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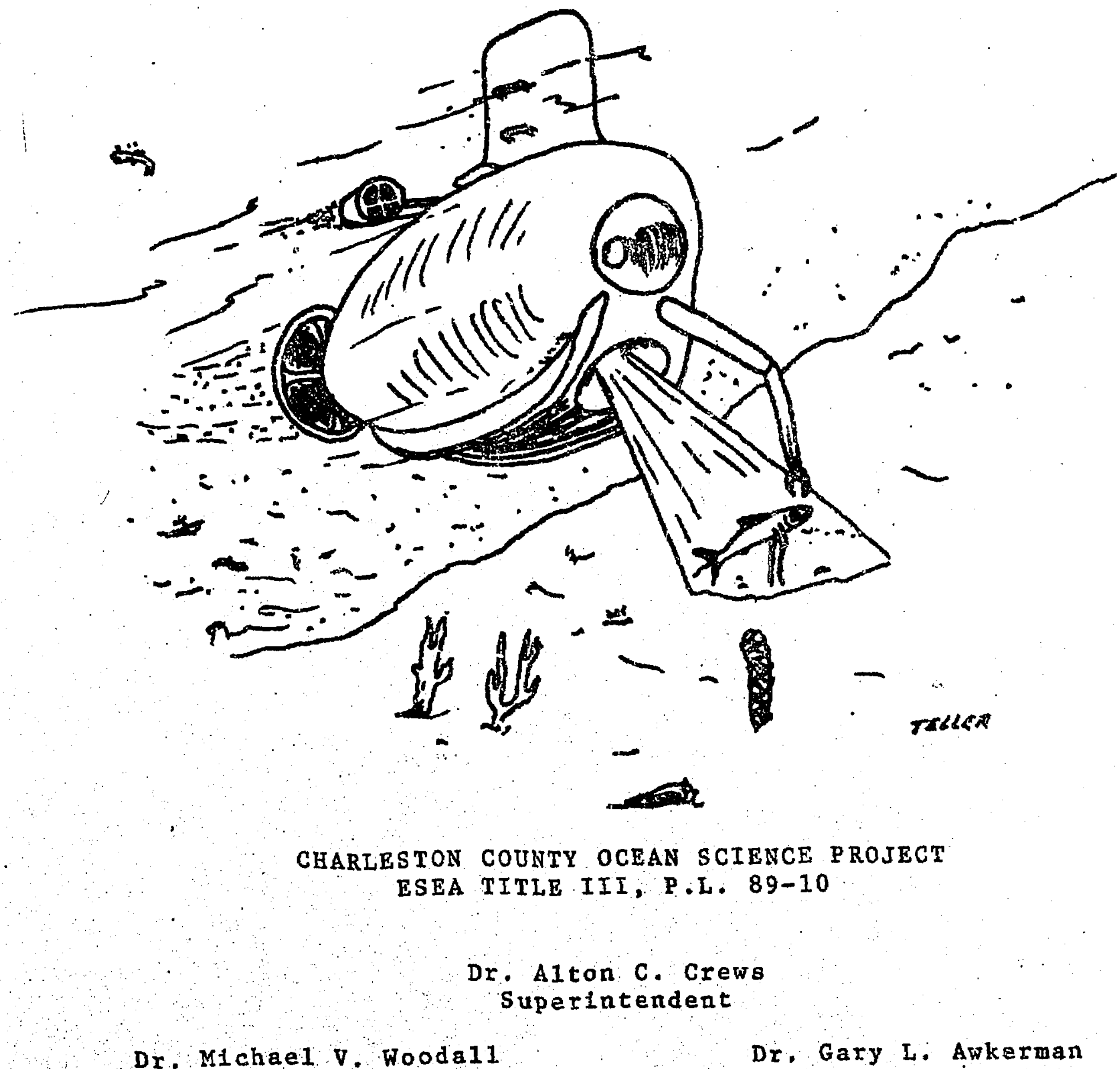
ABSTRACT

This publication is designed for use in 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. Specific learning objectives, the rationale, materials needed, and suggested teacher introductions are presented. The six student activities prepared should enable the students to achieve the suggested objectives: (1) to identify a number of oceanic zones; (2) to describe changes in environmental factors related to change in depth; (3) to identify zones of a beach; and (4) to describe the beach zones relative to diversity of organisms present. This work was prepared under an ESEA Title III contract. (Author/EB)

ZONES OF LIFE IN THE SEA



CHARLESTON COUNTY OCEAN SCIENCE PROJECT
ESEA TITLE III, P.L. 89-10

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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 You, 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

Objectives:

At the end of this exercise, the student should be able to:

1. IDENTIFY 9 out of 10 oceanic zones.
2. DESCRIBE how light, tmeperature, and pressure vary with different ocean depths.
3. IDENTIFY three zones of a beach.
4. LIST which beach zones are usually most or least diverse in kinds of organisms.

Where do we find life in the sea?

Rationale:

Life exists in all parts of the ocean, from the surface to the greatest depths. The group of activities included here is designed to acquaint your students with the conditions prevailing in each major biotic zone in the sea.

The first activity introduces the basic classification of marine environments according to depth and distance from the shore. Each of the major ocean environments is characterized by its own set of physical conditions, particularly different degrees of illumination, different temperatures, and constantly increasing pressure in deeper waters. Activities 2-5 are designed for student self-discovery of how these factors fluctuate in the ocean.

The edge of the sea is the region most familiar to the average layman. In this region of tidal ebb and flow are found our popular beaches, salt marshes, and mangrove swamps. The beaches are popular as resort areas, and marshes and mangrove swamps are ecologically important nursery grounds for many valuable commercial species of marine life. The edge of the sea is an area of large fluctuations in water cover, temperature, and saltiness of the water, which makes it quite different from the relatively stable zones of the open sea. The familiarity, importance, and fluctuating nature of the edge of the sea are reasons enough to study it by itself in a special activity. Activity six uses a model of a beach to allow the students to measure for himself the fluctuating nature of the beach environment.

The teacher introductions to the groups of exercises will help you to answer questions the students may ask about this material.

Materials

	Item	No.	Activity Source
1.	Overhead transparency of zonation in the sea	1	1
2.	Individual student charts of oceanic zonation	30	1
3.	Bathymetric World Wall chart	1	1
4.	Bathymetric World desk outline	30	1
5.	Graduated cylinder, 1000 ml.	30	2 & 3
6.	Fine soil, 1 lb. bags	15	2
7.	Flashlights	15	2
8.	Mixing bowl, to hold 1000-2000 ml.	15	2
9.	Spoons	15	2
10.	Postal scale	5	3
11.	Artificial seawater (gallons)	5	3
12.	Rulers, metric, 12-inch	15	3
13.	Large shallow pan	5	4
14.	Thermometers, short, red-line	25	5
15.	Cups, plastic	5	5
16.	Ice (ml.)	1250	5
17.	Food coloring, yellow (bottles)	5	5 & 6
18.	Stream table	5	6
19.	Sand, building (lbs.)	100	6
20.	Thermometers, laboratory, 0-100 c.	20	6
21.	Overhead projector	1	1,6
22.	Projection screen	1	1,6

Teacher Introduction

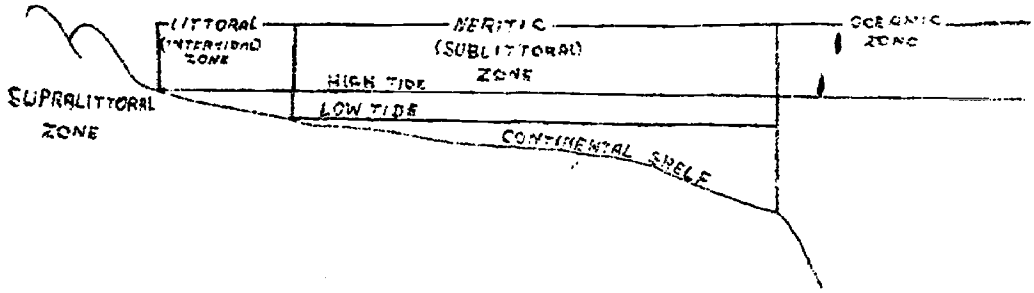
The Zones of Life in the Sea.

Life exists everywhere in the sea, from above the high tide mark to the greatest depths. This set of activities is designed to acquaint your class with the major areas in the sea in which organisms live and to help them understand some of the conditions prevailing in the major biotic zones.

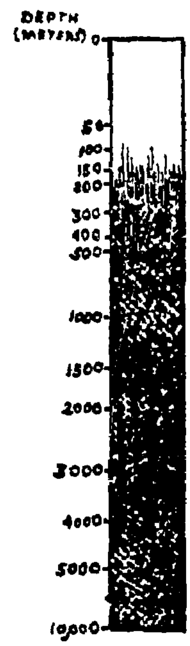
The marine environment most familiar to the layman is the very narrow edge of the sea, including marshes, beaches, and mangrove swamps. All three of these habitats are in the zone of tidal fluctuations in water level. This region is often called the <u>littoral</u> zone, but is most familiar to Americans as the <u>intertidal</u> zone. The area below the low-water mark is called the <u>subtidal</u> zone.

The subtidal zone extends seaward across the continental shelf, soon merging with the <u>neritic</u> zone. The neritic zone extends from the subtidal to the edge of the continental shelf. The neritic zone has also been called the <u>sublittoral</u> zone.

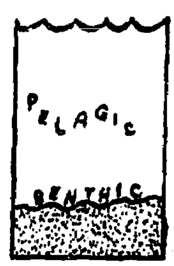
The bottom communities of the relatively



shallow littoral and neritic zones usually receive enough light to permit photosynthesis to proceed at productive levels. All areas of the sea which receive this amount of light are said to be in the photic zone. As waters get deeper or more turbid, the sunlight entering the sea is absorbed and scattered by particles (including organisms) suspended in the water, and absorbed by the seawater itself. In even the clearest waters, the sunlight has fallen below the levels needed for productive synthesis at a depth of 150-200 meters. The productivity of the entire world ocean is therefore centered in the thin 200-meter surface layer. Below this depth is a region of eternal night inhabited almost entirely by animals who subsist on a rain of biological remains coming from the surface, and on each other. The adaptations to the perpetual darkness have often resulted in many bizarre forms. The possession of glowing light organs is a common occurrence in the fauna of this aphotic zone.



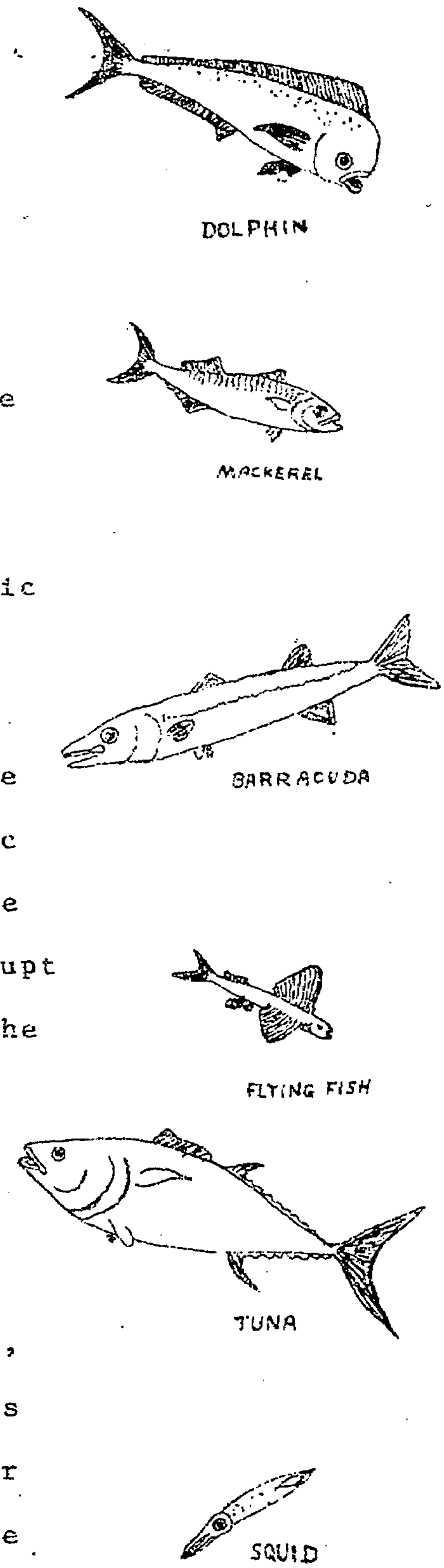
In all the zones of the sea, organisms live either on the bottom or up in the water column. Bottom dwellers are called benthic organisms. Those who live up in the water column are called pelagic organisms. Both benthic and pelagic organisms live in the littoral and neritic zones



and in the oceanic zone. The oceanic zone includes all waters seaward of the continental shelf. This is the zone of the "high seas". The oceanic zone is subdivided into several zones which occupy different depths of the oceanic.

The part of the oceanic zone which is in the photic zone is called the epipelagic zone. These brightly-lit waters support the productive microscopic plant life of the high seas. The fisheries of the open ocean are mostly based on organisms such as tuna who live in the epipelagic zone.

Below the epipelagic, from about 200-1000 meters, is the mesopelagic zone. The temperature of ocean water begins to drop in the mesopelagic zone. The energy of the absorbed sunlight in the epipelagic warms that area, but there is an abrupt change in temperature called a thermocline in the vicinity of the bottom of the epipelagic. The mesopelagic is the first deep zone below the themocline. Its temperature ranges from about 4^{o}-10^{o}C. The mesopelagic is cold and dark. Many species in this zone posess well-developed eyes, even telescopic ones, and many sorts of luminous organs. Black and red are very common colors for mesopelagic organisms. Many of the fishes of the mesopelagic still travel into the epipelagic at night. Many have epipelagic larvae.

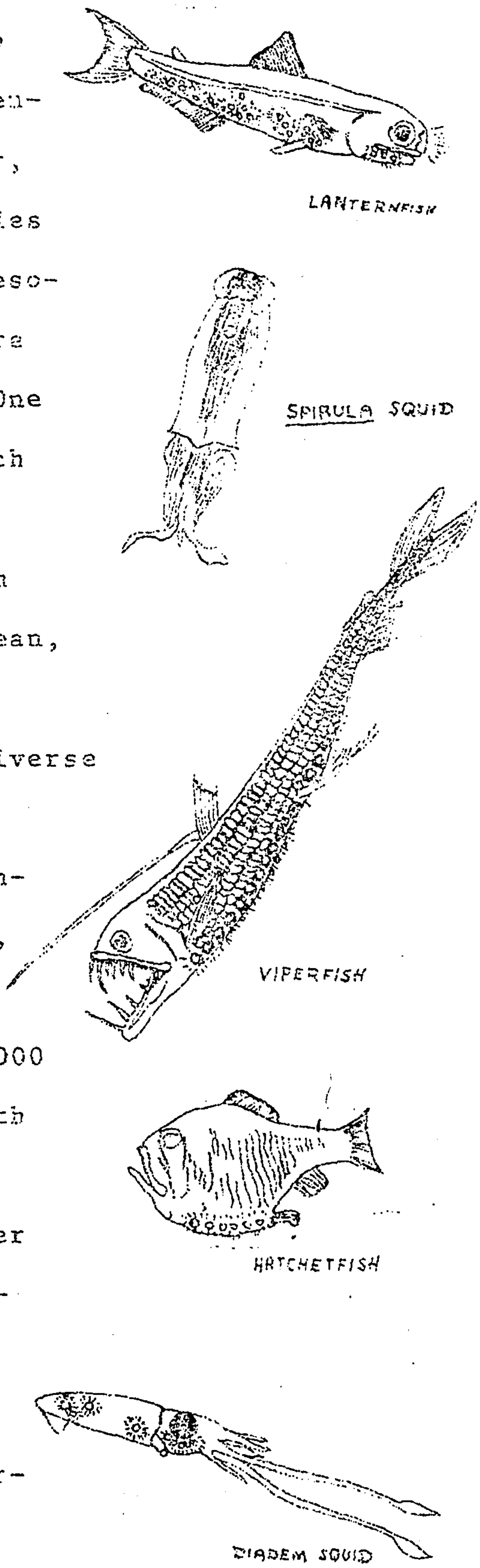


ANIMALS OF THE EPIPELAGIC

The bathypelagic zone is often hard to distinguish from the mesopelagic, but is generally just beneath it. The water is colder, but still 4°C or above. The number of species and of animals is much lower than in the mesopelagic. The bathypelagic can range anywhere from a few hundred meters to 4000 meters. One frequent dividing line is the depth at which water temperature is 4°C.

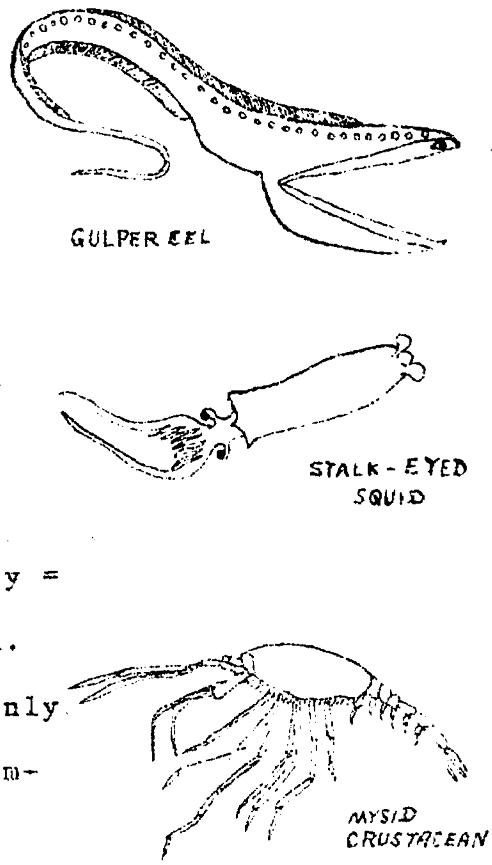
The abyssopelagic extends roughly from 4000 meters to the deepest parts of the ocean, about 10,000 meters. The organisms of the abyssopelagic are the least numerous and diverse of all the pelagic zone.

The bottom of the ocean beyond the continental shelf is divided into the bathyal, abyssal, and hadal zones. The bathyal zone is found between 100-300 meters and 1000-4000 meters. The exact depth depends on the depth of the break in the continental shelf, the local extent of light penetration, and other factors. The bathyal zone is generally considered to consist of the surface of the continental slope, the sloping edge of the continental shelf. It also includes the surface of the continental rise, a mound of



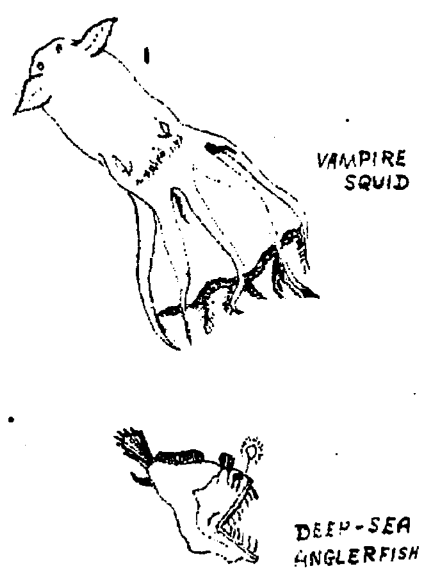
ANIMALS OF THE MESOPELAGIC

sediments often found at the foot of the slqpe. Some light penetrates into the upper bathyal, but not enought to result in productive photosynthesis. Temperatures of the bathyal may range from 15°-5°C in low and middle latitudes and 3° to -1°C in high latitudes. The water is very salty (Salinity = 34-36 o/oo), and currents are very sluggish. The number of both species and animala is only about half that found in neritic benthic communities.



ANIMALS OF THE BATHYPELAGIC

The abyssal zone extends from about 1000-3000 meters to 6000-7000 meters. The abyssal zone is the largest ecological zone in the world. It occupies more than three fourths of the area of the oceans, and more than half of the world. Temperatures range from 0°-2°C in most of the abyssal zone. These extreme low temperatures are caused by the cold dense water which forms in polar regions and sinks to spread over the whole ocean floor. The oxygen content is sufficient to sustain animal life, but it is only added to the water at the surface in polar regions.

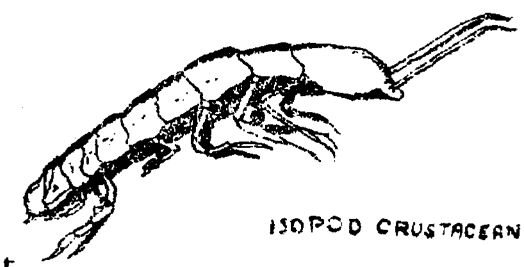


ANIMALS OF THE ABYSSOPELAGIC

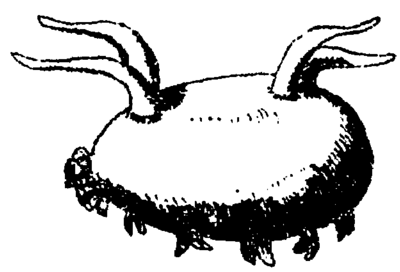
The quiet, dark conditions found in the abyssal regions are reflected in the fauna found there. The animals are often greyish or black. The very calm conditions allow some species to survive with very delicate structures. The number of organisms is very low, but recent work by Dr. Howard Sanders, et. al. of the Marine Biological Loaboratory at Woods Hole, Massachusetts, indicates that the number of species in the deep-sea benthos may be the highest of any area in the world. The reason for the high diversity of the deep-sea benthos is thought to be the very constant environmental conditions.

The abyssal fauna show two subdivisions, one above and one below 4500 meters. Below 4500 meters, there is very little calcium in the water. This may be responsible for the change in the fauna. Most abyssal species are found throughout all oceans. This cosmopolitan distribution results from the lack of effective distribution barriers on the ocean floor. All the ocean basins are interconnected. Species evolving in one basin have always had ready access to other basins.

OCTOPUS
AFTER IDYLL, 1964



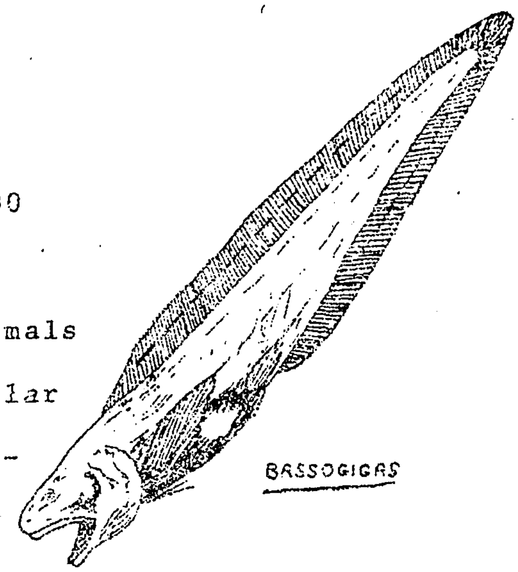
ISOPOD CRUSTACEAN



SEA CUCUMBER
AFTER IDYLL, 1964

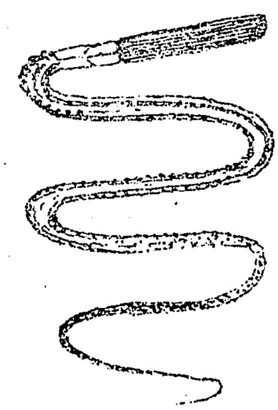
ABYSSAL BENTHIC ANIMALS

The hadal zone is found at the bottom of the great ocean trenches deeper than 7000 meters. The temperature at these depths is generally between 1.3°C and 3.6°C. Many animals at these depths are found only in a particular trench. Trench walls act as barriers to distribution.



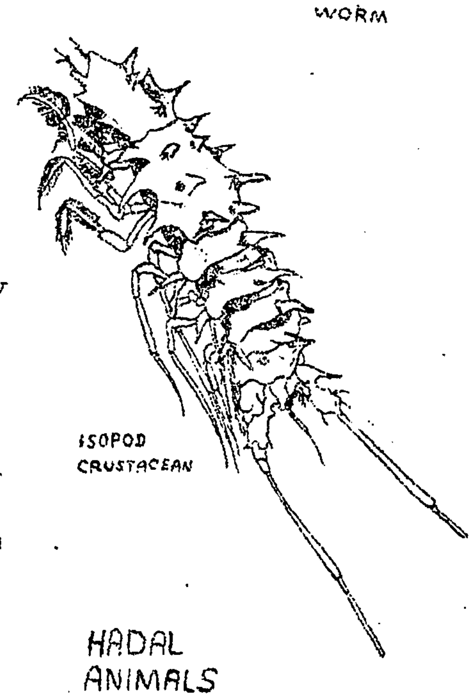
BASSOGIGAS

All the deep oceanic bottoms are covered with sediments of various types and different origins. The sediments are important as food and as substrate.



POGONOPHOR WORM

Pressure is a constantly increasing factor in the oceanic zone. At 10,000 meters, the pressure of the overlying water amounts to 6 tons per square inch. This has been shown to be a limiting factor to various marine animals. It is limiting mainly to changes in the depth at which they live. If an animal grows up at a particular depth, it does not seem to be affected adversely, no matter how great the pressure at that depth. The animal only gets into trouble when it changes depth drastically and/or quickly. For example, a deep-sea fish dragged to the surface too quickly can be killed if it possesses an air bladder. The air will expand faster than it can be removed from the bladder. The expansion of the bladder will



ISOPOD CRUSTACEAN

HADAL ANIMALS

cause death.

One universal effect of pressure has been mentioned in regard to the 4500-meter abyssal faunal division. The pressure at this depth causes increased breakdown of calcium carbonate and carbon dioxide. This poses problems for animals with calcium carbonate structures because the calcium carbonate is less easily precipitated for construction of skeletons, shells, and the like.

The following exercise with charts of oceanic zones, maps of the world, and models of the light penetration and temperature situations of the deep oceans are designed to familiarize your students with the areas of the sea in which life exists, the conditions in the different zones, and some of the reasons for those conditions. The foregoing introduction should have helped you to answer some of the more probable questions they may ask you about the zonal conditions.

Activity 1 (Life Science, Biology)

1. Pass out the desk outlines of the transparency, "Classification of Marine Environments" or the commercial transparency "Divisions of the Ocean" (Instructo #820-1).

2. Go over the transparency with the class to acquaint them with the names and locations of major ocean zones. Use the teacher introduction to help them with physical factors in the different zones.

3. Let the class see what kinds of organisms live in the various zones. You can do this by showing the following transparencies. Follow the teacher guides enclosed with the transparencies.

   a. Littoral and sublittoral:
      Instructo 820-7-Seashore life: Warm Sandy Shores
      Instructo 820-8-Seashore life: Temperate Marshy Shores
      Instructo 820-9-Seashore Life: Cold Rocky Shores

   b. Epipelagic (Neritic and Oceanic)
      Instructo 820-11: Animals of the Open Ocean

   c. Animals of the deep zones
      Instructo 820-13: Animals of the Deep

4. As the class studies the various transparencies, have them look for adaptations of the animals to their environments (e.9. the luminescence of deep-water animals).

Activity 2

A. Give each team of two students a pair of 1000 ml. graduated cylinders, a mixing bowl, a bag of soil, and a flashlight.

B. Have the class fill the mixing bowl with 1000 ml. of tap water from one of the graduated cylinders, and have them refill the cylinder with tap water.

C. Have the class empty the soil into the mixing bowl and stir it with a spoon. After the large particles have settled, have them pour the resulting suspension of fine soil particles into the empty graduated cylinder.

D. Each team of students should shine their flashlight down through the top of each graduated cylinder. Call their attention to the easy penetration of the light through the tap water and the diffused nature of the light passing through the soil particles.

E. Call the class's attention to their charts of ocean zonation. The euphotic zone extends to 200 meters in clear ocean water. Ask them if they think it will go that deep in muddy harbors (NO).

F. Point out to the class that light in the sea is not only scattered by suspended particles, but is also absorbed by the water itself. Ask them how they think photosynthesis will be affected by the combination of these two phenomena (IT WILL DECREASE WITH DEPTH BECAUSE OF THE DECREASE IN AVAILABLE LIGHT.) Ask the class if they think plants live on the bottom of the deep ocean (NO. THEY DO NOT LIVE THERE BECAUSE THERE IS NO LIGHT AVAILABLE FOR PHOTOSYNTHESIS).

Activity 3

A. Distribute postal scales, 1000 ml, beakers. Make up 5 gallons of artifical seawater.

B. Have the class weigh their graduated cylinders and record the weights. Have them fill the cylinders to the 200 ml. mark with articicial seawater and record the weight. This procedure should be repeated for the 400, 600, 800, and 1000 ml. marks.

C. Ask the class what force is making the scale move (THE WEIGHT OF THE WATER IS EXERTING PRESSURE ON THE SCALE.)

D. Have the class measure the length of the 1000 ml. water columns in their cylinders. Have them determine the pressure of the graduate-sized column of water at 100, 1000, and 5000 meters depths. This calculation is carried out by dividing the desired depth by the length of the water column in the graduate. Multiply the weight of the 1000 ml. water column by this figure. If an actual figure of g/cm^2 or kg/cm^2 is desired, divide the weight of the graduate-sized water column by the cross-sectional area of the graduate in centimeters.

E. Ask the students what would happen to them if they were exposed to the water at 5000 meters (THEY WOULD BE CRUSHED). Ask them what would happen to a deep-dwelling fish with an air bladder who swam too near the surface (THE AIR IN THE BLADDER WOULD EXPAND AND MIGHT RUPTURE, KILLING THE FISH).

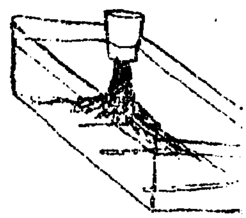
Activity 4*

A. Each team of 6 students should receive a transparent pan, a plastic cup, 100 ml. of ice, a piece of 1" masking tape, a bottle of yellow food coloring, and four thermometers.

B. The class will construct a model thermal ocean in the following manner:

   a. Fill the pan to within one inch from the top with warm tap water (artificial seawater will probably be denser than melting ice and would defeat the purpose of this experiment). Tell the class to regard the pan of water as the world ocean.

   b. Lay the four thermometers equally spaced along the bottom of the pan. Record the temperatures registered by each thermometer.



   c. Perforate the plastic cup with several small holes. Fill it with 100 ml. of ice and tape it to one corner of the pan. Tell the class to regard this cup as the polar regions.

   d. When the ice starts melting and dripping from the bottom of the cup, add a little food coloring to the melt in the cup.

   e. As the cold meltwater sinks to the bottom of the pan, the temperatures shown on the thermometers should be recorded. The class should also look at their models from the side. The cold water will usually spread out in a layer on the bottom of the pan.

C. When the temperatures of the model oceans are recorded, ask the class what they think the temperature is at the bottom of the sea (COLD).

D. Ask the class if they know why the bottom of the sea is cold (COLD WATER FROM THE POLES SINKS TO THE BOTTOM OF THE SEA BECAUSE IT IS HEAVIER THAN THE WARM SURFACE WATER.)

*Borrowed in part from Investigating the Earth, ESCP, Boston: Houghton-Mifflin, 1967.

Teacher Introduction
Conditions in the littoral zone

Now that we have established the general picture of environments in the sea, we shall pay closer attention to the conditions in the intertidal zone; our familiar beaches, marshes, and mangrove swamps. This area at the edge of the sea is characterized by strong daily and seasonal fluctuations in temperature, water coverage, salinity, and various meteorologic conditions.

The dominant fact of life in the intertidal zone is the rise and fall of water levels due to the gravitational attractions among the earth, moon, and sun. The resulting changes in coastal water level can be further influenced by the geographic area and local topography to result in tides ranging from imperceptible to heights of 45 feet or more. These daily tidal changes can be increased by storms which may pile the water even higher.

The most obvious environmental variable in the intertidal is the daily covering and uncovering of the intertidal zone with seawater. When the tide goes out, the animals and plants of the intertidal are exposed to the air. This creates a danger of the organisms drying out. Relatively few species of animals and plants live in a particular intertidal habitat, even though those few species, such as oysters, may occur in immense numbers. That is, the diversity of the intertidal community is low, compared to the subtidal community a short distance away, which is always covered by water.

The organisms exposed to the air are also exposed to the sun. This speeds the drying process on hot days and causes enormous temperature fluctuations between high tide when cooling water is in and low tide when the sun is shining directly on the intertidal communities.

The salinity of the intertidal zone also fluctuates. During rainy weather, the dilution of the water covering the intertidal areas causes osmotic hardship to the members of that community. When the water is fresher than their own body fluids, it tends to diffuse into the organism's bodies. They must avoid or compensate for this influx or die.

Some sea animals have adapted to terrestrail existence. An example is the ghost crab, Ocypode, which lies in burrows above the high tide mark.

This crab is so well adapted to the land that it must wet its gills only occasionally. The ghost crab can often be seen out on the beach at night running along like a small pale ghost, hence its name. When the sun is too hot, it retreats into its burrow at the seaward edge of the sand dunes. The burrow is sufficiently deep to stay cool and moist. The fiddler crab, Uca, of the marshes, is another example of a semi-terrestrial crab that hides in a burrow during inclement conditions. The following exercise on a model beach will enable your students to duplicate many of the conditions we have just discussed.

There are a few phenomena that cannot be exactly duplicated in the model, but the operation of the model will show examples of them. Both tides and waves create currents. The waves crashing in on the beach are associated with strong currents and pressures. These pressures can grind up shells on the beach and keep the sands in constant motion. This makes it very difficult for many animals to live in the sand on an exposed beach. Some animals such as the mole crab take advantage of the wave currents for feeding. They may be seen scuttling along between the waves and suddenly burrowing, shoving out their antennae, and straining food particles from the currents of receding waves.

On the protected beach, breakers are usually absent and currents are slow enough for mud bottoms to form. These act are as stable substrates for the attachment of various larvae. These larvae include polychaete worms, who find suitable homes in the mud, and oysters.

The effect of current on the bottom can be seen while the model beach is filling. The inrushing water will clear away some of the sand from the inlet. You may wish to point this out to your students as an illustration of the effect of strong wave currents.

Activity 5 - Factors affecting zonation in tidal areas (Life Science, Biology)

A. The students should set up stream tables with sand sloping from the top of the inlet end to the bottom of the outlet end, as in Figure 1. It will be helpful to show the transparency of a model beach in a stream table at this time. It will serve as a guide to the students as they construct their own models.

B. The stream tables should be filled with water at the outlet end to about one half the depth of the stream table. The top of the slope should have model sand dunes represented by piles of sand 10 or 12 centimeters high.

C. Slowly raise and lower the reservoir to show the effects of high and low tide on the beach.

D. Have the students watch the wave motion for a few cycles after telling them to let the waves washing ashore represent the rise and fall of the tide.

E. Leave the reservoir at low tide position to let the heat lamp warm the beach while asking the class the following questions.

Question	
1. Where is the SUPRATIDAL zone?	1. The supratidal is the region above the highest point reached by the tides (HIGHWATER MARK).
2. How often is it covered by water?	2. Almost never.

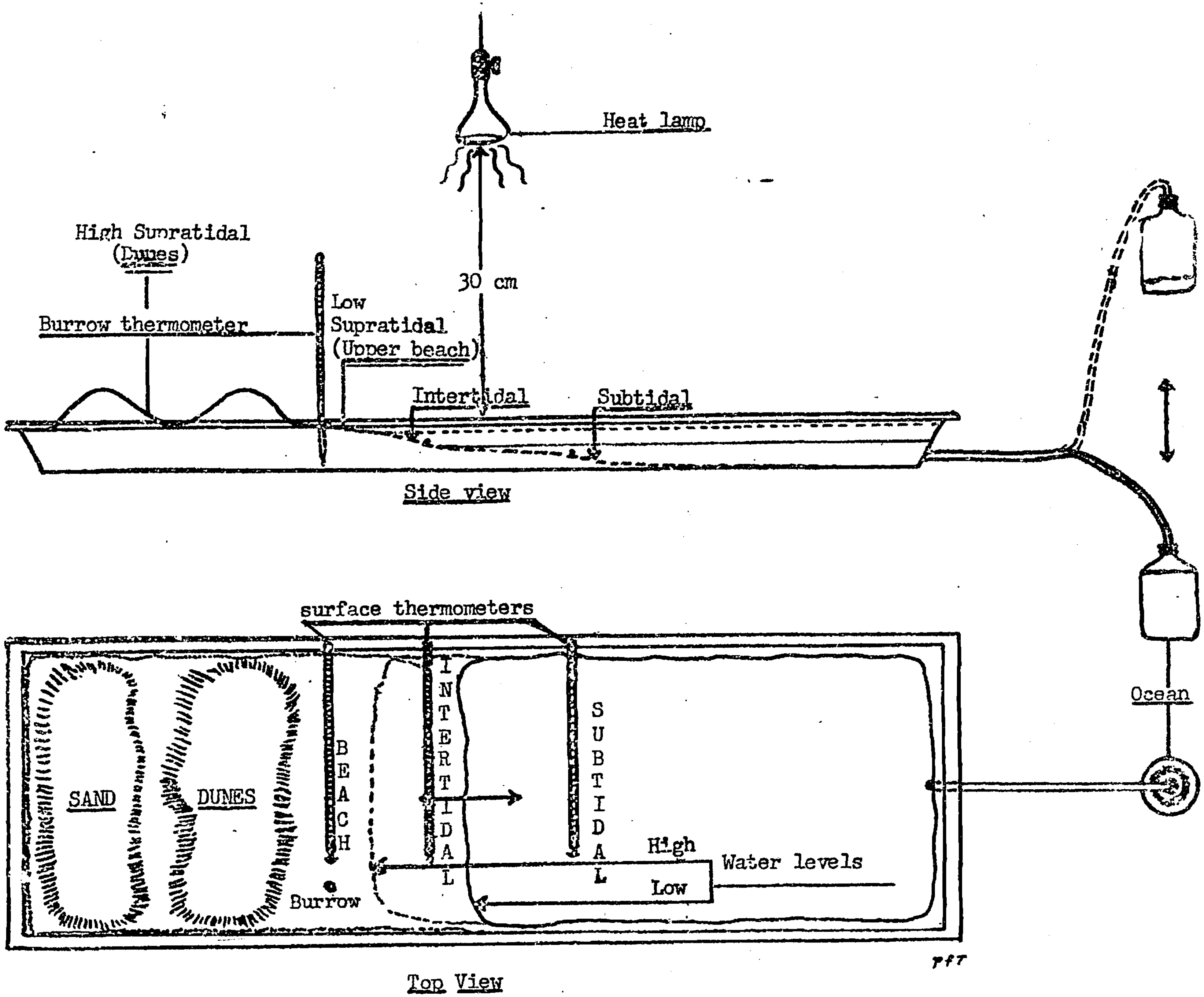


Figure 1. A model beach in a stream table.

3. How many different regions can you see in the supratidal?

3. There are two primary regions in the supratidal; the dunes and the flat beach. The dunes can be called HIGH SUPRATIDAL. The flat beach can be called the LOW SUPRATIDAL.

4. Do you think any of the supratidal zone is ever wet?

4. Yes. Storm-driven tides can reach even behind the dunes. The low supratidal is often moistened by spray blown off waves by winds coming in toward the beach. The low supratidal is sometimes called the SPRAY ZONE.

5. How do you think temperature will change in the supratidal zone?

5. The supratidal zone is rarely covered by water. The temperture of this zone will reflect daily and seasonal temperatures of the air.

6. What are the two main environmental dangers facing supratidal organisms?

6. Dessication and extreme temperatures.

7. Where is the INTERTIDAL zone?

7. The intertidal zone is located between the highwater mark and the lowest point reached by the daily tide. (LOWWATER MARK)

8. How often is the intertidal covered by water?

8. The intertidal zone is alternately covered and exposed by the tides.

9. Do you think the temperatures fluctuations in the intertidal are as extreme as in the supra tidal zone?

9. No. The intertidal is covered by thermally stable water for a large part of each day. Even when the intertidal is exposed the sand or mud is wet. This helps in damping temperature fluctuations. An exception is tide pools left behind when the tide goes out. These pools can reach extreme temperatures on hot summer days.

10. Can you think of an environment factor in the intertidal zone that is not found in the supratidal zone?

10. Wave pressures. On exposed beaches, the organisms of the intertidal are exposed to the pressures of crashing waves and the fast currents associated with advancing and retreating waves. The currents and wave pressures keep the bottom in constant motion.

11. Can you think of three types of intertidal habitats?

11. Beaches, marshes in protected waters, and rocky shores.

12. What are the environmental factors with which intertidal organisms must contend?

12. Dessication, temperature fluctuations, wave pressures and currents.

13. How do the dangers of dessication and temperature fluctuations compare with conditions in the supratidal?

13. The intertidal is wet more frequently than the supratidal resulting in less danger of dessication. The thermally stable water covering the intertidal at high tide results in less temperature fluctuation than in the supratidal.

14. Where is the SUBTIDAL zone?

14. The subtidal zone is located seaward of the lowwater mark.

15. How often is it covered by water?

15. Almost always.

16. Do you think the subtidal zone could ever be exposed to the air?

16. In times of extremely low tides and strong offshore winds, part of the subtidal may be uncovered.

17. What kind of temperature fluctuations do you think exist in the subtidal zone?

17. The subtidal zone usually shows very slow fluctuations in temperature. It is almost always covered by water and reflects only the slow seasonal fluctuations of seawater temperature.

18. Are subtidal organisms over in danger of drying out?

18. No.

19. How do pressures and currents from waves compare with those in the intertidal zone?

19. They are far less.

20. Are conditions more comfortable for most marine organisms in the subtidal than they are in the intertidal or supratidal?	20. Yes.
21. Where do you think you would find the greater number of kinds of marine organisms?	21. In the subtidal zone.
22. Where do you think you would find the least number of kinds?	22. In the supratidal.

Activity 6 (Life Science, Biology)

1. Read the field guide "Marine Biological field Techniques.

2. Distribute 1 copy of the guide to each student. Assign it to them as homework.

3. Rehearse the use of all equipment in class before going on the field trip.

4. Assign work parties to carry out the tasks outlined on the last three pages of the field guide.

5. Recruit a bus or private transportation to a local beach for you and the class. Obtain partental releases and otherwise observe legal precautions pertinent to student field trips.

6. Carry out the assigned tasks in the field guide.

7. Bring back some examples of beach flora and fauna alive in plastic bags. If the organisms are used to being covered with water, put enough water in the bag to cover them well. Do not fill the whole bag! Air space over the water will let the organisms live much longer.

8. Preserve some organisms, at least one or two of each kind found, Invertegrates require 5% formalin. Fishes should be put in 10% formalin and slit in the side so the fluid can enter. Plants may be pressed in the plant press.