MAN AND THE GULF OF MEXICO

Marine Habitats

Compiled and Edited by
Bobby N. Irby
Malcolm K. McEwen
Shelia A. Brown
Elizabeth M. Meek

MGM

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PROJECT STAFF

Dr. Bobby N. Irby
Principal Investigator
Chairman, Department of Science Education
University of Southern Mississippi
Hattiesburg, MS 39046

Dr. Malcolm K. McEwen
Evaluator and Curriculum Consultant
Department of Science Education
University of Southern Mississippi
Hattiesburg, MS 39046

Dr. Shelia A. Brown
Associate Investigator
Curriculum Consultant
University of Southern Mississippi
Hattiesburg, MS 39046

Dr. Elizabeth M. Meek
Associate Investigator
Curriculum Consultant
University of South Alabama
Mobile, AL 36688

CONTRIBUTORS

Dr. Shelia A. Brown
Mr. Gerald C. Corcoran
Dr. Bobby N. Irby
Dr. Malcolm K. McEwen
Dr. Elizabeth M. Meek
Dr. Marlene M. Milkent
Dr. Lloyd E. Story

TYPISTS

Barbara B. O'Brien
Kay Everett

CLERKS

Susan Stewart
Maureen Corcoran
Leona S. Woullard
Mary Woodard

ILLUSTRATORS

Teri Kinslow
Richard Ford
Lois P. Irby

TEACHER CONSULTANTS

Joe Ash
Beatrice Blount
Taska Brantley
Margaret Caldwell
Ann Carothers
Hargie Crenshaw
Robert Crittenden
Mervin Denton
Mary Ann Erdman
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Angela Faulkenberry
Iva Nell Fortenberry
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Harmon Ross
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Carol Smith
Linda Standridge
Dorothy Steinwinder
Silvia Wallace
Madeene Watts
Raymond Werthner
Lou White
Dan Whitson
Martha Wilson
Charles Wollfarth
Janice Woodall

TEST-CENTER TEACHERS, 1980-81

Robert Crittenden
Auburn High School
Auburn, AL

Mervin Denton
McComb High School
McComb, MS

Mary Ann Erdman
Baker High School
Mobile, AL

Iva Nell Fortenberry
Monticello High School
Monticello, MS

Wattine Hannah
Gulfport High School
Gulfport, MS

Diana Jones
Woodland High School
Woodland, AL

Rebecca Jones
Fairhope High School
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William Lay
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Hamilton, MS

Bessie Moffatt
Pascagoula High School
Pascagoula, MS

Marie Patrick
Foley High School
Foley, AL

Silvia Wallace
Strider Academy
Webb, MS

Raymond Werthner
St. Martin High School
Biloxi, MS

TEST CENTER TEACHERS, 1981-82

Sarah Ainsworth
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Hernando, MS

Timothy Benjamin
East Union Attndnce. Cntr.
Blue Springs, MS

Janice Chitwood
Carver Junior High School
Montgomery, AL

Peggy Croutch
Gulfport High School
Gulfport, MS

Richard Davis
Hamilton High School
Hamilton, AL

Wattine Hannah
Gulfport High School
Gulfport, MS

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Moss Point High School
Moss Point, MS

Sharon Johnson
Petal High School
Petal, MS

William Lay
Hamilton High School
Hamilton, MS

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Mobile, AL

Jane Lusk
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Starkville, MS

Lenora McWhorter
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Cedar Bluff, AL

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Pascagoula High School
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Foley, AL

Billy Pierce
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Decatur, MS

Sarah Sims
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Opp High School
Opp, AL

Mary Ulrich
Provine High School
Jackson, MS

Brenda Vaughn
Huntsville High School
Huntsville, AL

Silvia Wallace
Strider Academy
Webb, MS

STATE DEPARTMENT OF EDUCATION CONSULTANTS

Donna Bentley
Science Specialist
Alabama State Department
of Education

Michael Carothers
Consultant, Science and
Environmental Education
Mississippi State Department
of Education

Edward Ford
Science Specialist
Aerospace
Alabama State Department
of Education

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Preface

If the oceans of earth should die...it would be the final as well as the greatest catastrophe in the troublous story of man and the other animals and plants with whom man shares this planet.

—JACQUES COUSTEAU

Cousteau's warning appropriately summarizes the need to include marine education in our curriculum today. The history of mankind is closely linked to the ocean. Man has always been awed by the vast expanse of the sea. It is ironic indeed that such a valuable resource has been neglected so long in education.

"Man and the Gulf of Mexico (MGM)" is a marine science curriculum developed for grades 10-12 with funds from the Mississippi/Alabama Sea Grant Consortium. The MGM materials were specifically designed to meet the need for marine science in all secondary schools of Mississippi and Alabama.

The MGM project was a two-state effort, involving the University of Southern Mississippi, the University of South Alabama, and the Gulf Coast Research Laboratory in cooperation with the Alabama and Mississippi State Departments of Education. Similarities among the coastal problems of the two states not only made this an appropriate arrangement, but also heightened the potential for success of the project. Additionally, the educational needs for increased dissemination of marine studies in the public schools of the sister states are equally urgent. Perhaps the most significant feature in the development of the MGM materials was the cooperation between University science educators, innovative secondary school science teachers and other resource personnel. These cooperative relationships were established at the outset of the project and continued throughout the duration of this curriculum development effort. The design, development, field testing, revision, and a second field tet evaluation spanned four years of intensive and dedicated work.

During the initial phase of the MGM project, selected high school science teachers responded to a questionnaire designed to provide information concerning each teacher's impression of the importance of certain marine topics, each teacher's self-assessment of his/her knowledge of the same marine topics, and each teacher's preference in terms of curriculum format. Results of the survey were used to provide direction for the selection of topics and for the development of activities to be included in the materials. The completed materials include four units: **Marine and Estuarine Ecology, Marine Habitats, Diversity of Marine Animals,** and **Diversity of Marine Plants.** Field testing of the materials was conducted in eleven schools by biology teachers during 1980-81. Included were two inland and two coastal districts in Mississippi. Based on those classroom evaluations, the materials were thoroughly revised during the summer of 1981. The revised materials were then used in 35 schools throughout Alabama and Mississippi during the 1981-82 academic year.

The field-testing of the MGM materials in the classroom has demonstrated that the marine science materials are equally appropriate for both inland and coastal schools. Many teachers have successfully incorporated selected MGM materials into their existing courses of study in biology, while others have used the complete curriculum as a separate course in marine science. In either case, teachers have found the MGM Marine Science Curriculum enjoyable to teach and very informative.

Information and activities indexed and accumulated on microfiche through the Marine Education Materials System (MEMS) have been invaluable during preparation of the MGM units. Some of the activities and concepts included as a part of MGM were modified from resources in the MEMS collection. Appropriate credit is given to the original authors in the reference section of each MGM unit. We are particularly indebted to the following marine education curriculum projects for their contributions: "Man and the Seacoast," a project sonsored by the University of North Carolina Sea Grant College Program which resulted in the publication of the **North Carolina Marine Education Manual** series; "Project COAST" (Coastal/Oceanic Awareness Studies), funded by the Delaware Sea Grant College Program; and the **Hawaii Marine Sciences Study Program** developed by the Curriculum Research and Development Group at the University of Hawaii.

We wish to acknowledge the cooperation that we have received from other marine education projects, the Alabama and Mississippi State Departments of Education, The University of Mississippi Law School, the National Marine Education Association, and many individuals who offered suggestions that were incorporated into the MGM materials. Our gratitude is also extended to Dr. J. Richard Moore for permission to include his plant key in the teacher supplement for **Diversity of Marine Plants.** We are indebted to the Department of Science Education at the University of Southern Mississippi for serving as a base of operation, allowing use of its equipment, and providing financial support. We especially would like to thank all of the dedicated Mississippi and Alabama teachers who worked so diligently on the MGM materials. We hope that high school students and their teachers will continue to find that these efforts have been of value.

Bobby N. Irby
Malcolm K. McEwen
Shelia A. Brown
Elizabeth M. Meek

MARINE HABITATS

Objectives of *Marine Habitats*

1. To help students realize the diversity of habitats present in the marine environment.
2. To present general information relative to the various types of organisms that live in the marine environment.
3. To compare and contrast adaptations of marine organisms necessary for survival in their particular habitat.
4. To illustrate the interdependency of plants and animals.
5. To provide activities which allow students to investigate several marine habitats.
6. To discuss the importance of certain abiotic factors in marine habitats.

INTRODUCTION

The **environment** in which an organism lives is known as its **habitat.** Aquatic and terrestrial habitats are varied and provide living space for large numbers of organisms. The oceans cover approximately 71% of the earth's surface and average about four kilometers in depth. Both the large size and variable depth are factors responsible for the variety of marine habitat types. The kinds of organisms found in each environmental type are different. Many **biotic** and **abiotic factors** contribute to the **diversity.**

In this topic, we will concern ourselves with two aquatic habitats, the saltwater or **marine** and the **brackish** water habitats. The marine habitat is divided into a shore habitat, the sea surface habitat, and the deep sea habitat. Coastal areas under the influence of tides and fresh-water streams contain brackish water and are called **estuaries.** The organisms that live on or near shore must be able to survive in an environment which is highly variable. In these habitats the organisms must be able to tolerate changes in temperature, salt, and oxygen concentrations.

VOCABULARY

abiotic factors—physical (non-living) aspects which interact with the organisms of an ecosystem.

biotic factors—relationships among living organisms in an ecosystem.

brackish—less salty than the ocean; estuaries are brackish because fresh river water mixes with salty ocean water.

diversity—the number of different kinds of organisms that have varying characteristics found in a particular area.

environment—the surroundings of an organism.
estuary—a relatively small body of water that is set off from the main body of water and is affected by the rise and fall of the tide. Estuaries contain mixtures of fresh and salt water.
habitat—the place where an organism lives.
marine—growing within the influence of the sea or immersed in its water.

CONCEPT A

The salt marsh habitat includes a diversity of plants and animals living in close proximity to one another. All the organisms are affected by limiting environmental factors.

Objectives

Upon completion of this concept, the student should be able:

a. To explain how the terms "niche" and "habitat" are related.
b. To define the term "limiting factor" and provide examples of limiting factors that affect various organisms.
c. To correctly distinguish among the terms "herbivore", "carnivore", and "omnivore".
d. To give two examples of herbivores, carnivores, and omnivores in a salt marsh.
e. To draw a simple diagram of the relationship between feeding types.
f. To name the four regions (zones) of the salt marsh.
g. To list two factors that are involved in the formation of salt marsh zones.

THE SALT MARSH

If you ever visit a salt marsh, you will probably encounter a bunch of old grass, some smelly mud, and a few snails. However, if you are an **ecologist** you will see much more. You will see the grass, the snails, and the mud all as a unit with each part dependent on the others in some way. An ecologist studies the interactions between organisms and their physical and biological environment. The study of the interactions of **biotic** and **abiotic** factors of the environment is called **ecology.**

If we look closely at a salt marsh, we would see there are many more organisms present than just snails and grass. In fact, we could find several kinds of snails and several kinds of grass. If we study these organisms, we would find that each lives in a slightly different place with slightly different conditions. Each one would seem to be adapted to a certain way of life. They would get their food in a certain way and react to a **stimulus** in a certain manner. Ecologists call this particular way of life the organism's **niche.** We also said that each organism lives in a particular place and around certain other organisms. Ecologists call this particular place the organism's **habitat.** Dr. Eugene Odum, a famous ecologist, has given us a good way to remember this. He says an organism's niche is its profession and the organism's habitat is its address. It would be very strange for us to find a mountain goat in the salt marsh eating snails. It would also be strange to find a salt marsh organism on a mountain eating pine trees. However, we would think it normal to see salt marsh organisms occupying their own niche and living in their own habitat.

Ecologists often use the term population. **Populations** are made up of all of the individuals of the same species in a particular area. In the salt marsh, salt marsh cordgrass, *Spartina* *alterniflora,* makes up a large plant population and the marsh periwinkle, *Littorina irrorata,* makes up a large animal population. When ecologists speak of all the populations that live together in a certain area, they call them a **community.** The community and the abiotic factors where the community is found are called an **ecosystem.** All of the ecosystems on earth make up the **biosphere.** These terms can be summarized in the following manner:

organisms of the same species	=	population
all populations in an area	=	community
community + physical environment	=	ecosystem
all ecosystems in the world	=	biosphere

An ecosystem sounds like a very large geographical area, but this is not necessarily true. It can be a small pool of water left by a very high tide, or it can be an entire salt marsh. It depends on the size of the area that we want to examine.

All of this probably seems rather complicated. However, ecologists have provided us with ecological terms to make it easier for us to study and discuss the interrelationships of organisms. Let us consider some other ways in which an ecologist studies the interrelationships of organisms and their physical environment.

The non-living portion of the environment greatly affects organisms. In salt marshes, as well as in other places, we find plants and animals can live only under certain physical conditions. Texture of the soil, moisture, temperature, sunlight, and chemistry of the soil are a few of the factors that limit the growth and survival of organisms. Any factor that affects an organism's survival is called a **limiting factor.**

Now that we know a little about the terminology of ecology, let us consider the salt marsh in more detail. Anyone living on the coast is familiar with the tides. The tides are very important to the salt marsh. During periods of high tide, salt water is brought into the marsh. The animals and plants there have become adapted over thousands of years to this salt water flooding. In fact, the ribbed mussel, *Modiolus,* must have this water in order to feed. This mussel feeds on tiny floating organisms and decaying matter that is carried into the marsh by tides (Figure 1). The dead, decaying matter is called **detritus.** When the tide changes, the water carries detritus and waste materials from the marsh out into the estuary.

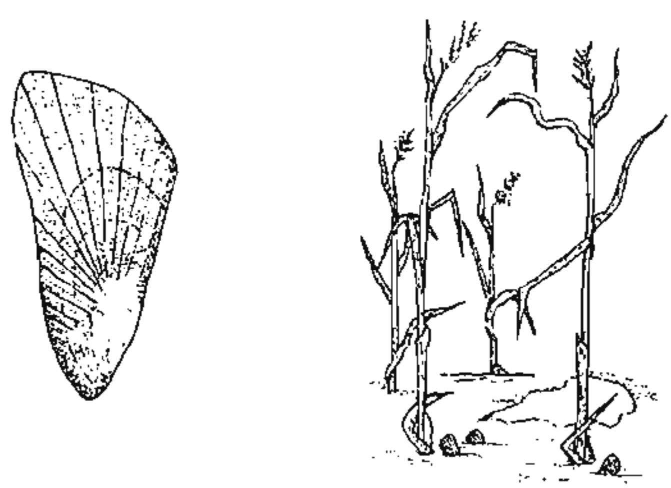


Figure 1. Ribbed Mussels. These mussels are usually found half-buried in the salt marsh muds. Threads anchor these organisms to the mud and to one another.

The behavior of the fiddler crab, *Uca,* is adapted to changing tides. The fiddler leaves its burrow at low tide to feed on detritus and small organisms found on the mud. At high tide the fiddler returns to its burrow (Figure 2). Shrimp, fishes, and some other animals use the high tides to feed in the marshes.

Many animals that live as adults in the sea developed through their larval stages in the salt marshes. During high tides the young organisms can swim into the marsh where they would be assured of sufficient food and protection.

When winter temperatures turn the marshes cold, some of the marsh animals disappear. However, few of these animals leave the marsh. Many of them simply burrow under the mud to hibernate and escape freezing. During the spring and summer months when the temperature is warmer, these animals come back to the surface. The periwinkle, *Littorina,* burrows during cold spells, but is abundant in salt marshes near the water's edge during warm weather. It clings to the stalks of grass and eats the detritus and algae it finds on the stalks (Figure 3). Another snail found crawling over the mud and on the surface of salt marsh grasses of the Gulf Coast is *Neritina. Neritina* is a colorful snail. The small shells vary in color (white, gray, yellow and olive). Also, the shells may have stripes, waves or lines on the

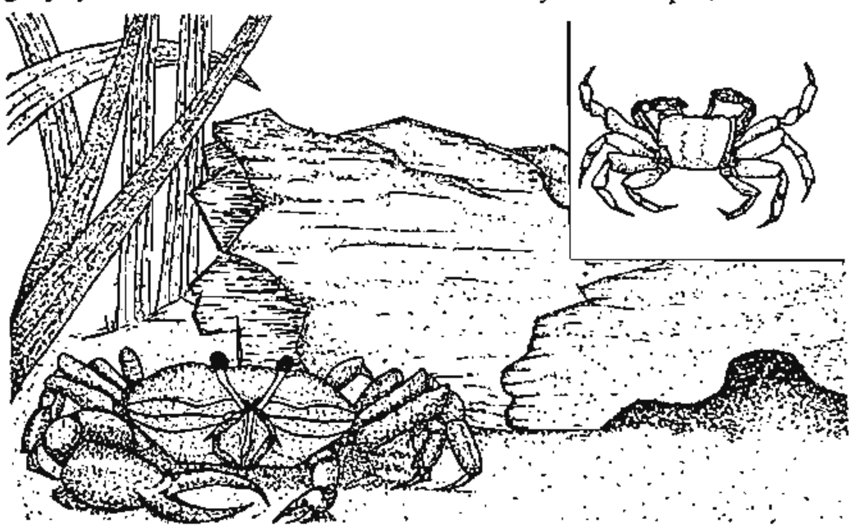


Figure 2. Fiddler Crab. This crab leaves its burrow at low tide to feed on whatever detritus it can find.

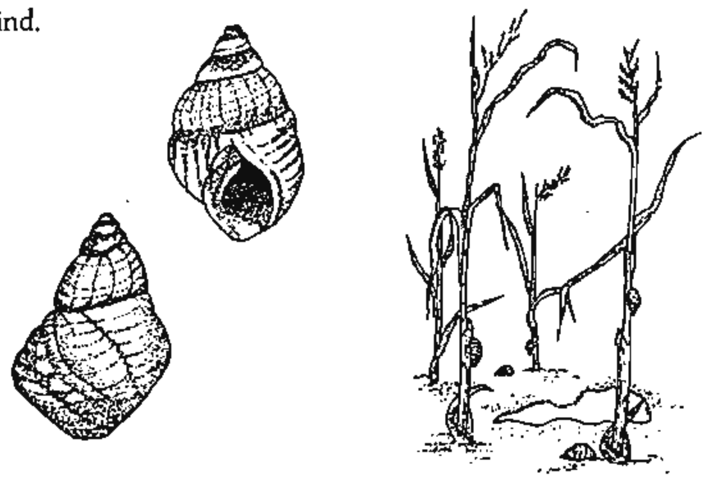


Figure 3. Marsh Periwinkle ***(Littorina irrorata).*** These snails are very abundant on the stems of cordgrass in the salt marsh.

outer surface. There is another snail usually found in the drier area of the marsh called *Melampus. Melampus* is a small snail about half the size of *Littorina.* It can sometimes be found under driftwood, often in the presence of a crab that looks very much like a fiddler crab without the large claw (Figure 4). Some people even mistake this crab, *Sesarma,* for a spider. Both of these animals eat detritus and small organisms. All of these animals are difficult to find in the cold winter months.

Insects are also very common in the salt marsh. The insects eat a wide range of material: plants, detritus, and even other insects.

So far, we have talked mostly about the invertebrate animals. But, there are some animals with backbones found in the salt marsh. Fishes, of course, come into the salt marsh with the rising tides. Killifishes, often called mosquito fish, are very common (Figure 5). They are very important in controlling mosquitoes. Young fish of many of our important game and commercial species are also found in salt marshes. The fact that they grow up here is very important to our fishing industry.

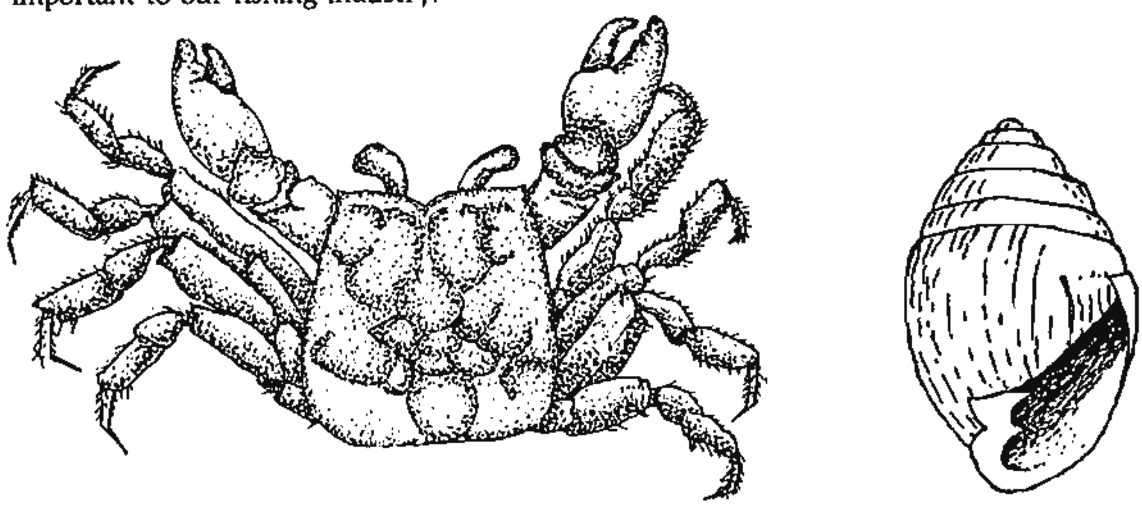


Figure 4. Marsh Snail *(Melampus).* The marsh snail can sometimes be found in the company of a spider-like crab called *Sesarma.*

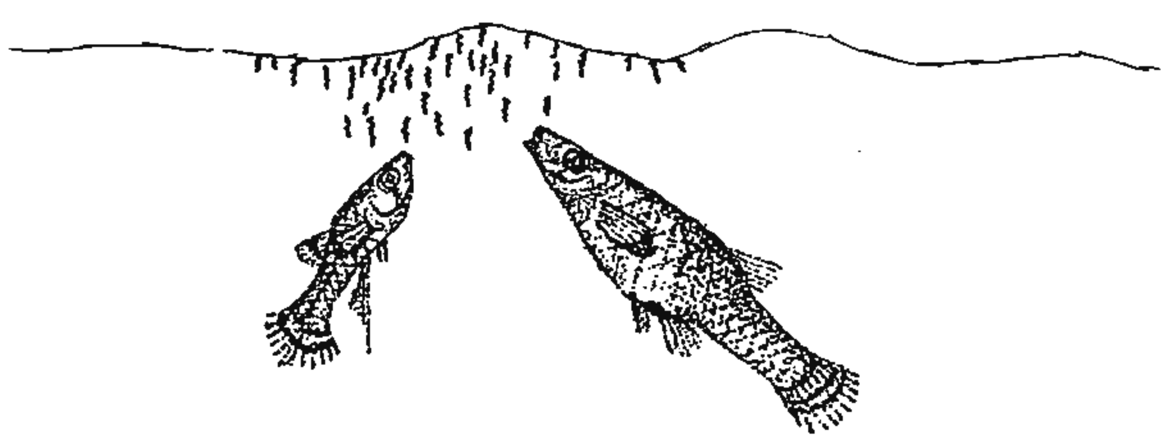


Figure 5. Killifish (Mosquito fish). A single killifish may consume hundreds of mosquito wigglers each day.

The diamond-backed terrapin is a common reptile found in the salt marsh. These turtles eat crustaceans, fish or almost anything they can catch in the marsh (Figure 6).

Red-winged blackbirds, seaside sparrows, and clapper rails are birds endemic to the salt marsh. The red-winged blackbird and the seaside sparrow eat mostly insects. If there are seeds on the grass stalks, they will eat the seeds. The fiddler crab makes up a large part of the diet of the clapper rail, but they will also eat insects (Figure 7).

One mammal, the raccoon, regularly visits the salt marsh at low tide. It eats animals left in the tide pools and the shellfishes that are found in the marsh.

Plants in the salt marsh are usually found in distinct zones. These zones are believed to be the complicated result of elevation, soil type, **salinity** (saltiness), temperature, and tidal fluctuations. The most abundant grass in the muddy low section of the salt marsh is salt marsh cordgrass, *Spartina alterniflora* (Figure 8A). It usually grows tall near the water, and appears to grow in pure populations. Higher in the marsh where the soil is sandy, salt meadow cordgrass, *Spartina patens,* is usually the most abundant. *Spartina patens* is often found farther from the water's edge just behind *Spartina alterniflora* (Figure 8B). Of the two common cordgrasses found in the salt marsh, *Spartina alterniflora* grows taller and has wider leaves than *Spartina patens.* Their adaptations to the habitat allow the cordgrasses to lie in slightly differing environments. Consequently, pure stands of each type of cordgrass can be found. This makes it possible to easily distinguish between the two species.

In some salt marshes black needle rush, *(Juncus roemerianus,* Figure 9A) grows in clumps or may cover whole marshes. On the drier hammocks where water seldom reaches, wax myrtle *(Myrica cerifera,* Figure 9B), yaupon holly *(Ilex vomitoria,* Figure 9C), and cotton seed bush *(Baccharis,* Figure 9D), can be found and serve as shelter and nesting sites for birds, mice, rats, and other animals.

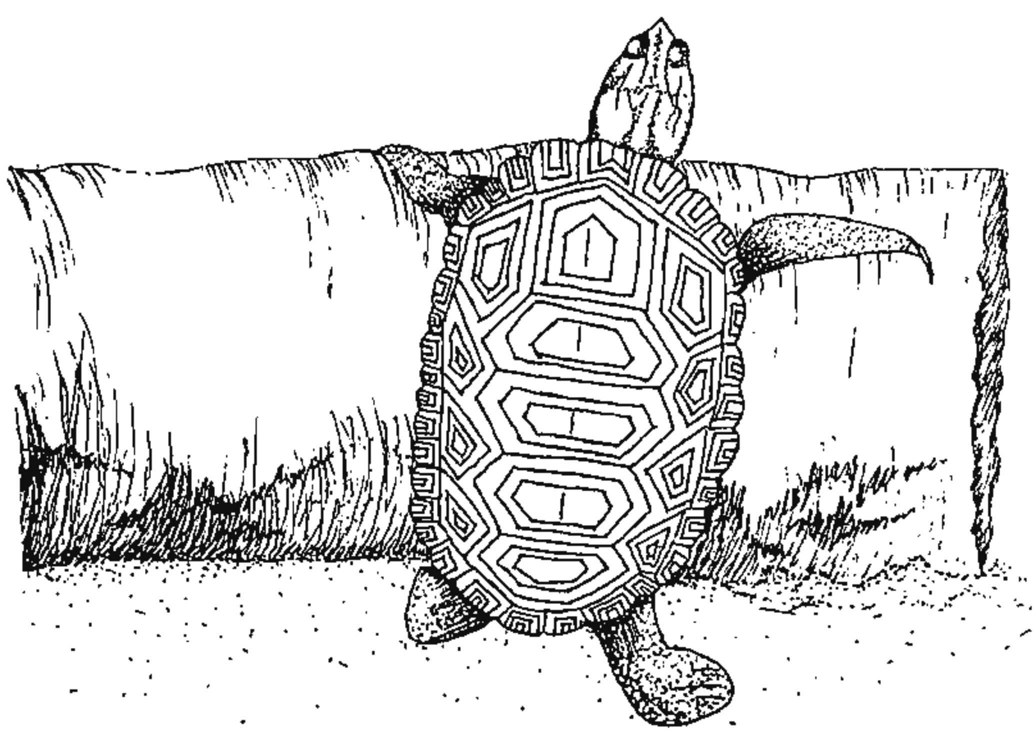


Figure 6. Diamond-backed terrapin. These turtles were once raised as food.

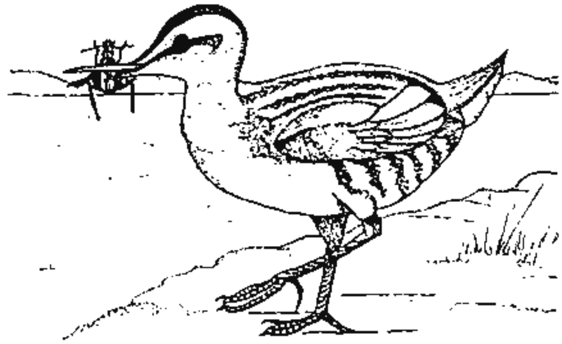


Figure 7. Clapper Rails. These birds eat insects, fiddler crabs or almost anything they can find.

Figure 8A. Saltmeadow cordgrass *(Spartina alterniflora).*
a. Flowering or fruiting head.

Figure 8B. Saltmeadow cordgrass *(Spartina patens).*
a. Flowering or fruiting head.

Figure 9. A, *Juncus.* B, Wax Myrtle. C, Yaupon. D, *Baccharis.*

There are some other plants scattered through the marsh. Sea lavender, *Limonium carolinianum*, is usually found in areas of marsh covered by high tide. Sea lavender, which blooms in the early fall, has many small purple flowers growing on a tall spike. Glasswort, *Salicornia*, is a fleshy, green plant with rounded leaves. It is usually found in sandy places of the marsh where the salinity of the soil is very high. Spike grass, *Distichlis spicata*, and the sunflower-like ox-eye, *Borrichia frutesens*, are also found in the high sandy areas of the marsh.

An interesting feature of the high areas of the marsh is the bare sand spots. Sometimes these spots are very large. Scientists believe that these areas represent the highest tide marks. When the tide is very high, the salt water covers these areas. When the tide goes out, these areas are left with a film of water. Exposure to the heat of the sun causes the water to evaporate. The salt is concentrated in the area after water evaporation. Since this is a very high tide the water will not reach the area again for some time and the salt will not be washed away. After this happens many times the area will be too salty for plants to grow there. These spots are called **salt barrens** (Figure 10).

Plants are important to the salt marsh community because they provide both food and shelter for the animals. Plants are able to use soil chemicals and sunlight to produce foods that animals can eat. Because they can make this food, they are called **producers.** Bacteria are very important to the plant's ability to produce this food. They break down the complex organic materials of dead plants and animals to a degree that living plants can use the simpler chemicals. Bacteria that perform this necessary task are called **decomposers.**

The animals that eat the producers constitute the first **tropic level** of consumers and are called **herbivores.** These animals are very close to the base level of the **food chains** in the community. These organisms probably occur in the greatest numbers in the food chain. At the second trophic level carnivorous animals can be found. These animals usually feed on

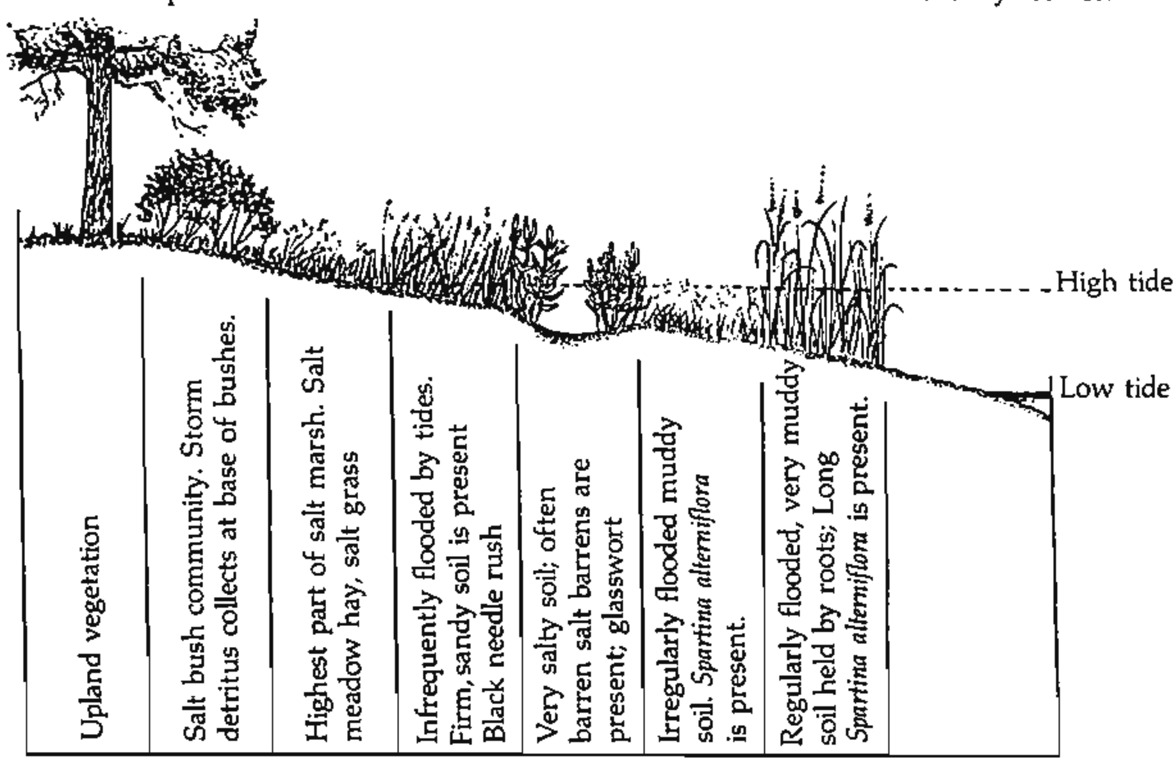


Figure 10. Zonation of a salt marsh.

animals of the first trophic level. Meat-eating animals are referred to as **carnivores.** There are some animals found in the **salt marsh** such as the red-winged blackbird which can feed on both animal and plant tissues. These birds have been observed feeding on insects as well as plant seeds. Animals that can feed on both plants and animals are called **omnivores.**

Carnivores, herbivores, and omnivores are all called **consumers** because they either eat plants (producers) or animals.

The simple diagram illustrated in Figure 11 will help show the interaction of plants and animals in a salt marsh. This diagram explains other communities as well as the salt marsh because a given community can only support a given diversity and quantity of organisms. This property is referred to by ecologists as the **carrying capacity** of a biological community.

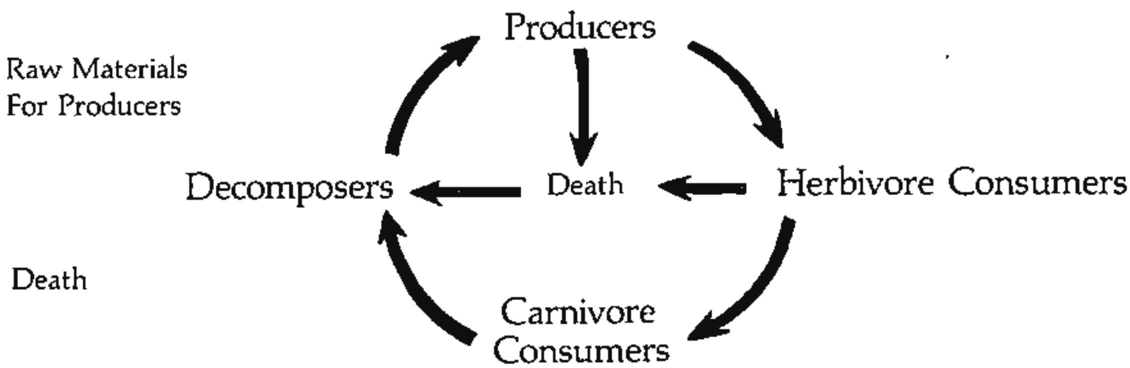


Figure 11. Diagram of the relationship of feeding types.
As you can see by the diagram, all of these types of organisms are dependent on each other in some way.

CHECK YOUR LEARNING

1. The manner or way in which an organism makes its living is called its ecological ______

   ____

2. What components does the biosphere include? ______________________

   ____

3. A ______________ is made up of all the organisms of one kind living in a certain area.
4. A physical or biological factor that influences the survival of an organism is called a

   ______________ factor.
5. The bacteria in a salt marsh that chemically break down plant and animal matter are called

   ____

6. If a raccoon eats only the animals in the salt marsh, he is called a ______________
7. An ______________________ will eat both plants and animals.
8. Areas in the salt marsh where plants do not grow because of high salinity are called

   ______________ .

9. The organisms in the salt marsh that manufacture the food are called the ______ .
10. ______________ is the broken-up dead plant and animal matter.

THINK QUESTIONS

1. Explain how salt barrens are formed.
2. What is the importance of decomposers in the salt marsh?
3. Why are producers important in the salt marsh?

VOCABULARY

abiotic factors—physical (nonliving) aspects which interact with the organisms of an ecosystem.

biosphere—the total world of life.

biotic factors—relationships among living organisms in an ecosystem.

carnivore—an animal which feeds on other animals.

carrying capacity—the number of individuals of a species that a particular environment can support indefinitely.

community—all of the populations of organisms in a particular area.

consumers—living things which obtain food from other organisms.

decomposers—organisms that break down the tissues and excretions of other organisms into simpler substances through the process of decay.

detritus—very small particles of the decaying remains of dead plants and animals; an important source of food for many marine animals.

ecologist—a scientist who studies the relationships of living things to their surroundings.

ecology—the study of the relationship of living things to their surroundings.

ecosystem—a community of organisms interacting with each other and the environment in which they live.

food chain—the passage of energy and materials in the form of food from producers to consumers as organisms feed on one another.

habitat—the place where an organism lives.

herbivores—animals that feed exclusively on plants.

limiting factor—single aspect of the environment which tends to prevent an increase in population size at any given time.

niche—the particular way in which an organism obtains its food and reacts; an organism's way of life.

omnivore—a consumer which feeds upon both plants and animals.

producer—a living thing that can make its own food.

population—a group of individuals of the same species in a given ecosystem.

salinity—total amount of dissolved salts present in a given amount of substance.

salt barrens—a high area of the marsh that is only flooded during very high tides. This area of marsh may eventually become too salty for plants to grow.

salt marsh—flat land subject to overflow by salt water. The vegetation of salt marshes may consist of grasses or even shrubs.

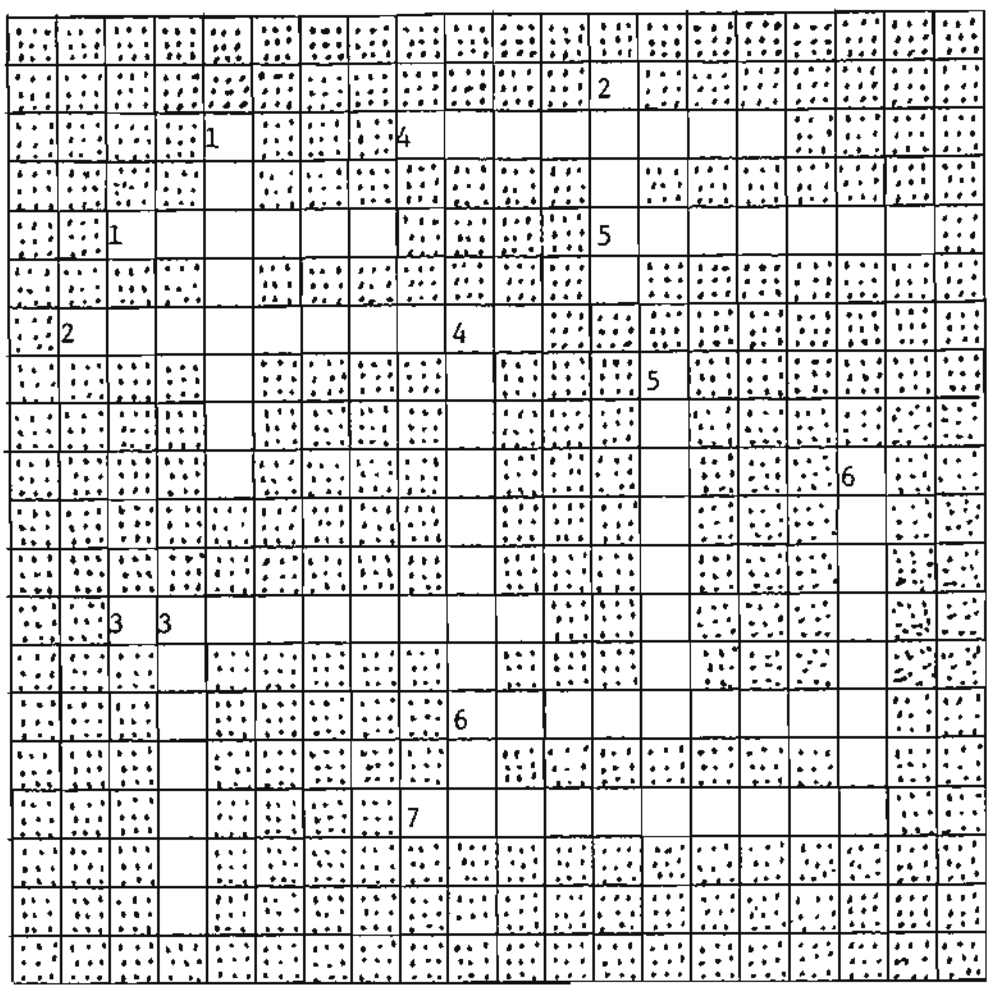
stimulus—anything that causes activity or change in an organism.

trophic level—levels of nourishment. A plant that obtains its energy directly from the sun occupies the first trophic level and is called an autotroph. An organism that consumes the tissue of an autotroph occupies the second trophic level, and an organism that eats the organism that had eaten autotrophs occupies the third trophic level.

VOCABULARY ACTIVITY FOR CONCEPT A

Across

1. The living components of the ecosystem
2. All members of the same species in a given area
3. An animal which feeds on other animals
4. Dead and decaying matter
5. The place where an organism lives
6. All of the biotic and abiotic factors interacting
7. The organisms of decay



Down

1. A plant.
2. An organism's way of life
3. Non-living factors of the environment
4. Eats plants and animals
5. A term which refers to the salt concentration
6. Gets food from other organisms

VOCABULARY ACTIVITY FOR CONCEPT A

Hidden in the letters below are 10 vocabulary words that are used in Concept A. The words may be written vertically (up-and-down), horizontally (across), backwards, or diagonally. Try to find the 10 words.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Z	C	H	Z	B	C	F	G	F	A	T	C	B	I	Z	D	C
P	D	G	A	L	V	E	A	N	E	Y	O	E	C	P	A	D
D	F	U	L	O	H	P	R	O	M	C	M	O	H	M	C	H
F	G	E	O	A	A	E	J	A	E	Q	P	G	E	Y	J	E
C	A	L	T	F	B	J	Q	L	G	C	R	C	Q	T	S	R
J	L	O	F	C	I	O	N	S	A	L	O	P	A	E	I	B
S	U	T	I	R	T	E	D	H	U	L	D	L	G	F	M	I
I	K	I	O	U	A	N	O	F	O	Z	U	M	O	Z	T	V
M	N	B	U	P	T	S	T	G	B	U	C	N	P	G	S	O
N	T	L	Q	J	E	J	I	Z	L	J	E	A	Z	W	Y	R
T	C	C	F	A	G	S	T	B	G	F	R	M	R	A	U	E
S	A	C	U	N	T	P	Q	U	S	U	L	U	M	I	T	S
T	B	O	N	E	B	T	W	P	O	I	U	Z	C	L	W	A
U	L	I	M	I	T	I	N	G	F	A	C	T	O	R	Q	F
W	Q	N	D	E	C	P	O	P	U	L	A	T	I	O	N	G
Q	H	Z	B	C	F	G	F	A	T	C	B	Z	D	V	I	I

Answers:

producer	detritus
population	niche
herbivore	ecology
ecologist	stimulus
habitat	limiting factor

Vocabulary

barrier island—a long, narrow island parallel to and not far from a mainland coast. The island is composed of material heaped up by ocean waves and currents.

consumers—living things which obtain food from other organisms.

decomposer—organism that breaks down the tissues and excretions of other organisms into simpler substances through the process of decay.

ecosystem—a community of organisms interacting with each other and the environment in which they live.

environment—the surroundings of an organism.

estuary—a relatively small body of water that is set off from the main body of water and is affected by the rise and fall of the tide. Estuaries contain a mixture of fresh and salt water.

food chain—the transfer of the sun's energy from producers to consumers as organisms feed on one another.

marsh—a tract of wet or periodically flooded treeless land, usually characterized by grasses, cattails, or other monocots.

microecosystem—an ecosystem that is very small, yet it contains an area filled with organisms which are exposed to various environmental factors.

producers—a living thing which can make its own food.

substrate—any hard surface on which a plant or animal is attached. Various soil types are examples of substrates.

Activity: **Diversity in Ecosystems**

Objective

To make an artificial ecosystem.

An **ecosystem** is usually thought of as all of the living organisms in a geographical area and the interactions of these organisms with the physical **environment.** How large then is an ecosystem? It may be very large or very small depending upon the boundaries that one imposes on the geographical area. An ecosystem could be a swamp, a **barrier island,** a pond, a sand dune area, a forest, a **marsh,** an **estuary** or an open grass field. These are all examples of ecosystems that exist in our area. Since it is sometimes difficult to do field work, this activity will bring the field to you. You are going to construct an artificial aquatic (water) community in your own laboratory. Later you can decide if this can be called an ecosystem or not.

Materials (per group of two students)

1 gallon jar
various kinds of water—tap, pond, creek, drainage ditch, aquarium
various kinds of soil, debris—topsoil, sand, leaves, forest floor litter
1 compound microscope
microscope slides

Procedure

Obtain one of the glass jars. With your partner, decide which combination of water and soil you will use in your **microecosystem.** Fill the jar approximately 3/4 full with the selected water. The microecosystem should then be placed where it can get moderate light and should be observed over a period of three weeks. All changes should be noted and recorded on the data sheets that will be provided daily. Should you decide to place extra animals and plants in your container, record the name and quantity of each. Record changes as soon as you notice them.

Do some organisms appear that you did not add at the beginning of the investigation?

__________ If this does occur, try to remove the organisms and examine them under the microscope, if necessary. What do you think these organisms are? __________

Do you feel that this is a growing population? __________ What do you think the role of this organism is in the community? __________

Do you think any of the organisms in your container have grown in size? __________

Did you notice any populations of organisms declining in numbers as the investigation came to an end? __________ Name some. __________

____

What do you think happened to these organisms? __________

Did any of the declining populations reoccur at a later time? __________

How do you account for this phenomenon? __________

____

Did you ever observe any organisms feeding? __________

What were they? __________ What types of food were they eating? __________

Did you have in your microecosystem any organism that did not have to eat? __________

Name them. __________ What do we call this kind of organism? __________

Make a comparison of your microecosystem with a pond.

How are they similar?	*How are they different?*
1. __________	1. __________
2. __________	2. __________
3. __________	3. __________
4. __________	4. __________

Daily Data Sheet for the Microecosystem

Type of water used ______________________________

Type of **substrate** used ______________________________

Kinds of organisms introduced ______________________________

Day	New Populations	Populations growing	Populations declining
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Give one **food chain** that you discovered in your microecosystem? ____________________

____

How do producers differ from consumers? ____________________

____

Name three **producers** found in your microecosystem ____________________

____

Name three **consumers** found in your microecosystem ____________________

____

Name two **decomposers** found in your microecosystem? ____________________

____

What is the chief role of the decomposer in any ecosystem? ____________________

____

Activity: A Salt Marsh Community

Objectives

To identify some of the common organisms found in a **salt marsh.**

To prepare diagrams of **food chains** found in a salt marsh using organisms discussed in this activity.

To identify the biological **niche** of representative organisms found in a salt marsh.

You have been studying the relationships that exist in a biological **community**. Many food exchanges are possible and this creates a very complex **food web**. All **trophic levels** are found in the salt marsh even though some of the food chains may be shorter than those in the open seas. The shorter food chains often can be attributed to the lush **productivity** of the **producers** of the area. The variety of producers present in this habitat is quite evident, ranging from the large sea grasses to the **phytoplankton**. With all of the producers available, it only seems natural to find many herbivores of grazers that can exist very low in the ecological pyramid. This factor is one of the reasons that the salt marsh is so important to us. These foundation orgainsms provide the food source for many other organisms or are of direct food value to man.

In the following investigation, you will try to identify the organisms of a hypothetical salt marsh **ecosystem** and then try to determine their ecological niche in the community.

Material (per student)

Guide sheet of the marsh ecosystem

Procedure

You are provided with a picture of a hypothetical marsh and a list of the organisms found in the marsh. Each organism is numbered in the picture. These numbers correspond to the list of orgainsms. Study both the picture and the list. After studying the organisms of the marsh, complete the data table for the niche of each organism (detritus feeder, filter feeder, grazer, producer, carnivore, herbivore).

1. Name three food chains that you can construct from your investigation.
   1. ______________________________
   2. ______________________________
   3. ______________________________

2. Construct a small food web from the organisms in the picture. Select at least 12 organisms.

3. What is the longest food chain that you can find in this marsh? ______________________________

____

4. What do you consider to be the ultimate consumer? ______________________________

5. Name three organisms that are at the base level in this community. ______________________________

____

6. Could this community exist on our Gulf? ____________ Explain ______________________________

____

____

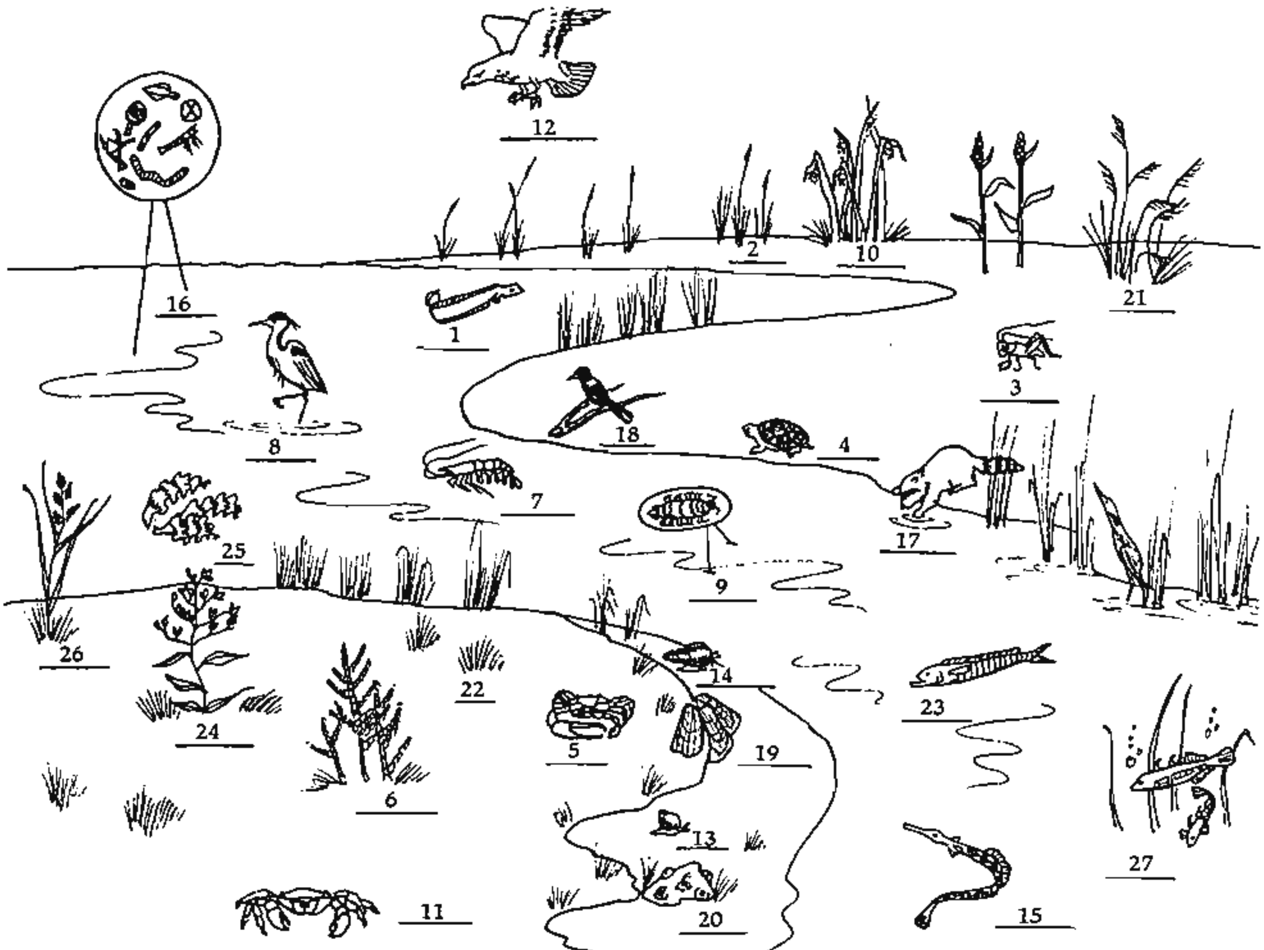


Figure 1. Salt marsh community.
Adapted from: Field Guide Sheet for Southeastern New England Marine Environments: Salt Marsh (Carole Eldridge).

Organisms Found in the Marsh

1. American eel (*Anguilla*)
2. Cat-tail (*Typha*)
3. Cricket (*Gryllus*)
4. Diamondback terrapin (*Malaclemys*)
5. Fiddler crab (*Uca*)
6. Glasswort (*Salicornia*)
7. Grass shrimp (*Palaemonetes*)
8. Great blue heron (*Florida*)
9. Isopods (*Idotea*)
10. Marsh bulrush (*Scirpus*)
11. Mash crab (*Sesarma*)
12. Marsh hawk
13. Marsh periwinkle (*Littorina*)
14. Mud snail *(Neretina)*
15. Pipefish (*Sygnathus*)
16. Plankton assortment
17. Raccoon (*Procyon*)
18. Red-winged black bird (*Agelaius*)
19. Ribbed mussels (*Modiolus*)
20. Rock barnacles (*Balanus*)
21. Salt marsh cordgrass (*Spartina alterniflora*)
22. Salt meadow cordgrass (*Spartina patens*)
23. Sand launce (*Ammodytes*)
24. Sea lavender (*Limonium*)
25. Sea lettuce (*Ulva*)
26. Spike grass (*Distichlis*)
27. Sticklebacks (*Gasterosteus*)

Organisms Found in a Hypothetical Salt Marsh

	Name of Organism	Usual Niche of this Organism
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
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17		
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22		
23		
24		
25		
26		
27		

VOCABULARY

community—a naturally occurring group of organisms living in a particular area.
ecosystem—a community of organisms interacting with each other and the environment in which they live.
food chain—the passage of energy and materials in the form of food from producers to consumers as organisms feed on one another.
food web—complex food chains existing within an ecosystem.
niche—the particular way in which an organism obtains its food and reacts; an organism's way of life.
phytoplankton—the plant forms of plankton. The most abundant of the phytoplankton are the diatoms.
producer—a living thing that can make its own food.
productivity—amount of organic material formed in excess of that used for respiration. It represents food potentially available to consumers.
salt marsh—flat land subject to overflow by salt water. The vegetation of salt marshes may consist of grasses or even shrubs.
trophic levels—levels of nourishment. A plant that obtains its energy directly from the sun occupies the first trophic level and is called an autotroph. An organism that consumes the tissue of an autotroph occupies the second trophic level, and an organism that eats the organism that had eaten autotrophs occupies the third trophic level.

CONCEPT B

The mud flat is an important part of the marine environment because of its role as a feeding ground.

Objectives

Upon completion of this concept, the student should be able:

a. To explain what makes it possible for salt marsh land organisms and salt marsh aquatic organisms to both feed in the mud flat.
b. To predict what would eventually happen to a very small mud flat organism if it was not attached to a substrate.
c. To list three examples of substrates used by organisms.
d. To explain the importance of having "scavengers" in the mud flat.

THE MUD FLAT

Along the edges of the salt marsh there is usually an **intertidal mud flat.** Mud flats are periodically covered and uncovered by water. The **limiting factors** associated with mud flats are similar to those of the salt marsh.

In the water of the mud flat are many small floating organisms called **plankton.** The plankton can be separated into two major kinds, **phytoplankton** and **zooplankton** (Figure 1). The microscopic floating algae called phytoplankton are swept into the mud flat with the tides. The word phytoplankton was derived from the Greek words, "phyto", meaning plant, and "planktos", meaning drifting. **Algae** are usually larger than the phytoplankton and are often found attached to hard **substrates** such as old shells, logs, and even bottles. The term zooplankton was derived from the Greek words "zoion", meaning animal, and "planktos", meaning drifting. Both zooplanktonic and phytoplanktonic organisms serve as a food source for filter feeders of the mud flat.

The mud snail, *Melampus,* is common in the muddy area (Figure 2). Mud snails are **scavengers** and eat living as well as dead animals. They have a very interesting way of finding their food. They detect the presence of food in the water by tasting the water, much like we smell cooking. As soon as food is detected, they begin to wave their **siphons** in all directions. The siphons pump water over their "taste" organs. When the snail determines in which direction the taste is strongest, it moves in that direction.

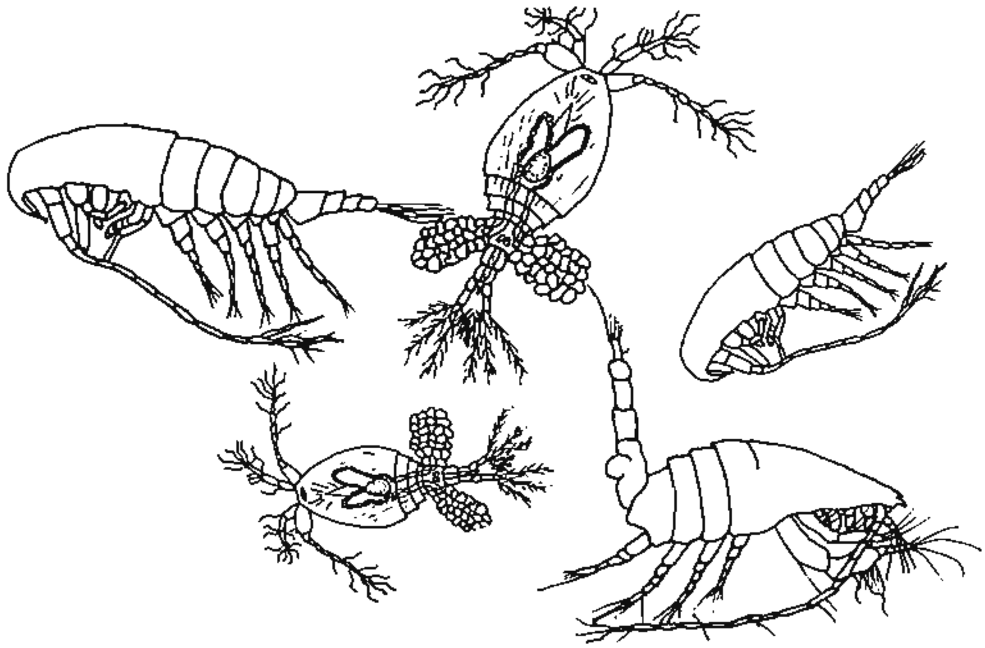


Figure 1. Plankton as seen through a microscope. Zooplankton, like these tiny **crustaceans,** eat phytoplankton which are the major producers in salt water.

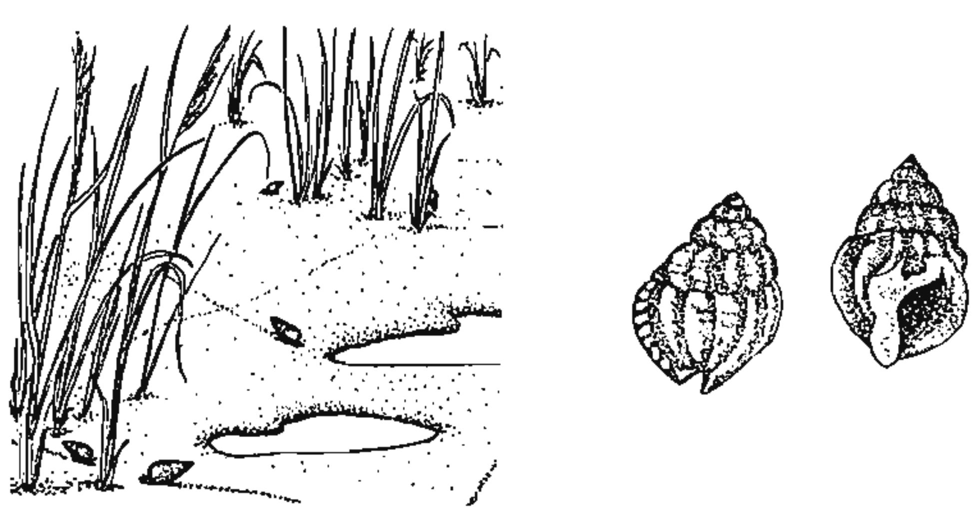


Figure 2. Mud snails. These snails are very common along the edge of the mud flat.

Although we seldom see them, there are small worms living in the mud. They are called **polychaetes.** They are important as food for many of the organisms that come to the mud flat. The parchment tube worm leaves each end of its tube sticking out of the mud and can be easily found (Figure 3). This worm never leaves its tube. It pumps water in one side of the tube and out of the other. Food is filtered out of the water.

At low tide, some of the organisms that normally live and feed in the salt marsh go out on the mud flat to feed. Fiddler crabs feed on the **detritus** and small organisms left by the tide. Clapper rails, a type of bird, feed on the fiddlers and worms they find here, and the raccoon comes to eat whatever it can find.

At high tide the organisms that always live in water come to the mud flats. The blue crab *(Callinectes sapidus)* and several kinds of hermit crabs scavenge along the edge of the marsh in search of food (Figure 4). They help the mud snails "clean up" the dead plants and animals. Besides being important as a scavenger on the mud flat, the blue crab is a very important seafood product in the United States. However, they are mostly caught in deeper water.

Fishes also come to the mud flat at high tide to feed. Pinfish, killifish, and silversides are the most abundant. It's easy to see that many animals visit the mud flat to feed, but few stay there. At low tide, land animals invade the mud flat and at high tide, marine animals invade the mud flat.

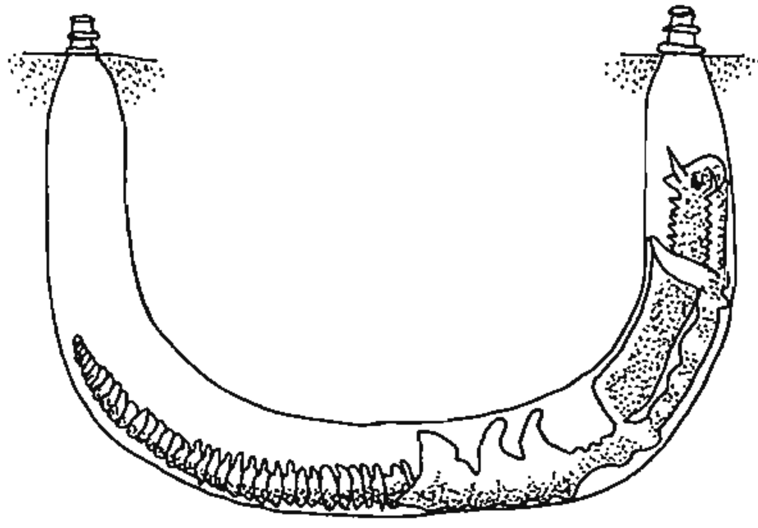


Figure 3. Parchment tube worms. Parchement tube worms can be cound by looking for the tubes that stick up out of the bottom. They look like short sections of soda straws.

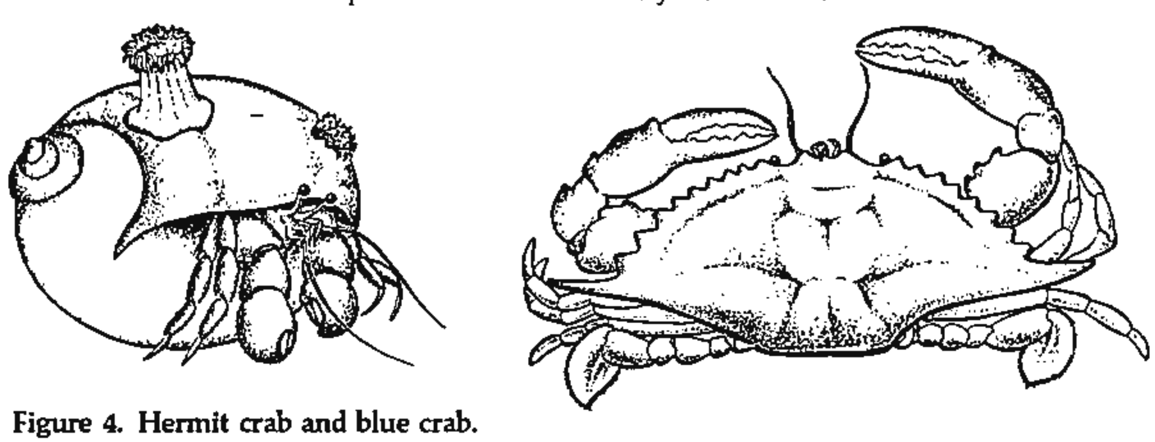


Figure 4. Hermit crab and blue crab.

VOCABULARY

algae—single-celled or many-celled aquatic photosynthetic plants.
crustacean—a class of the arthropods; these organisms consist of common marine animals, including shrimp, crabs, water fleas, barnacles, etc.
detritus—very small particles of the decaying remains of dead plants and animals; an important source of food for many marine animals.
intertidal—in the marine environment, the area of the shore that is periodically covered and uncovered by water.
limiting factor—single aspect of the environment which prevents an increase in population size at any given time.
mud flat—level tract of land at little depth below the surface of the water, or alternately covered and left bare by the tide.
phytoplankton—the plant forms of plankton. The most abundant of the phytoplankton are the diatoms.
plankton—small plants and animals floating in the upper layers of the water column.
polychaetes—the most common marine worms which have short, unsegmented stumplike limbs which bear bristles. They have separate sexes.
scavenger—an animal which feeds on the dead remains of other animals and plants.
siphon—tube-like structures of many clams and snails which take water into their body where it is filtered for food and oxygen, and also pass out water with excrements.
substrate—any hard surface on which a plant or animal is attached.
zooplankton—microscopic or nearly microscopic free-floating aquatic animals that feed on other forms of plankton.

VOCABULARY ACTIVITY FOR CONCEPT B

Below you will find a group of eight vocabulary words that are used in Concept B. Unscramble the letters of each word and write it in the blank provided. Notice that each word has one letter circled. If you write each one of these letters down, you will have a scrambled "mystery word". Unscramble the letters to find out the mystery word.

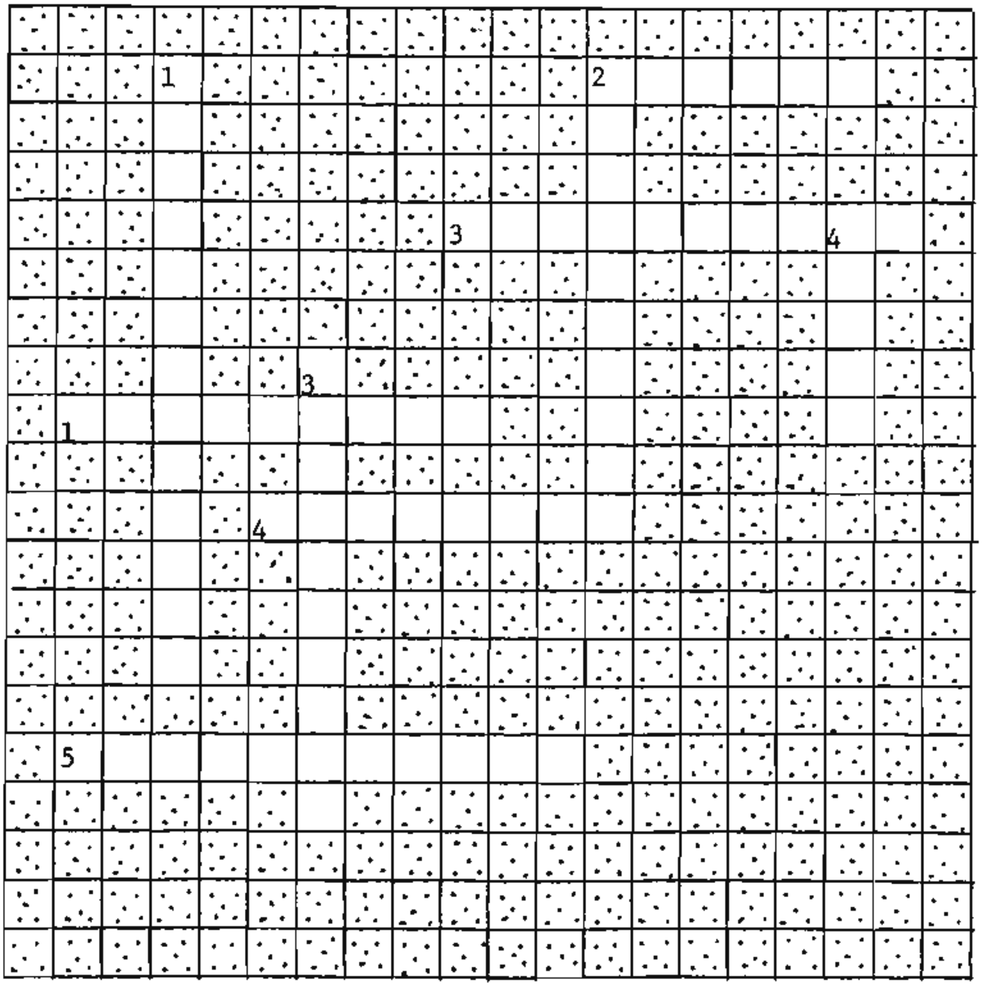
1. k m l o (u) l s ______________________
2. l e i (d) n t i r t a ______________________
3. n a e c a t (s) u r c ______________________
4. g (r) e v a c s n e ______________________
5. s u b a t t s r (e) ______________________
6. u m d f l a (t) ______________________
7. p s (i) o h n ______________________
8. (t) o o n a z p l k n o ______________________

What is the "mystery vocabulary word"? ______________________

VOCABULARY ACTIVITY FOR CONCEPT B

Across

1. An animal which feeds on the dead remains of other plants and animals.
2. Tube-like structures of many clams and snails which take water into their body, also passes water out.
3. An arthropod such as shrimp and crabs.
4. Decaying plants and animals.
5. Animal plankton.



Down

1. Microscopic plants of the sea carried with the water.
2. Hard surfaces on which plants and animals attach.
3. The area of the shore that is periodically covered and uncovered by water.
4. Single- or many-celled photosynthetic plants found in water.

Activity: A MUD FLAT COMMUNITY

Objectives

To identify some of the organisms in a **mud flat.**

To prepare diagrams of food chains found in a mud flat using organisms discussed in this activity.

To identify the biological **niche** of representative organisms found in a mud flat.

In the following investigation, you will identify the organisms of a hypothetical mud flat **ecosystem** and then determine their ecological niche in this community.

Materials (per student)

Guide sheet of the marsh ecosystem.

Procedure

You are provided with a picture of a hypothetical mud flat and a list of the organisms found in the mud flat. The first thing you are to do is to match the correct name with the correct organism. Place the correct corresponding number under each organism in the picture. Once you have named all of the organisms found in the mud flat, complete the data table for the usual niche of each organism. If you are not familiar with some of the organisms, go to the library and see if you can find a reference book that will enable you to determine each organism's niche in its community.

Organisms Found in the Mud Flats

1. Bamboo worm *(Clymenella)* - The bamboo worm is very slender. The body is round and and smooth and divided into anterior, middle, and posterior regions. The distinct segments give it the bamboo look. It lives within a tube made of sand. The tubes are long and straight.
2. Broad-clawed hermit crab *(Pagurus pollicaris)* - This is a large hermit crab. The antennae are unequal in size. The first pair are short and the second pair are long. The claws are not elongate. The right claw is larger than the left. It is red to brown in color.
3. Clam worm *(Nereis)* - The clam worm is a very good swimmer. The head of this annelid is well formed. In the head region palps, tentacles, and eyes are distinct. The proboscis has horny jaws and teeth to capture prey. The body segments are similar in size and shape.
4. Glass sea cucumber *(Leptosynapta)* - Sea cucumber with elongate bodies. No tube feet present. They have ten to twenty-five branched tentacles.
5. Long-clawed hermit crab *(Pagurus longicarpus)* - This is a small hermit crab. The claws are elongate and cylindrical with a smooth surface. It is usually found in shallow, sheltered areas such as rock-pools and muddy bottoms.
6. Lugworm *(Arenicola)* - The lugworm is a thick green worm which lives in an L-shaped burrow. The worm has eleven pairs of reddish gills in the central region of its body. The burrow is lined with mucous and consists of a horizontal gallery and a vertical tail shaft. The worm is a direct deposit feeder as is the earthworm.
7. Ornate worm *(Amphitrite)* - The ornate worm is a mud flat worm which builds tubes. The body is flesh-colored with large plumelike branched gills at the anterior end. The gills are blood-red in color. Many flesh-colored tentacles are used to trap food and particles for the tube. It is a beautiful flower-like worm.

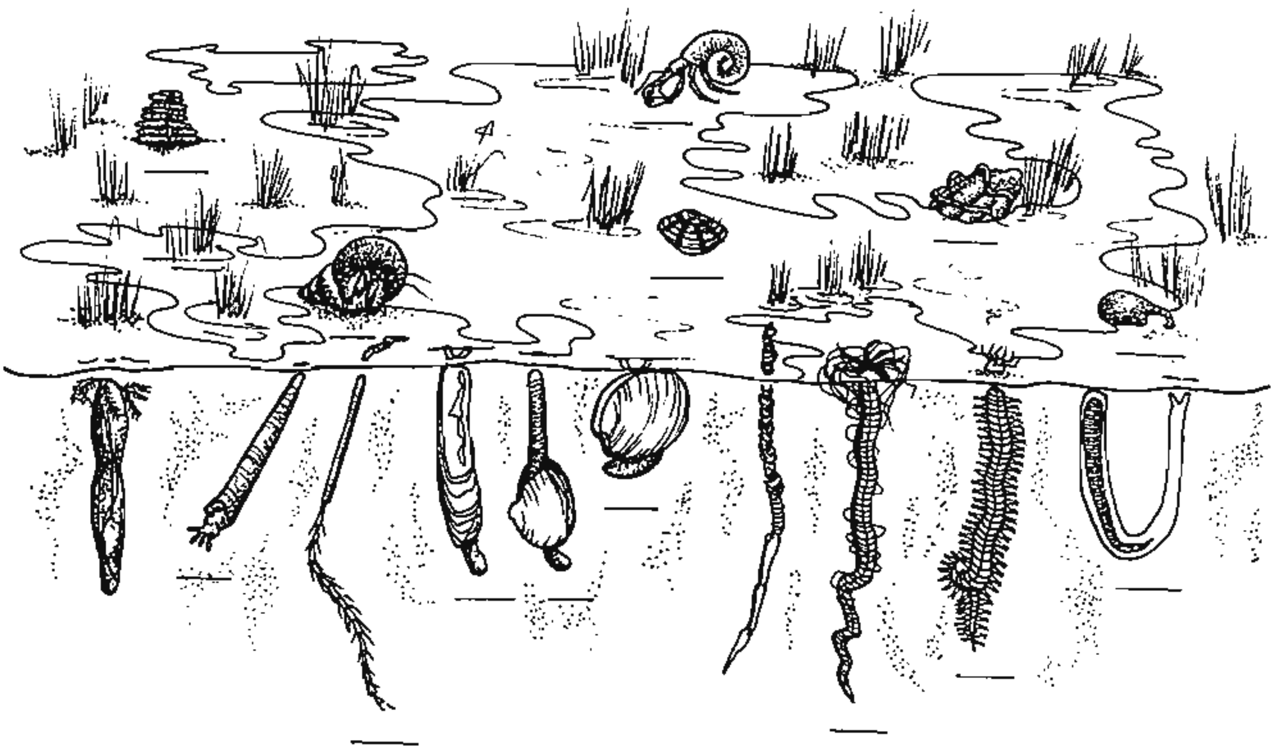


Figure 1. A Mud Flat Community.
Adapted from: Field Guide Sheet for Southeastern New England
Marine Environments: Tidal Flats (Carole Eldridge)

8. Quahog *(Mercenaria)* - The Quahog is a clam which varies in length from 3-6 inches. It is a dirty gray to white in color. The two shells are ovate to triagonal in shape. The shells are very thick and heavy with many sculptured, concentric growth rings. It is a common filter feeder of beachers and sandy mud flats.
9. Razor clams *(Ensis)* - Razor clams have elongate narrow shells which are smooth and fragile. The length of the shells may be as long as three inches. The shells are usually white to green with purplish interiors. It is a common filter feeder in mud flats.
10. Soft-shelled clam *(Mya)* - This clam is of medium size. The shell is porcelain-like to chalky with an elongated oval shape. The shell is white or fawn on the outside and white on the inside. The siphon is large and broad. It is a filter feeder.
11. Trumpet worm *(Cistenides)* - The trumpet worm constructs a trumpet-shaped tube composed of a single layer of sand grains. The tube is often burrowed into sandy mud. The head of this worm is truncate and can be extended from the larger end of the tube. The body of this worm is stout and tapering. The worm is flesh-colored with two sets of long, golden setae at the anterior end which are used for burrowing and digging downward.

Organisms Found in a Hypothetical Mud Flat

	Name of Organism	Usual Niche of this Organism
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

1. Name three **food chains** that you can construct from your investigation.
   1. ______________________________
   2. ______________________________
   3. ______________________________
2. Construct a small food web from the organisms in the picture.

3. Using this mud flat community, develop a food chain which has four links. ______________________________

4. What do you consider to be the ultimate consumer? ______________________________
5. Name one organism that is at the base level in this community. ______________________________
6. Could this community exist in the Mississippi Sound and the Gulf of Mexico? ________
   Explain. ______________________________
7. List the organisms that you think would not be found on the Gulf Coast mud flats. ______________________________
8. List three organisms that you would include in a sketch of organisms found on the Gulf Coast mud flats. ______________________________

VOCABULARY

ecosystem—a community of organisms interacting with each other and the environment in which they live.
food chain—the passage of energy and materials in the form of food from producers to consumers as organisms feed on one another.
mud flat—a level tract of land at little depth below the surface of water or alternately covered and left bare by the tide.
niche—the particular way in which an organism obtains its food and reacts; an organism's way of life.

CONCEPT C

Organisms found in a sound not only respond to limiting factors in the environment, they also develop special methods for carrying on life processes, such as feeding, in this unique habitat.

Objectives

Upon completion of this concept, the student should be able:

a. To define the term "nematocyst".
b. To account for the fact that filter feeders consume only small organisms.
c. To explain the difference between a sound and an ocean.
d. To list two limiting factors in an estuary.
e. To predict what would happen to an oyster population if the salinity of water in the estuary was too low.
f. To explain why the water temperature in a sound can change more rapidly than the water temperature of an ocean.
g. To give an explanation of why sound water is clear in the winter and cloudy (turbid) in warm weather.
h. To distinguish between organisms that are "hunters" and those that are "waiters."
i. To explain why some organisms found in the sound are called "grazers."
j. To describe some of the adaptations that organisms living in a sound have made in order to obtain food.

THE SOUND

The mud flat and salt marsh make up the edges of the **estuary.** An estuary can be the mouth of a river, a bay, a lagoon, or a sound where fresh water from the land and salt water from the sea mix.

Some estuaries are called **sounds.** The sounds are separated from the ocean by **barrier islands.** Fresh water pours into the sounds from mainland rivers. Sea water flows into the sounds through inlets between the islands. Since fresh and salt water come into these sounds, they are not as saline as the water in the ocean. The closer to the river, the fresher the water gets and the closer to the ocean, the saltier it becomes. The Mississippi Sound is an estuarine area between the mainland and the open Gulf of Mexico and has the characteristics just mentioned (Figure 1).

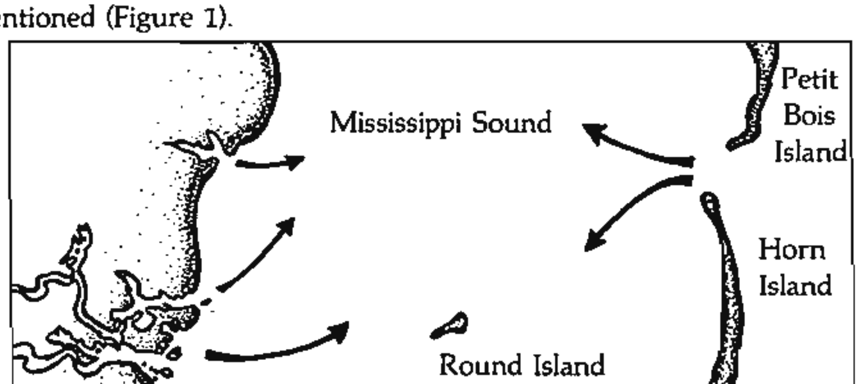


Figure 1. Estuaries are areas where salt water from the ocean mixes with fresh water from the land.

When the amount of rainfall occurring over the coastal drainage basin increases significantly, the salt concentration in the sound may decrease drastically. The reverse situation may also exist if there is an acute decrease in the amount of rainfall experienced by the region. This condition causes a rise in the salinity of the sound. Some bay-type estuaries can become more saline than the ocean. Can you think of how this can happen? At certain times, very little tidal water from the ocean flows into the bay and the salt water in the estuary is trapped. The sun's energy evaporates the water in the bay and leaves on and in the substrate minerals that cause the water to be salty. If this process continues for a long period of time, the water soon becomes saltier than sea water. In fact, it becomes so salty that some types of marine organisms are unable to survive.

As we have already guessed, the **salinity** in an estuary changes very often. Like the salt marsh and mud flat organisms, estuarine organisms are limited by salinity changes. This **limiting factor** is important to oyster fishermen. The oyster is able to survive in water of lower salinity than many of its natural enemies. If the oyster settles in an area of low salinity, it has a better chance to survive natural **predators.**

Since the Mississippi Sound is relatively shallow, the water temperature changes more rapidly than does the water temperature of the open ocean. Therefore, organisms that live in the sound, such as salt marsh and mud flat organisms, must be able to adjust to wide temperature fluctuations.

Another limiting factor of the sound is the **substrate.** The sound along the Gulf Coast has both sandy and muddy bottoms. The bottom type is a direct result of deposition of mud and sand from the fresh water streams of the drainage basin which empty into the sound. Grain and particle size of the bottom substrate of the sound determines the type of organisms found in the area. Particle size also determines the distribution and abundance of many of the plants, clams, worms, and crustaceans living in and on the substrate.

Of course, the survival of some organisms is dependent on other organisms of the sound. These, in turn, are biological limiting factors. For instance, along the Atlantic coastline, in the early 1900's the eel grass *(Zostera marina)* found in the sounds, was attacked by disease and began to disappear. Eel grass is one of the few seed plants found in salt water. Although scientists knew that certain organisms lived with the eel grass, they were not sure how important the eel grass was to these organisms. The most obvious change that took place after the eel grass died out was the disappearance of the bay scallop, *Argopecten irradians* (Figure 2). The bay scallop was an important fisheries product in the sound and many fishermen were hurt by the loss. Since the scallops filtered food out of the water, scientists wondered exactly how the eel grass affected the scallops. The scientists were never quite satisfied with their results. What ideas can you suggest? Today, eel grass is approaching its old abundance. The scallop is thriving again, and the fishermen are making large scallop catches.

Besides grasses, **phytoplankton** and attached **algae** are abundant in the sounds. A common attached alga is sea lettuce, *Ulva.* Sea lettuce is a paperlike green alga. Sometimes it gets broken up by waves and tides and floats around in the currents like phytoplankton (Figure 3). It is often washed up on the beach during high tide and can be found in the **strand line.**

The phytoplankton and the **zooplankton** sometimes have an unusual effect on the waters of the sounds. In the warm months the sounds are usually not very clear, while in the cold months the water becomes very clear. This happens because in the warmer months the plankton increases in numbers, and they actually cloud the water. However, in the

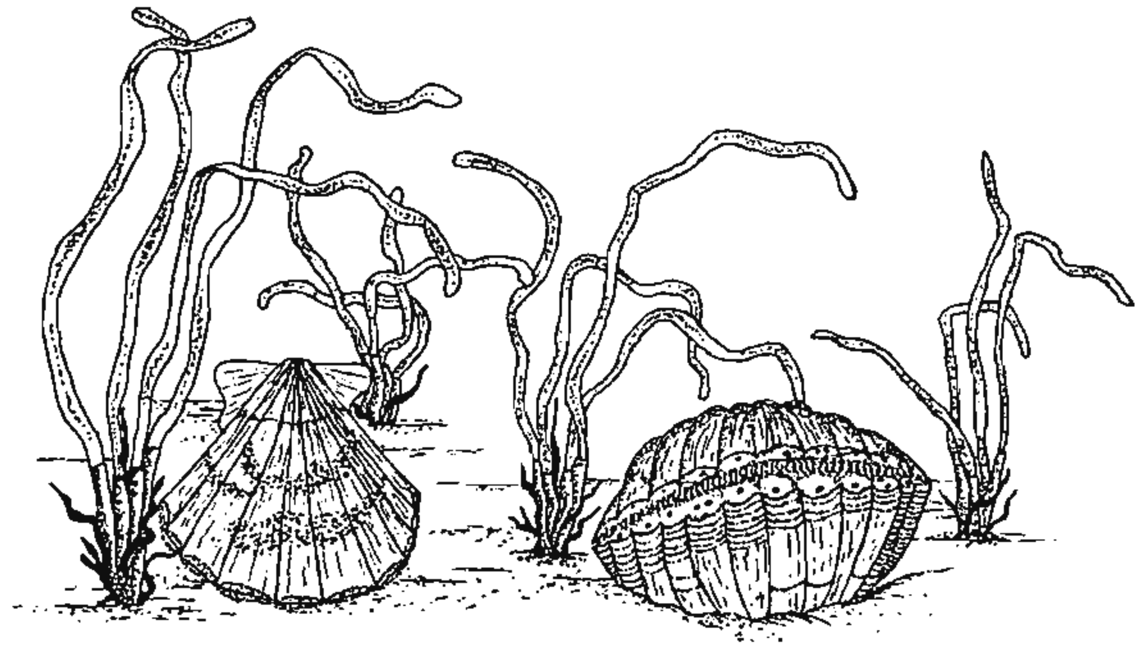


Figure 2. The bay scallop is dependent on eel grass. In the early 1900's the eel grass died out and the scallop disappeared.

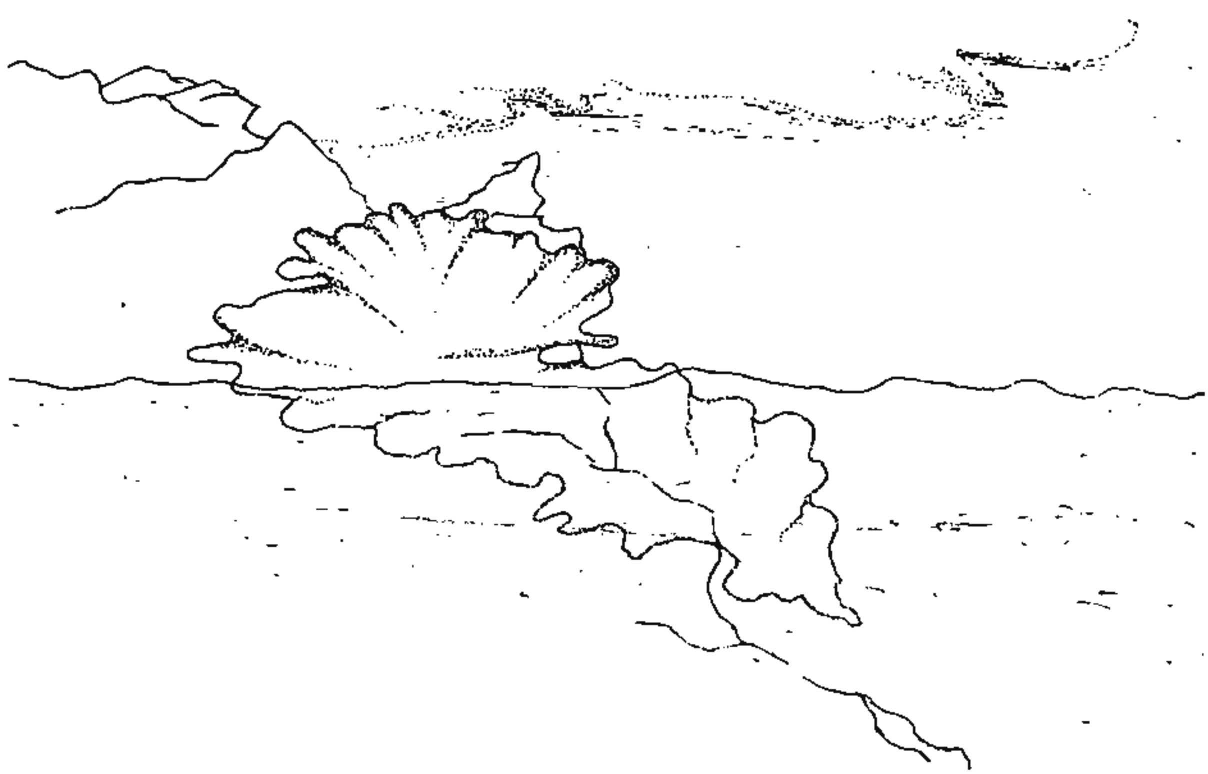


Figure 3. Sea lettuce grows attached to a hard substrate. Sometimes waves break it off and we find it washed up on the beach.

colder months the plankton is not as abundant and the water becomes clear again.

Animals found in the sound have made special adaptations to catch their food. These sound animals can be divided into the **hunters** and the **waiters.** The hunters move around searching for their food while the waiters let the food come to them.

Although the word hunter usually makes us think of a **carnivore,** some **herbivores** are also hunters. These are usually called **grazers.** The grazing snails can be found on rock jetties or pilings. They slowly move along the jetty scraping the small algae off the rocks. Some fishes also eat the algae off rocks. The surgeon fish has specially adapted teeth for this. This group of fishes gets its name from the sharp knife-like spines near the base of its tail (Figure 4A). Why don't we catch surgeon fish on a hook and line?

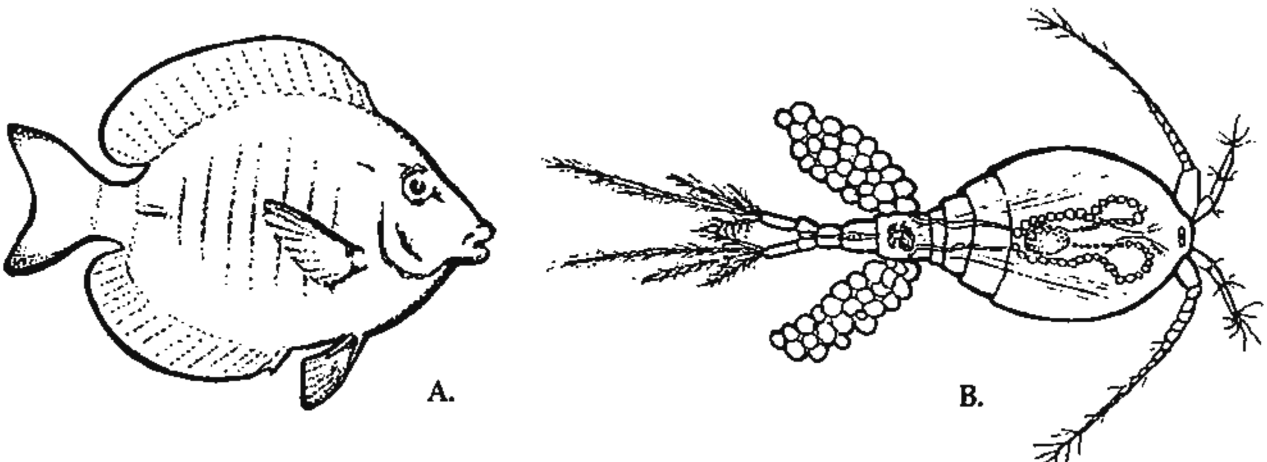


Figure 4. A, Surgeon fish. B, Copepod (greatly enlarged).

The carnivorous hunters are also well adapted for the way they feed. They are usually equipped with strong jaws for killing or for breaking hard shells. Marine worms (annelids) are usually equipped with strong jaws for holding and killing. These can live on sand, mud, or rocks.

Carnivorous snails are usually adapted for catching and eating other mollusks. The oyster drill, *Thais,* drills a hole in the shell of clams and oysters with a sandpaper-like structure called the **radula** (Figure 5). Large whelks, like *Busycon,* also eat other **mollusks** this way.

The blue crab, *Callinectes,* is a predacious **crustacean.** Its strong claws are able to crack shells and catch worms and fishes. When it is attacked by an enemy, the blue crab uses its claws in defending itself. Blue crabs eat many small clams.

Starfish also eat clams. They do this by forcing open the two halves of the clam shell (Figure 6). When the starfish opens the shell, it does not go into the shell. Instead it throws its stomach tissue into the open shell. After the stomach tissue digests the clam's body, the starfish retrieves its stomach. Apparently the scallop is able to detect the presence of starfish. If one is placed in an aquarium with a scallop, the scallop will jet itself back and forth as if to escape the starfish. Fish, of course, are well-known predators. They will eat other fish, crustaceans, mollusks, worms, or almost anything they can catch. Some of these fish have sharp teeth for killing their prey.

Some of the hunters also eat dead matter. Shrimp and hermit crabs hunt along the bottom eating **detritus** or other matter they can find as food. Sand dollars and some sea cucumbers also hunt in the sand for food (Figure 7).

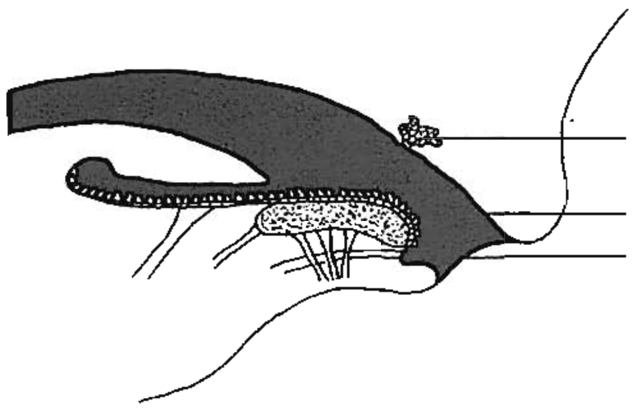


Figure 5. Diagram showing position of radula.

Figure 6. Starfish opening a clam.

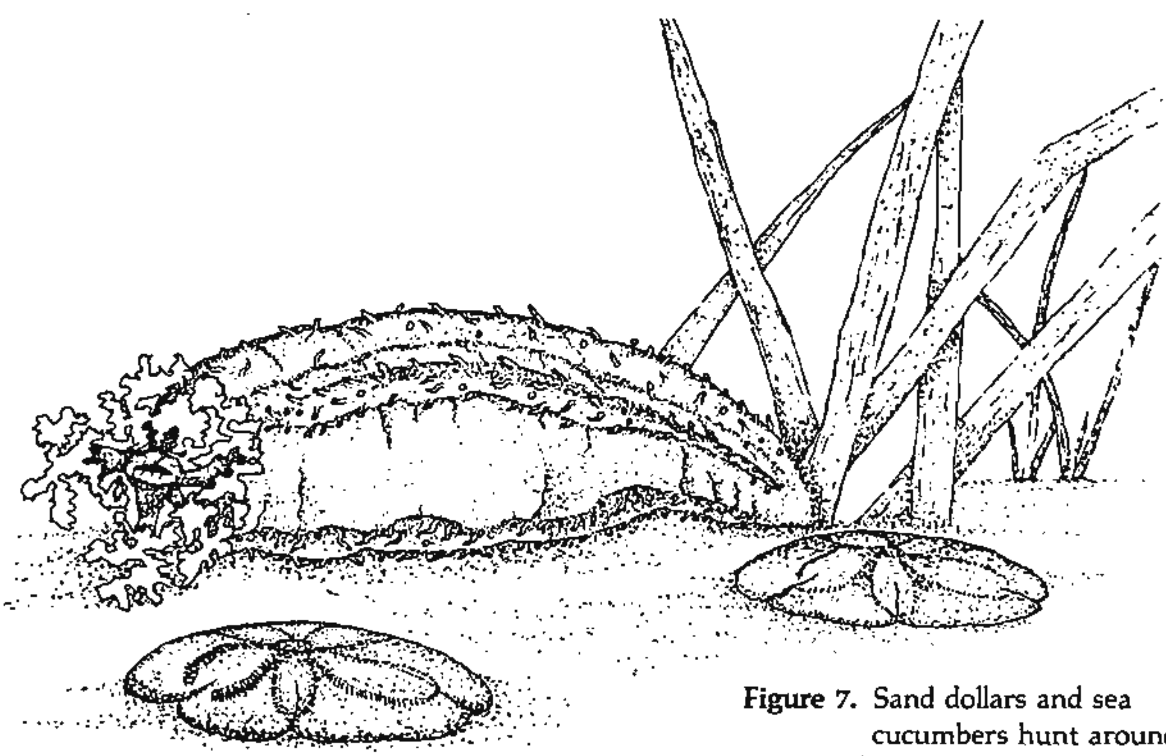


Figure 7. Sand dollars and sea cucumbers hunt around in the sand for detritus.

The other feeding group is called the waiters. The most common kind of waiter is the **filter feeder.** Filter feeders are not very particular about what they eat. They catch the plant and animal plankton that float to them. Marine worms, clams, scallops, slipper shells, barnacles, and sea squirts are a few animals that filter the water for their food. All of these except the barnacle pull water across a net-like structure. These structures are interwoven hair-like projections that trap the materials and allow the water to flow through. The structure can be a specially adapted part that is used only for filtering out food, or it can be the animal's gills that trap food.

The barnacle, instead of pulling water across its filtering apparatus, sweeps the water with specially modified legs. Because it has a hard outer shell, many people think the barnacle is closely related to the mollusks. However, barnacles are **arthropods** with jointed legs like the crabs, shrimp, and insects. The barnacles' legs are covered with hairs that serve as a net. Some people describe the barnacle as "a shrimp-like animal that lies on its shell with additional shell sides pulled over it, kicking food into its mouth" (Figure 8).

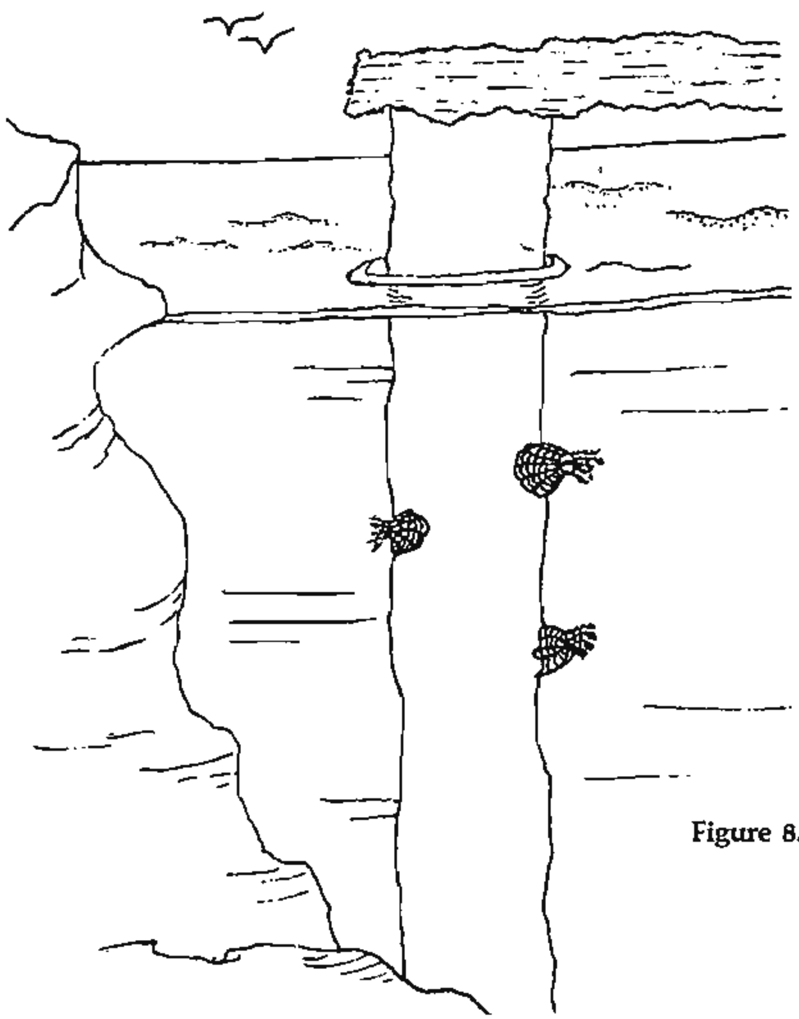


Figure 8. Barnacles strain organisms out of the water with a net-like structure. Its legs are covered with hair-like bristles that overlap. The barnacle creates water currents with its legs.

Another type of waiter could be called the grabber. Sea anemones, corals, and fishes represent grabbers. The sea anemone and the coral are considered **sessile** animals, which means that they are permanently attached to the substrate or available hard surface. They capture their prey with rather long, sticky tentacles. Their tentacles are armed with stinging cells called **nematocysts.** When an animal touches the nematocyst, a poisonous spear is shot out of the stinging cell. This is usually enough to stun the prey. The anemone or coral then pulls the animal into its mouth with its long tentacles (Figure 9).

Angler fish are also grabbers. Even though they are able to move around from place to place, they are still waiters. Their color is usually very much like that of their surroundings. Angler fish have a modified fin on their back that looks very much like a worm. This fin can be moved back and forth to attract small fishes. When the small fish try to eat the lure, the angler fish captures the small fish. The lizard fish and the toad fish, which are also waiters, are equipped with many sharp teeth. They live buried in the sand and grab small fish that swim close to their burrows (Figure 10). Can you name any other animals that feed in unusual ways?

Figure 9. **Coelenterates,** like the sea anemone, use stinging cells to capture their food. These cells are called nematocysts. When the tip of a nematocyst is touched, it throws out a sharp, thread-like spine that traps the prey.

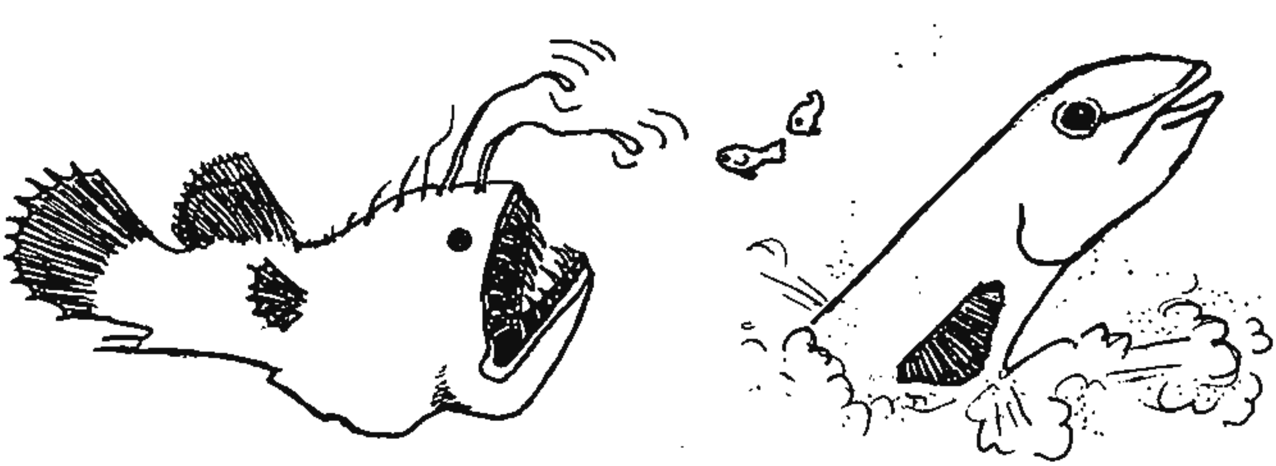


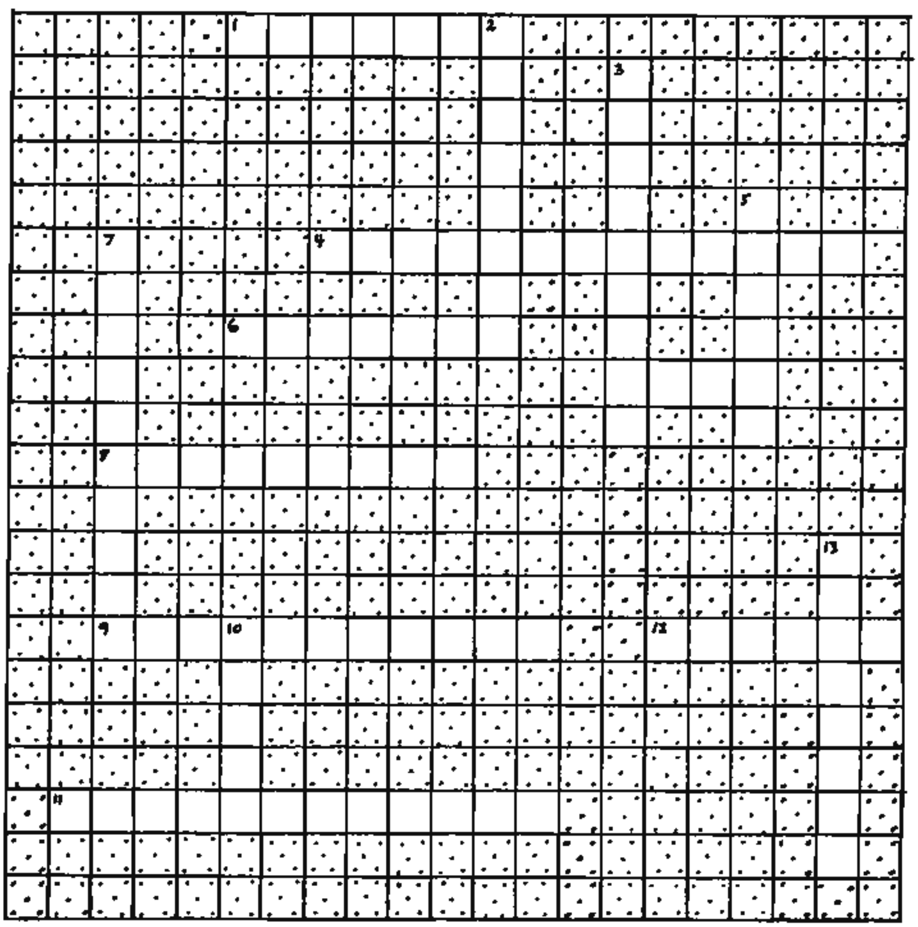
Figure 10. Lizard fishes and angler fishes wait for their food to swim by. The lizard fish buries itself in the sand (all except its head) and grabs its prey. The angler fish lures its prey with its worm-like back spine.

VOCABULARY ACTIVITY FOR CONCEPT C

The following crossword puzzle contains 13 vocabulary words. Complete the puzzle by using the clues provided.

CLUES ACROSS

1. Marine organisms that move around searching for food.
4. A long, narrow area of land parallel to and not far from a mainland coast.
6. A relatively small body of water that is set off from the main body of water and is affected by the rise and fall of the tide.
8. Animals having jointed appendages and an exoskeleton.
9. Stinging cells found in coelenterates. These specialized cells are used for trapping food.
11. An animal that takes food from water as it flows through the animals.
12. A term used to denote herbivores (plant eaters) that are hunters.



CLUES DOWN

2. A measure of the total amount of dissolved salts in seawater.
3. An animal which preys on other animals.
5. A rasping tongue-like organ used by mollusks to graze algae and break up food.
7. A class of the arthropods; these organisms consist of common marine animals, including shrimp, crabs, water fleas, barnacles, etc.
10. Single-celled or many-celled photosynthetic plants.
13. An animal that preys upon another organism.

CHECK YOUR LEARNING

1. The areas where fresh water from the land and salt water from the sea mix is called an

   ________________________________ .

2. Salinity is an example of a ____________________________ factor.
3. During the warmer months of the year, the sound can become cloudy from mud that is stirred up by the wind or because of the abundance of _______________________ .
4. The oyster drill can drill a hole in the shell of another mollusk by using a sandpaper-like structure called the ______________________ .
5. Most people think barnacles are mollusks because they have a shell. Actually, they have jointed legs like other ______________________ .
6. Coelenterates have stinging cells to catch their food. The cells are called ______

   ______________________ .

THINK QUESTIONS

1. Explain the difference between the "hunters" and the "waiters".
2. Explain how a barnacle obtains its food.
3. Explain how the radula of an oyster drill works.

VOCABULARY

algae—single-celled or many-celled photosynthetic plants.
arthropod—animal having jointed appendages and an exoskeleton.
barrier island—a long, narrow island parallel to and not far from a mainland coast. The island is composed of material heaped up by ocean waves and currents.
carnivore—an animal which feeds on other animals.
coelenterates—simple animals characterized by tentacles with stinging cells, two cell layers, and a single body opening.
crustacean—a class of the Arthropods; these organisms consist of common marine animals, including shrimp, crabs, water fleas, barnacles, etc.
detritus—very small particles of the decaying remains of dead plants and animals; an important source of food for many animals.
estuary—a relatively small body of water that is set off from the main body of water and is affected by the rise and fall of the tide. Estuaries contain a mixture of fresh and salt water.
filter feeder—an animal that takes food from water as it flows through the animal.
grazer—a term used to denote herbivores (plant eaters) that are hunters.
herbivores—animals that feed exclusively on plants.
hunters—marine organisms that move around searching for their food.
limiting factor—single aspect of the environment which tends to prevent an increase in population size at any given time.
mollusks—soft-bodied, mostly marine animals, usually enclosed within a hard outer shell of calcium carbonate.

mud flat—a level tract of land at little depth below the surface of water, or alternately covered and left bare by the tide.
nematocysts—stinging cells found in coelenterates. These specialized cells are used for trapping food.
phytoplankton—the plant forms of plankton. The most abundant of the phytoplankton are the diatoms.
predator—an animal that preys upon another organism.
radula—a rasping tongue-like organ used by mollusks to graze algae and break up food.
salinity—the total amount of dissolved salts present in a given amount of substance.
sessile—the condition of being permanently attached to another object.
sound—a body of water which occupies the area between a mainland and an island.
strand line—a shore line or beach; especially, one above the present water level.
substrate—any hard surface on which a plant or animal is attached.
waiters—organisms that do not actively search for food. These organisms let the food come to them.
zooplankton—microscopic or nearly microscopic free-floating aquatic animals that feed on other forms of plankton.

Activity: MARINE ORGANISMS AND OSMOTIC TOLERANCE

Objectives

To determine if salt concentration has an effect on the quantity of water that an organism contains.

To determine if various species of organisms will respond in the same manner to a change in a physical factor such as salt concentration.

Many marine animals have a high tolerance for **salinity** changes. This is called **osmoregulation.** The organism must have an **adaptation** that will allow for these external environmental changes. On the other hand, there are some organisms that have very little ability to adjust to a change in an environmental factor such as salinity. Organisms that can be found in the **estuarine environment** probably belong to which of these two groups? ______________________________. How could you design an investigation to test your prediction? One simple method of determining the osmoregulatory abilities is to compare weight changes in some organisms over a period of 24 hours. If an organism can maintain its weight when placed in different salt concentrations, the organism must have a fairly well-developed osmoregulatory mechanism. Conversely, a tremendous weight change indicates that the organism is not able to tolerate much of a salinity difference.

Materials (per team of four students)

Fresh, live crabs

Procedure

Using Instant Ocean or other synthetic sea salts, prepare solutions of the following concentrations: 5 parts per thousand (ppt), 10 ppt, 15 ppt, 25 ppt, 35 ppt, 45 ppt, 50 ppt. Each of these solutions can be prepared by dissolving the given number of parts of sea salts in 1000 ml of distilled or dechlorinated water. The number of different solution concentrations can be increased or decreased as desired depending upon the number of crabs available for the investigation.

Place a selected organism in each of the containers filled with one of the salt concentrations. At hourly intervals during the day take the crab out, dry it with paper towels, and weigh it. Try to keep all other physical factors constant during the period of investigation. List some of these physical factors.

______________, ______________, ______________, ______________, ______________.

Why should they not be allowed to change? ______________________________

On the following data table your group should keep an accurate record of the results from one of the salt concentrations. Date __________, common name of crab used ________,

salt concentration used ________, beginning weight of crab ____________.

Weigh your crab at hourly intervals and record the data in the "mass" column of the table provided on the next page. The column labeled "%" refers to the percent change in mass from one weighing to another. Your teacher will show you a method of calculating these values using the data that you collect.

Weight at the end of the investigation ____________

Was there a gain? ________ How much? __________

Was there a loss? ________ How much? __________

How can you explain these results? ______________________________

____

____

List the various species of crabs used in your experiment. ____________________,

________________, ________________, ________________.

Did all of the crabs respond in the same manner? ______________________________

Explain ____

____

____

How do you think that the crab maintains its osmotic balance? ____________________

____

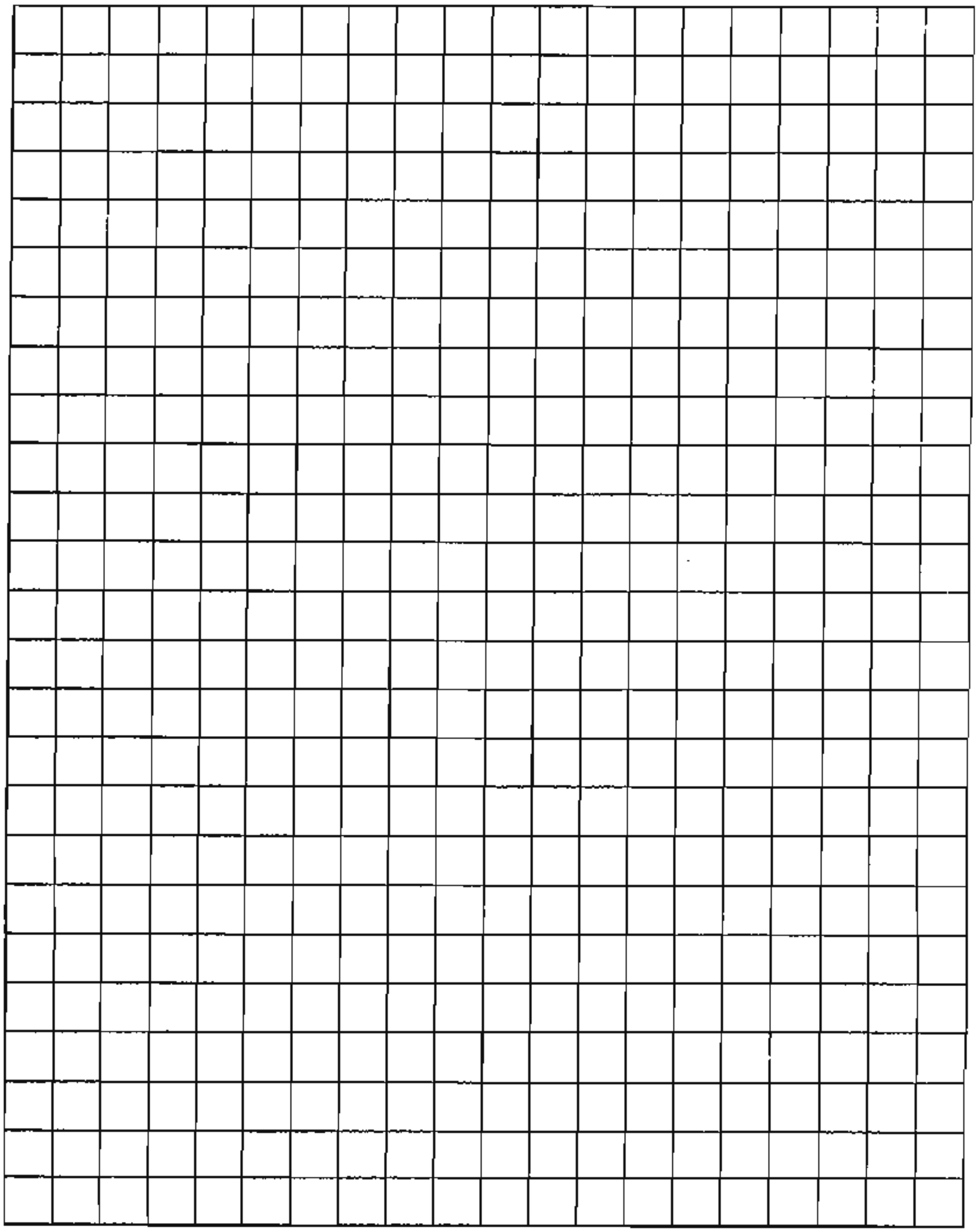
____

____

____

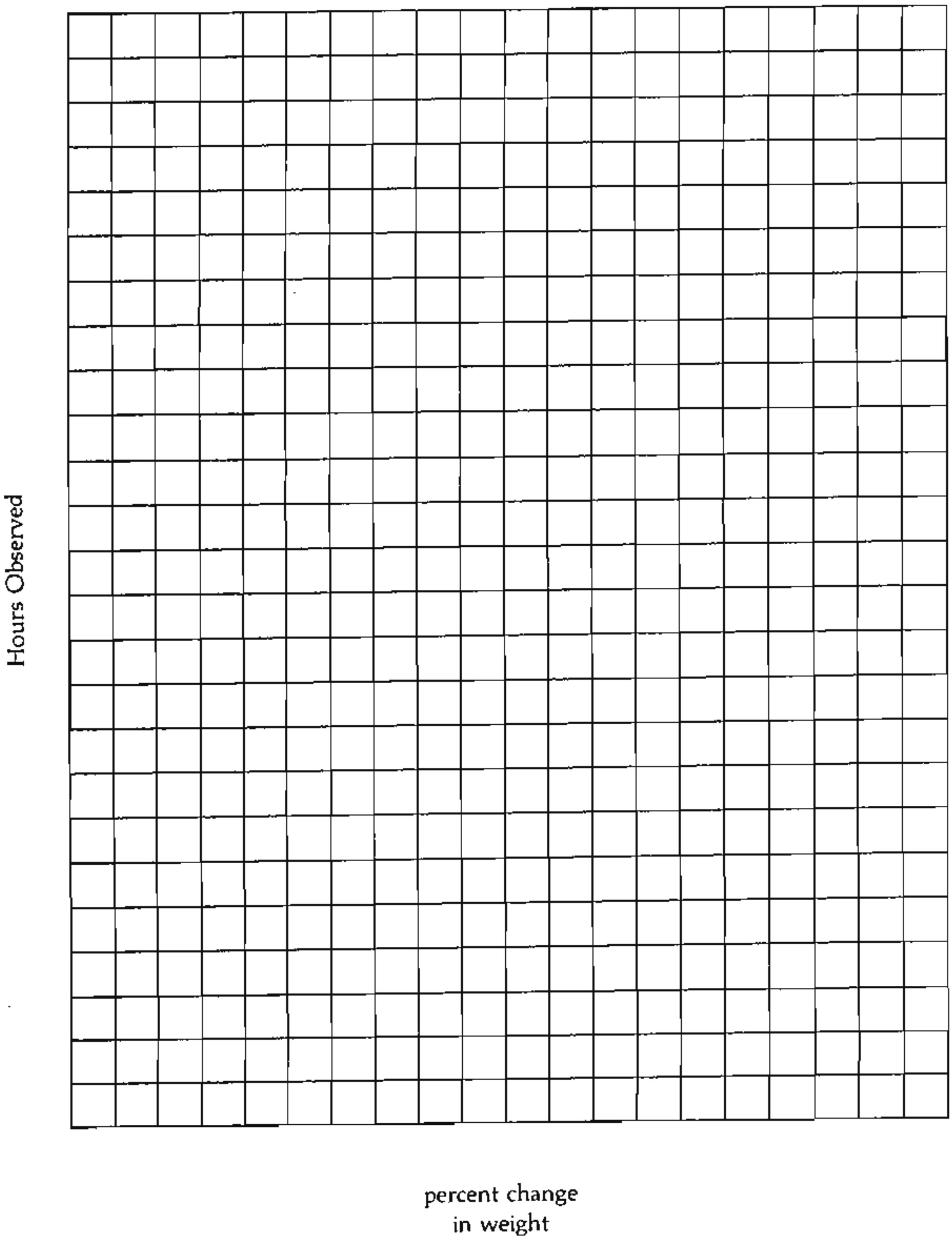
Prepare a graph of your hourly data in the space below.

Hours Observed



percent change
in weight

Collect the data from all other groups and prepare a graph for the entire investigation. Use different colored pencils for each of the different salt concentrations.



	5 ppt		10 ppt		15 ppt		25 ppt		35 ppt		45 ppt		50 ppt	
Hours	Mass	%	Mass	%	Mass	%	Mass	%	Mass	%	Mass	%	Mass	%
1st														
2nd														
3rd														
4th														
5th														
6th														
7th														
8th														
9th														
10th														
11th														
12th														

VOCABULARY

adaptation—the process by which a species becomes better suited to survive in an environment.

estuarine environment—situation in which the surroundings of an organism consists of water that is less saline than that in the open ocean.

osmoregulation—the process by which the osmotic activity of a living cell is increased or decreased by the organism in order to maintain the most favorable conditions for the vital processes of the cell and the organism.

salinity—the total amount of dissolved salts present in a given amount of substance.

Activity: BREATHING RATE OF FISH AS AFFECTED BY WATER TEMPERATURE

Objectives

To examine the effect of temperature on the respiration of fish.
To correlate the structural mechanisms found in fish with their ability to function in a changing **habitat.**

Respiration is an important bodily function for animals. Through this process, an animal obtains oxygen from its environment and releases carbon dioxide into the environment. Oxygen is transported to the cells for use in **oxidation** of foods and other metabolic activities. Eliminating excess carbon dioxide is necessary since a surplus of this gas within the body could be harmful.

Different organisms have specialized structures to accomplish the task of carrying on respiration. Many of the marine animals respire by means of **gills.** In the **vertebrates** the gills are made up of **gill filaments** found beneath the **operculum** (Figure 1). We could consider the operculum as a gill cover. Since it is difficult to extract the available oxygen from an aquatic (water) environment, the gill has to be constructed for high efficiency. The gill filament has a very large surface area, and this allows for maximum exposure to the water environment.

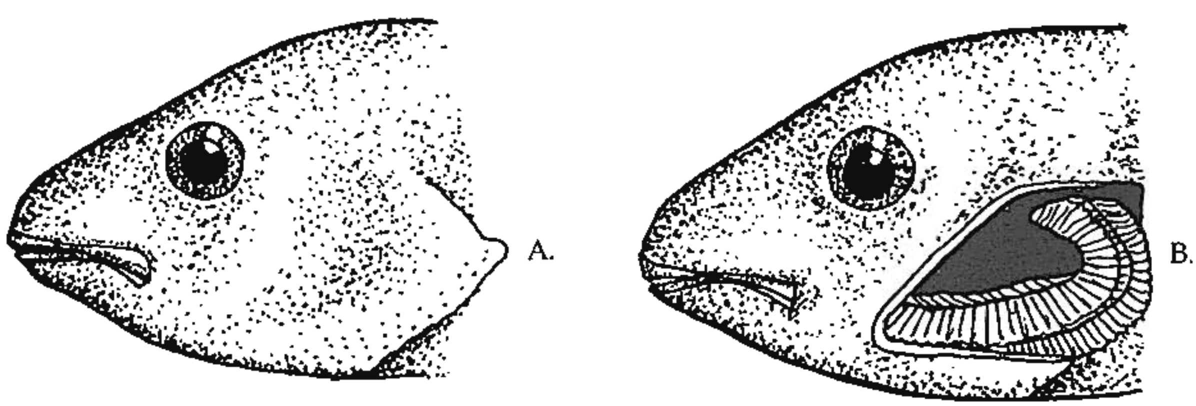


Figure 1. A, Operculum. B, Gill Filaments.

When a fish "breathes", it opens its mouth, and the operculum closes. It then closes its mouth and contracts the **pharynx** which forces the water across the gill filaments. As water passes over the delicate filaments, excess oxygen diffuses into the **capillary** circulatory network and is distributed throughout the fish's body. The excess carbon dioxide also diffuses from the capillary network into the surrounding water. When the pharynx contracts this forces the operculum open and completes the circuit for the water to flow. The water passes out of the operculum and another "breathing" cycle is ready to begin. Opening and closing of the operculum could be used as one way of determining the breathing rate of a fish. How do you think that a change in the water temperature will affect the breathing rate?

____

____

Materials (per team of two students)

1 aquarium net, 1 goldfish (minnows from bait shop), 1 beaker (1 liter), 1 beaker (500 ml), 1 glass stirring rod, 1 thermometer, 1 liter of water (85°C), 1 liter of crushed ice, 1 liter of pond water, graph paper

Procedure

Place a fish in the liter beaker of pond water. The beaker should contain enough water to allow the fish to swim around. Measure the temperature of the water. Add warm water until the temperature reaches 30°C. Stir the water to permit a constant temperature throughout the beaker. When the temperature reaches 30°C, allow the fish to adjust to the temperature by waiting a few minutes. Now count the number of beats of the operculum for a minute. Next, start lowering the temperature by two degrees at a time. To do this, slowly add crushed ice, stir, and observe the temperature. Allow the fish to adjust to the new temperature (1-2 minutes) and then record the number of operculum beats per minute.

Continue to lower the temperature until you reach 2°C. Each time stir the water to equalize the temperature and permit the fish to become adjusted to the new temperature and then count the operculum beats. Always record the operculum beats on your data sheet.

At the conclusion of the experiment gradually add warm water to bring the fish back to the temperature of your aquarium water; then place the fish in the aquarium.

Construct a graph showing the average respiration rate for your fish per minute. Compile the data from all of the teams in your class and plot that line on your graph.

Extending Your Thoughts

1. What effect did an increase in temperature seem to have on the respiratory rate of the fish? ____________________
2. Why did we wait a few minutes each time after changing the temperature before we took our reading? ____________________
3. How did your individual data compare with that of the entire class? __________

   ____

   ____

Can you explain this? ____________________

Why should we examine group data? ____________________

____

4. Do you think that all animals would be affected in this manner by a temperature change?

__________ Explain ____________________

____

Data Sheet *Operculum Beats/minute*

Teams	30°C	28°C	26°C	24°C	22°C	20°C	18°C	16°C	14°C	12°C	10°C	8°C	6°C	4°C	2°C
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
Total															
Average beats/minutes															

VOCABULARY

capillary—tiny, thin-walled blood vessel found in the tissues. These serve as the location for exchange of materials between cells and the blood.

gill filament—double rows of thin-walled tissue in gills through which capillaries pass.

gills—organs in fish and other aquatic animals which are modified for absorbing dissolved oxygen from water.

habitat—the place where an organism lives.

operculum—a hard covering of the gill chamber in fish.

oxidation—the addition of oxygen to a substance.

pharynx—in vertebrate organisms this is the passageway for gases and food.

vertebrates—animals with backbones.

Activity: SALINITY AND SMALL ORGANISMS

Objective

To determine if different **salt** concentrations affect the living organisms of a given aquatic (water) community.

Materials (per team of two students)

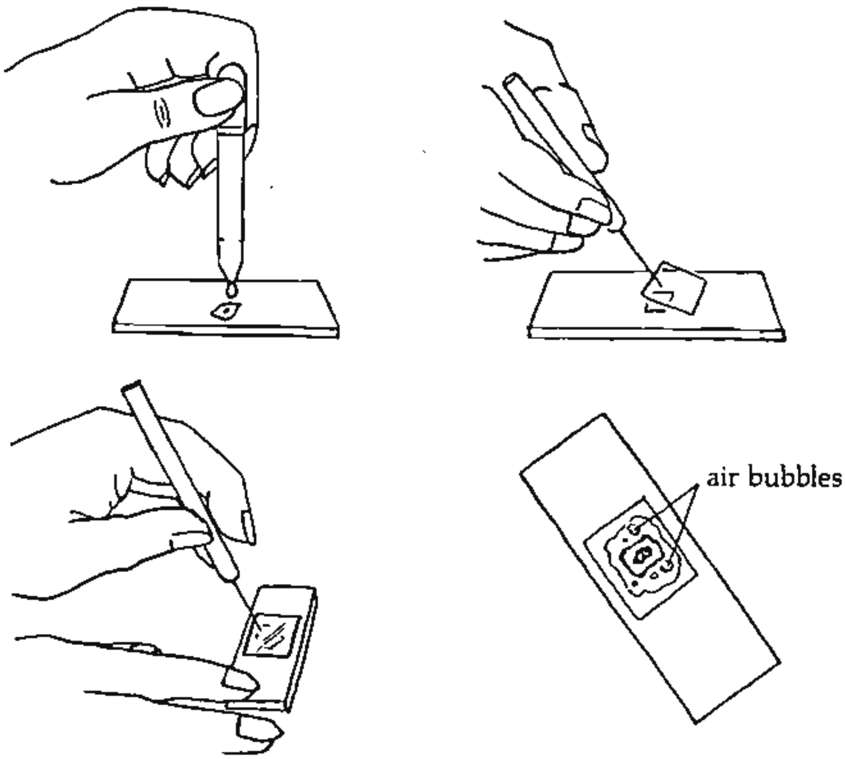
sodium chloride solution (1%, 3% and 5%), distilled water or tap water, microscope, microscope slides, microscope cover slips, clock, medicine dropper, paper towels, 3 cultures of small aquatic animals (paramecium, euglena, cyclops, daphnia, amoeba, or ostracods)

Procedure

With your medicine dropper, place a drop of water containing the first organism you intend to study on a microscope slide. Place a coverslip over the drop of water. If you are using a rather large organism, do not use the cover slip. For at least two minutes observe the normal behavior of the organism. Now, add one drop of the one percent salt solution to your sample. If you are using the cover slip draw the salt across using a paper towel as you have in other microscopic activities. As the salt moves across the slide, carefully observe the living organism. Record on your data table any changes in behavior that you observe. Also record the time when the reaction began. Continue to observe the organisms until no new reactions occur. Now, replace the salt water with tap water and observe the recovery of the organism. (The organism may not recover.) Record the length of time for recovery.

Repeat this investigation with the same organism with the 3% salt solution, and then the 5% salt solution. Complete the data table for each solution.

Repeat the entire investigation with the other two selected organisms. Record all data on each of these observations. The illustration presented below should be helpful as you learn to prepare your slides.



Data Sheet

	Salinity Used	Kind of Response	Average Time to Respond	Was there a Recovery	Average Time to Recover
Organism 1					
Organism 2					
Organism 3					

Extending Your Thoughts

1. Did each organism respond the same to the 1% salt solution? ______________

   Explain ____

2. Did the change in concentration of salt seem to make any difference? ______________

   Explain ____

   ____

3. What kind of **habitat** do you think that these organisms prefer? ______________

   Why? ____

   ____

4. Did you kill any organisms? __________ What were they? ______________

   ____

5. Which organism seemed to be the most tolerant to salt? ______________

6. Which organism seemed to be the least tolerant to salt? ______________

7. Which of these organisms might be found in the most diversified kinds of waters?

   ______________ Why would you think so? ______________

   ____

8. In the marine **environment** would you expect to find any of these organisms? ________

   ______________ Why? ______________________________

   ____

9. If you could find these in the marine environment, where do you think they might occur?

   ____

   ____

VOCABULARY

environment—the surroundings of an organism.
habitat—the place where an organism lives.
salinity—the total amount of dissolved salts present in a given amount of substance.
salts—chemical compounds that are derived from acids by replacing the hydrogen wholly or partly with a metal or a radical.

CONCEPT D

The beach habitat contains many communities, each having its own diversity of organisms and limiting factors.

Objectives

Upon completion of this concept, the student should be able:

a. To give the common names for two plants that are responsible for sand dune formation along the Mississippi-Alabama coast.
b. To describe some adaptations that mole crabs and clams have developed in order to escape pounding by the waves on a beach.
c. To list kinds of organisms found in greatest numbers along the strand line, splash zone, and intertidal zone.
d. To list three conditions that plants must tolerate in order to live in a sandy environment.
e. To explain how sand is naturally prevented from being blown away from the beach.
f. To construct a model of a sand fence and explain how it aids in sand dune formation.

THE BEACH

Now that we have looked at the **salt marsh** and **sound,** let us look along the edge of the ocean at the **beach.** The beach **environment** is very different from the marsh and sound. Along the Gulf Coast the beaches are made of sand. Much of this sand may temporarily be blown high on the beach to form **sand dunes** (Figure 1).

Figure 1. Sand dunes. Large mounds of sand piled upon a beach.

Sand dunes are large mounds of sand piled up by the wind. This formation of sand mounds is not an accidental phenomenon. Plants along the beach are responsible for much of this process since they act as physical barriers to sand movement.

The two most important kinds of plants for stopping sand along our coast are sea oats *(Uniola paniculata)* and salt meadow cordgrass *(Spartina patens)*. These plants must be able to tolerate strong sunlight, extreme temperatures, strong wind, and changes in **salinity.** Although many people think it is very dry on a sand dune, moisture is present.

Man has destroyed much of the plant life on the sand dunes. He did this by burning, building homes, and grazing cattle on the plants. When the plants are gone, the wind is capable of blowing dunes away. To keep this from happening, scientists have been studying ways to build sand dunes. They have piled sand up with bulldozers, caught sand from the wind with barriers called **sand fences,** and planted grass (Figure 2). Sand piled up with bulldozers is often readily blown away. Sand fences trap sand and cause it to accumulate forming a dune. When the fences rot, the wind will carry the sand away again. Cultivation of plants seems to be the best method of building sand dunes. As the sand builds up around them, the plants grow. The dune then becomes very large, and the plants continue to grow with them. Sand dune researchers found that sea oats and cordgrass did not grow very rapidly when they planted them. Another grass does grow rapidly and has been helpful in building sand dunes along northern shores. It is called "American beach grass", *Ammophila*. Not only is it strong enough to withstand great weather changes on the dune, but its thick leaves can catch a great amount of sand. Unfortunately, *Ammophila* is not found along the Mississippi and Alabama coasts.

The beach, which is between the sand dune and the ocean, gently slopes to the water. Beaches are known as high energy areas because the waves from distant storms release energy here. The waves move up and down the beach as the water level on the beach changes with the tides. Ocean beaches are usually covered with broken shells, driftwood, and seaweed. However, no large plants grow there because the waves continuously pound the beaches.

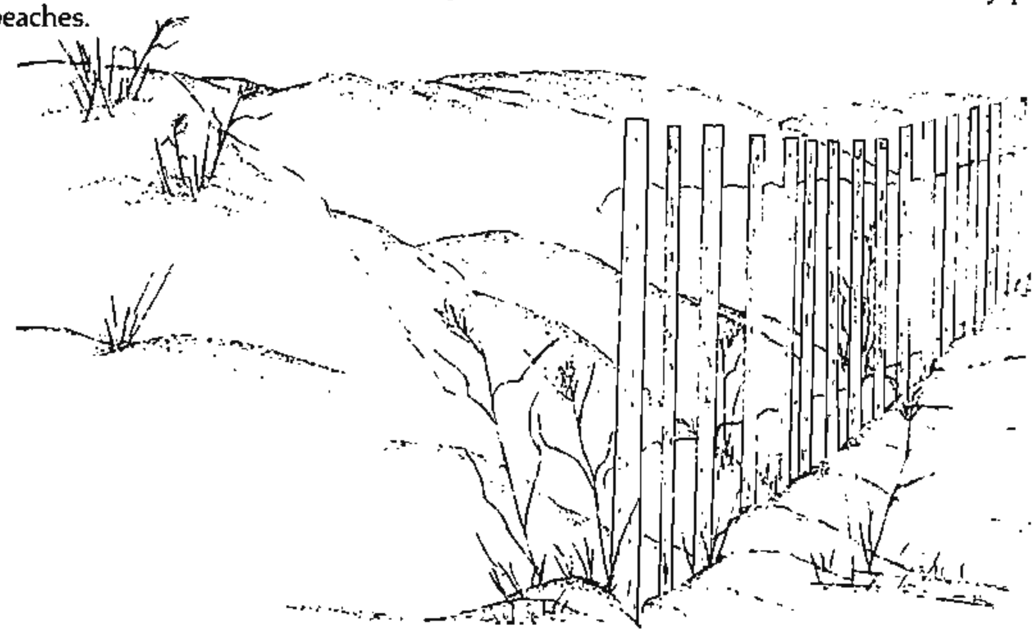


Figure 2. Sand fence. These structures are "artificial dune builders."

Waves at sea do not push water along with them. However, in shallow water they become breakers that do push the water along. If many breakers come to shore at an angle, they cause a current of water along the beach called the **longshore current.** This current moves large amounts of sand along the shore. This makes it very difficult for an organism to attach in the sand (Figure 3).

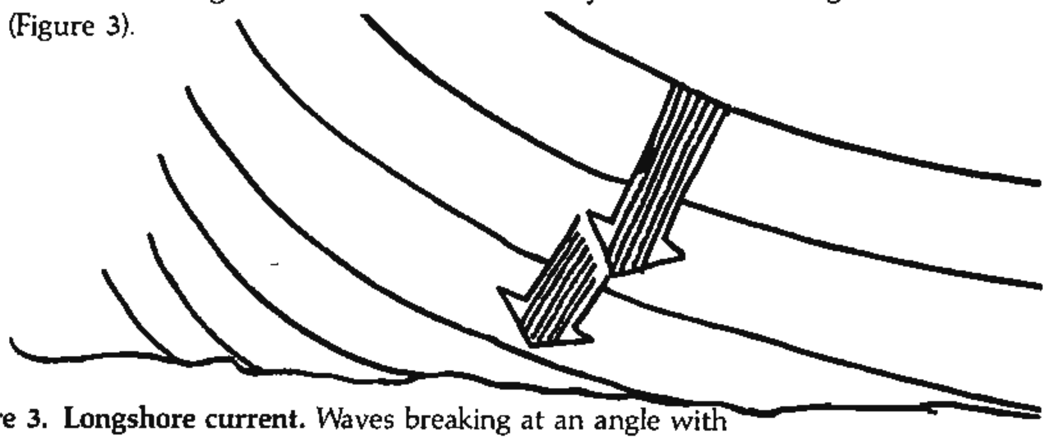


Figure 3. Longshore current. Waves breaking at an angle with the shoreline cause a current in the direction of the angle.

Since the waves pound the beach with enough energy to break shells, organisms living in the water must have some way to escape the pounding. The coquina clam *(Donax variabilis),* a small **bivalve mollusk,** and the mole crab *(Emerita talpoidea)* get protection from the energy of waves and from possible predators by burrowing the the sand. Mole crabs and coquinas (Figure 4) follow the tide waters from the low part of the beach to the high part by riding waves. As a wave comes in, the animal is uncovered and swept along with the waves. When the wave reaches the high part of the beach, the animal buries itself and waits for another wave. Both the mole crab and coquinas are **filter feeders.** Coquinas siphon water much like other bivalve mollusks. The mole crab uses its **antennae.** Its antennae are equipped with many hair-like projections that serve as nets. They stick these antennae out of the sand when a wave passes over and trap the food material from the water.

We have already said that seaweed washes up on beaches. This sometimes happens on a large scale. When the wind blows from the southeast for a long time, a brown seaweed (actually alga) called *Sargassum* will begin to pile up on the beach.

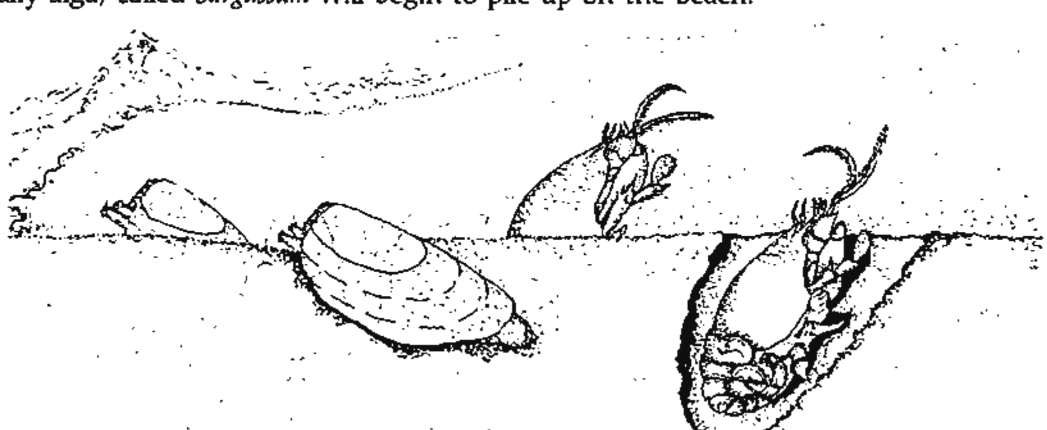


Figure 4. A. Coquina clams, B. Mole crab. These organisms burrow under the sand at the edge of the water. Both filter the water for food. The mole crab uses its feathery antennae to trap food from the water.

Sargassum is normally found floating on the ocean currents far at sea. Many animals are adapted to living with this sargassum, and some are colored so much like the alga that they are difficult to see. If you shake a piece of sargassum, you may be surprised. Many kinds of crabs, shrimp, shell-less snails, sargassum fish, and other kinds of animals may fall out of it (Figure 5).

One floating animal that sometimes gets blown to the beach along with the sargassum is not colored the same as sargassum. This is the very pretty, but dangerous, Portuguese man-of-war (Figure 6). This animal floats by means of a large, purple balloon-like sail. The Portuguese man-of-war is sometimes a very serious menace on beaches. Children mistaking them for balloons pick them up with sad consequences. Their sting can cause great injury. **Tentacles** trail below it in the water. The **nematocysts** on its tentacles are very toxic to other organisms. One species of fish, however, lives among these tentacles. The man-o-war fish, *Nomeus gronovii*, enjoys some strange immunity to the poison. The tentacles apparently offer protection for the fish.

Many young fishes find food and protection in the shallow surf area. One of these, the pompano, is very common in summer (Figure 7). Most of these leave this area when they grow larger.

Figure 5. ***Sargassum.*** This alga floats on the surface of the sea with aid of many small **air bladders.** The wind can blow sargassum and all of the animals adapted to living with it upon the beach.

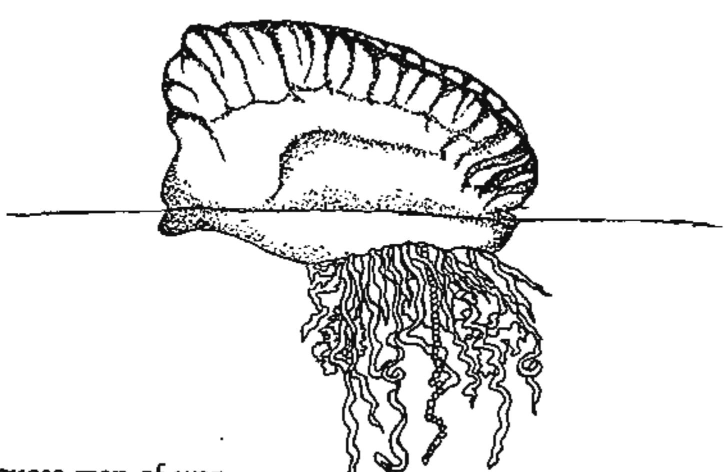


Figure 6. Portuguese man-of-war.

Upon the dry part of the beach, we can detect some rounded holes in the sand. These are burrows of ghost crabs *(Ocypode albicans)*. They use these for protection from weather and from predators. The ghost crab lives out of the water but must still wet its gills (Figure 8).

Another common beach animal is called the beach flea or sand hopper (Figure 8). During daylight hours, this small animal spends its time under the sand or debris on the beach. But at night it begins to search for food. We can find these animals by turning over debris or by placing a lantern on the beach at night. They are attracted to light.

Besides the animals that are adapted especially to living in or near the water, there are some that visit the beach to find food. Birds are probably the most common. We can often see sandpipers probing the sand with their bills for small animals. Some sandpipers, like the sanderling, run along the waves picking up the animals that are uncovered by the rushing water (Figure 9). Gulls also feed at the beach. They are scavengers and will eat anything they can catch or find. Offshore from the beach, brown pelicans or gannets may be seen diving for fishes.

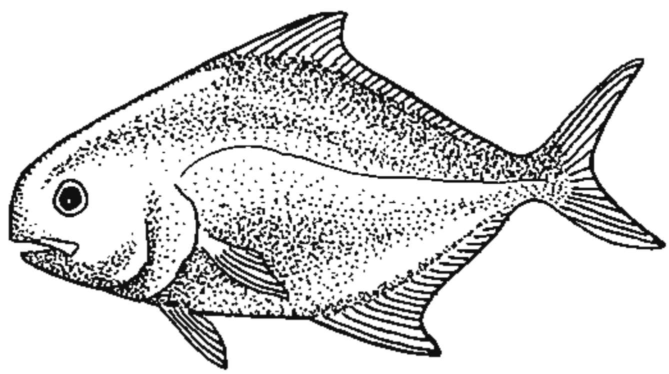


Figure 7. Pompano.

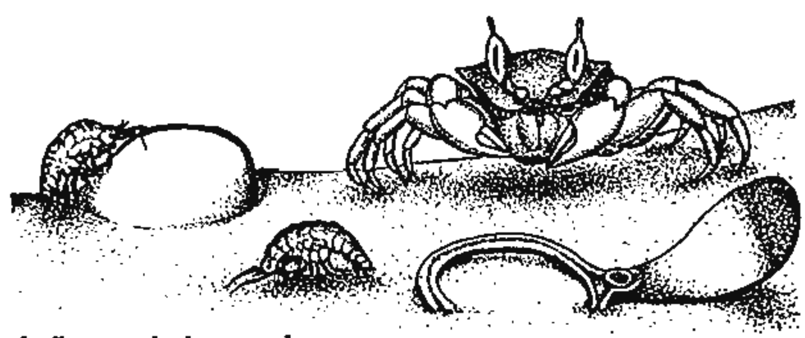


Figure 8. Beach fleas and ghost crab.

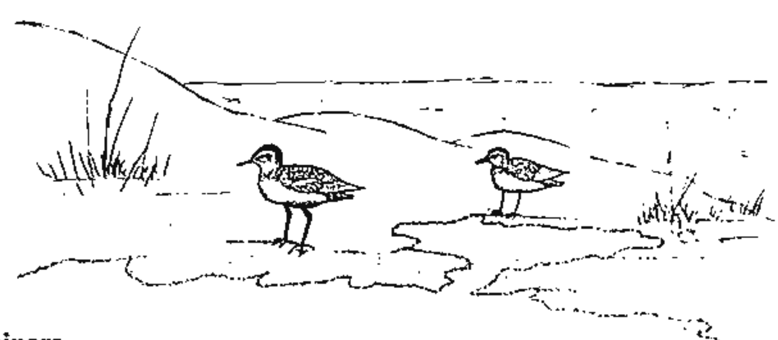


Figure 9. Sandpipers.

Many marine communities exist, and we shall include just a few that occur along the Gulf of Mexico. Marine shore communities include the following: the **strand line,** the **splash zone,** and the **intertidal zone.** Any shore community is going to be an area that is subjected to constant change. Therefore, the stability that terrestrial or oceanic organisms sustain will be absent from the shore communities. All organisms that are found in these communities withstand rigorous fluctuations in the physical environment. Structural adaptations which permit these organisms to endure such hardships are very prominent. What are some of the difficulties that will be encountered along the shore **habitats?** We find that there will be increased light intensity, respiration out of water, changes in temperature, changes in salinity, alternate flooding and desiccation (drying out), wave shock, abrasion, and feeding problems.

Exposure is probably the most important physical factor in determining the kinds of organisms inhabiting a shoreline. The shore may be totally exposed, partially exposed or completely protected from wave action. The type of **substrate** is probably second in importance as a physical factor limiting the diversity of organisms found in an area. The beach may be rocky, sandy, or muddy. What kind of beach do you find along the Gulf Coast? These two physical factors are not completely unrelated. Where do you think you would find rocky beaches? muddy beaches?

The substrate may serve as a place for attachment for an organism, thus the firmness is an important factor that has to be considered. Individuals that must attach to a firm foundation will not be able to attach to a bottom of shifting sand or mud.

Where there is a rocky beach there may be **zonation** exhibited from low tide through the strand line. This results primarily from light intensity. Zonation is exhibited along all shorelines, but it is not as noticeable along sandy and muddy beaches (Figure 10).

The zone where debris and **flotsam** are left as the tide advances and recedes is called the strand line. This narrow zone contains dead organisms such as fish, invertebrates, and algae as well as trash such as light bulbs, plastic bottles, and sometimes **driftwood.** Probably the most productive beach as far as the strand line is concerned is the sandy beach. It is very hard to distinguish a strand line on other beaches for obvious reasons. It is very difficult to leave a mark on a rocky beach and the muddy beach may be covered with vegetation such as *Juncus* which prevents a line being formed.

Both marine and terrestrial (land) animals inhabit the strand line. You may find **scavengers** or **carnivores** that feed on the scavengers. The organisms of this area must be able to utilize oxygen from the air instead of the water. Some snails have a modified **mantle,** (Figure 11), and some crabs are able to hold water in special branchial chambers. Most of the marine forms are very secretive. They may burrow in the soil or in the debris to provide themselves with some degree of protection from predators. Major predators of this area include seagulls, sandpipers, rats, skunks, flies, and beetles.

The changing climate has a very serious effect on the strand line organisms. The winter freezing and summer heat and desiccation (drying out) add to the severity of the zone as a habitat.

The greatest number of organisms found along the strand line are **arthropods.** Great numbers of crabs, beach fleas, sow bugs, arachnids, and insects may be found.

The area between the strand zone and the **high tide line** is called the Splash zone. The width of this zone depends upon the exposure and slope of the beach, but it is usually very narrow.

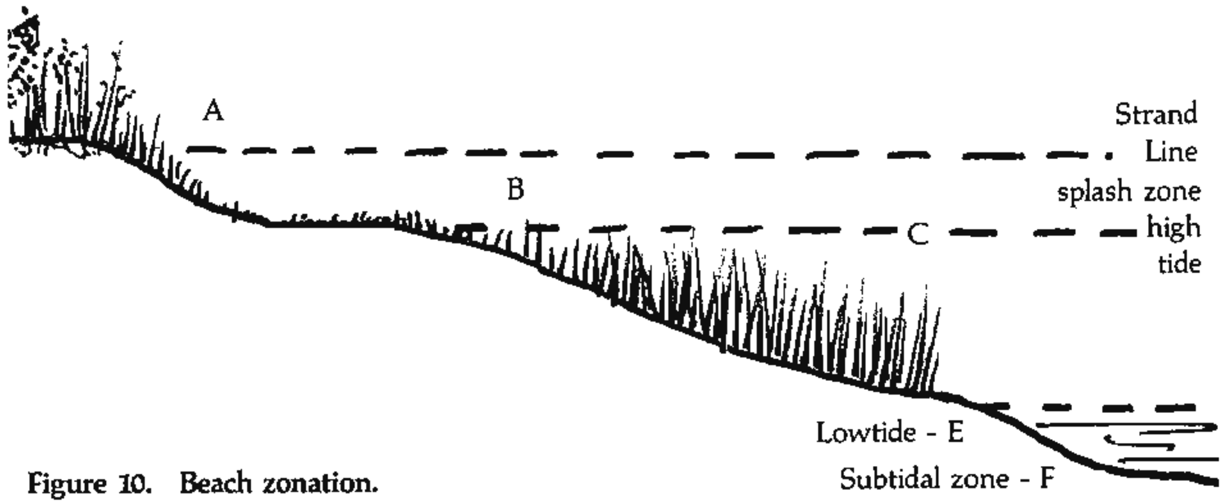


Figure 10. Beach zonation.

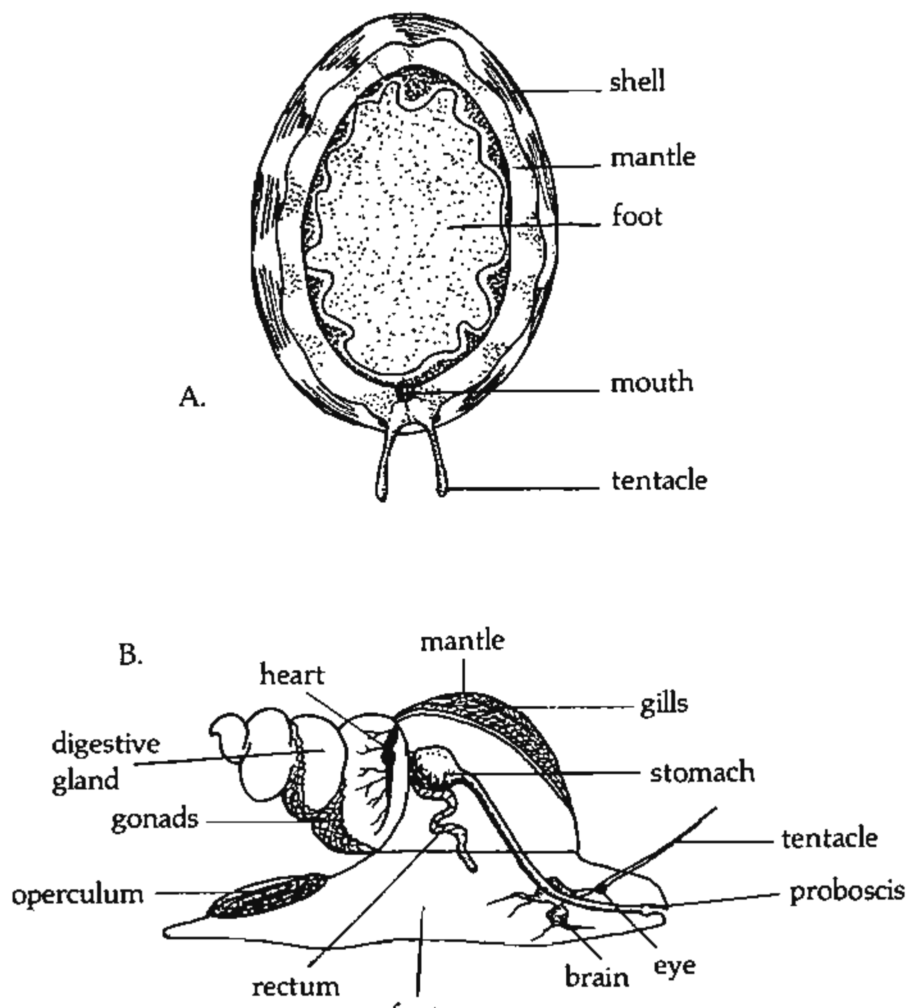


Figure 11. A, Ventral view of limpet. B, Cross-section of snail.

This zone is limited to marine organisms, except for a few terrestrial animals during low tide, because of the presence of salt water. On rocky beaches there is very little cover so the inhabitants must feed quickly. Between tides, organisms living on rocky beaches are in constant danger of being eaten. On the sandy or mud beaches animals burrow into the substrate.

The splash zones of sandy beaches have few inhabitants because of the unstable substrate. Some common animals that may be found here include: snails, limpets, beach fleas, barnacles, crabs, and **isopods.** Other animals that may be found especially on sandy and muddy beaches

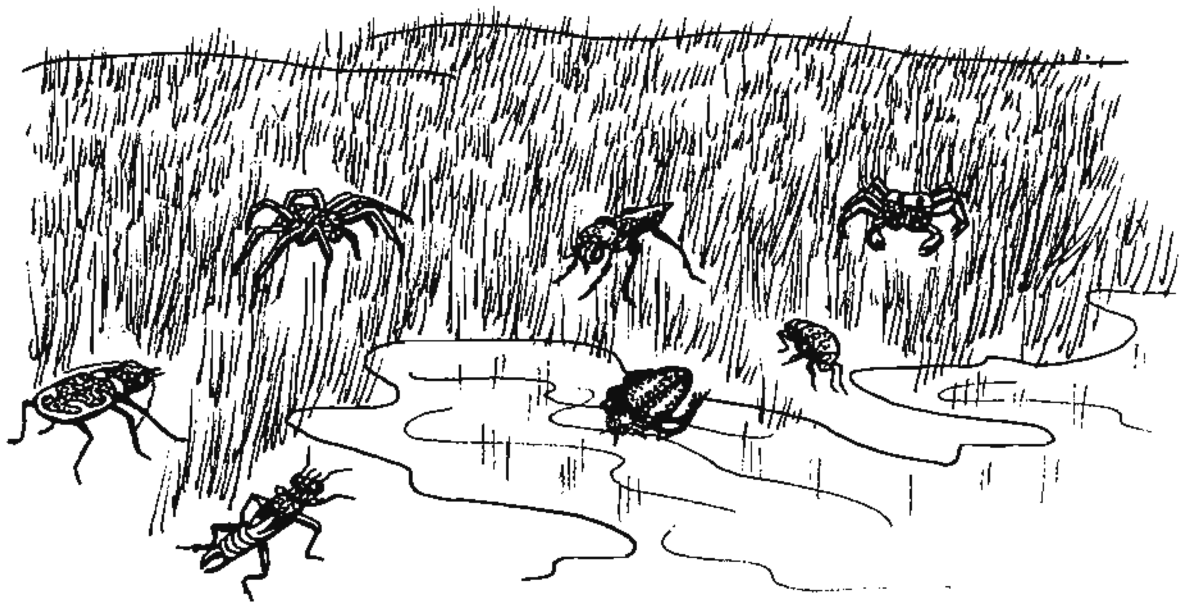


Figure 12. Organisms found on sandy and muddy beaches.

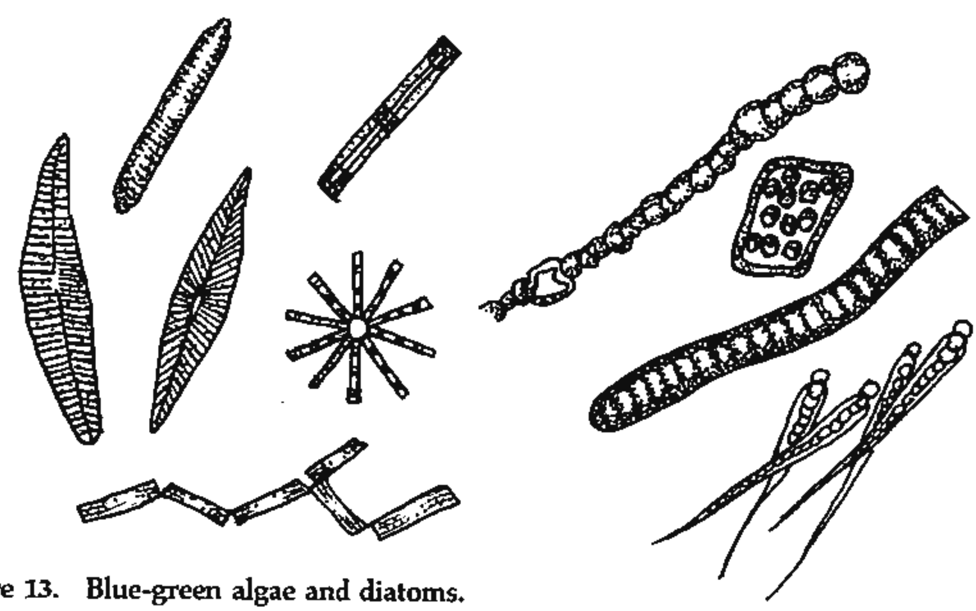


Figure 13. Blue-green algae and diatoms.

are: beetles, spiders, flies, earwigs, ghost crabs, and beach amphipods (Figure 12). Blue-green algae and diatoms may be found in this area also (Figure 13).

The intertidal zone receives varying amounts of water at various times, and this creates a habitat that is very unstable. This factor along with exposure, substrate type, and other conditions provide for a very diversified habitat. This results in a very large array of organisms. On the mud and sandy beaches, burrowing may give relief from light and heat.

Oxygen seems to provide no problem for most of the intertidal organisms. The organisms usually found on rocky beaches have developed unusually large gill filaments. Sandy beaches hold water and **dissolved oxygen** in the spaces between the sand grains. On the mud beaches, the native organisms must construct breathing tubes, since the mud lacks oxygen and may contain an excess of some of the gases from bacterial decay or organic matter.

The intertidal organisms must have a wide tolerance for salt because the salinity of the intertidal zone will change from season to season.

Food is more abundant here than in other zones because there are more planktonic algae, large algae, and numerous kinds of bacteria. Large **herbivores** which feed on algae include such animals as the periwinkles, limpets, isopods, crabs, and some fishes. **Plankton** provides food for the bivalves and barnacles. Scavengers, which include the sea urchins and amphipods, feed on dead algae and other pieces of **detritus.** Many of the gastropods, echiuroids, brachipods, bryozoans, tunicates, worms, and sand dollars feed upon the smaller particulate organic matter. Some of the worms may use bacteria as their main source of food.

With this variety of food available more predators can be maintained than in other zones. The common predators of the intertidal zone are: starfish, gastropods, nemertines, sea anemones, fishes, and birds. Due to specific adaptations to the environment, populations of specific organisms can be sustained. These adaptations include strong skeletons, burrowing mechanisms, attachment devices, and camouflage techniques. The predators, however, also have good adaptations which insure their continued success. Examples of this would include the oyster drill which can drill a hole in the oyster shell, moon shells which can burrow as fast as clams, and the seagulls which can lift the hard-shelled bivalve to a height and drop them onto a hard surface.

The dominant physical factor influencing survival in the intertidal zone is wave action. Since the tides move in and out, the organisms are subjected to the wave action at different intervals. Many of the living creatures will need some sort of adaptation to escape the breakers as they splash along the shoreline.

Sandy beaches are perhaps the least productive of intertidal habitats, and this is because of the unstable substrate, wave action and abrasion from the particles of sand, as they move from one plane to another. On this type of beach, burrowing is the main escape mechanism used by the inhabitants. Organisms present on sandy beaches include the bivalves, arthropods, some annelid worms, shrimp, burrowing sea urchins, and sea anemones.

The mud beaches form only in protected areas so wave action is not a severe problem for the organisms living there. Tube-dwelling worms are the dominant organisms found in this habitat. There will also be some clams and predaceous nemertine worms.

The tidal pool also offers an unusual array of organisms. Since the tide pool may be formed close to the high tide line or the low tide line, there may be a considerable difference in the diversity of organisms found in a particular tide pool. Salinity, which varies with the tide pool, influences survival of many of the occupants. Along our Gulf Coast tidal pools are often found on the barrier islands.

Check Your Learning

1. ______________________________ are important on the sand dune because they are nature's way of stabilizing the sand.
2. The grass found at the edge of the salt marsh and on the dune is __________ grass *(Spartina patens)*.
3. The current caused by waves along a beach is called the ________________ current.
4. The mole crab and coquina find protection from the pounding surf and predators by ____ .
5. A floating alga that is blown in from deep water and has many animals adapted for living with it is called __________________________ .

THINK QUESTIONS

1. Which one of man's methods of stabilizing dunes is best? Explain why.
2. Construct a probable food chain for the dune community.
3. Construct a probable food chain for the beach community.

VOCABULARY

air bladder—structures on certain algae which increase buoyancy so that the algae can float on water.

antennae—sensory structures used by organisms such as mole crabs in order to capture food.

arthropods—animals having an exoskeleton and jointed appendages.

beach—an almost flat shore of sand or pebbles over which water washes when high.

bivalve—a mollusk possessing a shell of two valves hinged together; includes clams, oysters, and mussels.

carnivores—an animal which preys on other animals.

detritus—very small particles of the decaying remains of dead plants and animals; an important source of food for many marine animals.

dissolved oxygen—oxygen which is found in a water solution. The amount of dissolved oxygen in water depends on the physical, chemical, and biochemical activities that occur in the body of water.

driftwood—wood which is carried along by water and eventually washed ashore in the strand line.

environment—the surroundings of an organism.

filter feeder—any organism which actively filters suspended material out of the water column by creating currents. Examples are tunicates, copepods, and oysters.

flotsam—materials that are found floating on the sea or washed ashore.

habitat—the place where an organism lives.

herbivores—animals that are adapted to feeding on plants.

high-tide mark—the uppermost level on a shoreline reached by the highest tides.

intertidal zone—in the marine environment, the area of the shore that is periodically covered and uncovered by water.

isopods—a group of small crustaceans that have flattened bodies and many legs of more or less equal size; most isopods are scavengers.
longshore current—an ocean current that flows parallel to a coastline; results from waves striking the shore at an angle.
mantle—a thin membrane covering the digestive organs, excretory organs, and the heart of a mollusk; in some, it secretes a shell.
mollusk—soft-bodied, mostly marine animals, usually enclosed within a hard outer shell of calcium carbonate.
nematocysts—stinging cells found in coelenterates. These specialized cells are used for trapping food.
plankton—small plants and animals floating in the upper layers of the water column.
salinity—a measure of the total amount of dissolved salts in seawater.
salt marsh—flat land subject to overflow by salt water. The vegetation of salt marshes may consist of grasses or even shrubs.
sand dunes—a mound or ridge of loose sand heaped up by the wind.
sand fence—a method of building sand dunes by using fences.
scavenger—an animal which feeds on the dead remains of other animals and plants.
sound—a body of water which occupies the area between a mainland and an island.
splash zone—area above high-tide mark which is moistened by spray from waves breaking on the shore.
strand line—a shore line or beach; especially, one above the present water level.
substrate—any hard surface on which a plant or animal is attached.
tentacle—a long appendage, or "feeler", of certain invertebrates.
zonation—organization of a habitat into more or less parallel bands of distinctive plant and animal associations as a result of variations in environmental conditions.

VOCABULARY ACTIVITY FOR CONCEPT D

Objective

To review vocabulary words used in concept D.

Materials

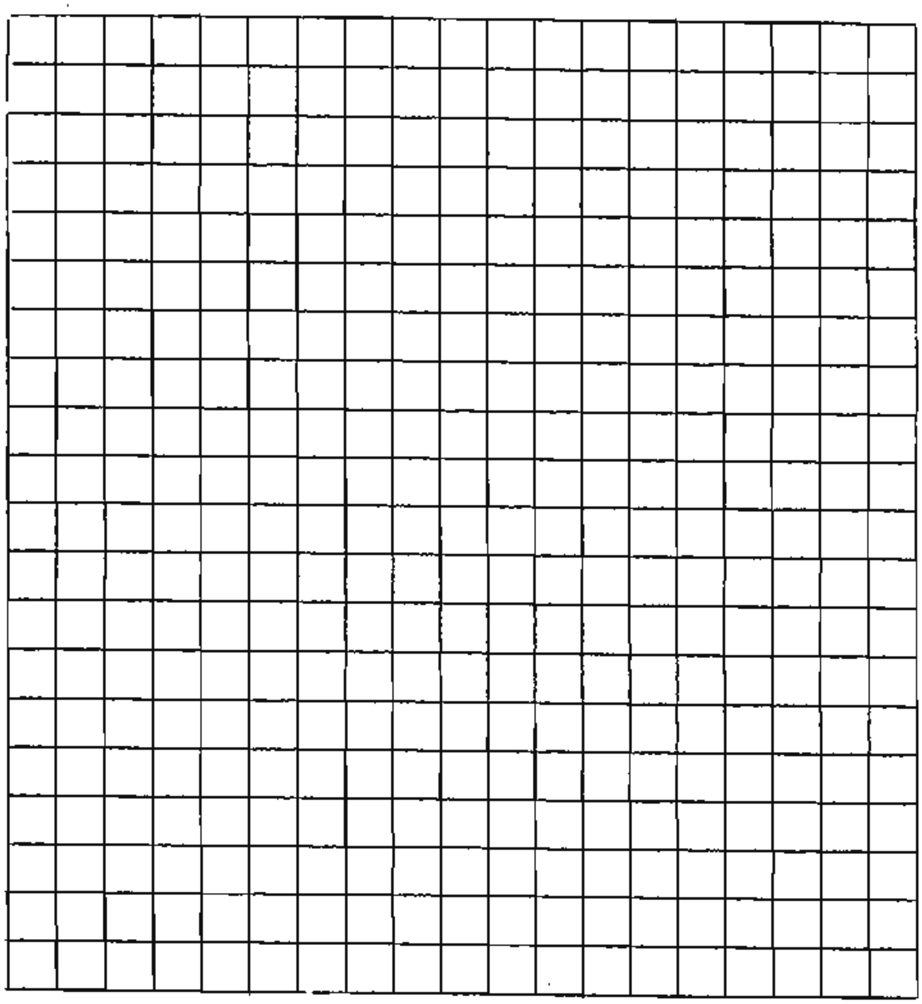
vocabulary handouts, pencils, copy of the square shown on the next page

Procedure

Here is an opportunity for you to "build" a crossword puzzle. Using the square on the next page you will find a list of clues (definitions of vocabulary words), to make a crossword puzzle. See if you can make each word connect in some way with at least one other word.

CLUES ACROSS

1. Active during the night.
12. The place where an organism lives.
68. Structures used by mole crabs in order to capture food.
101. A mollusk possessing a shell of two valves hinged together; includes clams, oysters, and mussels.
163. The surroundings of an organism.
234. A body of water which occupies the area between a mainland and an island.
322. A measure of the total amount of dissolved salts in seawater.
368. Structures on certain algae which increase buoyancy so that the algae can float on water.



CLUES DOWN

3. An animal which preys on other animals.
51. An almost flat shore of sand or pebbles over which water washes when high.
118. The uppermost level on a shoreline to be reached by the highest tides.
170. Soft-bodied, mostly marine animals, usually enclosed within a hard outer shell of calcium carbonate.
202. A group of small crustaceans that have flattened bodies and many legs of more or less equal size.
204. A shore line or beach; especially one above the present water level.
268. Materials that are found floating on the sea or washed ashore.

Activity: A BEACH AND DUNE COMMUNITY

Objectives

To identify some of the common organisms found on beaches and sand dunes.

To construct **food chains** from the individuals found on beaches and sand dunes.

To identify the biological **niche** of representative organisms found on beaches and sand dunes.

Introduction

In the following investigation, you will try to identify the organisms of a hypothetical beach and dune **ecosystem** and then try to determine their ecological niche in this community.

Materials (per student)

Guide sheet of a beach and dune ecosystem

Procedure

You are provided with a picture of a hypothetical beach and sand dune and a list of the organisms found on the beach and dune. The first thing you are to do is to match the correct name with the correct organism. Place the correct corresponding number under each organism in the picture. Once you have named all of the organisms found on the beach and dune complex, complete the data table for the usual niche of each organism. If you are not familiar with some of the organisms, go to the library and see if you can find a reference book that will enable you to determine each organism's niche in its community.

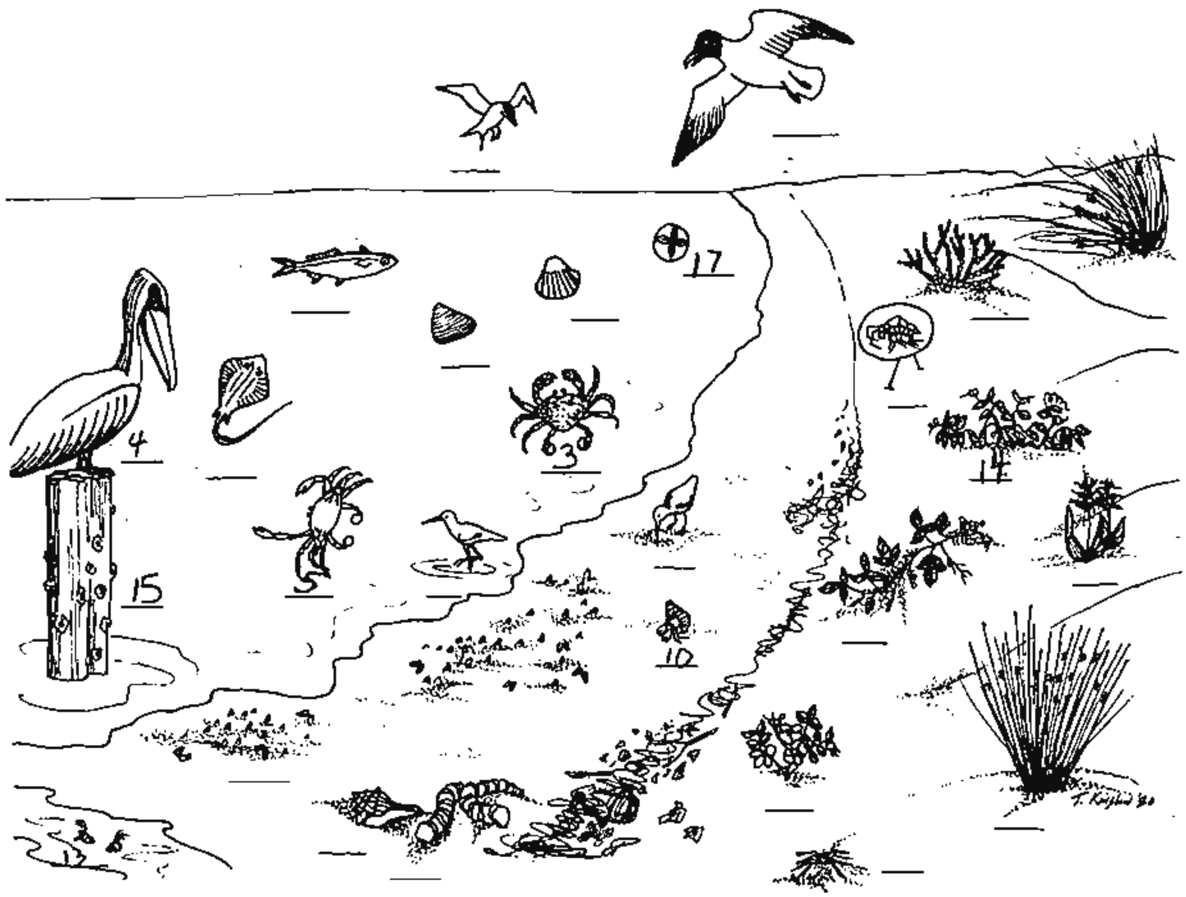


Figure 1. A beach and sand dune community.
Adapted from: Field Guide Sheet for Southeastern New England Marine Environments: The Sandy Shore and Dunes (Carole Eldridge)

ORGANISMS ON THE BEACH AND SAND DUNE

1. Ark shell *(Anadara)*
2. Beach pea *(Lathyrus)*
3. Blue crab *(Callinectes)*
4. Brown pelican *(Pelacanus)*
5. Calico crab *(Ovalipes)*
6. Coquina clams *(Donax)*
7. Egg cases
8. Glasswort *(Salicornia)*
9. Greater yellowlegs *(Totanus)*
10. Hermit crab *(Pagurus)*
11. Laughing gull *(Larus)*
12. Least tern *(Sterna albifrons)*
13. Mole crab *(Emerita)*
14. Poison ivy *(Rhus)*
15. Rock (acorn) barnacles *(Balanus)*
16. Salt-spray rose *(Rosa)*
17. Sand dollar *(Echinarachnus)*
18. Sanderling *(Crocethia)*
19. Sandhopper *(Talorchestia)*
20. Sea oats *(Uniola)*
21. Seaside goldenrod *(Solidago)*
22. Silversides *(Menidia)*
23. Southern stingray *(Dasyatis americana)*
24. Surf clam *(Spisula)*
25. Whelk *(Busycon)*
26. Wolf spider *(Lycosa)*

Organisms Found in a Hypothetical Beach and Sand Dune

	Name of Organism	Usual Niche of this Organism
1		
2		
3		
4		
5		
6		
7		
8		
9		
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25		
26		

1. Name three food chains that you can construct from your investigation.
   1. ____________________
   2. ____________________
   3. ____________________
2. Construct a small food web from the organisms in the picture. Select at least 12 organisms.

3. Using this beach and dune community, develop a food chain which has four links.

____

____

4. What do you consider to be the ultimate consumer? ____________________
5. Name one organism that is at the base level in this community. ____________________
6. Could this community exist on the Gulf of Mexico? ________ Explain. ____________________

____

____

VOCABULARY

ecosystem—a community of organisms interacting with each other and the environment in which they live.

food chain—the passage of energy and materials in the form of food from producers to consumers as organisms feed on one another.

niche—the particular way in which an organism obtains its food and reacts; an organism's way of life.

Activity: PARTICLE DISTRIBUTION ON SANDY BEACHES

In the development of a sandy beach the natural sorting out of the material which forms the beach causes certain sized particles to be left at the top of the slope (farthest from the water) while other sizes are moved toward the bottom (closest to the water). Because of the constant movement of the material by tide and surf action of varying heights and force, there will be some material of virtually all sizes at any level along the slope of the beach.

In this exercise you will go to various beaches and sample sand from at least three spots—high tide, mid-tide, and low tide levels. You will sort these sand samples by particle size and determine if there is any relation between elevation on a beach and percent particle sizes found there.

Materials

For this activity it is not necessary to purchase a set of graduated sieves. All that is required are four or five pieces of screen (which can be purchased at a hardware store) tacked onto simple wooden frames about eight inches across. The mesh of the screen should range from approximately 1/2 inch down to 1/32 inch. The precise sizes of the screen are not so important, but there must be a distinct graduation from larger to smaller. You will also need five plain sheets of paper, numbered one through five.

Procedure

Collect sand samples from three elevations on selected beaches. Note the slope of the beaches you work on. Use about a pint-sized can for each sample and try two or three beaches with slopes of different angles (Figure 1).

Place a moderate quantity of the sample in the top of the stack of sieves (do not attempt to fill the top sieve). Be sure the sieves are stacked in order of decreasing size of screen, the largest being on the top. *Be sure the sand is dry.*

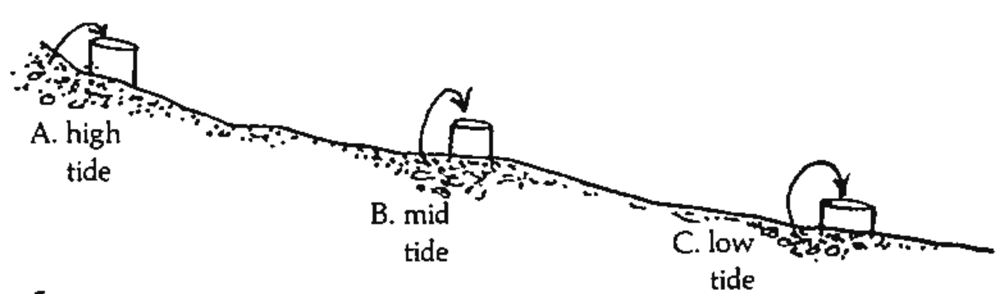


Figure 1.

Shake the sample through the sieves. Remove the material from each sieve (make sure that you remove all the material) and place it on a piece of paper. Number the papers from one through five, with No. 1 being the largest and No. 5 the smallest.

Weigh each size sample carefully.

Add the weights of the size samples in order to get the total weight.

Calculate the percentage of the total sample represented by each size sample as indicated on the accompanying data sheet. (see next page).

Data Sheet

	Sample 1	Sample 2	Sample 3
1. Total weight of particles size 1			
Total weight of particles size 2			
Total weight of particles size 3			
Total weight of particles size 4			
Total weight of particles size 5			

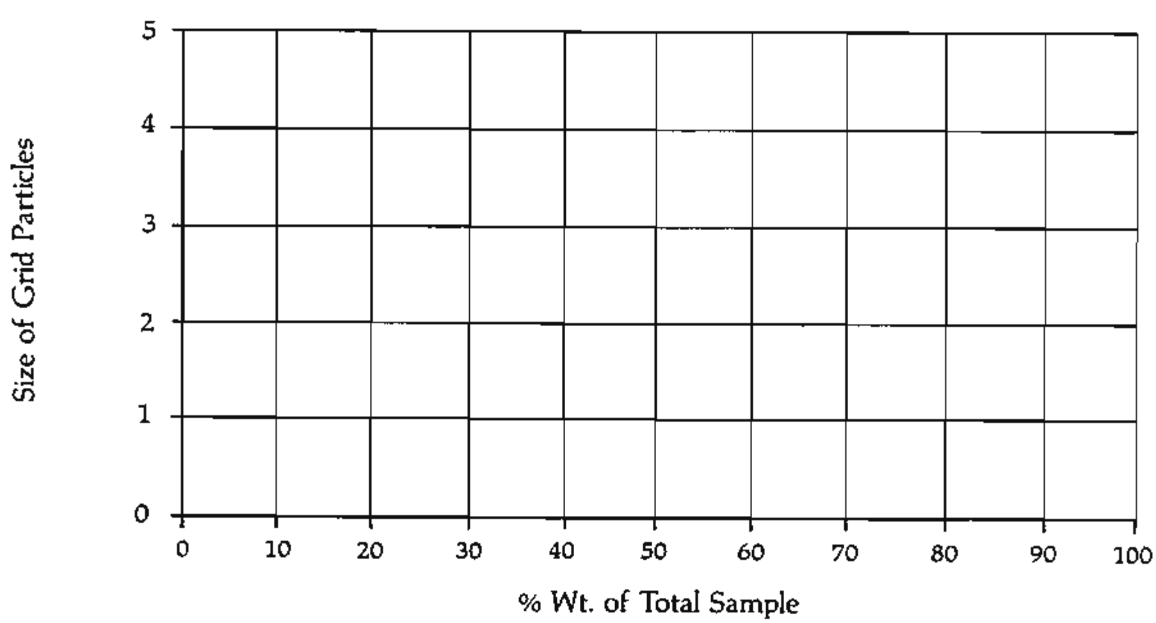
2. Percentage of the weight of the total sample represented by the weight of:

Particle size 1			
Particle size 2			
Particle size 3			
Particle size 4			
Particle size 5			
Total Percentage			

The method for calculating the percentage of the total weight represented by each particle size is as follows:

$$\% \text{ of wt. of total sample} = \frac{\text{wt. of particle size}}{\text{wt. of the total sample}} \times 100$$

3. Plot your results on a graph with the percent of the total sample on the vertical axis and the particle size on the horizontal axis.



CONCEPT E

The six barrier islands of the Gulf of Mexico parallel the Alabama-Mississippi mainland. The islands form the Mississippi Sound, a unique estuarine area.

Objectives

a. To list the six barrier islands of the Gulf of Mexico.
b. To explain how the islands are maintained.
c. To list two habitat types found on Gulf Coast barrier islands.

THE OFFSHORE BARRIER ISLANDS OF MISSISSIPPI AND ALABAMA

The six barrier islands which skirt the mainland shores along a distance of 110 km (about 70 mi.) play a major role in determining the character of Mississippi-Alabama coastal lands and waters. They are located 5-20 km (3½ to 12½ mi.) from the mainland, further offshore than similar islands along the Atlantic and Gulf coasts of the United States (Figure 1).

Dauphin Island, Alabama presently is about 23 km long (14 mi.) and is the largest, while the smallest of the six is East Ship* which is only 4 km long (2½ mi.). Most of the islands are covered by low dunes, 4-6 m (13 to 20 ft.) at the highest. The only exception is the eastern end of Dauphin Island (named early in the eighteenth century for the crown prince of France), where large dunes reach 14 m (47 ft.) above sea level.

Only a short time back in the geological evolution of the coast, there was no sea where the long, narrow barrier islands stretch today, and the gentle waves of Mississippi Sound roll. Waters from melting ice sheets of the last ice age pushed the oceans gradually over the land and, by about 6,000 to 7,000 years ago, the area of the present islands came under water. By 3,500 years ago the sea reached its present shores and the chain of islands was already established.

Barrier islands need an adequate sand supply to maintain themselves. Littoral currents and drift supply the sediment material, enabling the islands to survive. On the north central Gulf Coast, waves generally approaching from the south-southeast supply the force which sets into motion the process of sand drifting toward the west. The immediate source of the sand

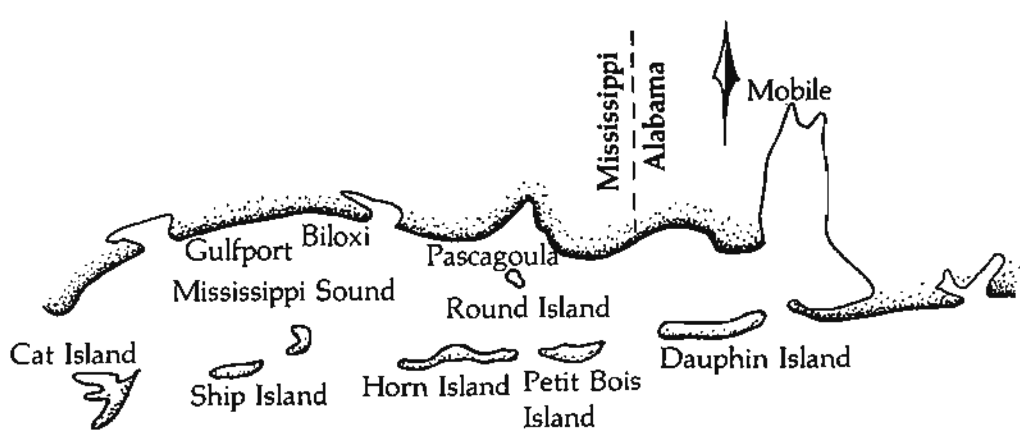


Figure 1. Six barrier islands.

is Mobile Point Peninsula which affords a path for the sand grains to travel from the Alabama mainland shores across the mouth of Mobile Bay. Originally, all sand was derived from the southern Appalachian Mountains which are drained by a number of southflowing rivers that reach the Gulf of Mexico in present-day Florida and Alabama.

How did the islands appear? Opinions are divided as to the ways barrier islands form. Some think they evolve when storms and tides cause the segmentation of narrow, elongated coastal tongues or "spits" of sand. Others believe the engulfment of mainland beach-dune ridges, during times of encroaching seas, turns such ridges into islands by surrounding them.

Another view credits barrier islands with having been formed originally a long distance seaward from their present positions, where they have been shifted by the slow landward movement of the invading seas. According to this view, barrier islands might have travelled over 100 miles in a time span of perhaps 14,000 years.

We know that some of the coastal islands (Deer, Round and eastern Dauphin) started from already existing, higher ridges which the invading seas have found at their present positions. Remnants of older ridges on Dauphin Island acted as a core for further westward expansion of the island. Segmentation of long spit-peninsulas is unlikely in the area as a way for island formation. Such long spits couldn't have developed ordinarily, due to the strong tidal currents which move the waters in and out of Mississippi Sound and Mobile Bay to the Gulf of Mexico. Such currents would limit the growth of spits.

More likely, several of the islands formed from the extensive sand shoals which are found around and between the islands. Once a shoal can grow slightly over sea level and establish itself as an island, dune vegetation will soon get hold of the surface sand and may prevent the island from being washed back to the sea.

One example of the emergence of such an island was the Isle of Caprice, or Dog Key, a small islet between East Ship and Horn Islands. The island emerged some time around the turn of century. It was a favorite excursion resort in the 1920's. Storm erosion, problably aided by the commercial harvesting of sea oats which once stabilized the dunes, finally cut back the island and it disappeared completely with the 1947 hurricane.

Hurricanes often cut up barrier islands into smaller ones. This happened to Ship Island in 1947 and again in 1969. Dauphin Island underwent similar changes. Storms permanently eliminate the eastern ends of the islands, which are eroding even in fair weather, and supply the western ends of the islands with sand needed to grow. Drastic changes within the last 120 years resulted in a 4.5 km (2.8 mi.) westerly growth of Petit Bois ("small woods") Island. In the eighteenth century several miles of Petit Bois belonged to Alabama, but the westward growth "moved" the whole island into Mississippi by the 1950's.

Environments are varied on the barrier islands. Some of the islands, such as Horn, eastern Dauphin and East Ship are heavily wooded (mostly pines, some live oak) and all contain salt and brackish marshes in depressions between dunes and ridges. More open lakes are also found on the islands, as well as narrow water bodies or lagoons connected with the adjoining Sound. Unusual vegetation covers the dune ridges, and "precipitation ridges" on southeastern Dauphin Island are still moving inland, covering fences and buildings on their way.

The contrast between the north (Mississippi Sound) and south (Gulf of Mexico) beaches is striking. The greater wave energies on the south shores created wide beaches with finer sands than those of the narrow northern beaches. Walking on these beaches one often finds evidence of ongoing coastal erosion. The shore dunes are being cut back by wave action and peat beds are exposed underwater at the foot of the beaches. These dark peat beds formed at times when the present beaches were locations of inland marsh ponds, isolated by strips of dunes from the beaches of the time. The retreating shores brought the location of the present beaches within the realm of wave action. Radiocarbon age data show that this usually occurred within the past few hundred years.

Cat Island, the westernmost of the six, reveals an interesting life history. Over 3,000 years ago, sand drifted freely westward of this island into the present Orleans Parish area of Louisiana which then was mostly under sea and bay waters. Cat Island has grown southward by sand ridge accretion until a delta of the Mississippi River has encroached around it from present-day St. Bernard Parish and cut the route of westward-directed sand drift. The island started to erode strongly on its eastern end and the eroded sand was pushed into sand spits pointing north and south, giving the island its unusual and characteristic mushroom shape. The sea is steadily intruding into the depressions between the northern ridges of the slowly sinking island and creating long, narrow embayments along its Mississippi Sound shores. St. Bernard delta stopped its active discharge around 1,800 years ago and since that time is being heavily cut back and destroyed by the erosion of the sea.

The Mississippi-Alabama barrier islands create a special, protected, low-salinity, high-nutrient habitat in Mississippi Sound, so important for costal marine life. By providing shallow areas in Mississippi Sound, they also afford a certain measure of protection against hurricanes striking the coast. Their economic and recreational values are increasingly being protected; at present four of the islands (Horn, East and West Ship, and Petit Bois) belong to the National Park Service's Gulf Islands National Seashore.

Activity: SIX BARRIER ISLANDS OFF THE MISSISSIPPI/ALABAMA GULF COAST

Objective

To learn the names and location of the five barrier islands.

Materials

handout sheets, reference books, pencil

Introduction

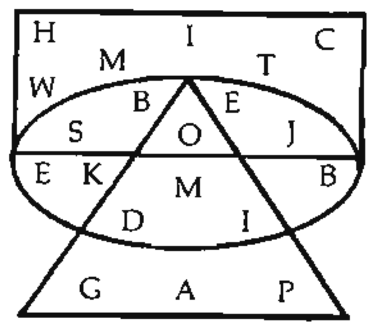
Approximately ten miles off the Gulf Coast of Mississippi, there lies a string of long, narrow islands running parallel to the shoreline. These islands separate the waters of the Gulf of Mexico to the south from the waters along the mainland to the north; therefore, they are called barrier islands. Because of this, the water environment between the islands and the mainland is different from that of the Gulf of Mexico. This body of water is called the Mississippi Sound.

The Mississippi Sound is about eighty miles long. It extends from Mobile Bay, across the entire Mississippi coastline, to Lake Borgne in Louisiana. The series of barrier islands which mark the southern boundary of the Sound, from east to west, are called Dauphin, Petit Bois, Horn, Round, Ship, and Cat Islands.

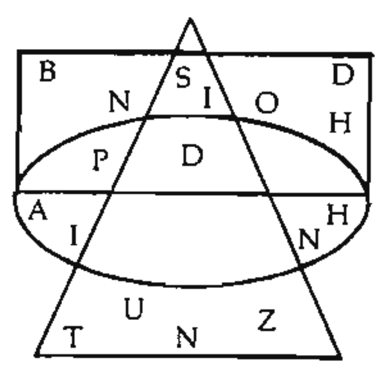
Procedure

On the following pages you will find five puzzles. If you solve them correctly, each puzzle will spell out the name of one barrier island. You must pick letters according to specific statements. After you have picked the proper letters, you should be able to find the five barrier islands. The letters will be in the proper order, but you must decide which letters make up the name.

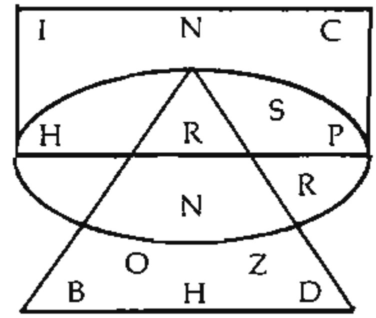
△ means triangle, ○ means circle, □ means square.



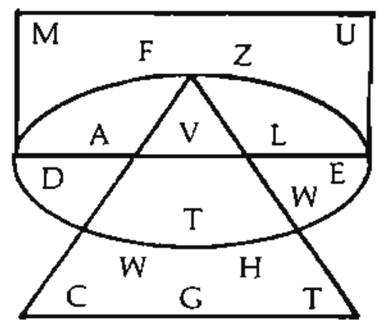
1. The first letter is in the △ only.
   The second letter is in both the ○ and the □ .
   The third letter is in the □ only.
   The fourth letter is in both the ○ and the △ .
   The fifth letter is in the □ only.
   The sixth letter is in the ○ and the □ .
   The seventh letter is in the ○ , the □ , and the △ .
   The eighth letter is in both the ○ and the △ , or in the □ .
   The ninth letter is in both the ○ and the □ , but not in the △ .



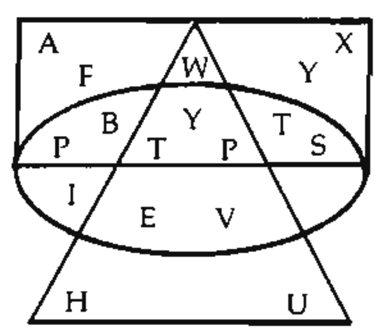
2. The first letter is in the ○ , the □ , and the △ .
   The second letter is in the ○ only.
   The third letter is in the △ only.
   The fourth letter is in the ○ and the □ .
   The fifth letter is in both the □ and the ○ .
   The sixth letter is in the ○ or the □ and the △ .
   The seventh letter is in the ○ or the □ or the △ .



3. The first letter is in both the □ and the ○ .
The second letter is in the △ .
The third letter is in the ○, the △ , and the □ .
The fourth letter is in the ○ and the △ .



4. The first letter is in △ only.
The second letter is in the ○ and the □ .
The third letter is in both the ○ and the △ .



5. The first letter is in both the ○ and the □ .
The second letter is in the △ only.
The third letter is in the ○ only.
The fourth letter is in the ○ , the □ , and the △ .

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