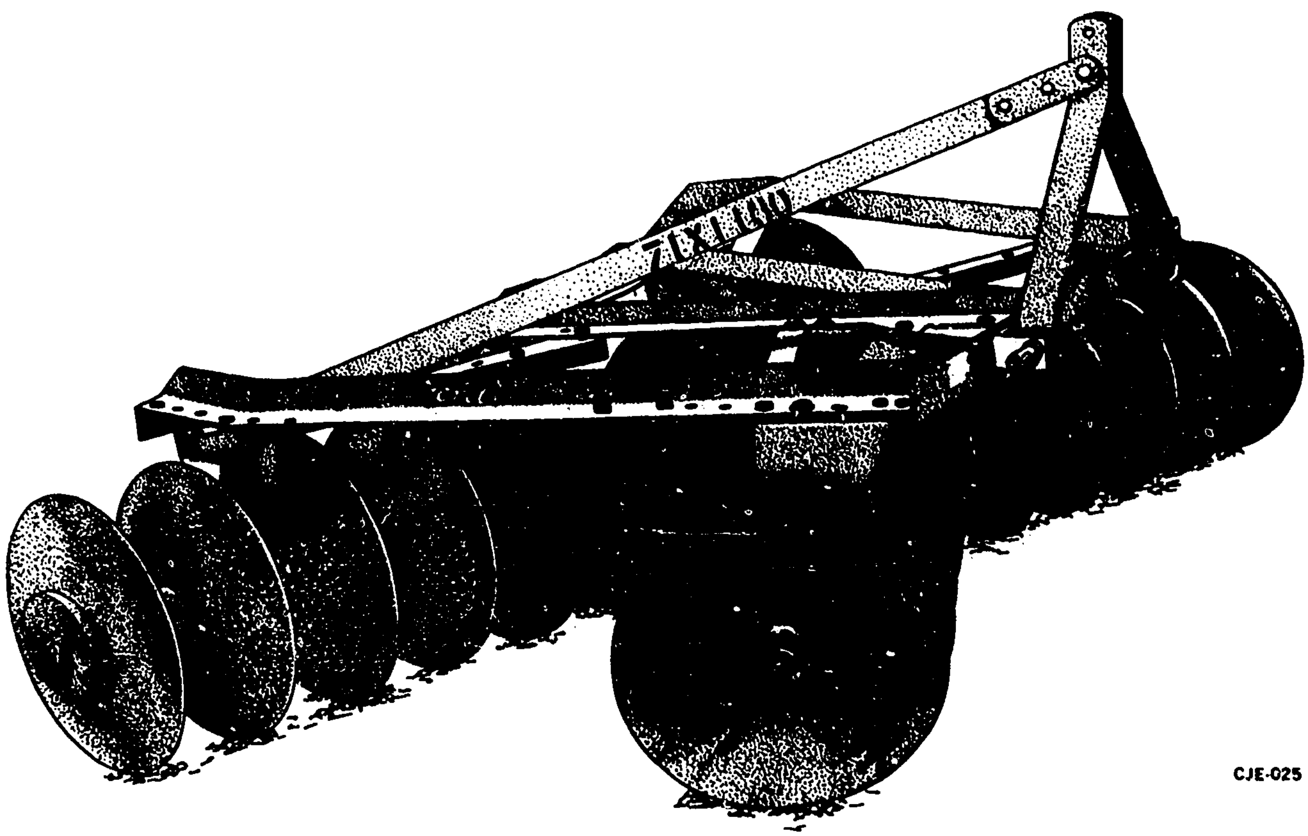

Figure 6-22. Disk harrow.

by setting the controls in the same manner as was explained for the plow.

A spring-tooth harrow, (fig. 6-23) acts like a chisel when it is placed into the soil. You can be use it to pulverize plowed ground or soft ground that has not been plowed. The spring teeth are adjustable and can be arranged to cultivate by cutting undesired weeds at their root base. The greatest use for a spring-tooth harrow, however, is in road work. It is an exceptionally good implement for mixing and stirring soils during stabilization.

A spike-tooth harrow (fig. 6-24) is used primarily for smoothing soil after it has been gone over with a disk harrow. The rows of offset spikes are adjustable. A spike-tooth harrow can be made as wide or as narrow as desired simply by adding or removing sections. Older models are fastened to the tractor drawbar and the spikes adjusted with the lever on top of each section. Some of the newer models can be attached to the three-point hitch and the spike angle can be controlled with a remote hydraulic cylinder.

Mowers. Air Force installation acreage is normally divided into improved, semi-improved, and unimproved lands. It all must be maintained and the vegetative growth controlled. One of the most economical and efficient means of controlling the growth of both desirable and undesirable plants is through the use of tractor-mounted, or tractor-towed mowers.

Reel-type mowers (fig. 6-25) are used on grounds where the turf is in excellent condition. These mowers are not used in tall growth or on woody plants. The design of the mower tends to push over, or knock down, high growth without cutting it. They are used primarily on lawn areas where good cutting appearance is desired.

These mowers are used in three or five gang combinations and can cut at speeds from 4 to 8 miles per hour. The mower blades are driven from the traction of the attachment wheels. The mower is not driven by the tractor PTO. These mowers may be towed from the drawbar, or some newer models can be connected to the three-point hitch.

A rotary-type mower, as shown in figure 6-26, can be used on semi-improved and unimproved grounds. They can also be used to clear brushy areas, and they can handle small trees up to a diameter of 2 inches. These mowers can be used in a single unit, or, if a large area is to be covered, they can be arranged in gang. They are powered by the PTO, and are attached to the three-point hitch. Rotary mowers are the most dangerous of all mowers; they should never be used where there is a concentration of people, buildings, or vehicles.

Two other types of mower attachments that are available at some installations are (1) the flail type and (2) the bar (sickle) type. The flail mower operates off the PTO and the three-point hitch. It is a heavy-duty, high-volume cutter used for rough and coarse mowing as well as for fine grooming. Because all moving parts of the flail mower operate beneath a chamber, it is considered to be the safest mower in the Air Force inventory. A cutter bar mower is designed for high-speed cutting when used in the open field. Because of the flexibility in the cutter bar, it is adaptable for cutting along fences, ditch banks, and other rough areas. The cutter bar mower is bolted to the frame beneath the tractor, and is positioned and controlled with the hydraulic system. When cutting along fence lines or drainage ditches with the cutter bar mower, it is best to operate the tractor in first gear and never faster than second gear. The cutter bar mower is a dangerous piece of equipment. Never approach the cutter bar or handle it unless it is disengaged.

Exercises (E61):

1. State the most modern and convenient method for mounting equipment to an industrial tractor.

2. Which link adjustment is used to level or position the equipment when a three point hitch is mounted to a tractor?

3. State the purpose of the PTO located on the tractor.

4. What two safety precautions must you observe to when operating a tractor with a PTO attached?

5. Name the three hydraulic controls used with the three-point hitch.

6. Name three attachments used with the three point hitch.

6-7. Water Distributors

Water distributors are truck—or trailer-mounted—tanks with a spray bar for sprinkling dry soil so that it will compact well. They are also used for storing water, hauling water, and washing equipment—anything that calls for water. This vehicle is commonly called a water truck. It is equipped with an auxiliary engine for pumping water from a stream into the tank. The same engine can be used to pump water out of the tank, under pressure, through the spray bar. The water will also flow through the spray bar by gravity—it's just a little slower this way. This water can be pumped out of the tank at other places besides the spray bar. It depends on the use you are making of the water.

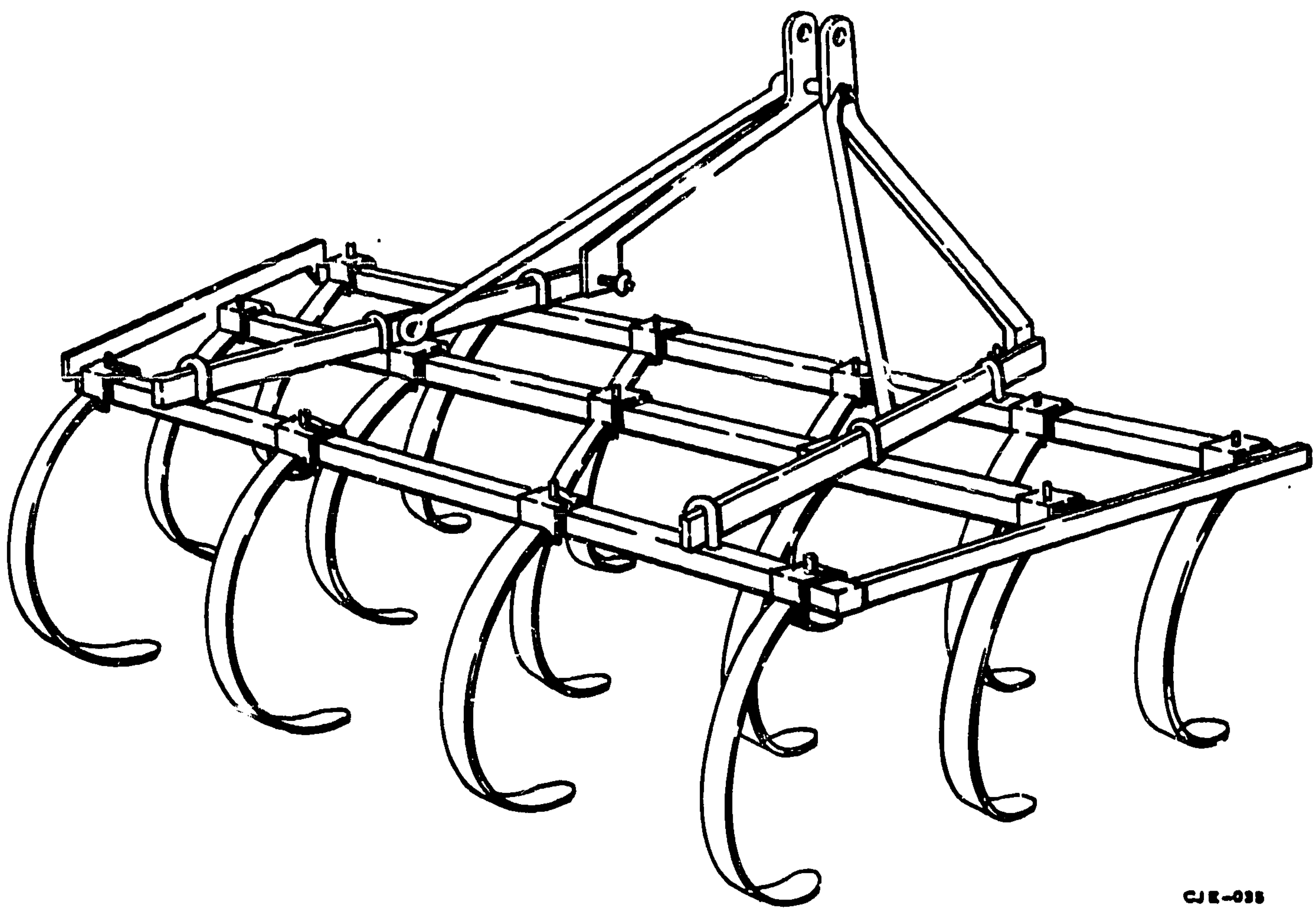

Figure 6-23. Spring-tooth harrow.

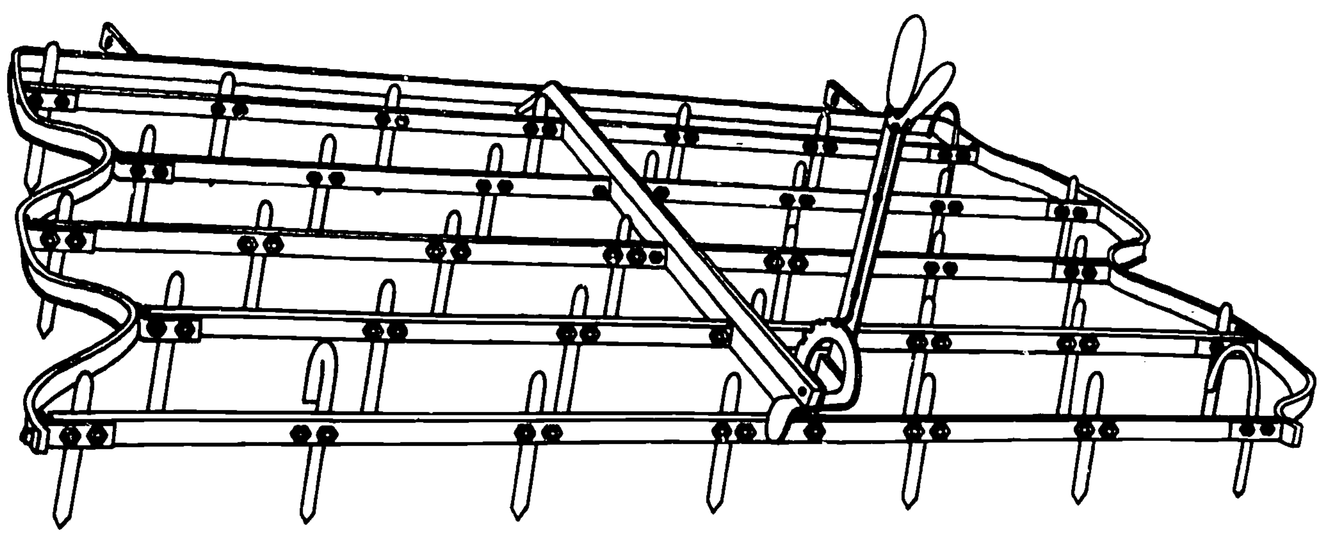

Figure 6-24. Spike-tooth harrow.

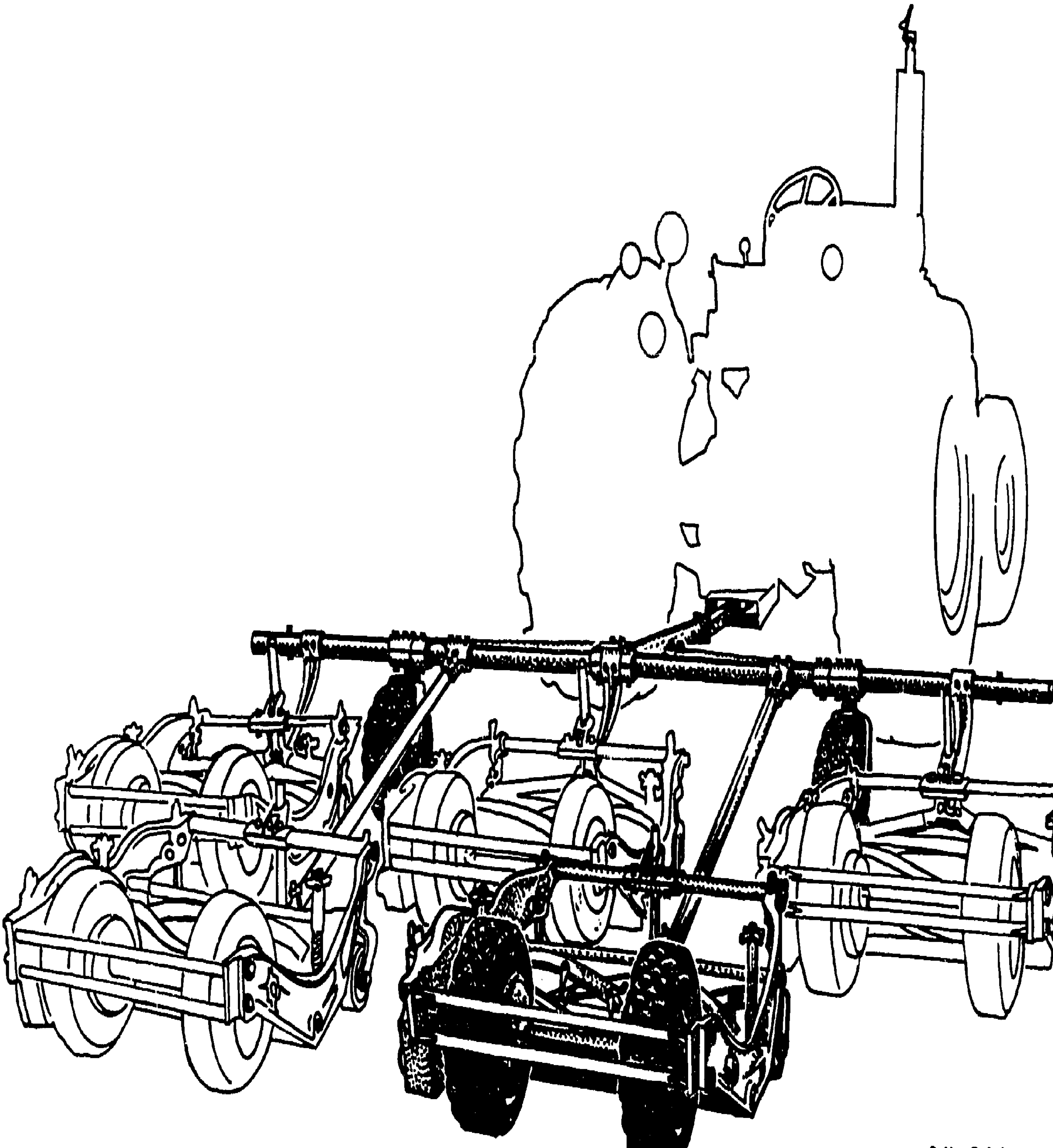

Figure 6-25. Reel-type mower.

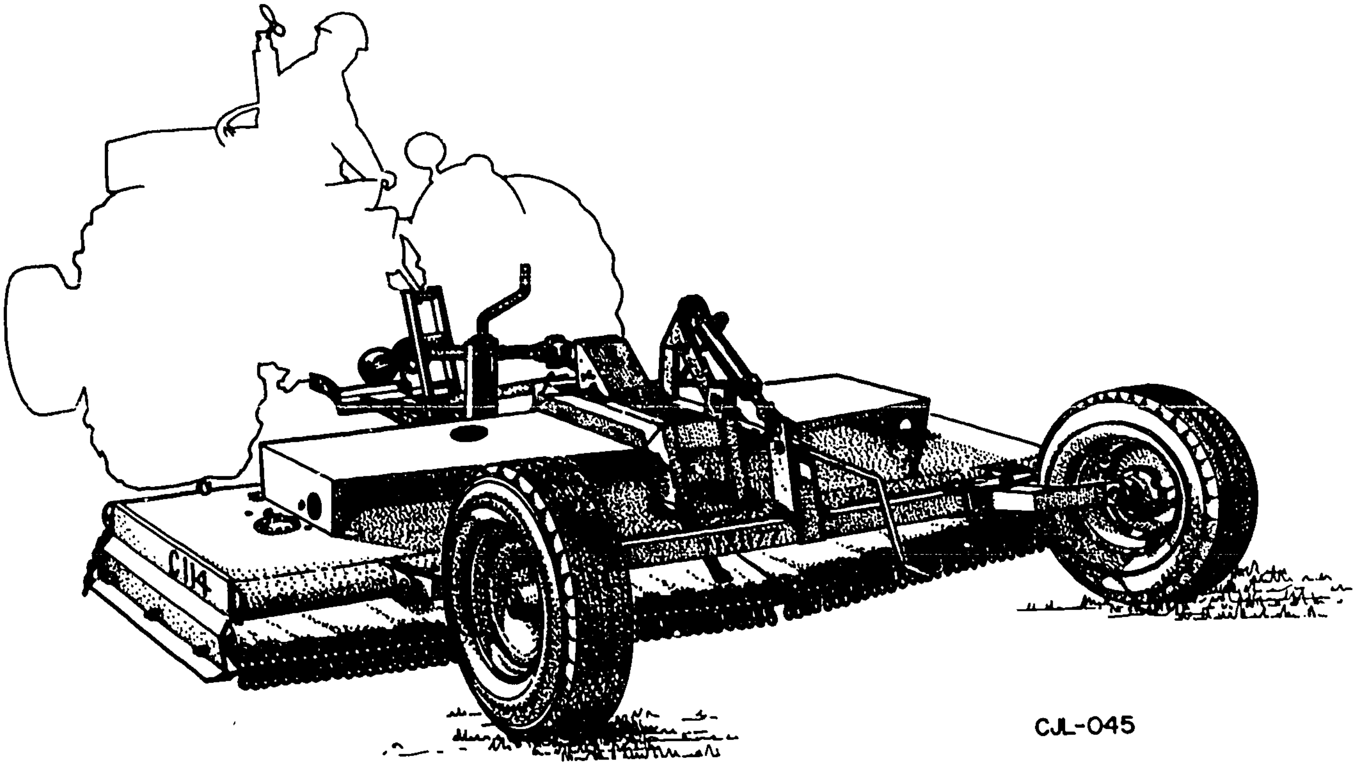

Figure 6–26. Rotary-type mower.

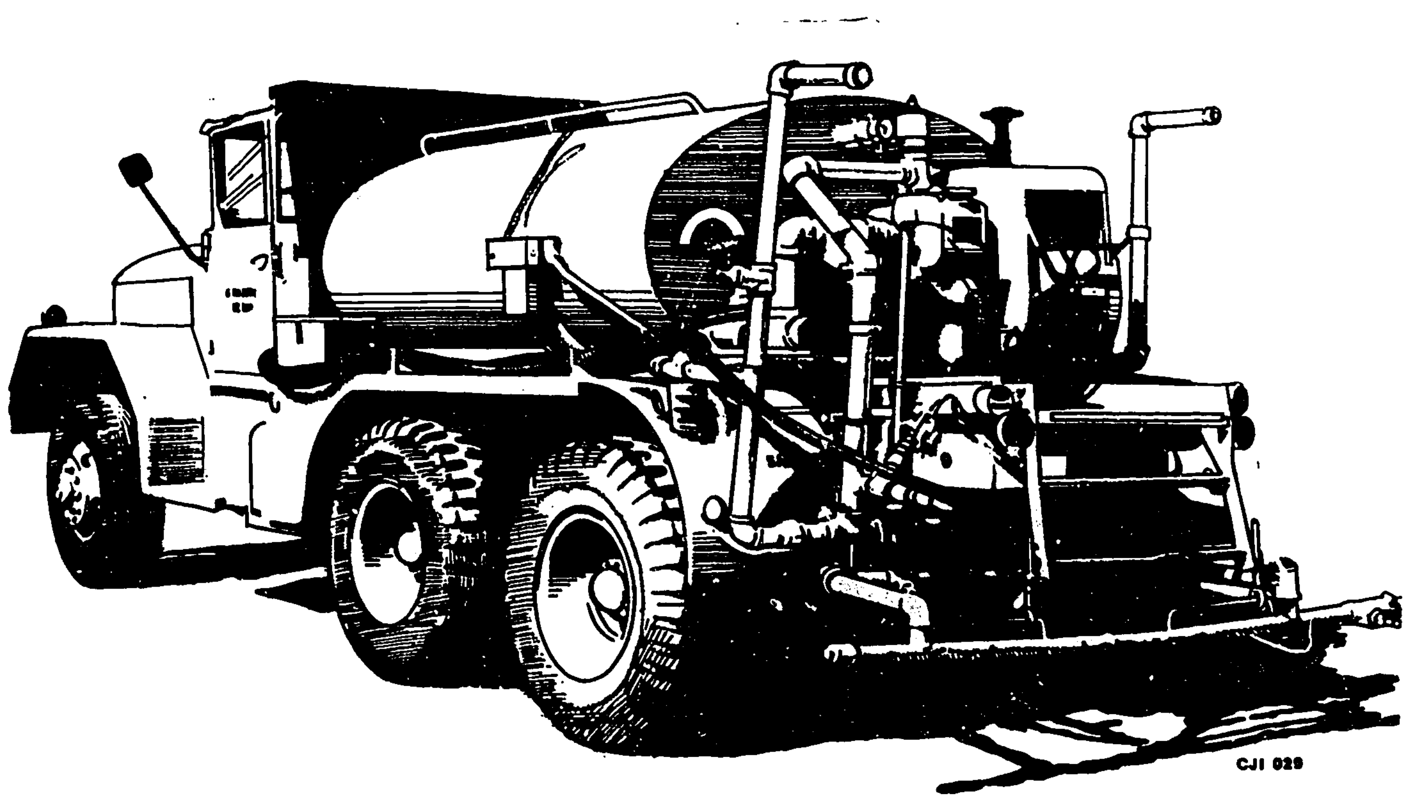

Figure 6–27. Water truck.

E62. State how to fill the tank and specify the procedures and safety actors involved in the operation of the truck.

Filling the Tank. The first task in operating a water truck (fig. 6-27) is to fill the tank. For normal operation on a base with fire hydrants, you connect a firehose onto the hydrant and fill the truck from the hydrant. Be sure that the hose won't come out of the tank when you turn on the water. You can do this by putting several feet of the hose in the tank, having someone hold the hose in the tank, or by tying the hose to the tank near the opening. Use a special hydrant wrench to turn the water on. If you use a pipe wrench or other common wrench, you will round the corners of the three-cornered hydrant cock.

If you must haul a large amount of water, a fill station should be set up to reduce loading time. A typical fill station consists of a pole set in the ground near a hydrant (fireplug) and a pipe connected to the hydrant (fig. 6-28 illustrates a typical setup). The pipe is strapped to the pole for stability and to protect the pipe from accidental damage. The pipe has a short piece of firehose at the exit end to allow a truck to pull under the pipe. The firehose then can be put easily into the water tank for filling. When you are working in the field, you can set up a system similar to the one just described near a stream or lake. Use the gasoline engine-powered pump to fill the water tanks.

Driving the Truck. A word of caution when operating a tank truck. You must be very careful while operating the truck when the tank is not completely full. The reason is that ballast plates inside the tank normally are designed only to reduce water movement forward and backward. If you make a sudden turn, the water sloshing from side to side may cause you to loose control. The vehicle can tip over.

The factor most important in determining how well a soil can be compacted is the degree of moisture in the soil. Sprinkling soil so that it will compact well requires that

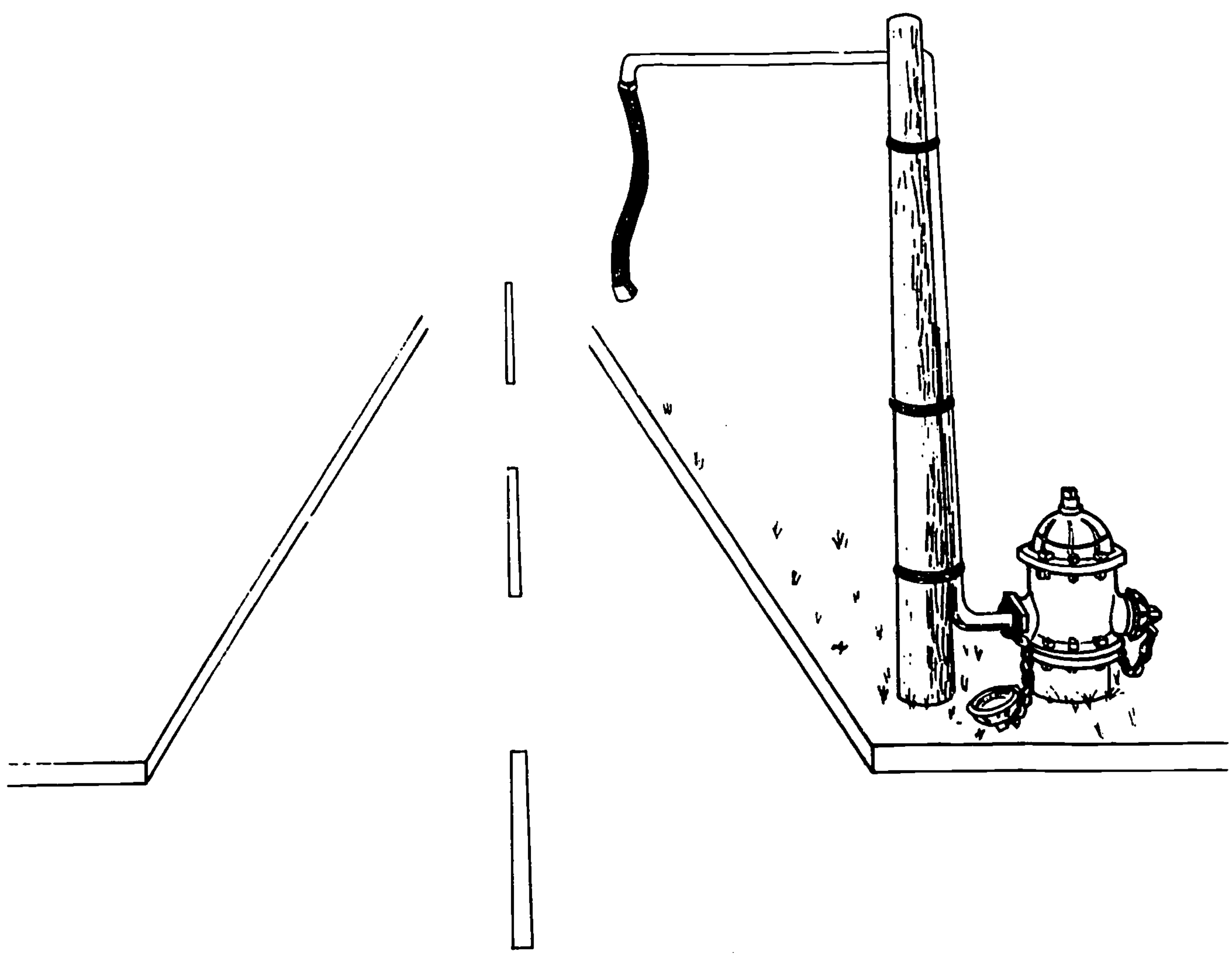

Figure 6-28. Rig for loading water trucks.

you sprinkle slowly to allow the water to soak in instead of running off. Sprinkling behind a sheepsfoot roller will also prevent the water from running off. The depressions made by the roller feet will retain the water so that it will soak in. Sprinkle just enough water so that the soil will compact well. You can't compact mud any better than you can dust.

Exercises (E62):

1. Explain the procedure for filling the tank of a water truck.

2. If you are to haul water for long distances, you should set up a fill station. What does a typical fill station consist of?

3. Explain the danger in operating a tank truck when the tank is not completely full.

4. State the most important factor in determining how well the soil can be compacted.

5. Explain the procedure in the use of the water truck when compacting soil.

ANSWERS FOR EXERCISES

CHAPTER 1

References:

B01 – 1. First aid measures for injuries such as fractures and chest wounds, for emergencies such as drowning and electric shock, and for common emergencies such as minor wounds and unconsciousness. You should learn as much as you can about first aid measures for sickness and injury resulting from industrial toxic substances.
B01 – 2. Observations of the plans, soles, nail beds, mucous membranes of the lips and mouth, and mucous membrane which lines the eyelids and is reflected onto the eyeball.
B01 – 3. Know what to do and what not to do.

B02 – 1. The four lifesaving steps are: assure breathing, stop the bleeding, protect the wound, and prevent or treat shock.
B02 – 2. Pulling clothing over the wound increases the danger of infection, and moving the wounded part may make the wound worse, as well as cause needless pain.

B03 – 1. True.
B03 – 2. True.
B03 – 3. True.
B03 – 4. True.
B03 – 5. False. The sword-swallowing position means the victim's chin and neck are stretched away from his chest.
B03 – 6. True.
B03 – 7. True.

B04 – 1. (1) a, C.
(2) b, A.
(3) a, C.
(4) b, B.
(5) c, A.
(6) c, A.
(7) b, A.
(8) c, A.
(9) a, B.
(10) c, A.

B05 – 1. You dress a wound to reduce bleeding and to protect it from infection and further injury.
B05 – 2. A dressing is a pack or padding placed directly on the wound.
B05 – 3. A bandage is the material you use to hold a dressing in place or create pressure to stop the blood flow.

B06 – 1. True.
B06 – 2. True.
B06 – 3. False. Cold and clammy skin is indicative of shock.
B06 – 4. True.
B06 – 5. False. Wine is alcoholic, and alcoholic beverages should not be given to any injured person.
B06 – 6. True.
B06 – 7. True.
B06 – 8. False. You treat for shock whenever the symptoms appear. If they don't appear, you start treating to prevent shock, after assuring breathing and stopping the bleeding.

B07 – 1. (1) a.
(2) b.
(3) c.
(4) d.
(5) e.

B08 – 1. True.
B08 – 2. True.
B08 – 3. True.
B08 – 4. False. Change "stroke" to "exhaustion."
B08 – 5. True.
B08 – 6. False. Change "6" to "12."
B08 – 7. True.
B08 – 8. True.
B08 – 9. False. Change "when he or she regains consciousness" to "at once."

B09 – 1. True.
B09 – 2. True.
B09 – 3. True.
B09 – 4. True.
B09 – 5. True.

CHAPTER 2

B10 – 1. True.
B10 – 2. True.
B10 – 3. True.
B10 – 4. True.

B11 – 1. Infection is the invasion of a person's body by disease-producing organisms.
B11 – 2. a. Skin and mucous membranes.
b. Cellular system (lymphatic system).
c. Blood system.

B12 – 1. True.
B12 – 2. True.
B12 – 3. True.
B12 – 4. True.
B12 – 5. False. Delete "toothpaste." Insert "a toothbrush alone."
B12 – 6. True.
B12 – 7. True.

B13 – 1. (1) c, B.
(2) a, E.
(3) b, D.
(4) d, A.

B14 – 1. a. 4.
b. 2.
c. 1.
d. 3.
B14 – 2. a. Iodine tablets; calcium hypochlorite ampules.
b. Calcium hypochlorite.
c. Twenty minutes after mixing.
d. One canteen.

B15 – 1. True.
B15 – 2. False. Change "is not" to "is."
B15 – 3. False. Change "are suitable" to "are not suitable."
B15 – 4. True.
B15 – 5. True.

B16 – 1. 1. c.
2. d.
3. a.
4. e.

CHAPTER 3

B17 – 1. Concealment from direct and indirect observation.
B17 – 2. Hiding.
B17 – 3. Deceiving.
B17 – 4. Choice of position, camouflage discipline, and camouflage construction.
B17 – 5. Noise and light discipline.

B18 – 1. Burnt cork, charcoal, lampblack, and mud.
B18 – 2. Paint, bands, and helmet covers.
B18 – 3. The position of the enemy force.
B18 – 4. Through use of camouflage nets.

B19 – 1. Cover.
B19 – 2. Concealment.
B19 – 3. Use both.

B20 – 1. Rushing is a technique where you start from the prone position or cover, pick a location to move to, and quickly get up and run to that position.
B20 – 2. The low crawl is pushing and pulling yourself along the ground with your weapon lying across your arm and your head low to the ground; the high crawl allows you to hold your head up and carry your weapon across your arms in front of your body.
B20 – 3. To walk at night, you lift your legs high and come down on your toes.

B21 – 1. Part of your force moves forward 10 to 15 meters at a time while the remainder of the force lays down cover fire.
B21 – 2. The only difference between individual and team fire and movement is that the number of people moving at one time is greater with team movement.

B22 – 1. To advance on a hostile position and gain a position close enough to be able to conduct an assault.
B22 – 2. To lay down sufficient fire on the hostile position to provide an effective cover for the maneuver echelon.

B23 – 1. a. To observe a large area for enemy activity.
b. To specifically locate enemy activity as you move through an area.
c. To observe a single point and record information concerning enemy activity.

B23 – 2. (1) b.
(2) 0.
(3) c.
(4) 0.
(5) a.

B24 – 1. a. Destroy a moving or temporarily halted target.
b. Attack and destroy an enemy position and then withdraw.
c. Move into an area, destroy or remove the enemy, and hold the territory.
d. Screen or cover the flanks of a position, area, or route.
e. Establish a road block to prevent enemy movement or reinforcement, seize key terrain to prevent enemy use, or act as a blocking force.

B24 – 2. (1) d.
(2) a.
(3) 0.
(4) b.
(5) e.
(6) c.

B25 – 1. a. Preparation—gather intelligence and plan counterattack.
b. Fire and maneuver—depart the line of departure and maneuver under cover fire to the final coordination line.
c. Assault—cover fire is shifted away from the maneuver echelon as they stand and assault the hostile position, retake, and secure the position.

B26 – 1. Men in kill zone assault the ambush position. Men not in kill zone maneuver against the ambush force. Eliminate the ambush or break contact as directed.
B26 – 2. Men in kill zone return fire and take available cover. Men not in kill zone maneuver against the ambush force. Eliminate the ambush or break contact as directed.

B27 – 1. To insure that all hostile forces have fled or been neutralized and all boobytraps found and disarmed.
B27 – 2. Areas and buildings previously held by an enemy are taken from enemy control and made available for occupation by friendly forces.
B27 – 3. Enter building from top; search and clear from top to bottom.
B27 – 4. Enter on second floor, search and clear second floor; proceed to top of building and search and clear down.
B27 – 5. Reconnaissance in force, flight size.
B27 – 6. Raid, squad size.

B28 – 1. No.
B28 – 2. Yes.
B28 – 3. Yes.

B29 – 1. d.
B29 – 2. c.
B29 – 3. b.
B29 – 4. e.
B29 – 5. a.

B30 – 1. b. To break up enemy attack formations and to hold or channel the enemy in areas covered by your most intensive fire.
B30 – 2. c. To camouflage the position of your primary wire barriers and to connect barriers surrounding your defensive positions.
B30 – 3. a. To prevent surprise assaults from points close to your defensive area.

B31 – 1. c.
B31 – 2. g.
B31 – 3. b, e.
B31 – 4. e.
B31 – 5. d.
B31 – 6. e.
B31 – 7. f.
B31 – 8. e.
B31 – 9. a.
B31 – 10. c.
B31 – 11. b.

CHAPTER 4

B32 – 1. a. Motor column in which a prescribed space between vehicles is maintained, regardless of speed.
b. Time-distance graph used in planning and controlling motor marches.
c. Major subdivision of a motor column, consisting of elements from one area to the same destination.
d. Number used to multiply the speedometer reading to determine vehicle distance in yards.
e. Time required for a motor column to move a certain distance at a given rate of speed.
f. Number of vehicles passing a given point within a given time period.
g. A convoy of general-purpose vehicles which do not exceed legal limitations and which are not carrying hazardous cargo.
h. A convoy of vehicles exceeding legal size limitations or traveling at unusually slow speed.

B33 – 1. The amount and type of cargo that is to be moved.
B33 – 2. It is used to gather information concerning the route and the adjacent areas for planning the move.
B33 – 3. Number and type vehicles needed.
B33 – 4. Maps; forecasters; fuel (or repairs, rations, water); points (or bottlenecks).

B34 – 1. Base transportation officer in coordination with the security police officer.

E34 – 2. Security officer.
E34 – 3. The American Trucking Association, Inc.
E34 – 4. State, local military, and Director of Transportation, Headquarters USAF.
E34 – 5. DD Forms 1265 and 1266.

E35 – 1. Vehicle spacing.
E35 – 2. Close column march.
E35 – 3. Open column march.
E35 – 4. Because to an enemy observer, the move looks like ordinary traffic flow.
E35 – 5. (1) Requires the greatest amount of time to complete a move.
(2) Internal control of the column is difficult.
(3) Usually requires more detailed briefing of drivers.
(4) Maintenance, refueling, and messing are sometimes difficult to arrange.
(5) Tactical employment of unit may be difficult during march.

E36 – 1. 60 miles.
E36 – 2. 1100 hours.
E36 – 3. 1130 hours.
E36 – 4. 7 miles.
E36 – 5. Jackson Heights.

E37 – 1. A convoy of two vehicles would have more than one function performed by each vehicle. Normally, both vehicles are load-carrying and would constitute the main body. The lead vehicle carries the individual in charge (head), and the second vehicle would act as the trail.
E37 – 2. A detached party operates apart from the column and performs special duties in advance of or following the convoy.
E37 – 3. The head of the convoy follows the prescribed route, checks in at scheduled points, receives orders or changes in orders, issues instructions as required, and coordinates with civil authorities along the route.
E37 – 4. The pace setter (usually slowest vehicle).
E37 – 5. By subdividing the convoy into serials and, where necessary, march units. Each of these has a commander.
E37 – 6. The 19th vehicle in the 4th serial.

E38 – 1. Signs, written messages (delivered by messenger or guide), two-way radios, sounds, and signals (such as hand and arm signals).
E38 – 2. Written message or two-way radio.
E38 – 3. Signs posted on roadway.

E39 – 1. They provide for periods of rest, personal comfort, and relief, messing, refueling, maintenance and inspection of equipment, and allowing other traffic to pass.
E39 – 2. They should be scheduled to allow 10 minutes rest after each 110 minutes of driving time.
E39 – 3. (1) The comfort of personnel and (2) servicing facilities for vehicles.

CHAPTER 5

Reference:

E40 – 1. (1) f; (2) d; (3) h; (4) j; (5) b; (6) k; (7) e; (8) i.

E41 – 1. T.
E41 – 2. F. Large.
E41 – 3. T.
E41 – 4. F. 5 gallons is appropriate for a temperate zone.
E41 – 5. F. Increases.

E42 – 1. Mark the can. Then clean and disinfect them before they are used to carry potable water again.
E42 – 2. One bag.
E42 – 3. By evaporation.
E42 – 4. Treat them with a strong chlorine solution and rinse several times with potable water.
E42 – 5. To prevent water from collecting.
E42 – 6. Add calcium hypochlorite ampules until the prescribed residual is reached.

E43 – 1. c.
E43 – 2. a.
E43 – 3. c.
E43 – 4. a.
E43 – 5. c.
E43 – 6. b.
E43 – 7. a.
E43 – 8. b.

E44 – 1. Calcium hypochlorite.
E44 – 2. Enough to fulfill the chlorine demand and have some chlorine residual.

E45 – 1. 1/4 gallon per minute.
E45 – 2. 5.
E45 – 3. It must be disinfected.
E45 – 4. 5 ppm.
E45 – 5. 300 pounds.
E45 – 6. 3.
E45 – 7. 30 minutes.
E45 – 8. Orthotolidine.
E45 – 9. It is equal or greater.

E46 – 1. (1) C, I; (2) B; (3) B; (4) C, I; (5) I; (6) C; (7) C; (8) B.
E46 – 2. Fuel is needed; long time required for water to boil and then cool; no protection from recontamination.
E46 – 3. Have no physical changes; must be steel gray in color; should not be stuck together or be crumbled.
E46 – 4. 15 seconds.
E45 – 5. Medical services.

E47 – 1. You should have placed a checkmark (1), (3), (5), (6), (7), (9), (10), (12), (14), (15), and (17).

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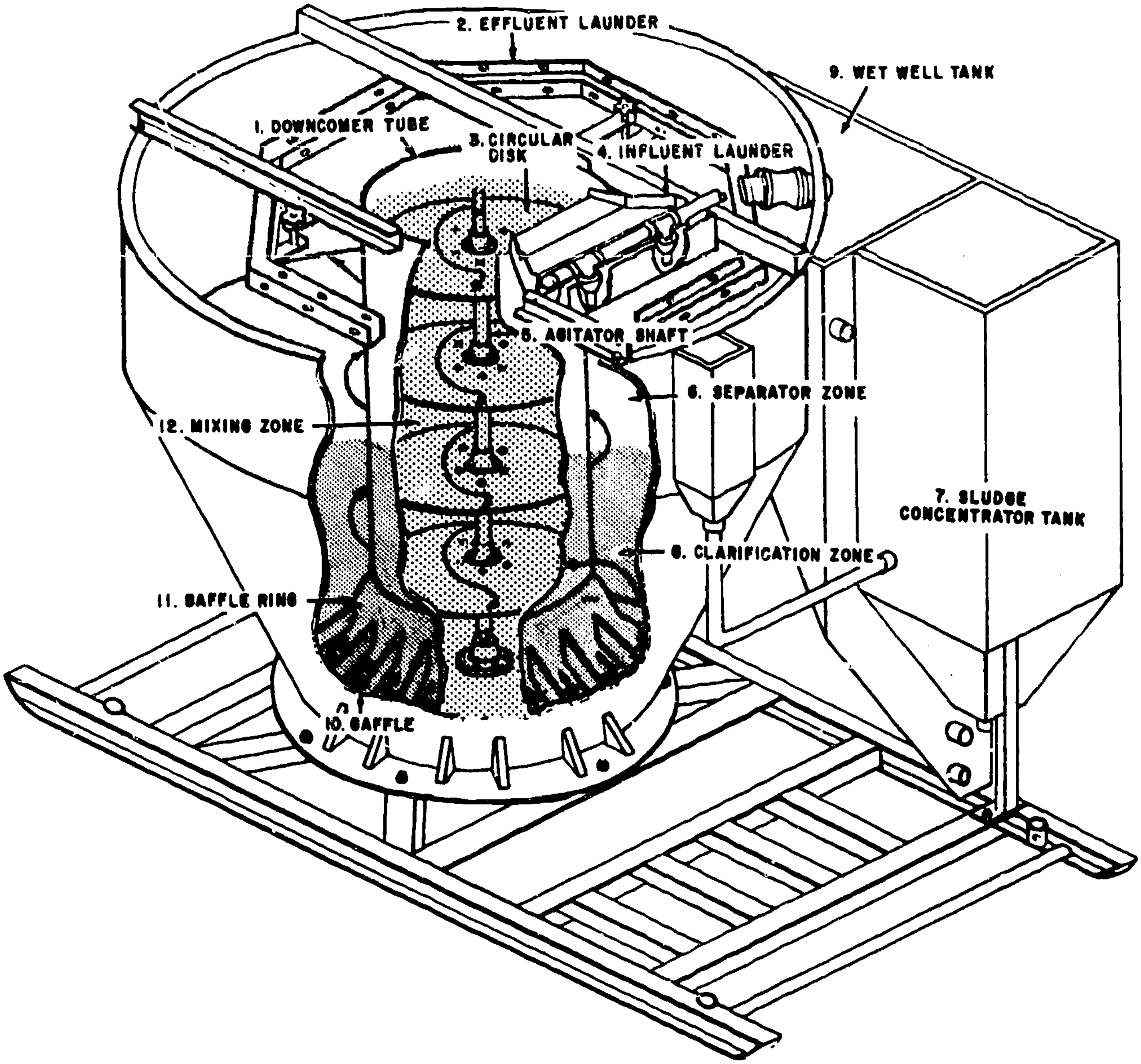

Figure 1. Answer for objective E54, exercise 1.

E48 – 2. Effluent; distomite.
E48 – 3. Aspirator; aerates.
E48 – 4. Ferric chloride; limestone; calcium hypochlorite; activated carbon.
E48 – 5. Flat, circular.
E48 – 6. Baffles; counter; clarification.
E48 – 7. Slurry.
E48 – 8. Separator.
E48 – 9. Wet well; filter.
E48 – 10. Sludge concentrator.
E48 – 11. Gravity.
E48 – 12. Stopped.
E48 – 13. Incoming supply.
E48 – 14. Flocculent.
E48 – 15. Auxiliary.
E48 – 16. Upflow; slurry.
E48 – 17. Manually.

E49 – 1. Concentrated diatomaceous earth slurry.
E49 – 2. Effluent, influent, and wash ring.
E49 – 3. Influent.
E49 – 4. Filter elements.
E49 – 5. Cylindrical baffle.
E49 – 6. Plug; flow; gate; drain gate.
E49 – 7. Influent.
E49 – 8. Shell dome.
E49 – 9. By 2 pipes, 1 at the base and 1 at the top.
E49 – 10. Plastic.
E49 – 11. The filter shell dome and release value.
E49 – 12. Wires.
E49 – 13. Filter.
E49 – 14. Influent; effluent.
E49 – 15. Filter aid; foreign matter.

E50 – 1. Pulverized limestone, activated carbon, diatomite slurry, ferric chloride, and calcium hypochlorite solution.
E50 – 2. Pulverized limestone to the erdlator as a coagulant aid; activated carbon to the erdlator to remove taste and color; diatomite slurry to the suction inlet of the filter pump pumped to the filter as a filter aid; ferric chloride in the mixing zone of the erdlator, serving as a coagulant; calcium hypochlorite solution in the mixing zone of the erdlator, serving as a disinfectant.

E51 – 1. (1) e; (2) f; (3) d; (4) a; (5) c; (6) b; (7) g.

E52 – 1. Only if you are a member of the advance party.
E52 – 2. 50 feet or less.
E52 – 3. X.
E52 – 4. X
E52 – 5. X.
E52 – 6. The raw water source should not be near a latrine.
E52 – 7. X.
E52 – 8. Should be on planks or timbers.
E52 – 9. Should be downstream.

E53 – 1. B.
E53 – 2. B, A.
E53 – 3. B.
E53 – 4. B.
E53 – 5. B, A.
E53 – 6. B, A.
E53 – 7. B.
E53 – 8. B.
E53 – 9. B.
E53 – 10. B.
E53 – 11. B.
E53 – 12. B.
E53 – 13. D.
E53 – 14. D.
E53 – 15. D.
E53 – 16. A.
E53 – 17. B, A.
E53 – 18. A.
E53 – 19. A.
E53 – 20. A.

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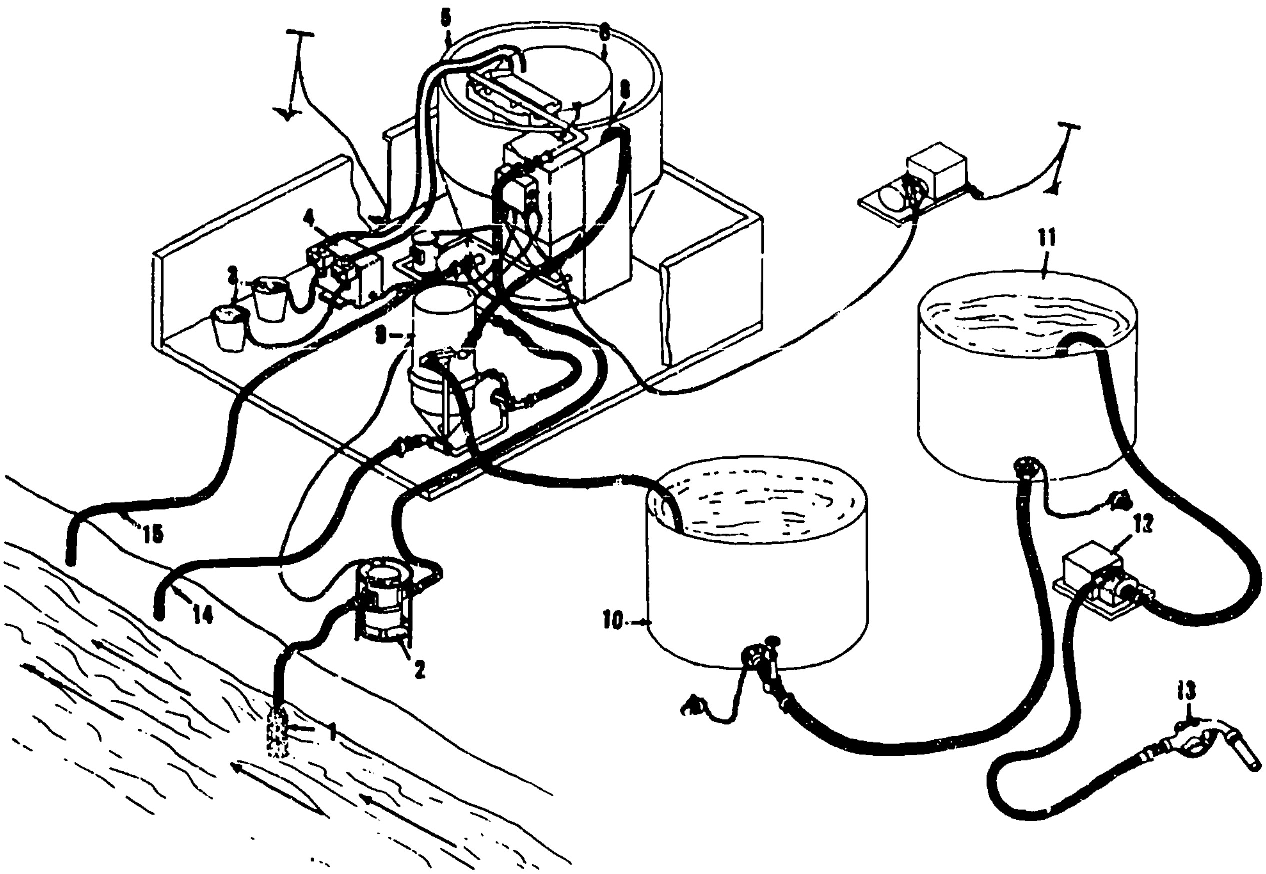
E54 – 1.



1 STRAINER
2 RAW WATER PUMP
3 RUBBER PAILS
4 CHEMICAL SOLUTION FEEDER
5 ERDLATOR TANK
6 DOWNCOMER
7 SLUDGE CONCENTRATION TANK
8 WET WELL
9 DIATOMITE FILTER
10 FIRST FILTERED WATER STORAGE TANK
11 SECOND FILTERED WATER STORAGE TANK
12 DISTRIBUTION PUMP
13 DISTRIBUTION NOZZLE
14 FILTER WASTE WATER HOSE
15 ERDLATOR TANK WASTE WATER HOSE

CND-019

Figure 2. Answer for objective E59, exercise 1.

E54 – 2. Strainer. Removes large particles of foreign matter from raw water.

Raw water pump. Supplies raw water from source to unit.
Rubber pails. Contain ferric chloride and calcium hypochlorite solution for coagulation and disinfection.
Chemical solution feeder. Two pumps operated through a gearbox by one motor; chemicals pumped from rubber buckets to the mixing zone.
Erdlator tank. Where the mixing and purification takes place.
Downcomer. Mixing zone.
Sludge concentration tank. Functions as a small auxiliary clarifier.
Wet well. Provides limited storage of coagulated water and serves as a sump for the filter pump.
Diatomite filter. Filters suspended solids from water.
First filtered water storage tank. Stores treated water for future use.
Second filtered water storage tank. Same as first tank.
Distribution pump. Gasoline engine driven; supplies waterflow to users.
Distribution nozzle. Similar to gasoline pump nozzle used to dispense water.
Filter waste-water hose. Provides path for waste water from filter, and is placed downstream from intake.
Erdlator tank waste-water hose. Provides path for waste water from erdlator; also placed downstream from intake.

E55 – 1. You should have placed a checkmark beside (1), (3), (4), (6), (8), (10), and (11) through (15).

CHAPTER 6

B56 – 1. 500 to 700.
B56 – 2. Check data plate on dash.
B56 – 3. Engage the clutch, and pull PTO lever toward seat.
B56 – 4. A large hydraulic jack.

B57 – 1. Crossed.
B57 – 2. 2½ to 10 tons; 18 to 40 feet long and 8 to 10 feet wide.
B57 – 3. Lower.
B57 – 4. To block the trailer wheels with woodblocks.

B58 – 1. Poor steering with limited visibility.
B58 – 2. Manufacturer's specifications.

B59 – 1. Insure stability.
B59 – 2. Load binders.
B59 – 3. 4.

B60 – 1. Move it parallel with the ground with the cutting edge skimming the surface while moving loader forward at slow speed; increase power as the cutting edge contacts the bank or stockpile. Then raise and roll the bucket back to prevent spilling.
B60 – 2. Loading; it can be used for loading by either a regular bucket by driving into the stockpile or by use of the clamshell engaged to the dozer position. Excavating; it can be used to dig or excavate. Start by leveling the bucket with the ground, then drive forward and tilt bucket forward until it penetrates the ground and bucket is filled.
B60 – 3. One set controls the bucket; the other controls the engine, transmission, and brakes.
B60 – 4. One is used to raise, hold, lower, and float the bucket; one to tilt the bucket or forks; and one to open and close the clamshell.
B60 – 5. Dozer.
B60 – 6. Clamshell.
B60 – 7. In soft to medium materials, and when working on flat, smooth, surfaces with proper space to maneuver.
B60 – 8. It is affixed to the boom.

B61 – 1. The three-point hitch, which provides three separate points at which an attachment is connected.
B61 – 2. The upper link adjustment and the right lower link adjustment.
B61 – 3. It provides operating power from the tractor engine to the mounted or attached equipment.
B61 – 4. Never engage the PTO unless PTO-driven equipment is attached. Never step down from the tractor until after disengaging the PTO.
B61 – 5. Draft, position, and response controls.
B61 – 6. Plows, harrows, and mowers.

B62 – 1. For normal operation on a base with fire hydrants, you connect a fire hose onto the hydrant, then put several feet of hose in the tank and tie it or have someone hold it, and then use a wrench to turn water on.
B62 – 2. A pole set in the ground near the hydrant, a pipe connected to the hydrant, and the pipe strapped to the pole.
B62 – 3. If you make a sudden turn, the water sloshing from side to side may cause the truck to tip over, because the ballast plates are normally designed only to reduce water movement forward and backward.
B62 – 4. The degree of moisture in the soil.
B62 – 5. Sprinkle water slowly so that it will soak instead of running off and apply just enough so that the soil will compact well.

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S T O P – 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

56650 08 21
GENERAL CONTINGENCY RESPONSIBILITIES

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet .
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover your answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you have to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If mandatorily enrolled student, process questions or comments through your unit trainer or OJT supervisor. If voluntarily enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the Learning Objective Number where the answer to that item can be located. When answering the items on the VRE, refer to the Learning Objectives indicated by these Numbers. The VRE results will be sent to you on a postcard which will list the actual VRE items you missed. Go to the VRE booklet and locate the Learning Objective Numbers for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

Note to Student: Consider all choices carefully and select the best answer to each question.

1. (E01) As it pertains to administering first aid, which one of the following statements is incorrect?

   a. First aid refers to the treatment given the sick and injured before a trained individual can administer medical treatment.
   b. In administering first aid, it is alright to attempt treatment that may be beyond your skill.
   c. In administering first aid, it is important to know what to do and what not to do.
   d. A person administering first aid deals with the whole situation.

2. (E02) Of the four lifesaving steps applicable to administering first aid, which one of the four should be taken first?

   a. Protect the wound.
   b. Stop the bleeding.
   c. Clear the airway.
   d. Treat for shock.

3. (E03) As it pertains to administering first aid, which of the following statements is incorrect?

   a. When a victim is unconscious their jaw muscles will relax and sometimes allow the tongue to roll backward and block the throat.
   b. Usually you have to drive your fingernails into a victim's tongue to hold it firmly.
   c. You must use extreme care in removing obstructing matter from a victim's airway.
   d. When someone stops breathing you must establish and open an airway at once.

4. (E04) Usually, a tourniquet would be used to control which type of bleeding?

   a. Venous.
   b. Arterial.
   c. Capillary.
   d. All of the above.

5. (E05) To insure that you do not contaminate a wound,

   a. probe the wound for fragments, apply a sterile dressing, and use a bandage to hold the dressing in place.
   b. don't touch the wound, apply a sterile dressing, and use a bandage to hold the dressing in place.
   c. tear up your undershirt for a bandage and apply it directly to the wound.
   d. any of the above actions are acceptable.

6. (E05) Which of the following treatments must be administered in all casualty situations?

a. Treat for shock.
b. Stop the bleeding.
c. Restore breathing.
d. Apply bandages and dressings.

7. (E06) An indication that a victim has gone into the final stages of deep shock would be that he or she is

a. gasping for air.
b. excessively thirsty.
c. retching and vomiting.
d. listless and apathetic.

8. (E07) Which method is best for transporting a victim a short distance when you are alone and are not exposed to gunfire?

a. Litter carry.
b. Two-hand carry.
c. Fireman's carry.
d. Pistol belt drag.

9. (E08) Of the following heat conditions, which one, if any, is the most severe?

a. Heat stroke.
b. Heat cramps.
c. Heat exhaustion.
d. All are about the same.

10. (E08) Which one of the following first aid measures is applied in the treatment of heat stroke, heat exhaustion, and heat cramp victims?

a. Massage the affected area.
b. Give the victim water containing salt.
c. Immerse the body in the coldest water possible.
d. Immediately transport the victim to the nearest medical facility.

11. (E09) Of the following cold weather injuries, which one is considered to be the most severe?

a. Snow blindness.
b. Immersion foot.
c. Trench foot.
d. Frostbite.

12. (E09) In a frostbite situation, if your body part has been numb for only 5 to 10 minutes you should

a. report to the nearest medical facility.
b. place the affected area in cold water.
c. treat yourself for skin frostbite.
d. rub or massage the affected area.

13. (E10) Foods form each of the seven recommended food groups should be eaten

a. daily.
b. weekly.
c. monthly.
d. when they are offered.

14. (E11) The third line of defense that your body provides to combat infection is your

a. skin.
b. blood.
c. mucous membranes.
d. lymphatic system.

15. (E12) Clothing that cannot be washed should be hung in the sun to

a. reduce wrinkles.
b. fade the material.
c. brighten the material.
d. combat the presence of disease germs.

16. (E13) What is usually the cause of ingrown toenails?

a. Improper toenail cutting.
b. Socks are too small.
c. Socks are too large.
d. Fungus.

17. (E14) Under field conditions, water must be certified to be safe for use by

a. the commander.
b. the base engineer.
c. medical personnel.
d. sanitation personnel.

18. (E14) If you are near a lake in a field situation and need water, the lake water can be used for drinking purposes if you observe which of the following precautions?

a. Skim any film or contaminates from the surface, fill your canteen, and drink.
b. If the water is clear, dissolve one iodine tablet in a canteen of water, and drink.
c. If the water is clear, dissolve two iodine tablets in a canteen of water, and drink.
d. If the water is clear, dissolve one iodine tablet in a canteen of water and wait 20 minutes before drinking.

19. (E15) A bulging can of food will most likely indicate

a. contaminated contents.
b. an overheated can.
c. rough treatment.
d. poor storage.

20. (E16) How deep is a temporary straddle trench latrine?

a. 1 1/2 feet.
b. 2 1/2 feet.
c. 3 1/2 feet.
d. 4 1/2 feet.

21. (E17) What is the primary disadvantage of indirect observation?

a. It is costly in human lives.
b. It produces a record of the area observed.
c. It is far reaching and covers large areas.
d. Photography covers a short period of time.

22. (E18) If you should be surprised by the light from a flare,

a. run for the nearest cover.
b. drop to the ground and remain motionless.
c. freeze in place with your face pointed down toward the ground.
d. freeze in place and look toward the direction of the flare to detect and fire on any enemy movement.

23. (E20) In the rushing technique of moving from one spot to another, what is the maximum distance you should try to rush at one time?

a. 20 meters.
b. 15 meters.
c. 10 meters.
d. 5 meters.

24. (E21) What is usually the safest way for a unit to move when it is under heavy fire?

a. By squads.
b. As a unit.
c. In groups of 2 or 3.
d. By individual movement.

25. (E22) When dividing your force into a base-of-fire echelon and a maneuver echelon, the two factors to be considered are the

a. situation and the division of the unit so as not to disrupt the integrity of its elements.
b. element of surprise and the time of day.
c. time of day and the available cover.
d. time of day and the situation.

26. (E23) What type of patrol would be identified with the assigned task of locating specific enemy positions and reconfirming previous data?

a. Area surveillance.
b. Area reconnaissance.
c. Point reconnaissance.
d. None of the above patrols.

27. (E24) Which of the follwoing combat patrols has the mission of screening or covering the flanks of your position or area?

a. Economy of force patrol.
b. Search and clear patrol.
c. Security patrol.
d. Ambush patrol.

28. (E24) What type of partol would best be utilized to act as a blocking force to allow a major effort to be made without interference at another location?

a. Economy of force patrol.
b. Security patrol.
c. Ambush patrol.
d. Raid patrol.

29. (E25) In a combat assault, the "base" man is used for

a. acting as a rear guard.
b. assisting in the evacuation of wounded.
c. giving cover fire to the advancing forces.
d. controlling the speed or direction of the assault.

30. (E26) Of the examples given below, identify the one that differentiates between actions to be taken in near and far ambush.

a. Always assault or attack the ambush position.
b. Retreat as rapidly as possible without awaiting orders.
c. Those personnel not in the kill zone maneuver against the ambush.
d. The attack or return fire is continued until the enemy position is destroyed or you are ordered to break contact.

31. (E27) The primary objective of a "search and clear" operation is to

a. capture enemy hostages.
b. gain control of enemy territory.
c. obtain usable space for use by friendly troops.
d. eliminate hostile forces and remove booby traps.

32. (E27) For "search" operations, the best place to enter a building is

a. from the top.
b. through the basement.
c. at the first floor level.
d. at any existent middle floor.

33. (E27) What is considered to be the key feature of a raid?

a. Complete the raid and slowly withdraw to encourage further action with the enemy forces.
b. Complete the raid then withdraw immediately from enemy territory.
c. Penetrate the enemy territory slowly by using extreme caution.
d. Penetrate and hold enemy territory with a large force.

34 (E28) The degree of protection to be gained form field fortifications is determined by

a. the construction and strength of the fortification.
b. how well you distribute the fortifications within the tactical defense.
c. how well you adapt the fortifications to the terrain and conceal them from enemy observation.
d. any or all of the above factors.

35. (E29) Of the following defensive positions, which one would provide the most protection?

a. Foxhole.
b. Shell crater.
c. Hasty emplacement.
d. Prone emplacement.

36. (E30) Which type of a barrier would be best suited for breaking up enemy attack formations and channeling the enemy into areas covered by most intensive fire?

a. Supplementary.
b. Protective.
c. Tactical.
d. Belt.

37. (E31) Which of the following factors should be considered when planning to erect a perimeter fence?

a. The fence must have depth.
b. All forms of concealment should be removed.
c. It must be effectively covered by defensive fire.
d. All of the above factors should be considered.

38. (E32) Using convoy terms, the average speed of a motor column over a period of time that include short periodic halts would be referred as the

a. time distance.
b. rate of march.
c. march graph.
d. march unit.

39. (E33) The number and type of vehicles needed for a convoy is determined by

a. the amount and type of cargo.
b. the distance to travel.
c. the Personnel involved.
d. all of the above factors.

40. (E34) Vehicles transporting explosives must be equipped with warning signs. Where are such signs posted on the vehicles?

a. Front.
b. Rear.
c. Both sides.
d. All of the above locations.

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41. (E35) As it pertains to close column formations, which of the following statements is false?

a. Close column formations provide for rapid dispersion of vehicles.
b. Column control is increased when the vehicles are closer together.
c. Communications are better and fewer guides, escorts, and markers are needed.
d. In a close column formation, the full traffic capacity of the traffic lane can be used.

42. (E36) A "march graph" is used

a. for recording the progress of a convoy over a given route.
b. for planning movement of a convoy over a given route.
c. to control the movement of a convoy over a given route.
d. to accomplish each of the above actions.

43. (E38) Which one of the following selections identifies the best type of intracolumn communication for convoy control?

a. Two way radios.
b. Visual and arm signals.
c. Flags of different colors and shapes.
d. Whistles or other audible sounding devices.

44. (E39) When convoy columns are halted there should be a minimum of how many yards of clear visibility to the front and to the rear of the column?

a. 400.
b. 300.
c. 200.
d. 100.

45. (E39) During convoy halts, it is the responsibility of officers and noncommissioned officers to

a. check vehicles and perform operator maintenance.
b. post guards and check vehicle tires for proper inflation.
c. make necessary inspections to insure resumption of movement of the column.
d. check security of loads, welfare of personnel, and performance of operator maintenance.

46. (E40) Which of the following chemicals is used to disinfect water?

a. Calcium chloride.
b. Calcium hypochloride.
c. Magnesium chloride.
d. Magnesium hypochloride.

47. (E40) The amount of chlorine added to water is computed by the amount of

a. dosage plus residual.
b. demand minus residual.
c. demand plus residual.
d. residual minus dosage.

48. (E41) If shower facilities are provided at an installation in a temperate zones, how much water should be available per man per day?

a. 10 gallons.
b 15 gallons.
c. 20 gallons.
d. 25 gallons.

49. (E41) Water requirements of five gallons per person per day is planned for a climate which is

a. cold.
b. arid.
c. semiarid.
d. temperate.

50. (042) What is the chemical dosage of disinfectant used to decontaminate water cans?

a. One ampule to one gallon of water.
b. One ampule to two gallons of water.
c. Two ampules to one gallon of water.
d. Two ounces to one gallon of water.

51. (E42) What is used when cleaning Lyster bags?

a. Lye solution.
b. Soap solution.
c. Chlorine solution.
d. Detergent solution.

52. (E43) To obtain water from a stream, the intake should be located

a. downstream from any source of contamination.
b. upstream from any source of contamination.
c. on the bottom of the stream bed.
d. just below the water surface.

53. (E44) Sea water may be treated to remove contaminates by

a. distillation.
b. chemical coagulation.
c. precipitation of the contamination.
d. filtering with a diatomite filter.

54. (E45) By using two filter pads simultaneously, how much muddy water can normally be filtered with a knapsack filter unit before the filters become plugged?

a. 5 gallons.
b. 10 gallons.
c. 15 gallons.
d. 20 gallons.

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55. (E45) How much chlorine residual should normally be present in the water after a 30-minute contact time?

a. 2 ppm.
b. 3 ppm.
c. 4 ppm.
d. 5 ppm.

56. (E45) What is the initial dosage of calcium hypochlorite that should be placed in a 36-gallon Lyster bag?

a. One ampule.
b. Two ampules.
c. Three ampules.
d. Four ampules.

57. (E45) What color should be obtained when testing the chlorine residual?

a. Red.
b. White.
c. Clear.
d. Yellow.

58. (E46) How many iodine tablets should be used to disinfect cloudy water in a canteen and how long should the water set before using it?

a. One tablet and ten minutes.
b. Two tablets and ten minutes.
c. Two tablets and twenty minutes.
d. One tablet and twenty minutes.

59. (E46) How long should you let the chlorine set in the canteen before using the water?

a. 10 minutes.
b. 15 minutes.
c. 20 minutes.
d. 30 minutes.

60. (E46) How long should you keep water at a rolling boil to assure safe water?

a. 20 seconds.
b. 15 seconds.
c. 10 seconds.
d. 5 seconds.

61. (E47) The primary purpose of the mobile water purification unit is to produce

a. safe, germ-free water for human consumption.
b. clear, clean water for general purposes.
c. pure water from lakes and streams.
d. pure, soft water for laundry purposes.

62. (E47) The 600 gallon-per-hour mobile water purification unit is mounted on

a. a 2-ton truck.
b. four-by-four skids.
c. a two-wheel trailer.
d. a four-wheel trailer.

63. (E48) The slurry level in the erdlator tank is controlled by

a. continually withdrawing slurry from the top of the slurry pool.
b. regulating the amount of slurry added to the filter elements.
c. placing any excess slurry in a holding tank.
d. directing the excess slurry to waste.

64. (E48) When water in the wet well of the erdlator is unsuited for filtering, the operator should

a. extend the retention period in the wet well.
b. recirculate the water through the erdlator.
c. add chemicals to the wet well.
d. drain the water to waste.

65. (E48) The sludge concentration tank

a. provides a longer holding period for slurry concentration.
b. drains the flocculant concentration from the system.
c. increases the upflow to the erdlator.
d. mixes the clear water with the slurry.

66. (E49) The filter in the erdlator is divided into three sections, they are the

a. concentrator, wet well, and wash ring.
b. influent section, wet well, and wash ring.
c. effluent section, concentrator, and wet well.
d. effluent section, influent section, and wash ring.

67. (E49) The air release valve in the filter section

a. forces waste out under air pressure.
b. releases air in the dome of the filter.
c. prevents aeration of the slurry.
d. aerates the effluent.

68. (E50) The chemical feeders are used to supply

a. calcium hypochlorite and calcium chloride.
b. ferric chloride and calcium hypochlorite.
c. calcium chloride and ferric chloride.
d. calcium sulfate and ferric chloride.

69. (E51) Which one of the following components is <u>not</u> a minor component of the field purification unit?

a. The generator.
b. The distribution pump.
c. The diatomaceous earth filter.
d. The raw water and filter pumps.

70. (E52) It is recommended that the maximum distance separating the mobile water purification unit and the raw water source not be in excess of

a. 10 feet.
b. 25 feet.
c. 50 feet.
d. 100 feet.

71. (E53) Maintenance service on field purification units include

a. daily, weekly, and monthly services.
b. startup, operation, and shutdown services.
c. filling, operating, and draining services.
d. preoperation, during operation, and after operation services.

72. (E54) Ferric chloride is used with the field purification unit as

a. an absorber.
b. a coagulant.
c. a filter aid.
d. a disinfectant.

73. (E54) Activated carbon is used in the field purificati nit to

a. disinfect the water.
b. coagulate the limestone.
c. filter out the coagulant.
d. control objectionable odors and tastes.

74. (E55) Ferric chloride and calcium hypochloride should never be mixed because they

a. give off a suffocating chlorine gas.
b. become extremely flammable.
c. are highly corrosive.
d. may explode.

75. (E56) The length of materials that can be carried by a truck is governed by

a. state laws.
b. the type of material carried.
c. the data plate capacities.
d. the method of securing the load.

76. (E56) If you drive through an area of heavy traffic with an oversized load, you should

a. have spotters.
b. not exceed 5 mph.
c. stop all traffic.
d. get a Security Police escort.

77. (E56) To engage the power take off (PTO) on a dump truck,

a. accelerate engine in neutral.
b. drive forward 15 mph.
c. depress the clutch.
d. hold the brake.

78. (E57) The "fifth wheel"

a. is the spare tire.
b. is the landing gear.
c. is the steering wheel.
d. couples the tractor and trailer.

79. (E57) To be certain the tractor and trailer are securely coupled,

a. try pulling the tractor forward with the trailer brakes set.
b. jack the trailer up with the landing gear.
c. drive forward rapidly.
d. drive forward slowly.

80. (E57) The safest way to stop a tractor-trailer on steep grades or slippery surfaces is to apply the

a. tractor brakes only.
b. trailer brakes only.
c. trailer brakes first, then the tractor brakes.
d. tractor brakes first, then the trailer brakes.

81. (E58) What is the moment, in inch-pounds, if a 75 lb. weight is placed 20 inches from the pivot point?

a. 150.
b. 1500.
c. 3.75.
d. 37.5.

82. (E59) The rough terrain forklift can be converted for use as

a. a dozer.
b. a scraper.
c. a front end loader.
d. any of the above equipment.

83. (E59) When transporting a load with a rough terrain fork life, raise the load

a. above the chassis for stability.
b. above the chassis for visibility.
c. just high enough to clear the ground.
d. to a position level with axle centers.

84. (E60) When using the front-end loader, approximately how far should the bucket be off the ground when carrying a load to a dump site?

a. 12 inches.
b. 24 inches.
c. 36 inches.
d. 48 inches.

85. (E60) To maintain front-end loader efficiency when handling sticky material that has a tendency to cling to the bucket, you should

a. use the one-piece bucket equipped with bolt-on teeth.
b. lubricate the bucket with diesel fuel oil.
c. apply water to the bucket to keep it wet.
d. use a clamshell-type bucket.

86. (E60) A front-end loader will maintain its highest efficiency rate when

a. working on flat smooth surfaces with proper space to maneuver and with material that is of soft to medium consistency.
b. working on flat smooth surfaces with proper space to maneuver.
c. working on flat surfaces and loading medium to hard material.
d. when loading soft to medium material.

87. (E61) Why are industrial tractors equipped with larger rear tires than those of a farm tractor?

a. For more traction.
b. For better control.
c. Because of the heavier load they are subjected to.
d. To reduce maintenance due to their heavy use.

88. (E61) One characteristic of the floating drawbar is that it

a. is free to swing the width of the support bar for easier steering.
b. is adjustable up and down to match the height of the equipment to be used.
c. is adjustable up and down and swings from side to side for easier steering.
d. consists of a flat U-shaped drawlink for better load-carrying capabilities.

89. (E61) To operate the PTO on a tractor, the gear shifts must be in which position?

a. Forward.
b. Reverse.
c. Neutral.
d. Any of the above.

90. (E62) Ballast plates are used inside the tank of a water truck to

a. distribute the water evenly.
b. reduce the water movement forward and backward.
c. reduce the water movement from side to side when turning a corner.
d. reduce the water movement from side to side and forward and backward.

END OF EXERCISE

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ATC/ECI SURVEY

The remaining questions (125-135) are not part of the Volume Review Exercise (VRE). These questions are a voluntary ATC/ECI survey. Using a number 2 pencil, indicate what you consider to be the appropriate response to each survey question on your answer sheet (ECI Form 35), beginning with answer number 125. Do not respond to questions that do not apply to you. Your cooperation in completing this survey is greatly appreciated by ATC and ECI. (AUSCN 100)

PRIVACY ACT STATEMENT

A. Authority: 5 U.S.C. 301, Departmental Regulations

B. Principal Purpose: To gather preliminary data evaluating the ATC/ECI Career Development Course (CDC) Program.

C. Routine Uses: Determine the requirement for comprehensive evaluations in support of CDC program improvement.

D. Whether Disclosure is Mandatory or Voluntary: Participation in this survey is entirely voluntary.

E. Effect on the Individual of not Providing Information: No adverse action will be taken against any individual who elects not to participate in any or all parts of this survey.

QUESTIONS:

125. If you have contacted ECI for any reason during your enrollment, how would you describe the service provided to you?

a. Excellent.
b. Satisfactory.
c. Unsatisfactory.
d. Did not contact ECI.

126. My ECI course materials were received within a reasonable period of time.

a. Strongly agree.
b. Agree.
c. Disagree.
d. Strongly disagree.

127. The condition of the course materials I received from ECI was:

a. A complete set of well-packaged materials.
b. An incomplete set of well-packaged materials.
c. A complete set of poorly packaged materials.
d. An incomplete set of poorly packaged materials.

MAIL TO: ECI, GUNTER AFS AL 36118-5643

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012. PRINCIPAL PURPOSE: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package, and used by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's inquiry. Failure to provide all information would result in slower action or inability to provide assistance to the student.

I. CORRECTED OR LATEST ENROLLMENT DATA

1. THIS REQUEST CONCERNS COURSE (1-6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7-15)	6. GRADE/RANK	7. NAME (First initial, second initial, last name) (17) (18) (19-32)

8. ADDRESS	
OJT ENROLLEES Address of unit training office with zip code.	(33-53)
ALL OTHERS Current mailing address with zip code.	(54-75)

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33-39)

II. REQUEST FOR MATERIALS, RECORDS, OR SERVICE

X	Place an "X" through number in box to left of service requested.
1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction. *(Provide Old or Incorrect data here)*
4	Request Grade/Rank change/correction.
5	Correct SSAN. *(List incorrect SSAN here.)* *(Correct SSAN should be shown in Section I.)*
6	Extend course completion date. *(Justify in "Remarks")*
7	Request enrollment cancellation. *(Justify in "Remarks")*
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 10 Originals were: [ ] Not received [ ] Lost [ ] Misused
9	Send course materials. *(Specify in "Remarks")* [ ] Not received [ ] Lost [ ] Damaged
10	Course exam not yet received. Final VRE submitted for grading on ________ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 10 not yet received. Answer sheet(s) submitted ________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on ________ (date).
13	Previous inquiry ([ ] ECI Fm 17, [ ] ltr, [ ] msg) sent to ECI on ________ (date).
14	Give instructional assistance as requested on reverse.
15	Other *(Explain fully in "Remarks")*

FOR ECI USE ONLY

16		
G	33	
K	VOL 33-35	GR 36-38
M	33-34	35-40
N	33-35	
P	VOL 33-35	
P	TC 36-37	38
P	DOE 39-45	
Q	33-34 ØØ	38 1
Q	MC 39-42	

REMARKS *(Continue on reverse)*

OJT STUDENTS must have their OJT Administrator certify this record. *ALL OTHER STUDENTS may certify their own requests.*	*I certify that the information on this form is accurate and that this request cannot be answered at this station.* SIGNATURE

ECI FORM 17 DEC 84 PREVIOUS EDITION WILL BE USED.

BEST COPY AVAILABLE

REQUEST FOR INSTRUCTOR ASSISTANCE

NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

VRE ITEM QUESTIONED:	MY QUESTION IS:
COURSE NO ______	
VOLUME NO ______	
VRE FORM NO ______	
VRE ITEM NO ______	
ANSWER YOU CHOSE ______ *(Letter)*	
HAS VRE ANSWER SHEET BEEN SUBMITTED FOR GRADING?	
[ ] YES [ ] NO	
REFERENCE	
(Textual reference for the answer I chose can be found as shown below.)	
IN VOLUME NO ______	
ON PAGE NO ______	
IN [ ] LEFT [ ] RIGHT COLUMN	
LINES ______ THROUGH ______	

REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

ECI FORM 17, DEC 84 *(Reverse)*