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ABSTRACT

This publication is designed for use in a standard science curricula to develop oceanologic manifestations of certain science topics. Included are teacher guides, student activities, and demonstrations designed to impart ocean science understanding to high school students. It could be a useful instructional tool for any high school student field trip experience. Suggestions for wearing apparel and necessary equipment are listed. Objectives to be gained by the students include: (1) to learn how to use the various nets for capturing marine life; (2) to identify the common organisms of Folly Beach; (3) to identify major beach zones; and (4) to define salinity and describe its principal ... on organisms. The publication includes pictorial repre...s of the various organisms in marine collections that can be ..., equipment to be used, and diagramatic sketches of ...id trip sites. This work was prepared under an ESEA Title III contract. (Author/EB)

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ERIC
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FOREWORD

Prior to 1970, Charleston County possessed no formal program to develop an organized study of ocean science. A few teachers would cover selected topics on occasion, but there was no formal, district-wide effort to make ocean science curricula available to all students in the secondary schools of the district.

The increasing emphasis on the study of the oceans by federal, state, and local governments and the resultant increase in the importance of the ocean to all citizens has created a need for coherent ocean science programs for all students. Nowhere is the need for coherent study of the sea more immediately relevant than in Charleston County. The county is permeated with food and sport-filled waterways and heavily dependent on naval and commercial shipping. Present and future problems in harbor maintenance and problems of estuarine multiple use indicate a need for a local citizenry literate in ocean science. The most effective means of developing large-scale literacy is the public school.

This publication is one of a series made possible through a Title III, ESEA grant entitled Oceanographic Science Conceptual Schemes Project. These publications are designed for use in standard science curricula to develop oceanologic manifestations of certain science topics. The publications include teacher guides, student activities, and demonstrations designed to impart ocean science understanding to Charleston County high school students.

The members of the ocean science staff include Dr. Gary Awkerman, Director of Natural Sciences, Mr. Michael Graves, Assistant Director of Natural Sciences, and Mr. Paul F. Teller, curriculum specialist in ocean science. They were assisted by the following writing staff: Sister Bernadette Kostbar, Ms. Beverly Lauderdale, Ms. Dorothy Bonnett, Ms. Caroline Pearson, Ms. Pat Hayes, Mr. Tommy Yon, Mr. Nat Bell, Mr. Steve Proctor, and Mr. Leonard Higgins. Principal typists were Ms. Anita Skinner, Ms. Roberta Brown, and Ms. Lynda Wallace. Without their cheerful, dedicated efforts and excellent typing, this project could not have been completed.

Special thanks are due to consultants Dr. Norman A. Chamberlain and Dr. F. J. Vernberg, who contributed much valuable information on tides and estuaries, respectively. Ms. Virginia Bolton prepared the cover drawings. Mr. Paul F. Teller completed the internal figures.

Gary L. Awkerman
Director of Natural Sciences

How to dress and what to bring for the short course in Marine field Techniques

What to wear

The standard dress for field work in most laboratories has become blue jeans, tennis shoes, and an old shirt. This outfit has the advantages of durability and low price while affording protection from cuts and abrasions.

If you do not have any jeans, bermuda shorts or other sports attire will do if you don't mind getting them muddy.

The shirt you wear will be subjected to salt water, mud, and other slings and arrows of the weather's discontent, so be sure you wear the grubbiest thing available.

The most convenient footwear are the cheap, almost disposable tennis shoes available in discount houses. Bogging in mud and walking through salt water make short work of most materials, so the cheaper the shoe, the better. There are also more conventional styles of rubber-soled shoes available with a coarse grade of canvas top. If you spend a lot of time outdoors, you may find these a worthwhile wardrobe addition. Above all, wear something! Never go into the field barefooted! Hauling dredges and seines precludes careful footing, and you're bound to get gashed.

An alternate dress sometimes used in safe areas is a bathing suit. If you wear such a suit, bring dry clothes to put over the suit when you are finished. The air may get rather cool in the fall and winter. A light jacket may also be advisable.

What to bring:

Lecture and demonstration - Bring a notebook.

Field trip - Bring lunch!
Bring binoculars, if you have them.
If you wish, bring a camera.
Bring a towel.
Bring a pocketknife, if you have one.

Laboratory wrap-up - Bring a stereomicroscope from school, if possible
Bring a notebook
Bring a dissecting kit
If you wish to make your own collection, bring some small jars.

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A. Objectives

At the end of this exercise you should be able to:

1. DEMONSTRATE the use of a plankton net, a seine net, a sieve, and a dredge.
2. IDENTIFY ninety percent of the common organisms of Folly Beach.
3. DRAW a profile of Folly Beach showing three major beach zones.
4. PLACE ten organisms in their proper beach zones.
5. DESCRIBE temperature changes in the three major zones.
6. DEFINE salinity.
7. DESCRIBE principal effect of salinity on organisms.
8. DEFINE plankton, nekton, and benthos.

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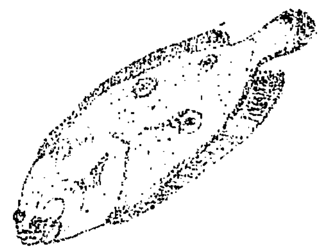
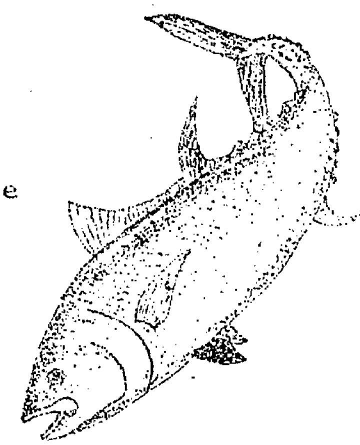
B. Marine Collections - General

Marine biology, also called biological oceanography, is the study of organisms living in the sea. It is studied by persons working in all major biological disciplines, including botany, zoology, physiology, embryology, genetics, mycology, herpetology, ornithology, and almost any other field that comes to mind.



Flounder (X 1/10)

Marine biology originated in man's concern with fisheries. Much present-day marine biology is still connected with fisheries. There are many studies currently underway in other aspects of marine biology. These include the fouling of ship bottoms by growths of marine organisms, damage to shoreside facilities by borers and to cordage by marine fungi, basic marine ecological research, marine microbiology, and a host of other subjects.

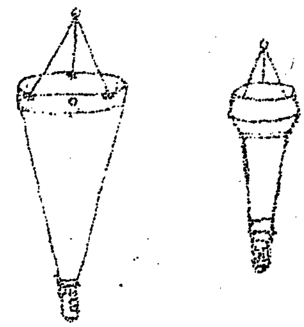


Tuna (X 1/30)

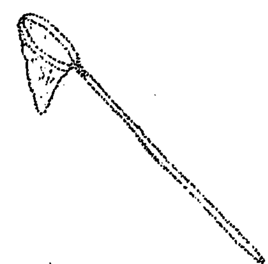
All of these important fields of marine biology must at some point involve the collection of marine organisms. In marine ecology, a major field of study is the zonation of communities with depth and other conditions. Collecting and identifying the animals of different zones are two major activities of this sort of work after the physical characteristics of the zones have been discovered. At the other extreme, one may wish to use animals strictly in the laboratory, raising all the required organisms. One must still enter the field to get animals to begin the cultures.

The items of biological sampling equipment we shall use in this exercise are standard the world over - the plankton net, the dip net, the dredge, the seine, and the sieve. All of these are basic tools of the marine collector. Marine biologists also use salinity determinations and temperature measurements as much as you will.

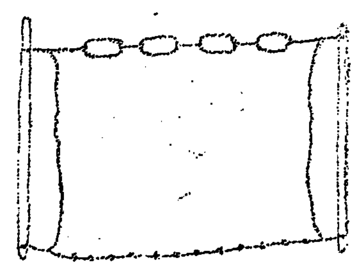
Fine-meshed nets called plankton nets will be used to sample the microscopic and near-microscopic forms drifting in the water. The whole world of plankton was unknown before the 19th century, when people first started dragging fine silk nets through the water. The plankton communities have since been recognized as the great nursery and larder of the ocean. Many animals, including fish, worms, oysters, and crabs have planktonic larval stages. Larval stages and permanent members of the plankton such as copepods (a group of crustaceans) are



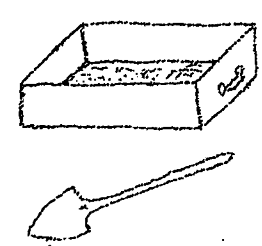
Plankton Nets



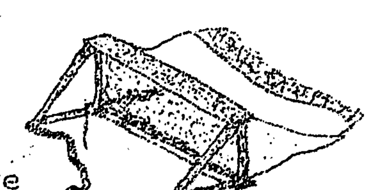
Dip Net



Seine

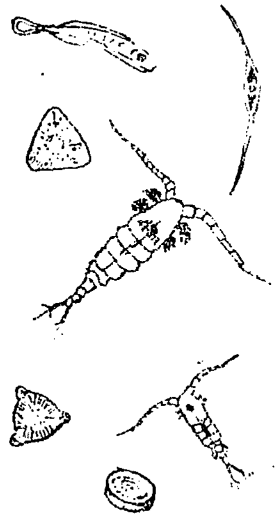


Sieve



Dredge

a source of food for other animals as well as the source of new populations.

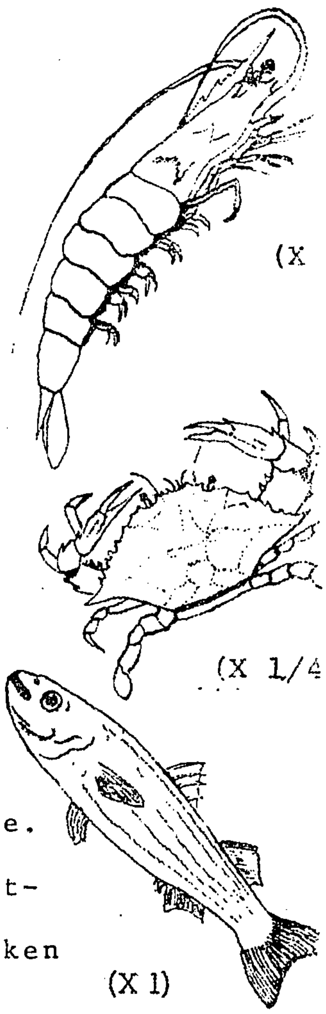


Plankton Organisms (X 200)

The larger animals living up in the water column are sampled by seining. A seine as we shall use it is a net of about ¼" average mesh which is dragged through shallow water. Nets on shrimp boats and fishing boats are larger, more elaborate versions of the seine we shall be using. Nets of this type are in use the world over for the capture of fish, shrimp, crabs, and other active organisms swimming in the water or living in or near the bottom.

The biological dredge samples the organisms living on the bottom and slightly buried in it. Organisms buried just under the sand or lying flat on the bottom are usually missed by the seine unless they move up into the water when startled, as do crabs. The lip of the dredge is designed to move slightly below the surface of the bottom to scoop up these sessile forms and deposit them in the bag of the dredge.

Organisms having their roots deeper than a few millimeters below the sediment surface must be dug out by hand. This is the role of the sieve. The bottom sediments are shoveled out and deposited in the sieve during low tide. The sieve is taken



Seined Anima

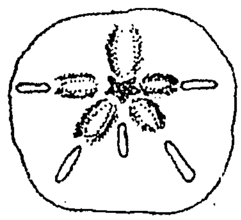
to the water and shaken to wash off the sand and expose the animals dug up with it.

Marine organisms will vary in abundance and type according to the temperature and salti- ness (salinity) of the overlying seawater.

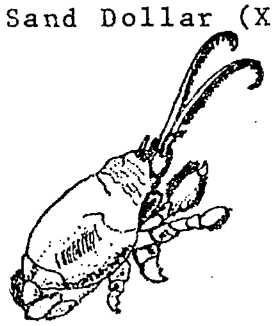
All the animals we shall collect on our field trip are cold-blooded forms. Cold-blooded animals cannot control their body temperature as do the warm-blooded birds and mammals. The temperature of their surroundings will profoundly influence their activity. These organisms will die if the temperature is too high and also if it is too low. Certain temperatures still within these lethal limits will halt reproduction, resulting in ge- netic death of the organisms involved (1). There is an optimum temperature somewhere within this range that is the best temperature for a par- ticular organism (2). The temperature of the water is an important and easily measured char- acteristic of the environment which should al- ways be included in your data.

Salinity is an expression of the total saltiness of the water. The greatest physio- logical and ecological importance of the total salinity is in its osmotic effects on organisms (3). If the seawater is too fresh, water will tend to enter cells, swelling them to disruption.

Mud Crab (X 1)



Sand Dollar (X 1/



Mole Crab (X 1)

Sea Lettuce (X 1/3)

Dredged Organisms

The salinity of an estuary such as the Folly River fluctuates with each tide. Some animals will move in and out with the tide. We may find that our catches can be correlated with the salinity of the water. Salinity, like temperature, is a very important physical parameter that is easy to measure and should be measured at the same time as the temperature. We shall measure salinity with a hydrometer and by chemical methods.

C. Folly Beach zonation and its determination

For our field trip, we shall be going to the southern end of Folly Beach on Folly Island, South Carolina to study the organisms found there.

The southern end of Folly Island is a peninsula bounded on the west by the Folly River, and on the east by the Atlantic Ocean. Figure 1 shows the study sites on Folly Island and the relation of Folly Island to Charleston.

A sandy beach continues from the eastern front beach around the point to form a back beach on the bank of the Folly River. This results in a protected beach on the west in walking distance of an unprotected beach on the east.

The unprotected beach is in a constant state of flux (1) because it is exposed to the action of wind and waves. The back beach is more protected

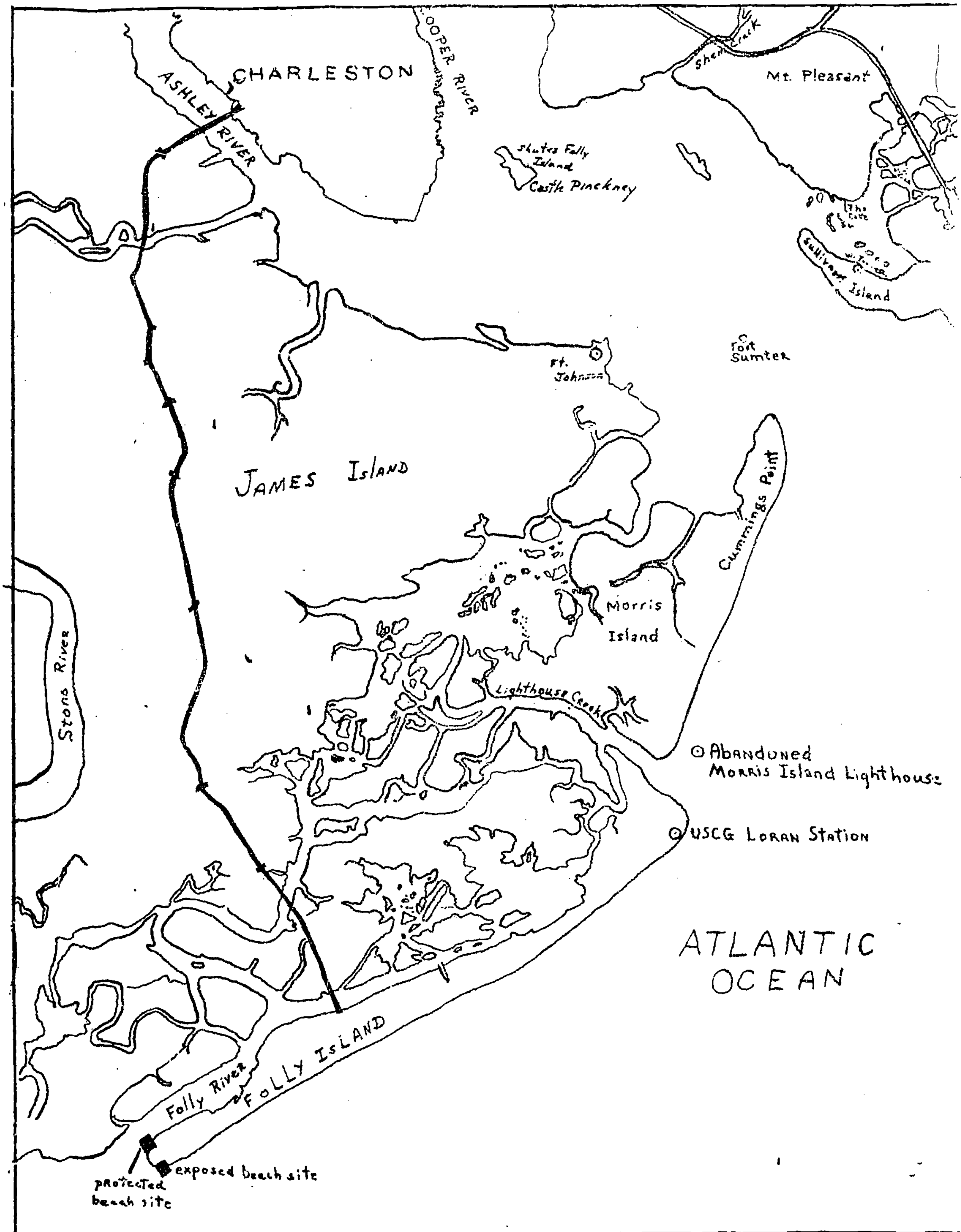


Figure 1. Location of Folly Beach in relation to Charleston, S.C.
■ = Collecting sites on this field trip.

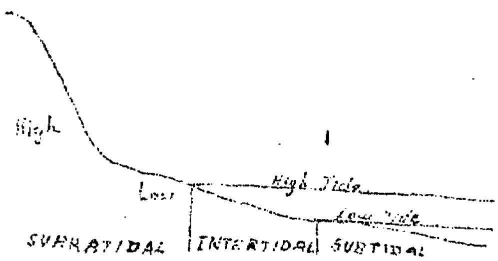
from violent weather. Is is more stable than the unprotected beach.

On both beach types, there is a definite zonation of organisms from the tops of the dunes to points below the low tide mark.

Today's exercise will consist of using various standard pieces of field sampling equipment to study the organisms inhabiting the zones of these two beaches.

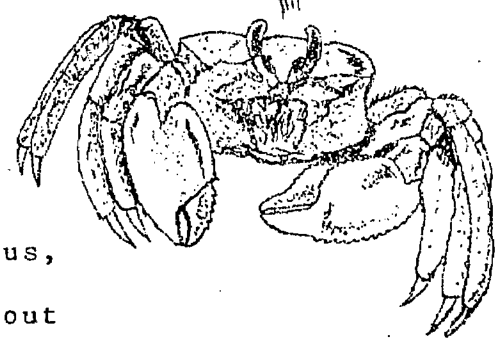
The primary zones of the beach are the supratidal, intertidal, and the subtidal.

The supratidal zone extends from the sand dunes to the mean high tide mark and it is characterized by its dryness and reflection of daily temperature fluctations. We shall find various kinds of plants inhabiting different parts of this zone. Some plants will be found only in the very dry dunes, while others will be found on the flat beach. We shall also see what animals inhabit this zone. Some will be very obvious, such as the birds we shall see flitting about the dunes and hunting along the beach. Other animals will not be so obvious. We shall look for them in holes and under the mats of weeds and other flotsam that has been washed up on



Zones of the Beach

Sea Oats
(X 1/10)



Ghost Crab
(X 1)

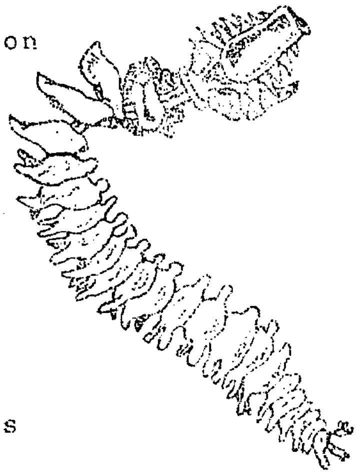
Life in the Supratidal

the beach.

The intertidal zone is the area of the beach between mean high tide and mean low tide marks. Its principal feature is a periodic wetting and drying and resultant temperature fluctuations as the tides pass in and out. In the intertidal zone, we shall be digging animals out of the sand and looking under objects that have been washed in on the last tide.

Coquina (Donax)- Size (X 2)

The subtidal zone is the area beneath the low tide mark. This zone is always covered with water. Here we shall find large numbers of different types of organisms. We shall be using most of our equipment in this area. Many more organisms can live under those conditions. The three beach zones are characterized by different periods of flooding. Because the subtidal zone is almost always covered with seawater, subtidal temperature fluctuations reflect the mild fluctuations of sea surface temperatures. They do not exhibit the wide daily ranges found as a result of the dry conditions of the supratidal and the alternating wet and dry conditions of the intertidal.



Parchment Worm (X 1/5)

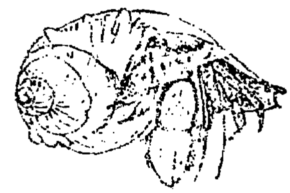
(A Polychaete Worm)

Animals of the Intertidal

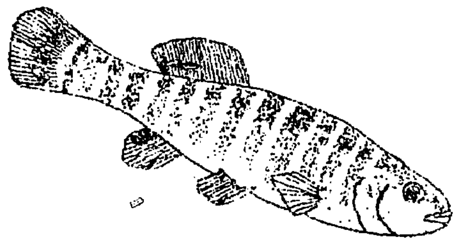
The subtidal zone displays several different communities; the plankton, the nekton and the benthos. The plankton are tiny organisms not capable of massive movement who drift with the currents. They must go wherever the currents carry them. The phytoplankton is composed of tiny plants, mostly diatoms. The zooplankton include a host of tiny crustaceans, fish larvae, arrowworms, worm larvae, and small jelly fish. Some zooplankters are permanent members, such as copepods. Others are only temporary, such as the young larvae of fish and crabs. Some of these larvae will grow to be adult fish, part of the nekton community. Others will be eaten by other members of the plankton or by other forms.

The plankton community is very important in the sea as a food source. Small fish eat various plankters and are in turn eaten by other animals. The phytoplankton are tremendously important to the world. They convert sunlight and simple minerals into body substance which serves as food for other organisms. They also use carbon dioxide and release oxygen for use by animals.

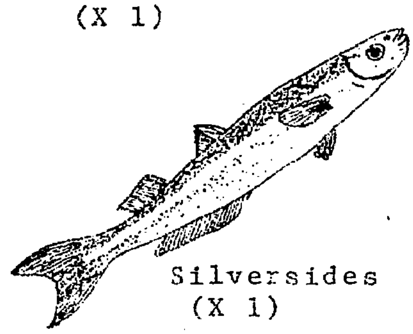
The nekton consist of macroscopic animals who can swim strongly enough to move independently of currents. It consists of the more



Hermit Crab
(X 1)

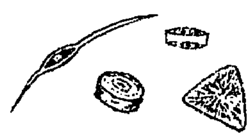


Killifish
(X 1)



Silversides
(X 1)

Animals of the Subtidal

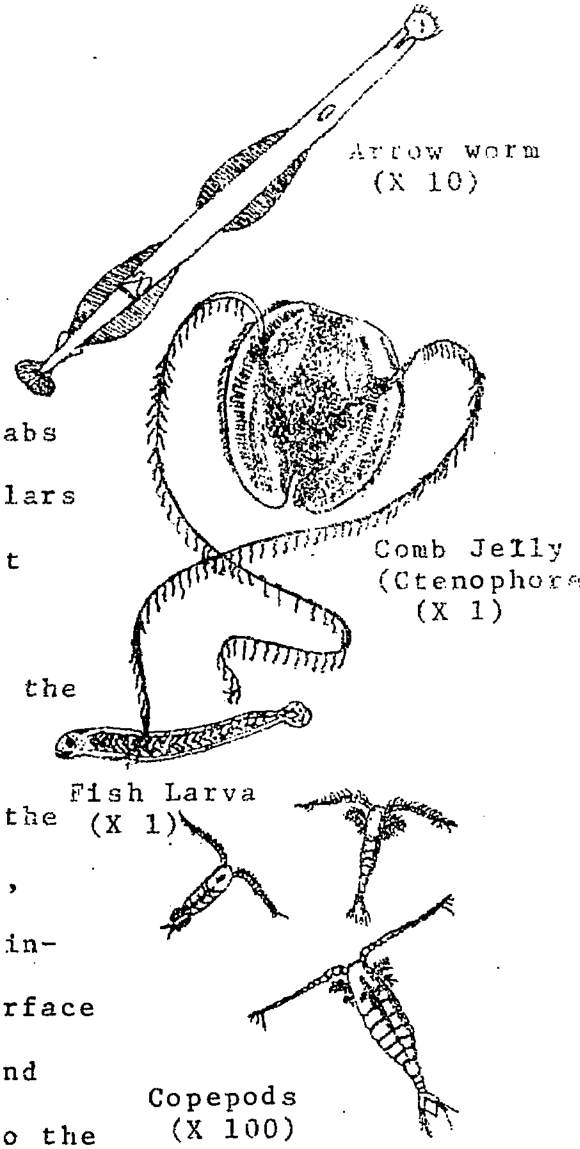


Diatoms
(X 100)

Dinoflagellates
(X 500)
Phytoplankton

familiar animals of the sea, including fish, porpoises, and whales.

The benthos consists of animals living on the bottom. On the bottom large marine algae attach and grow, crabs and shrimp shuttle about, and sand dollars and star fish work their slow way about the sand and mud of the bottom. We may divide the animals of the benthos into the epifauna and the infauna. The epifauna rest on or crawl about the surface of the bottom, as in the case of hermit crabs, starfish, and blue crabs. The infauna include animals buried just under the surface of the sand, such as the sand dollar and heart urchin. Others burrow deeper into the bottom as in the multitudes of polychaete tubeworms, marine annelids who live in tubes of various sorts that we shall find sticking up out of the sand. Many benthic animals live in the intertidal zone. Polychaete worms and crabs are very common examples of these intertidal forms.



Zooplankton

We shall break our field exercise into several parts to study this zonation. Each part will answer one of the questions in table 1. Table 1 has been arranged to show the particular field equipment and methods needed to answer each question.

Table 1

Questions on beach zonation, and personnel, methods and equipment needed to answer each question.

# Persons	Question	Method	Equipment
3	1. What sort of plants are found on the sand dunes (These may be classed as the "high supratidal.")	1. Identify all the plants you can on the sand dunes and collect some, if necessary. <u>Don't pick sea oats</u>!	1. Plant Press, "Flora of the Carolinas" by Radford, Ahles and Bell.
3	2. What sorts of plants are found on the flat beach in front of the sand dunes? (The "low supratidal".)	2. Same as #1	2. Same as #1.
3	3. What sorts of animals are found in the high supratidal?	3. (a)See how many types of birds you can see. (b)Search the plants for attached insects. (c)Look for holes in the ground.	3. Binoculars, plastic bags, forceps.
3	4. What sorts of animals are found in the low supratidal?	4. Look under planks, kick apart masses of dry rushes, disturb other objects on the shore. Look for holes in the ground. What kinds of birds land in this zone?	4. Plastic bags, forceps.
2	5. What is the temperature beneath the surface of the sand (a)in the high supratidal, (b)in the low supratidal?	5. Stick a thermometer into the sand.	5. Centigrade thermometer.
2	6. How wide is the intertidal?	6. Place stakes at the water's edge until the low tide mark is reached. Wait until the tide is high, and measure distance between stakes at high and low tide.	6. Stakes (5), Metric tape.

Table 1 (Continued)

Questions on beach zonation, and personnel, methods and equipment needed to answer each question.

# Persons	Question	Method	Equipment
12 2-seine 2-sieve 2-dredge 6-plankton	7. What sorts of organisms live in the intertidal zone?	7. (a)While the tide is in, seine the intertidal zone, dredge it, catch plankton. (b)When tide is out, pick up animals on the exposed flats, put shovelsful of sand into sieve to collect the contained animals. (c) Identify the birds you see running by the water's edge.	7. Sieve, seine, dredge plankton nets, shovel. Binoculars
4	8. How does the temperature of the sand of the intertidal zone fluctuate?	8. (a)Divide the intertidal into upper and lower areas. Put a thermometer into the sand at the midpoint of each part as soon as it is uncovered by the receding tide. (b)Simultaneously check both thermometers once every half hour. (c) Check for the last time and remove just before it is recovered by the returning tide. (d)Take the temperature of the water. (e) If you have found temperature changes, graph those changes.	8. Two thermometers, notebooks, graph paper.
3	9. Is there any difference in the infauna of the upper and lower intertidal?	9. Dig up and sieve the same amount of sand from a place in line with each thermometer.	9. Sieve, shovel.

Table 1 (Continued)

Questions on beach zonation, and personnel, methods and equipment needed to answer each question.

# Persons	Question	Method	Equipment
6	10. What sorts of organisms are found in the subtidal zone?	10. Seine for nekton, dredge for benthos, collect plankton.	10. Sieve, plankton, net, seine, plastic bags.
5	11. What is the temperature of the subtidal zone and the salinity of the overlying water?	11. (a)Take sea-surface temperature. (b)Measure salinity by both hydrometer and chemical means.	11. Water bottle, hydrometer, thermometer, salinity kit and jar.
all	12. Is there any functional relationship between nekton, plankton, and benthos?	12. Look for planktonic larvae, check stomachs of fish for plankton, benthos, and other fish. Study feeding habits of the more important organisms in reference library at Science Office.	12. Dissecting kits, stereomicroscopes, compound microscopes, slides, reference library.
all	13. Are there any biological differences between protected and unprotected beaches?	13. Carry out all previous exercises on both front and back beaches.	13. All listed above.

The dip net is an auxiliary piece of equipment to be used for catching various single creatures on all portions of the beach.

D. Short Notes on the use of equipment

1. Plankton net.

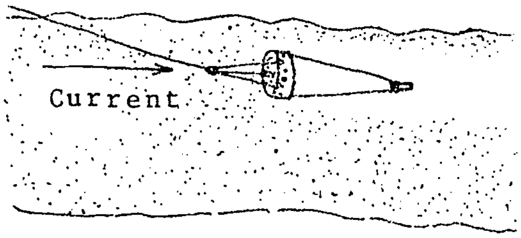
Plankton nets are very fine-mesh nets used for collecting small drifting organisms. They come in a variety of sizes.

Plankton nets are generally conical in shape with a collecting bucket at the small end to concentrate the catch. Some plankton buckets have a screen in their sides to improve the efficiency of the net. If nets and buckets of different sizes of mesh are disassembled, be sure that the mesh size of the bucket screen is the same as that of the net to which you attach it. A large mesh bucket on a fine net will retain only what is held by the bucket screen.

The proper use of the assembled plankton net is as follows. Attach a line securely to the bridle of the net. Walk out into the current, and pay the line out a few yards. In very slow currents, walking with the net will give enough force to keep it just under the surface. In beach collecting, one should go beyond the breakers to calmer water and tow the net just under the surface.

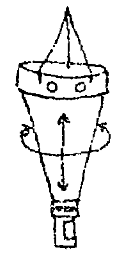
Plankton Net
Exploded

Plankton Net
Construction



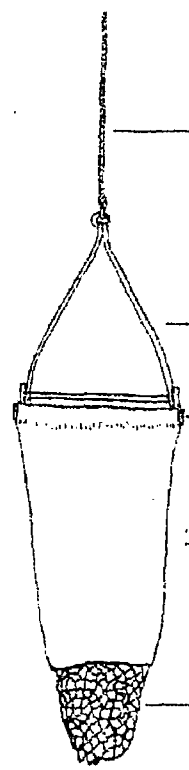
Plankton Net Operation

When the net has operated for the desired time, lift it clear of the water using the bridle. Wash the net down by splashing water through it from the <u>outside</u>. This will wash down organisms clinging to the side but will prevent contamination by other plankters in the wash water.



Plankton Net-Method of Washing

After you have washed the net, hold the bucket in one hand and unscrew the retaining clamp with the other. Place the contents of the bucket into a jar or vial. Add formalin to about 5% of the total volume of the catch and excess water. Drop in a label listing date and time of collection, collector(s), water temperature, and salinity. A chip of marble placed in the jar will help neutralize the acidic formalin. Neutralization will help keep crustacean and mollusk shells in good condition.



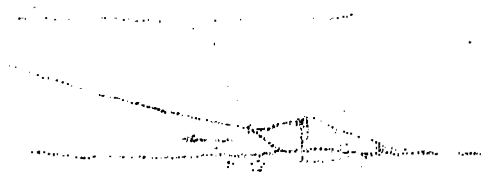
2. <u>The Dredge</u>.

The dredge you will use consists of a rectangular mteal frame with attached bridle. Behind the frame is a heavy cloth bag which protects an inner net bag from wear and tear by the bottom.

The dredge is the best way to collect

sessile and sluggish epifauna and the shallow infauna.

Attach the hand line to the dredge and drag it through the area in which you wish to collect. Bring it ashore and empty the contents of the net bag onto a plastic sheet on the beach. Check the large cloth bag for smaller organisms that may have slipped through the net but which have been retained.



Operation of the dredge

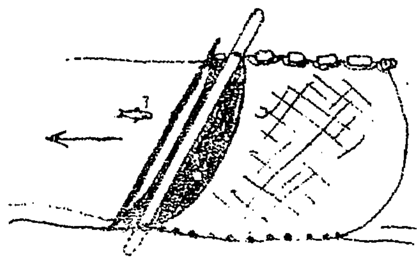
Place all specimens in 5% buffered formalin, listing time, locality, date, water depth, collector(s), water temperature, and salinity.

3. The seine.

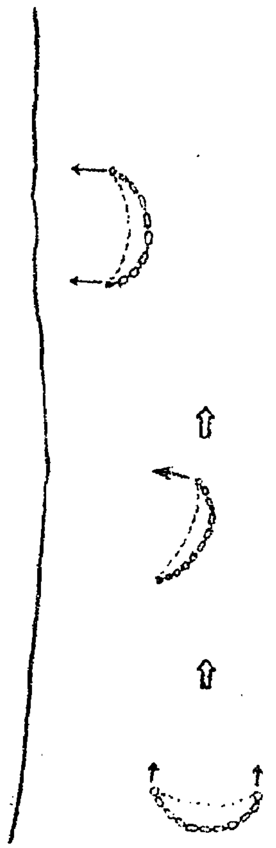
The seine should be carried rolled as neatly as possible by starting with one pole and rolling it to the other. It should not be dragged through the sand or used as a battering ram to get through underbrush. It consists of a net of organic or inorganic fiber. It may be torn if treated roughly. Many seines are not of knotted construction. In unknotted seines, a small tear will wuickly become a large hole.

Upon arrival at the site, unroll the seine with one person using each pole. Carry it horizontally through the water in a stretched-out position. Upon arrival at the desired spot in the stream, lower the lead line into the water and let the corks float on top.

Dig the bottoms of the poles into the substrate. Drag the net along the bottom in the direction of the current. This procedure should keep the lead line on the bottom. In very strong currents, a good catch may sometimes be obtained by merely holding the sein in working position and letting the current do the work.

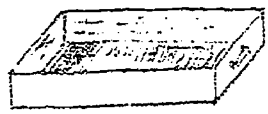


When the run is completed, the inshore person should serve as an anchor man while the offshore person sweeps around with the net, still in the direction of the current. As the net swings around, the anchor man shluld start walking to the shore. Be careful to always keep a belly in the net to retain the catch. <u>Be sure that the lead line stays on the bottom!</u> When the seine is landed, all hands should turn to and sort the catch.



Preserve the catch in 5-10% formalin, making small slits in the sides of the fish to allow the formalin to enter the interior. Label all collections with time, date, locality, collector(s), temperature and salinity.

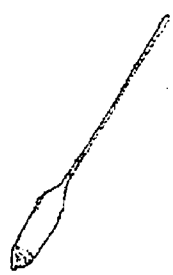
4. The sieve.



The sieve is used on patches of beach which have been uncovered by the tide. The operation is simple. Dig up the sand with a shovel, going as deep as possible and removing the sand as fast as possible. Put the sand in the sieve, carry the sieve to the water, and gently rock it back and forth to wash away the sand. Be sure that only the bottom of the sieve is in the water! Do not let the water overflow the top, lest the organisms swim away.

Go through the exposed animals with forceps and fingers, preserving everything in 5% formalin. The tag should bear time, date, locality, sand temperature, area of sand scooped out, and the distance of the center of the site from high water mark.

5. The hydrometer.

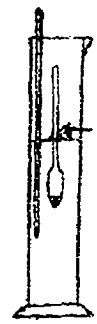


The hydrometer is a delicate instrument for measuring the density of seawater. Measurements have been made to correlate density with salinity. The measurements are listed in the tables that come with the hydrometer.

Scoop up a water sample in a suitable container and empty it into a hydrometer jar. Place a thermometer in the jar.

Gently remove the hydrometer from its case and lower it into the jar. Use tissue paper to handle the hydrometer. This will keep its delicate weight from being changed by finger oil, etc.

Let the hydrometer come to rest. Note the mark covered by the top of the meniscus. Remove the hydrometer, wash in distilled water. Dry it with soft tissue paper. On your return to the laboratory, wash the hydrometer well in distilled water and let it dry in the air. Put it in a dust-free area for drying.



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Record the temperature of the water. Consult the tables to determine salinity. The correct salinity will be found in a box at the intersection of the appropriate density row and temperature column.

6. Chemical determination of salinity.

Specific instructions for chemical salinity determination will vary with the apparatus used.

The main rule to follow is to be sure to wash the test bottle two or three times with the water to be tested. This should dispose of soluble compounds on the walls of the container which might cause error in the determination.

Literature Cited

1. Vernberg, F. J., and Winona B. Vernberg. The Animals and The Environment. New York: Holt, Rhinehart and Winston, 1970.

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3. Friedrich, H., Marine Biology. Seattle: University of Washington, 1969.

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