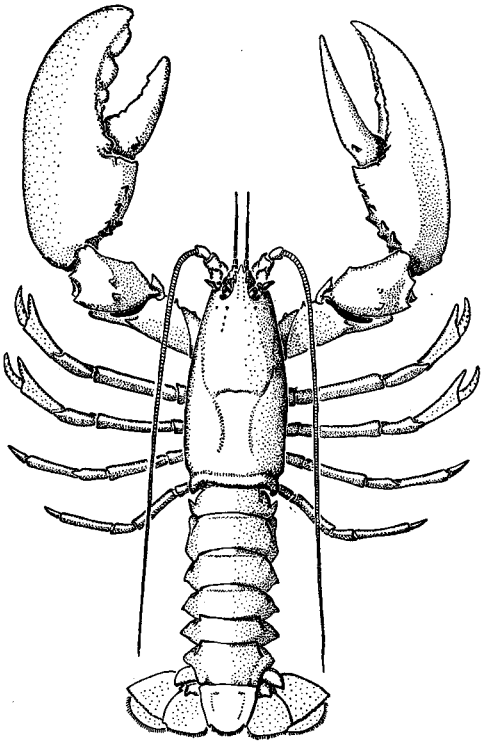
Some Common Marine Animals

The eighth in Nature Magazine's series of educational inserts

By E. LAURENCE PALMER

IN spite of the fact that an ancient writer said that "those who go to the sea are only four inches from death" men will still continue to "go down to the sea in ships", or by any other conveyance available. Those who do not will have representatives of the sea brought to them for decoration, to satisfy hunger, or to provide dyes, medicines and other articles of daily use.

The sea connects and separates nations. It brings livelihood or death to men. It modifies climates. It is the major reservoir of the waters of the earth, and undoubtedly was the cradle in which life first appeared. There is much in common between sea-water and protoplasm, and one writer has said that a mammal is little more than a glorified sack of sea-water, in which bones are comparable to the limestones that have been deposited in association with corals. It is the purpose of this article, however, to stimulate the study of marine animals rather than to suggest a philosophy of life.



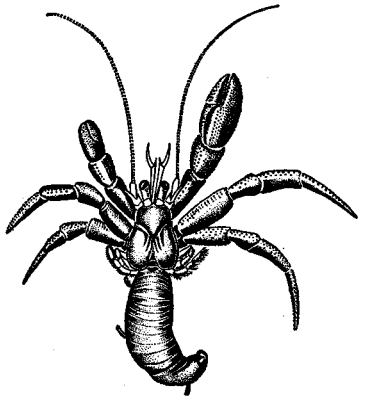
LOBSTER

The sea varies almost as much as the dry land. Biologists speak of it as being the more static because the variations in temperature are not normally made so quickly, or through so great a range. At the edge of the sea, however, there are violent changes that may take place with every incoming wave and with every tide. A living thing may at one moment be exposed to intense sun on dry sand and a second later be immersed in rapidly-moving water. It may be compelled a thousand times a day to adjust itself to living first in the air and then under water. Such an existence forces on some creatures the ability to move quickly and with freedom, to modify feeding, breeding and protective activities, and to withstand excessive variations in pressure, exposure to heat and light and to a variety of enemies, both from the sea and from the land.

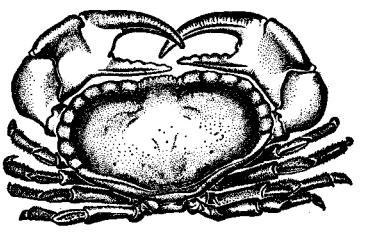
The depths of the sea are practically unknown and uncharted. What strange creatures live there no one knows, and what wealth of a mineral and organic nature exists there may only be guessed. We do know that some of the lesser depths are inhabited by strange creatures that carry their own lights, have mouths like the gates of doom, and whose shapes rival anything one's imagination can create. Only rarely will these things come to the attention of those who get their pleasures of the sea from walking on its shores and viewing its products.

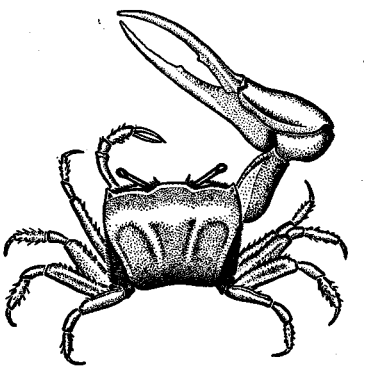
Muds, sands, rocks and great masses of vegetation typify the major kinds of seashore, and just as these vary so does the kind of animal life to be found. An oyster must have something firm to cling to and spend the major portion of its life. Many of the crabs, on the other hand, may prefer the loose oozes into which they may sink when the occasion arises.

Life in the sea is concerned with protection and food getting. If the water is constantly shifting, food may be procured by staying still and letting it come to the hungry one. It is not, however, always easy to stay in one place on a wave-beaten cliff. Make a study of a cliff to see how various creatures maintain their positions. Many of them adopted the stream-line idea ages before automobiles were even imagined. Others, like the sea urchins, dig them-



AT LEFT, THE HERMIT CRAB; AT THE RIGHT, FIDDLER CRAB; BELOW, THE COMMON EDIBLE CRAB



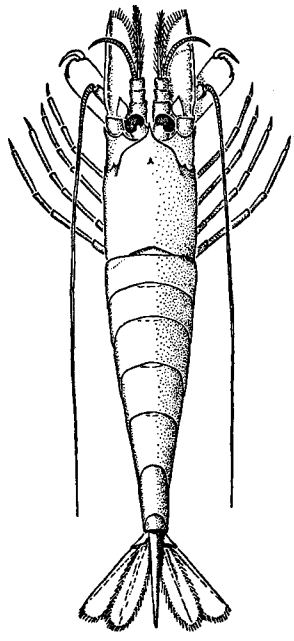


selves little holes in the rocks and sink into them for anchorage.

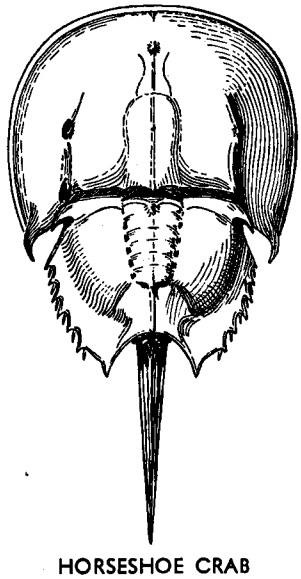
Marine animals provide an almost endless assortment of types of swimming. The crabs move sideways with incredible speed; the scallops flop like butterflies; some forms swim backward, others forward. All are interesting. They may swim by bending their bodies, flipping their tails, waving their antennae or squirting water from inside their outer coverings? Try to find out their methods from your own observations. Free any little marine creature that you may capture in a pail of water and see what it does and how it does it. Those forms that are free-moving may move fast enough to be timed easily, but some forms that bore their way into rocks must be checked from day to day to show progress.

Of course marine creatures often have seasonal movements, just as do the dwellers on the land or in the air. The horseshoe crabs, lobsters, true crabs and certain fishes are possibly the most interesting in this connection. Fishermen who learn about these migrations are generally the most successful in making catches. Unfortunately too much knowledge about these habits by selfish humans may not be good if the supply of marine forms is to be maintained. If fishermen knew less about the movements of lobsters the supply might last longer. On the other hand, if information is used wisely, practices may be established whereby the surplus stock may be harvested without interfering with the breeding stock that maintains the supply. Laws should be based on facts and should be applied wisely to each situation, and there is great seasonal variation in the habits of all living things. Sometimes this is recognized and sometimes it is not.

Most people who have had some experience with small marine animals use caution in handling anything strange to them. They know that they can get stings from some; vicious pinches from others. Some, like the squids, may squirt unpleasant liquids; others may rasp the skin or produce a rash. A foot cut on a coral or pierced by a sea urchin is not pleasant, and a jelly fish or a Portuguese-man-of-war may be a thing of beauty, but, mishandled, not a joy forever.



SHRIMP



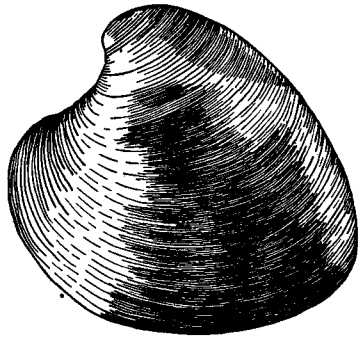
HORSESHOE CRAB

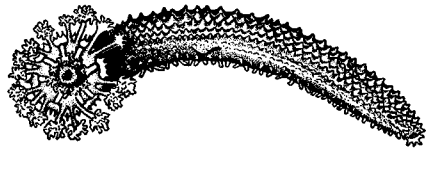
Some marine creatures protect themselves by less violent means. Some need only an opportunity to reproduce. A shipworm, for instance, may lay 2,000,000 eggs, and with this number of offspring the supply may easily be maintained if only a few reach maturity. See how many of the animals listed in these charts use this technique of maintaining their kind on the earth. Fortunately many marine forms have effective protection when they are older and in a fixed position. When they are free-swimming, like the young of oysters, they are in the hands of fate, which decides whether they will become a meal for some larger animal or will grow into an adult capable of perpetuating the species.

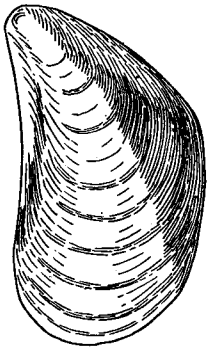
Make your own classifications of the methods used by the small animals of the shore for protection. Do not be too disturbed if you cannot name everything you see. You still have your own senses and can use them for getting information for yourself.

Some people seem to think that other creatures should be made in the image of human beings. Other creatures should have their eyes where we have them. They should breathe as we do and have similar experiences. This, of course, is not the case even though some Nature writers seem to imply that it is.

Sit on a pier over some clear sea water and see if a shadow made by your moving arm makes any difference in the appearance of the animal life under water. Try this wherever you can and if you have some strange creature captive in a pail of water try to find out how he learns of your

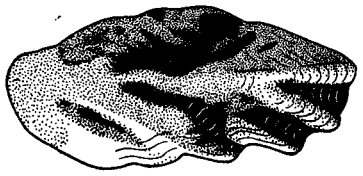






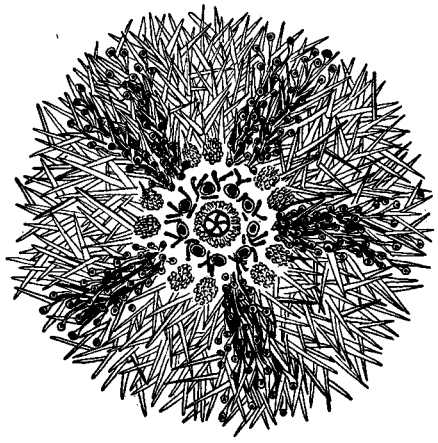
ABOVE, A BARNACLE; AT LEFT, THE COMMON CLAM; BELOW, A SEA CUCUMBER; AT RIGHT, THE COMMON MUSSEL

presence. Can he see you, or does a slight vibration produced by jarring the pail bring quicker results? You might even decide in what part of the captive's body its sense organs are located. If you wish some suggestions on this point read the accompanying charts to find how some of these creatures get acquainted with what is going on in their immediate vicinity.

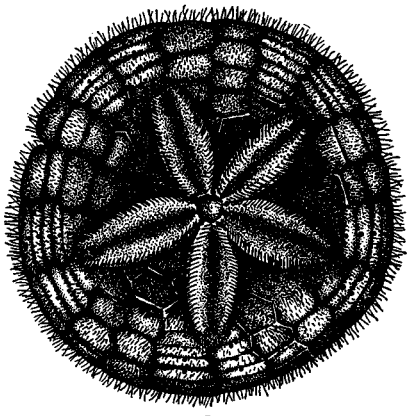


OYSTER

Some of the things to investigate about the sensitivity of captive marine animals might be centered around what they see; what they hear; what they feel; their ability to taste freshness or saltiness in water; their reaction to changes in temperature and the temperature ranges at which they are most active; their reactions when placed in the air; when turned bottom-side up; when put with others of their kind. Common sense should suggest to anyone who would investigate these things how it may be done.

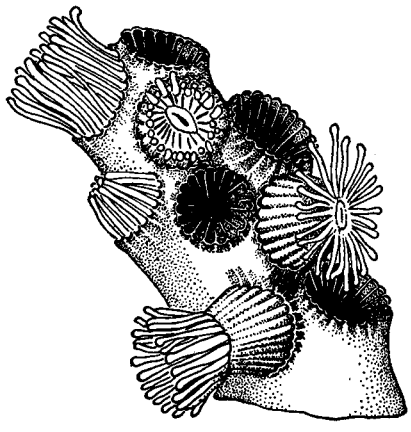


SEA URCHIN



SAND DOLLAR

Even as with us, the getting of food is important to small marine animals. How some do it is obvious; with others it is not easily observable. It should be sufficient for the purposes of this article to suggest those that may be easily demonstrated. Most haunters of the seashores have had the opportunity to watch crabs and their kin feeding. There are few things more interesting, and one regrets that they do not have the ability to express enjoyment of a feast. The fiddler crabs are among the most interesting. The males of these crabs have one of the claws so greatly enlarged that it cannot be used to convey food to the mouth, thus the females can get more food in a given time than their mates. With these crabs the food is largely small plant materials rolled into little balls and eaten where it is collected, or carried into burrows for consumption. How many other marine creatures available for study carry the food to the mouth by claws?



STAR CORAL

A sea squirt brought out of its element begins to expel little streams of water at intervals. This may suggest how it gets its food. The animals live in little colonies, each colony expelling the water through a common opening. The water brought in carries with it micro-organisms that have food value. These are strained out before the water is expelled. How many other seashore animals get their food by drawing in and sending out a stream of water? With some animals this water current is associated only with respiration. With some it is associated with escape, but with many it is the chief device for food-getting. While working with some creature that does use this technique, try to see if it can be made to reverse the direction of the current. Can it, for example, start to take in some liquid; find it unsuitable and expel it through the opening through which it entered?

We cannot here give summaries of the economic angle of marine invertebrate animals. Look through your local state reports to see what the income may be from marine life. Compare this with the income from hay, wheat and other agricultural products. It may surprise you, for example, to know that the financial returns from shellfish in a state like New York, with its small shoreline, is almost equal the returns to the state from growing wheat, and exceeds that gained from growing either barley or buckwheat.

Government projects that are likely to change the flow of water through the different channels to the sea may so change the salinity of the water of different bays and harbors that existing sources of revenue from shellfish may be completely destroyed. This has not always been recognized by the politicians. It is economically important, then, to many people that there be a more general understanding of the needs of these interesting and economically important fellow inhabitants of our earth. Continued pollution of our streams and seashores by the work of industry is a constant menace to such forms of life.

(Continued on last page of insert)

NAME	LOBSTER *Homarus americanus*	BLUE CRAB *Callinectes sapidus*	FIDDLER CRAB *Uca*	HERMIT CRAB *Pagurus*
DESCRIPTION	Length, up to two feet; weight up to or more than 28 pounds, although average weight nearer two pounds. Color, dark green above with darker spots, yellowish beneath. First pair of claws very large and used as pincers. Back part of body jointed to turn under body.	Shell about 2½ times as wide as long; good-sized male, 2½ by 6½ inches; females, smaller, with smaller claws. Apron under male, inverted T; of virgin female, equilateral triangle with concave sides; of fertile female, a plump triangle. Gray or blue-green; red spines.	Shell width, up to one inch; length, 3/5 inch. Color, light brown or purple and dark brown. In male, one claw, usually the right, much larger than other; pincers of female about equal in size. Eye stalks, very long and slender.	Found as occupants of spiral shells; the rear, soft parts protected by the shell, and the claws form a cover over the shell opening. Great variation in the species and in shells occupied. Abdominal appendages of female modified for egg-carrying.
HABITAT	In shallower salt water in summer and in deeper waters in winter. Very young forms swim at surface six to eight weeks.	In shallow salt or brackish water chiefly on mud bottoms near river mouths where vegetation is abundant.	On mud and sand flats, at tidewater in burrows, at low tide on surface.	In shells on sea shore, in deep water, or on land, depending upon species; some live in trees much of their lives.
RANGE	Common along Atlantic coast from Labrador to North Carolina.	From Cape Cod south to east coast of South America, sometimes in fresh water adjacent to salt water.	From Cape Cod to Florida with other species in same area and on Pacific Coast. Generally common, conspicuous.	*P. longicarpus,* small, from Maine to South Carolina; *P. pollicaris,* large, from Maine to Florida, deeper water.
RELATIVES AND LIFE HISTORY	Arthropoda. Decapoda. Family Homaridae. American species, two. A 15-inch female may carry 100,000 1/16-inch eggs under abdomen, 10 to 11 months. Young at surface two months, through five or six moults; go to bottom as one-inch lobsters. Moult about 16 times first year (two to three inches long); by five years, mature, have moulted about 25 times and reached 10-inch length. Eggs at seven years, every other year. Hatch June.	Family Portunidae. Eggs, light orange-yellow to brown; one to five million; in mass carried by female; hatch into free-swimming "zoea", followed by quieter "megalops" which develop into crab forms. Summer hatch transforms by winter. Moult weekly; later, monthly, increasing in each moult about ⅓. Mature, third summer. Adults do not moult, may live four years. Males carry females before final moult. Females mate once.	Arthropoda. Decapoda. Family Ocypodidae. About seven American species; the group, cosmopolitan. Male courts female with fiddler-like motion of huge claws. Young freed into water usually on incoming tide. Free-swimming stages precede transformation to adult forms. Adults find refuge in holes rather than in water.	Arthropoda. Decapoda. Family Paguridae. Some 20 genera and more than 100 species of hermit crabs. Coral-colored eggs, about size of mustard seed, hatch early in year into "zoea", free-swimming stage; followed by symmetrical "glaucothoe" stage that lasts four to five days. This is followed by shell-occupying period. As crab grows, larger shells taken from dead molluscs, or are wrested from less powerful hermit crabs; transfer rapid.
BEHAVIOR	In males, first appendage of abdomen is hooked; in females, normal. Feeds largely on living or dead animal matter; very little plant food. Protected by shell, by ability to fight and to conceal themselves. Most helpless when swimming at the surface as young or just after moulting. Have definite seasonal migrations to and from deep water, influenced by temperature and age.	Crawl or swim along bottom. See fairly well. Food, dead animal matter. Eat each other if crowded. Defend selves by escape and by claws. Enemies, fish, also barnacles and bryozoans, which clog respiratory system. Males vigorously defend virgin females from rivals; may carry mates two days before mating and two days while mating. Females may produce two lots of eggs a summer the first several weeks after mating.	Small, pugnacious crabs, found in great droves. Food mostly small, plant materials rolled into pellets, often carried into burrow for use. Females use both claws in food-getting; males, the smaller only. Run sidewise, the males commonly holding larger claw in a threatening attitude when frightened. Obviously able to sense vibration in the soil. May make noise as they bump each other.	Great fighters, readily attacking and killing own kind but retiring to protection of shell in presence of more powerful enemy. Corals, sea anemones, and other animals frequently find resting places on the shells. Walking done by second and third pairs of legs, the first pair being used in fighting and in food-getting. Walk surprisingly fast.
SENSITIVITY	Sensitive to light, to pressure, to chemical nature of water. Use antennae as sense organs. Prefer water temperature about 55°F. Individual may range 12 miles in three days; dig holes into which they retreat tail first; young transparent.	In summer, live close to shore; in winter, in deeper water; larger males favor deeper water. Soft-shelled, newly moulted forms hide. Build no permanent homes. Swimming movement so rapid animals appear like a flash. Run sidewise.	Build burrows ¾-inch in diameter and two or more feet deep. In retreat, males pull large claw in last, emerge large claw first. *U. minax* found farther from sea than others, in fresher water. *U. pugilator* favors sand or mud near high water.	Interesting to experiment with these animals to detect their ability to recognize position, disturbance, light, and other factors; highly sensitive to certain stimuli such as light, touch, and water-pressure.
USE TO MAN	Probably our most valuable crustacean. In past, more than 100,000,000 captured yearly, worth between one and two million dollars. Useful also as scavengers and as food for valuable food fish.	Valuable as scavengers and as food for man. Caught in nets or on lines baited with dead animal matter. Sold fresh, or cooked and canned. Provide some sport and, for many persons, a meager livelihood. Value, one-half million yearly.	Of some value as food for enemies such as birds and fishes; may burrow through dikes and cause damage; serve essentially as scavengers but are always interesting to watch.	Serve as scavengers, as food for fishes and other animals, and as means of locomotion for animals that live on the shells; one sea anemone consumes shell of host crab and provides direct protection for the crab.

SHRIMP *Crago septemspinosus*	HORSHOE CRAB *Limulus polyphemus*	BARNACLES	SCALLOP *Pecten irradians*	CLAM, QUAHOG *Venus mercenaria*
Length, two inches. Second pair antennae, long. Claws on second pair of leg-like structures back of mouth, with pincers. In Palaemonidae first two pairs with pincers and in Peneidae, pincers on first three pairs. Color, light with dark markings. Sexes, separate.	Crab-like animals up to 20 inches long with slender tail and broad, flat fore-part consisting of abdomen and broader fore-section. Relatively flat; males, much smaller than females. Two large separated eyes, and smaller pair close together.	Goose barnacles, or ship barnacles, with a five-pieced shell protecting feet and body and borne at end of stalk ½ to one foot long. Rock barnacles, Balanidae, stalkless with six-pierced shell joined by thinner shells to enclose soft body. Sexes usually not distinct.	Two shells, one flatter than the other, with straight hinges without teeth. About 20 radiating ribs on shell and abundant lines of growth. Up to a foot across, commonly much smaller. Edges of mantle may stick out of shell, with 30 to 40 bright blue eyes.	Up to 5½x4½x3 inches. Dirty white with prominent, eccentric ridges on each shell. Inner surface of shell dull white with the lower margin purple or violet. Shell margin, slightly uneven; hinge, with three spreading teeth in each valve. Sexes distinct.
Sand shrimp found commonly on and in sand at low-water mark and in shallow water below low-tide mark on to 300 feet.	In shallow sea-water or along shore in sand at breeding time; below low-water mark unless washed up by storm.	Ship barnacles on ships, piers, and logs under sea water. Rock barnacles on rocks, common between high- and low-tide marks.	In shallow salt-water bays where bottom is covered with sand or seaweed, on mud flats, or to hundreds of feet deep.	Common on sandy and muddy sea-bottoms from tide levels to 50 feet under the sea. Commonest in shallow bays.
This species from Labrador to South Carolina, in Europe, and on the Pacific Coast. Others replace it on other shores.	Along Atlantic Coast from Maine to Mexico with related species along eastern coast of Asia.	Ship barnacles world-wide in distribution, particularly abundant in tropics. Rock barnacles also cosmopolitan.	Nova Scotia to Texas, though most common in eastern Long Island Sound. Closely-related species range world-wide.	On coast from Nova Scotia to Yucatan; most common from Cape Cod to South Carolina. Other species extend range.
Arthropoda. Decapoda. Family Cragonidae. Eight American species. About 17 families of shrimps and prawns include several hundred species. Young of this group spend some earlier stages in eggs; this not true of all shrimps. Some from South go through four larval stages, "nauplii", "protozoea", "zoea", and "mysis", these being passed in egg in some forms.	Arthropoda. Arachnoidea. One genus with five species. Mate in early summer when large females come to shore bearing one or more smaller males each hanging to tail of animal ahead. Eggs laid in sand in hole made by female, fertilized by males and left for waves to cover; hatch, mid-summer. Young crabs, which may cover beach, finally make way to sea and disappear until well-grown; young lack spine-like tail.	Arthropoda. Order Cirripedia. Families Lepadidae and Balanidae. About 30 species of ship barnacles and 75 of rock barnacles. Crustaceans. Eggs carried outside fold of skin beneath shell. Young, free-swimming animals in "nauplius" stage; swim near surface; moult to two-shelled "cypris" stage, and swim about with butterfly-like motion; finally fasten to support for rest of life, and shed swimming legs.	Mollusca. Pelecypoda. Family Pectinidae. Breed in early summer and grow so rapidly that by winter may reach a length of one inch. After a free-swimming stage, which develops from the fertilized egg, attach themselves to submerged objects by stems secreted by glands in the feet. Here they develop to from one to one one-half inches across. Then take up a roaming life. Live about four years.	Mollusca. Pelecypoda. Family Veneridae. Several hundred species. Very small eggs expelled into the water by female; hatch, after fertilization, in about 10 hours into shell-less free-swimming stage, which lasts a day; shell-forming stage of six to 12 days follows. Settle to bottom and remain attached until one-half inch long; adults burrow. May live four to five years, lengthening about one inch a year.
Breathe by gills, which are hidden in the sides. Swim by flexing the abdomen, which ends with a tail fan and has swimmerets beneath to help in swimming and in carrying eggs. Walking done by legs of the middle part of the body. Head and thorax joined. Food captured by means of pincers as in crayfish, lobsters and crabs.	Walk with four pairs of forward feet, swim with hind feet, and burrow with help of shell. When moulting, shell splits on front edge. Not particularly aggressive animals. Animals are midway between the crabs and the spiders, with some characters of each. Survivors of a group of animals once abundant on earth but now represented largely by fossils. Burrow freely in sand and mud seeking small animals for food.	Animal lies on back inside shell and, with legs extended from shell, forces stream of food-bearing water to mouth; movement of legs shows clock-like regularity. When feeding, a mass of barnacles takes on a different appearance because of presence of moving legs.	Adults move by flapping the shells, which produces a zig-zag motion something like the flight of some kinds of butterflies. A single flap of the shell is accompanied by a jet of water and may move animal several feet. Food, minute forms of life taken in with the water that is used in breathing. Have rather definite seasonal migration. Are somewhat gregarious.	Wide, muscular, white foot permits burrowing in sand or mud. Water, carrying food, enters through short, blunt, yellow "siphon". Water leaves through opening nearest shell hinge. Food, microscopic or minute materials collected on gills and forced to mouth by cilia. Undesirable material rejected in outgoing water. Withdraw into shells when disturbed.
Some able to change color to match surroundings. Most are sensitive to disturbance and to light changes. Vary in amount of care given young by mother. Hide when disturbed. *Penaeus setiferus* in New York and southward.	Air-breathing animals even though they live in the sea. Rarely found above high water mark or in fresh waters. Protected largely by back covering and position close to sea bottom, or by being partly buried in bottom.	Highly sensitive to jar, particularly the rock barnacle. Some species live on whales, some in dogfish, and others in various unique places. In some, males are small animals without mouths or intestines, which live within the female.	Eyes, which border the mantle, often glow and provide power of sight; scallop takes fright at a mere passing shadow. Between the eyes are delicate feelers which are sensitive to disturbance. Close shells quickly when alarmed.	Highly sensitive to touch, to chemical nature of environment, and to mechanical disturbance. Soft bodies of some species not completely covered by hard shells. Soft-shelled clam lives in burrow.
Shrimp industry of great importance, particularly on Gulf Coast, Pacific Coast, and along Atlantic Coast of Southern States. Animals provide basic food for large numbers of food fish whose value is great; also valuable as bait.	Considered by some to be good food, but more commonly fed to hogs and chickens or used as fertilizer; not generally considered of economic importance in spite of their size.	Some species, food for fish; some, food for man. Ship barnacles, by covering ship bottoms and delaying swift movement, cause much expense to ship owners; do little actual damage to ship.	Muscles eaten by man. Basis for industry of several hundred thousand dollars. Captured by dredging but abundance varies greatly. Shell basis of art designs; in middle ages, one species had religious significance.	Quahogs worth more than $200,000 annually; soft-shelled clams more than twice as much. Shells of quahogs used by Indians in making wampum; blue portion most valuable.

NAME	OYSTER *Ostrea virginica*	MUSSEL *Mytilus edulis*	STAR CORAL *Astrongia danae*	SAND DOLLAR *Echinarachnius parma*
DESCRIPTION	Length, up to 18 inches; more usually, four to five inches. Two shells; upper, usually flat, and lower more convex; attached to bottom by left shell. Exposed shell very irregular, thick, or in folded layers. No foot present in adult. Sexes distinct, or both in an individual.	Length, to four inches; width, one-third length. Shells, about equal; pointed at front; round, behind; smooth; violet to dark brown, pearly within with violet margins. Attachment, a fibrous "byssus" belonging to cylindrical, grooved foot. Gills, rows of filaments.	Expanded polyps, one-eighth-inch wide, three-eighths-inch high, becoming practically invisible when contracted. White, glassy, translucent, and with 18 to 24 white-speckled, knob-ended, long, tapering stinging tentacles. Skeleton, like crowded, six-sided cups.	Flattened discs, more or less circular, less than three inches in diameter, covered with minute spines and bearing what appears to be a five-parted flower-marking in the center. Mouth, in center. Color, purple to grayish. Sexes, distinct.
HABITAT	In shallow brackish water, commonly on hard bottoms, and more commonly at or near mouths of rivers.	In sand or mud attached to rock or to each other between the tide lines or in shallow salt or brackish water.	Form crusts on shells or stones in shallow sea water. Few kinds found deeper than 300 feet.	In the sea, from tide marks to great depths, usually on sandy bottoms. Often washed up on beach after a storm.
RANGE	From Gulf of Mexico to the Gulf of St. Lawrence and introduced on the Pacific Coast, where it has become established.	Around the world, generally north of San Francisco and North Carolina. Common in European waters.	This species, Cape Cod to Florida. Other species of corals in most of the warmer seas of the world.	Common on the Atlantic Coast north of New Jersey and on Pacific, south to Puget Sound. Others extend range.
RELATIVES AND LIFE HISTORY	Mollusca. Pelecypoda. Family Ostreidae. At least three species. Females produce about 9,000,000 1/500-inch eggs. Fertilized eggs hatch in about five hours into free-swimming creatures. At 32 hours, shells appear; in six days, shells enclose soft parts; in three weeks, shells may become fixed as "spat" (still microscopic); growth more rapid, one-quarter-inch across in 10 days, two inches in 82 ideal days.	Mollusca. Pelecypoda. Family Mytilidae. Several hundred species in the family; species vary in size, color, and edibility. Sexes, distinct and sex glands distributed through the animal. Tiny, yellowish eggs found almost anywhere, as in foot, gills, or other parts. A California species may lay 100,000 eggs yearly, these developing to three and one-half-inch animals in a year.	Coelentrata. Anthozoa. Family Astraeidae. American species of genus, four. More than 1000 stony corals in world and more than 2000 corals of all kinds. Like sea anemones, which deposit lime between sections of barrel-like base. Reproduce by dividing, by buds, or by eggs that develop into free-swimming larvae which soon start a new colony.	Echinodermata. Echinoidea. Family Scutellidae. One of the sea urchins. 20 species in the family. Eggs and sperms thrown into seawater by parents, and fertilization takes place. After a larval stage known as the "pluteus," the young assume the form of the adults. In this species, intestinal opening on the margin.
BEHAVIOR	Sexually mature when two years old. In this species, males and females distinct, though not distinguishable externally. Food, minute plant and animal matter drawn in with water used in breathing. Waving hairs on gills cause water current. Heart, in freshly opened oyster, appears as delicate bulb, beating close to the inner side of great muscle which closes shells.	Move about by means of glue-like threads put out at will. Often tip of mantle protrudes from separated shells. This attracts fish that may come too close, and be captured by the closing shells. Food minute organisms in the water. Shells snap shut quickly when animal is disturbed. Those unable to close shells should not be eaten by man.	Colony tends to form as a crust on stones, shells and the like. Sensitive creatures whose moving tentacles force animal food towards gullet or paralyze prey. Can reduce size, withdraw into stony base, and in various ways injure small enemies. Stream of water forced in and out provides food, waste-disposal and oxygen. Direction of stream may be changed by waving cilia.	Slow-moving animals, usually partly buried in sand or on edge with the mouth downward. Sand is taken in with the help of spines and from this the food, minute plants and animals, is selected and digested. Spiny covering and lack of any considerable fleshy portion provide some protection. Closely resemble fossil species.
SENSITIVITY	Sensitive to heat, to chemical nature of water, to touch and either to sound or to vibration. Close at a noise. Sanitary practices demand that water reaching commercially harvested oysters be unpolluted.	Sensitive to touch and to amount of salt in water. Find protection from many enemies through shell and position in mud, sand or on wave-beaten rocks.	Sensitive to disturbance of environment and to chemical nature of potential food. Corals of the large-colony type in part responsible for the building of great land areas, and also for dangerous submarine reefs.	Able to recognize whether right side up. Can turn over on a sandy bottom but not on a hard surface. Moving spines resemble waving grain. Hardy, and may be kept in salt-water aquaria.
USE TO MAN	Most valuable shellfish, with an annual market value of over $16,000,000. Rarely contain pearls. Often shelter small, soft-bodied, female oyster crabs, *Pinnotheres ostreum*, males of which are free-swimming and hard-shelled.	This species used for food and in France and other parts of Europe has long been cultivated with profit. Mussels are sold in markets on east coast and west coast of America. Have a unique color when cooked. Commonly used in chowders.	Rôle in forming lime deposits makes significance of corals tremendous and not limited to seashore. Fossil corals of world-wide distribution. Their presence in a geologic formation may indicate clear, relatively shallow seas when deposited.	The skin and spines, ground and mixed with water, make an indelible ink.

SEA URCHIN *Arbacia punctulata*	STARFISH *Asterias forbesi*	BRITTLE STARFISH *Ophioderma brevispinum*
Body up to one and three-quarter inches through, protected by a skeleton (test) of lime plates under skin; covered with stout spines up to three-quarter-inch long arranged on five broad areas separated by narrow areas. Mouth underneath, five white teeth.	Usually five arms radiating from central disc. Width, up to six inches or more. Color, greenish black; usually small orange plate near base of two arms. Upper surface with coarse spines; below, rows of tube feet for walking. Mouth, beneath. Sexes, generally separate.	Central disc, five-sided, thin, about one-half-inch across with five slender arms each about one and one-half to two and one-half inches long, extending from corners; green or brownish gray. Arms appear segmented, tips often broken. Disc, rough. Sexes, separate.
On sea-bottom from tide marks to 700 feet, on sandy or rocky bottoms, also in depressions in rocks.	From seashore to a depth of 180 feet. Ordinarily common. Larger in northern Pacific species.	From the shore to depths of 700 or more feet; more abundant in the deeper waters, where it crawls over bottom.
This species from Cape Cod to Yucatan, with other species making sea urchins world-wide in distribution.	Atlantic Coast from Maine to the Gulf of Mexico with other species extending range in east and in the Pacific.	From Cape Cod south, with other species extending range on coasts of Europe, Pacific Ocean, and tropics.
Echinodermata. Echinoidea. Family Arbacidae. Some 500 different living sea urchins known and some 2000 fossil forms. Eggs expelled from five pores near summit of body, develop into clear larvae with reddish spots and eight rods. Swim for several weeks, then in a few hours, change into minute sea urchins about size of pin-head and settle to bottom.	Echinodermata. Asteroidea. Family Asteridae. About 1000 living species known. When broken in two, reproduce new individuals by regenerating parts. Eggs laid in water in late June hatch into transparent larvae that swim at surface; feed on minute animals until about one-third-inch long; in a few hours, take starfish form and settle to the bottom. May reach two and one-half-inch size in a year and breed.	Echinodermata. Ophiuroidea. Family Ophiodermatidae. Some seven families. More than 1000 species. Egg sacs, each with two openings, in pairs on lower side of disc between arms. Water circulates through egg sac, possibly to supply oxygen. Eggs freed from sacs when fertilized become free-swimming forms, "pluteus", which transform into adult form and settle down for life on bottom.
Mouth provided with five teeth and strong muscles which grind the animal and vegetable food. Teeth grow constantly as worn down. Teeth and jaw parts, called "Aristotle's lantern," often found on shore. Sand taken in with food may be ground fine before being freed into sea at opening at top of animal. Spines movable. Five double rows of sucker-bearing tube feet.	Young eat as many as 50 young clams in six days and destroy useful sea forms throughout life. Pull prey from bottom and if cannot open shells of prey completely, thrust digestive parts into opening. A large starfish may exert a pull of two and one-half pounds on shells of a clam which it wishes to open. Move by tube feet on under side of arms. Can regenerate some parts.	Rather active animals with snake-like motion and appearance, causing name "snake-skin stars", or "serpent stars". The name "brittle star" refers to tendency to break into parts. Lost parts are easily restored. The closely related basket starfish walks on tips of branches of arms.
Some have poisonous spines. The soft parts often decay, leaving the flattened, sphere-like "tests," minus the spines, on the beach. Some cover selves with vegetation for added protection.	Can right self if placed on back. Sensitive to light, disturbance and chemical nature of environment. Red eye-spot at tip of each arm; no other special sense organs. Water enters through orange plate on upper surface.	No eyespots evident on the arms, but the retreating action due to a passing shadow proves light sensitivity. Also sensitive to pressure and to chemical nature of water.
Internal parts, principally eggs, which may number 20,000,000 per individual in some species, are used as food, particularly in southern Europe. Marseilles fish market handles 100,000 dozen yearly.	Destroy millions of dollars worth of shellfish on coasts of America alone. One of the greatest enemies of oysters and clams. Fishermen who formerly cut starfish to pieces to kill them were only increasing them as each part became a new animal.	Interesting to collect because of difficulty in obtaining perfect specimens. Fossil starfish found in Devonian and Silurian rocks connect common starfish and "brittle stars".

ACKNOWLEDGMENT

This article is a modification of a similar one by the author published in the *Cornell Rural School Leaflet.* Appreciation is expressed to the New York State College of Agriculture at Cornell University for permission to make these modifications. The author has had first hand experience on most of the important beaches of the Atlantic and Pacific coasts of the United States and in Hawaii and Jamaica. These personal experiences have been supplemented by the use of standard publications on the subject. In the present case the more useful of these are included in the following list.

The Sea-beach at Ebb Tide, by Augusta Foote Arnold. D. Appleton-Century Company, New York City. 1901.

Sea-shore Life, by Alfred Goldsborough Mayer. The A. S. Barnes Company, New York City. 1916.

List of Marine Molluscs of the Atlantic Coast from Labrador to Texas, by Charles W. Johnson. Proceedings of the Boston Society of Natural History, vol. 40, no. 1, pages 1-204. 1934.

A Manual of the Common Invertebrate Animals Exclusive of the Insects, by Henry Sherring Pratt. P. Blakiston's Sons and Co., Philadelphia, Pennsylvania. 1935.

Parade of the Animal Kingdom, by Robert Hegner. The Macmillan Company, New York City. 1935.

The Tide, by H. A. Marmer. D. Appleton-Century Company, New York City. 1926.

The Sea, by H. A. Marmer. D. Appleton-Century Company, New York City. 1930.

The Book of the Seashore, by Howard J. Shannon. Doubleday, Doran and Company, Garden City, N. Y., 1935.

The Wealth of the Sea, by Donald K. Tressler. The Century Co., New York and London, 1927.

Seashore Animals of the Pacific Coast, by Myrtle Elizabeth Johnson and Harry James Snook. The Macmillan Company, New York City. 1935.

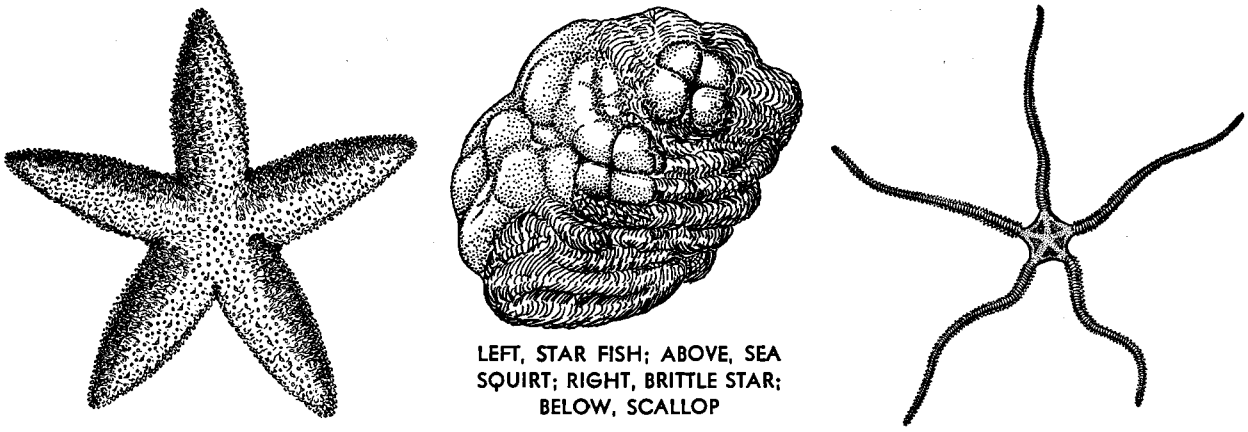
The Shell Book, by Julia Ellen Rogers. Doubleday, Doran and Company, Garden City, New York. 1908.

Florida Sea-Shells, by Bertha D. E. Aldrich and Ethel Snyder. Houghton Mifflin Company, Boston, Massachusetts. 1936.

Handbook for Shell Collectors, by Walter Freeman Webb. Published by the author, Rochester, New York. 1936.

Oyster Biology and Oyster Culture, by J. H. Orton. Edward Arnold and Co., London.

What Shell is That?, by Percy A. Morris. D. Appleton-Century Company, New York, London, 1939.

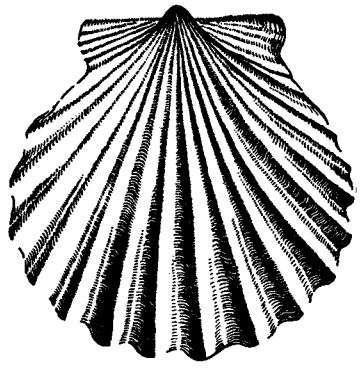


LEFT, STAR FISH; ABOVE, SEA SQUIRT; RIGHT, BRITTLE STAR; BELOW, SCALLOP

(Continued from third page of insert)

THE HISTORIC ANGLE

Seas and the life in and near them have left long and interesting histories that those who wish may read. Sediments originating in inflowing fresh-water rivers or on wave-beaten coasts are constantly settling on the sea-bottoms. These sediment deposits have been built quickly in some places and slowly in others. They may be of great depth or shallow. In general, the heavier sediments have settled near the shore lines and the lighter ones at points more distant from the place of disturbance. Often near the shores the sediments in suspension are sufficient to cut off the light that otherwise would penetrate deeply into the sea. Consequently, life that demands light has been unable to survive in the roiled waters. The relative effect varies, of course, with different kinds of marine life. The presence of a living coral in a present-day sea at considerable depth is almost conclusive proof that the waters above are relatively clear. Observations of this sort are tremendously important if we wish to interpret the conditions in which ancient sediments were laid down.



Within the year, the writer spent a number of days combing an ancient seashore in central Arkansas. Oysters were found with shells near a foot and one half long. Some of these oyster shells had been drilled by other molluscs whose remains were found associated in great abundance. Barnacles still clung to the outer surfaces of the shells of the oysters. Other small forms of marine life left their records of the past, just as they are now doing on any coast. The essential differences are that many of the creatures whose remains we found on that shore are not living today. The most interesting of these was one bone of a whale, the only one of its kind ever to have been recorded from this far north, or in the State of Arkansas. This was found by another member of the party, but was equally appreciated by all.

The story of these ancient seas and how they have carved this and other continents will be told in a later insert in this series, but, meanwhile, our readers would do well to examine whatever local rocks appear to have been laid down as sediments. How many of these contain the remains of plants or animals? Do these resemble modern plants and animals of the sea, or are they like those of the land? Are the sediments coarse or fine and how do they resemble those now being laid down in local waterways?

Of course, as sediments are laid down in the seas they add weight to that particular locality. At the same time, there is less weight pressing down at the places where these sediments were broken free by the wind or water. This must mean a great variation of pressure at different points on the earth's surface. This variation may easily lead to some change in the elevation of the surface, although such change would probably be the result of a combination of forces rather than just this one.

With these seas varying in depth through the ages, some may have become separated from the greater bodies of water. On occasion some of these dried up, leaving minerals of different kinds deposited on their bottoms. Great salt beds have been laid down in this way in the past, and are still being formed under suitable conditions. Then, too, these shifts in the elevation of different points of the earth's surface have produced important changes in the local weather, and these changes have so changed the soils in different places as to affect the success of agriculture as now carried on. Thus it is seen that what went on in these ancient seas is of more than academic interest to us today.

The future of civilization of course depends greatly on man's ability to understand and master the seas. Political and economic isolation is important but possibly results of more importance may arise from harnessing the forces of the tides, or in utilizing the great variation in the temperature of different parts of the sea. Wisely used, the sea can solve many of the fundamental food needs of man and it is obvious that we have only begun to understand its real possibilities. It offers one of the widest fields now available for research and discovery.