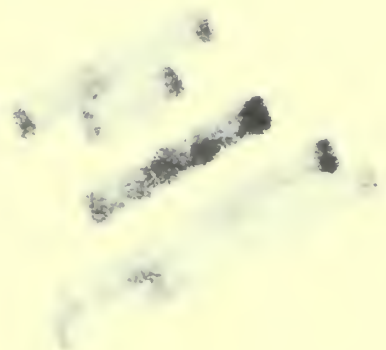
Exploring the Olympic SEASHORE



Exploring The Olympic SEASHORE

Text and Illustrations by
S. Forrest Blau
for the National Park Service

Cover by
Keith L. Hoofnagle

Introduction

Exploring the Olympic seashore can be an exciting adventure. This booklet tells of intertidal marine life along the 80 km (50 mi) coastal strip of Olympic National Park, the tides, the offshore islands and a little about the Ozette Village Archaeological Site. There is a rich variety of animal and plant life along the seashore of which I have included a few common and interesting forms. To help you explore them systematically, plants and animals are organized according to the zones in which they live. You will find the zone map on pages 8 and 9. The marine life is drawn to natural size unless noted otherwise.

You'll see many plants and animals not included here which you'll enjoy. Perhaps later you will want to read more about intertidal life and its interaction. For those interested in further readings in marine biology I suggest the following books: *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago* by E. N. Kozloff, and *Between Pacific Tides* by E. W. Ricketts, and J. Calvin, revised by J. W. Hedgepeth.

Be on the lookout for the Bald Eagle, our national symbol, and for offshore pods of whales. Above all, enjoy the beautiful Olympic seashore. I do.

S. Forrest Blau

Acknowledgements

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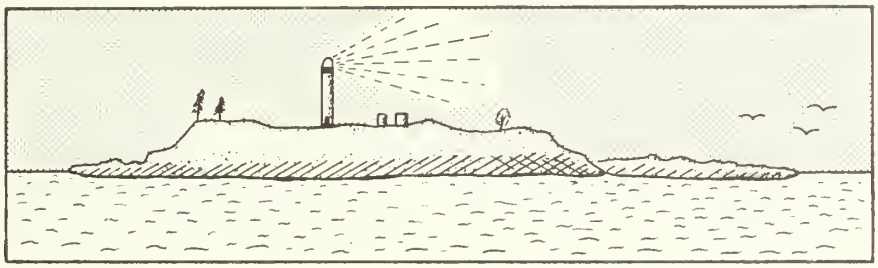
I want to express thanks to my friends at Olympic National Park and the Ozette Village Archaeological Site, who helped make my stays there enjoyable and memorable, and to all who offered suggestions and assisted in editing the manuscript. Chief among these were the following: James Richardson and John Douglass of the National Park Service and from the University of Washington, Seattle, Shirley A. Scott, Drs. Grant Sharpe, David Manuwal, and Eugene Kozloff (the last three composed my Masters Committee). A special word of thanks goes to Phyllis Wood for her guidance in my art work.

Offshore Islands



Destruction Island

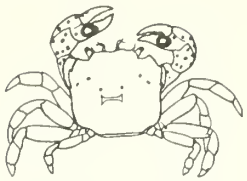
Unbelievable as it seems, all the Olympic Peninsula was once deep ocean floor millions of years ago! To form this peninsula (including the Olympic Mountains) fantastic geologic forces had to move, fold, fracture and uplift a portion of that ocean floor. Thousands of years ago the islands that today are off Washington's coast were part of the mainland. The coast has been worn away by water erosion, leaving these islands and smaller, columnar rocks called *seastacks*. These islands and seastacks (except James and Tatoosh Islands) now compose Washington Islands National Wildlife Refuge. They are important nesting grounds for many sea birds and hauling-out places for seals. The largest island off the outer coast of Washington and Oregon is Destruction Island which is part of the refuge. It is located between Kalaloch and the Hoh River at 5.6 km (3½ mi) offshore.

Ozette Island

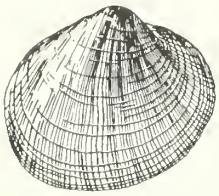
The westernmost point in the continental United States (excluding Alaska) is Cape Alava. The Ozette Indians, part of the Makah Nation, inhabited Cape Alava for several thousand years, until the early 1930's. Ozette Island, just offshore from Cape Alava, was named after these Indians. They sometimes traveled to the island to hunt deer and to collect California mussels. To date, the excavation of several Ozette long houses at Cape Alava buried by a mudslide about 500 years ago has revealed the most complete cultural record ever found of Northwest Coast Indians. Daily tours of the Ozette Village Archaeological Site at Capa Alava offer more information about the Ozettes. A low tide will expose the large tidal zone separating Ozette Island from Cape Alava. The gradually sloping, rocky reef offers a fascinating area to explore, where you can walk a long distance out, finding along the way many of the organisms described in this booklet. It is not possible to walk to Ozette Island because of a deep channel near the island. *Watch the Tide. Avoid Being Cut Off.*

Conservation and Good Manners

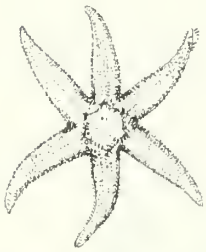
The coastal strip of Olympic National Park is the largest wilderness coast in the contiguous 48 states. We can all help to preserve this rare, beautiful place if we follow a few simple guidelines.



Always Replace Rocks in Their Original Positions. This re-establishes the natural home of organisms living on or under each part of the rock. Explore rocks gently so that plants or animals underneath or nearby will not be crushed. Remember that it can take nature a long time to correct our mistakes.



Fill in Holes If You Dig for Clams. Piles of sand or gravel left by clam diggers can smother many small clams and other animals whose burrows are covered. In compliance with the Washington State regulations which govern clam digging on these beaches, all razor clams dug must be included in the clam diggers catch and cannot legally be returned to the beach. When you dig any other clam species, those not used should be placed near the surface of the original hole after filling most of it in. Then spread the remaining sand and gravel evenly over the top. All clams with broken shells must be kept. Please ask a Park Ranger for full information about the regulations for taking edible seafood.



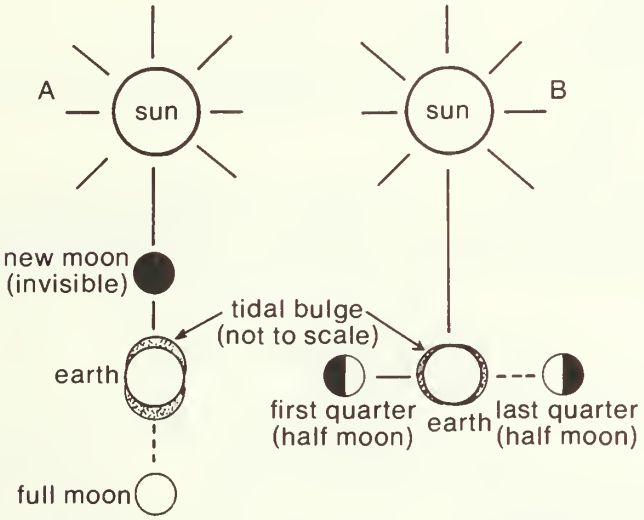
Leave Animals Not Meant for Food at the Seashore. Most seashore animals will not survive at your home and you can learn a great deal by observing them in their own habitat.

Pack Out Your Garbage. Plastic items and cans take many years to decompose and some plastic is poisonous if burned. Buried trash will be unearthed by skunks, raccoons, or bears and sometimes these animals may be harmed when attempting to extract food from cans. Consider packing out the litter of others if you have room. It makes sense to keep the park clean and natural.

Remember that Pets Are Not Allowed on Trails in Olympic National Park.

Tides

Tides are caused by the gravitational pull of the moon and sun on the earth's oceans. The moon's pull is about twice as powerful as that of the sun, because the moon is much closer to the earth. Ocean water facing the moon bulges slightly toward the moon and we call this increase of water level at its peak high tide. Curiously, the ocean on the other side of the earth also makes a bulge, so that there are two regions of high tide on earth at any given moment. In between the two high tides are the regions from which water is drawn to make them. The areas where the water level is lowest are known as low tide.

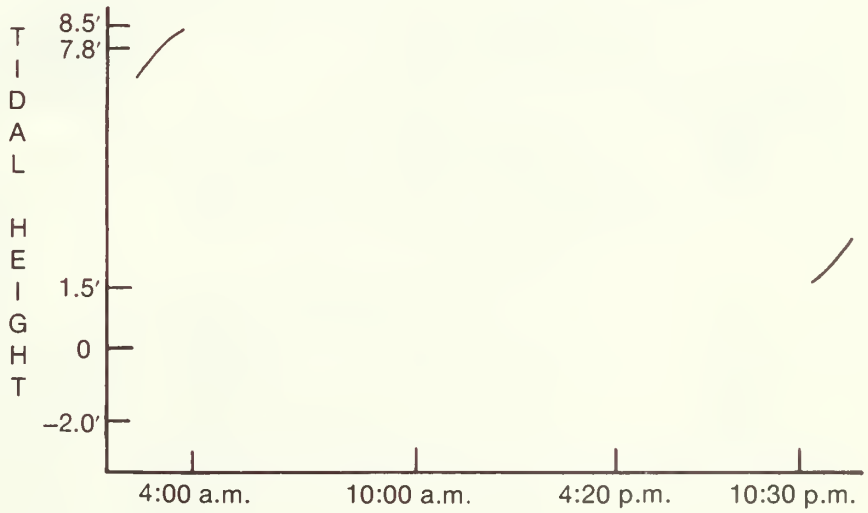


A. When sun, moon and earth are all in line, the pulling forces of sun and moon are combined, causing higher and lower tides than usual. This happens twice a month when the moon is either full or new. We call these *spring tides*.
B. The pulling forces of the moon and sun oppose each other when they form a right angle with the earth, minimizing the tidal bulge. At these times the tides are called *neap tides*. They happen twice a month when the moon is in its first or last quarter. Then, the smallest or least tidal height range is produced.

If you wish to learn the tidal pattern along the outer coasts of Washington, Oregon and California, use the sample tide table given to make dots where the tidal height corresponds with the time. Using the curve of lines already drawn in the graph, connect the 4 dots you have made.

TIDE TABLE

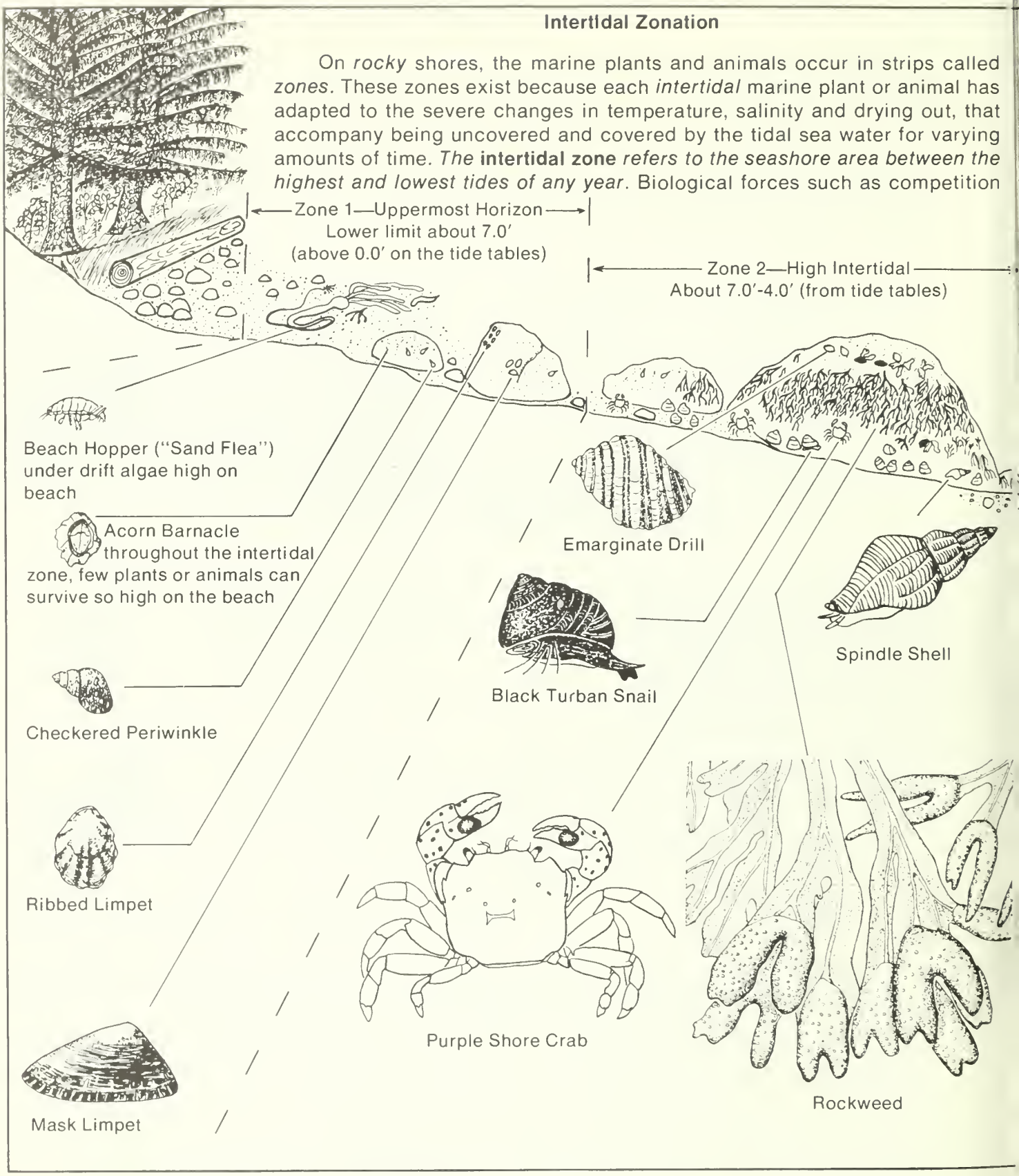
High Tides	
Time	Feet
4:00 a.m.	8.5
4:20 p.m.	7.8
Low Tides	
10:00 a.m.	-2.0
10:30 p.m.	1.5



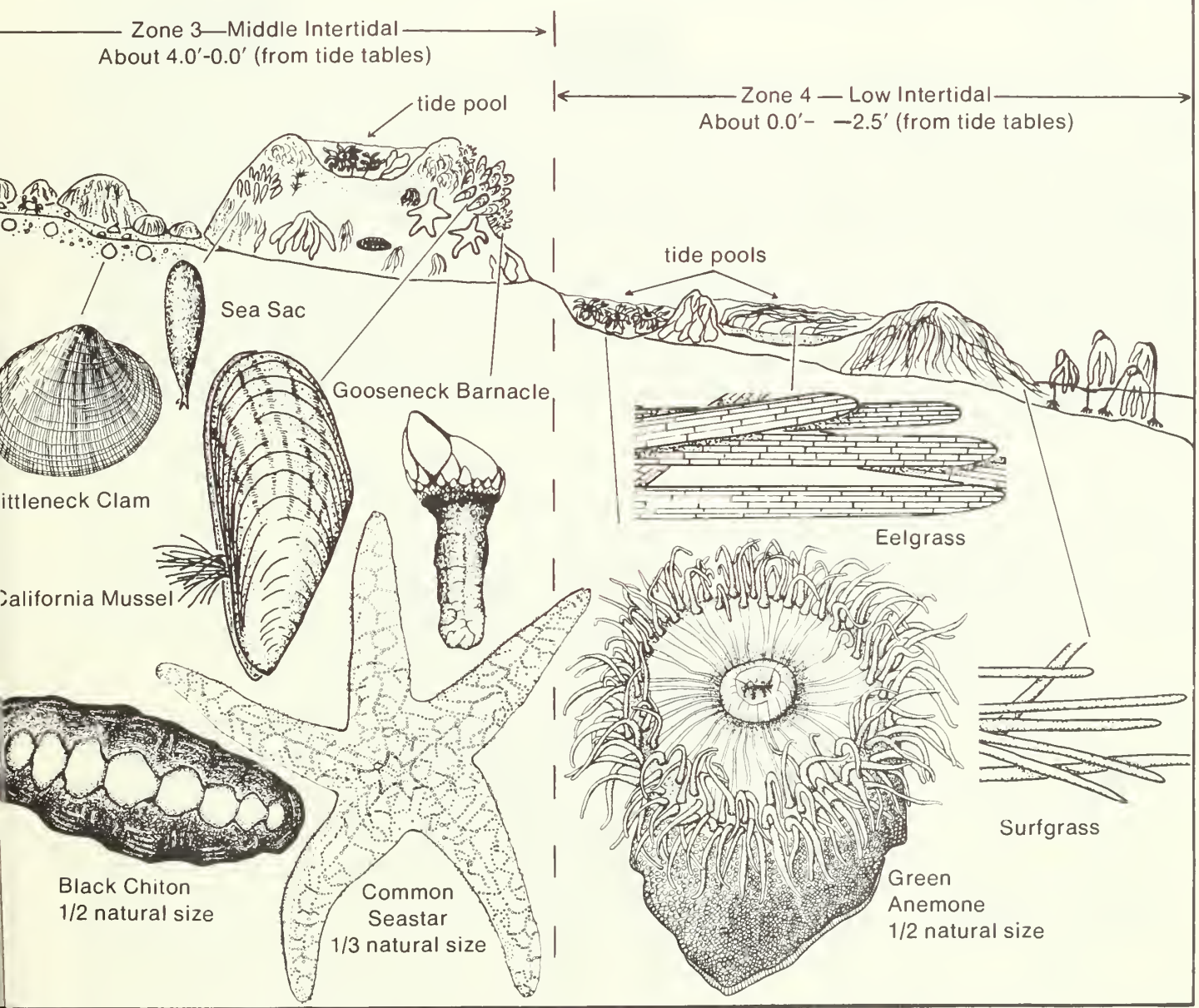
Because tides are controlled by the *lunar* day (24 hours and 50 minutes), you can see that the tidal patterns consists of 2 unequal high and low tides each day. The higher of the 2 high tides is followed by the lower of the 2 low tides. The same pattern exists throughout the year, although the tidal heights change daily. Learning to read tide tables is a valuable skill. You will find printed tide tables at many public places on the coast that will give you good approximate times of high and low tides for any particular day. In spring and summer low tides are the best times in which to search tide pools, dig clams or hike the coast. In contrast winter is the time to be most cautious. Deaths have occurred on the beach during the winter due to the combined action of powerful surf and high tides. Avoid floating logs because they too can cause fatal accidents.

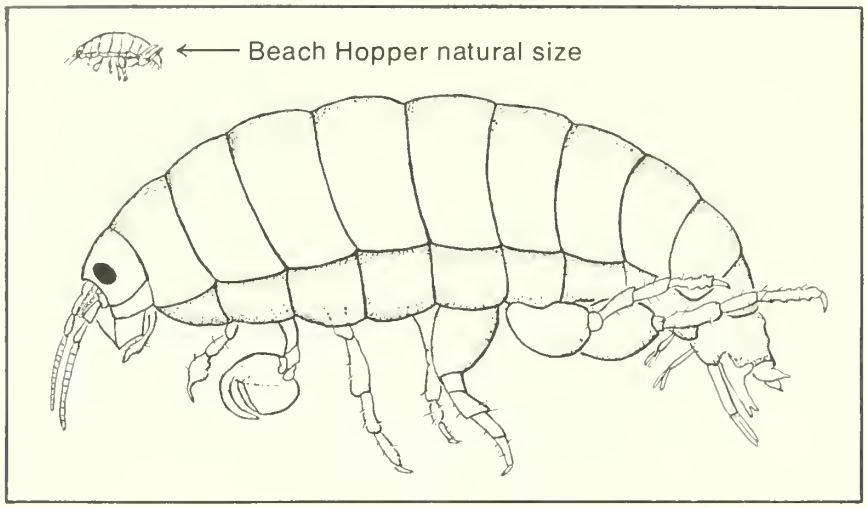
Intertidal Zonation

On *rocky* shores, the marine plants and animals occur in strips called *zones.* These zones exist because each *intertidal* marine plant or animal has adapted to the severe changes in temperature, salinity and drying out, that accompany being uncovered and covered by the tidal sea water for varying amounts of time. *The* **intertidal zone** *refers to the seashore area between the highest and lowest tides of any year.* Biological forces such as competition



and predation help define these zones. For example, if a black turban snail *(Tegula funebralis),* numerous and typical in zone 2, migrates into the area of the common seastar *(Pisaster ochraceus),* typical of zone 3, it stands a good chance of being eaten by the seastar. Therefore you will find fewer black turban snails in zone 3 than in zone 2 (there are other reasons, too). Zones 1-4 are filled with many more plants and animals than are shown here, but those shown in the drawings and others discussed in this booklet, will help you determine which zone you are exploring. Many organisms can live in more than one zone, such as the acorn barnacle *(Balanus glandula),* so a zone is recognized by groupings of certain plants and animals and not by the location of any one organism. *Tide pools* are pockets of water remaining when the tide goes out. Tide pools as well as channels and cracks in rocks enable some plants and animals to live in higher zones than they would be able to otherwise. The daily physical changes occurring in the intertidal zone are some of the most extreme anywhere on earth!



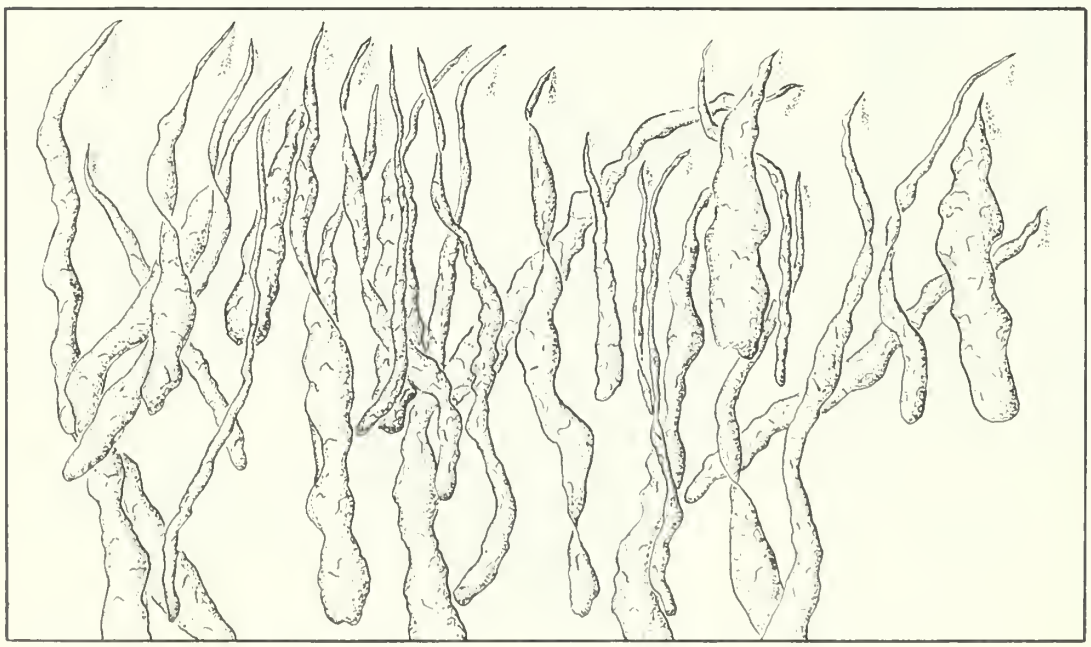


Beach Hopper ("Sand Flea")
10 times natural size

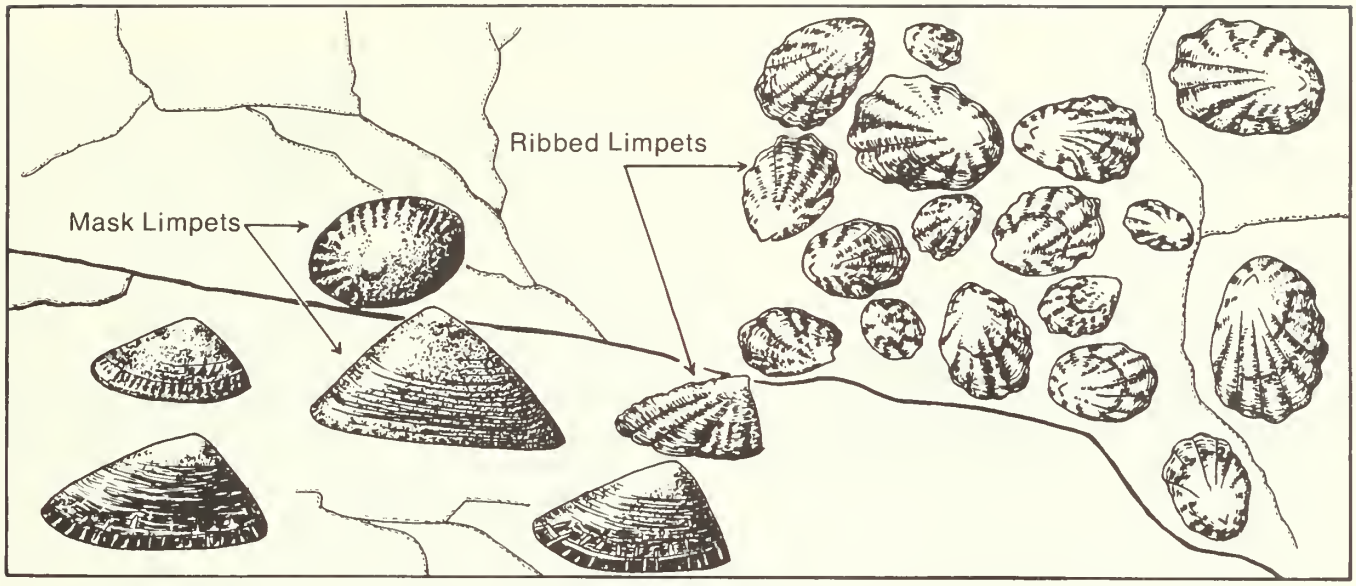
Beach hoppers are amphipods having 14 legs. Amphipods are related to crabs, shrimp and barnacles, however, their bodies are flattened side to side (or laterally) and have at least two different types of legs. Beach hoppers' first two legs on each side are modified for grasping: the last five for walking and jumping. They are often mistakenly called "sand fleas" but, unlike fleas, their primary food is algae. Perhaps their ability to jump great distances relative to their size causes people to think fleas and beach hoppers are closely related.

Beach hoppers' *(Orchestia traskiana)* will be found under piles of decomposing drift algae high on the beach, sometimes by the thousands! Crows, sandpipers and other birds feed on them.

Algae are thought to be the first plants from which all other plants evolved. Without them the animal life of the ocean could not be sustained. The word alga is derived from Latin, meaning "seaweed." Its plural is *algae* (not "algas") and is pronounced "Al-gee." In the intertidal zone the algae large enough to be seen with the naked eye are classified as *green, red,* or *brown,* based on their pigments. The green algae are always some shade of green, and the brown algae are brown; but the red algae are not only all shades of red including pink and magenta, they can appear olive, brown or nearly black. Green intestine *(Enteromorpha intestinalis)* is an interesting alga that often grows where there is an influx of fresh water, in pools at the uppermost portion of the intertidal zone, or at the base of shady cliffs. Its color and twisted, hollow, sacklike appearance make its name very appropriate.



Green Intestine
(a green alga)

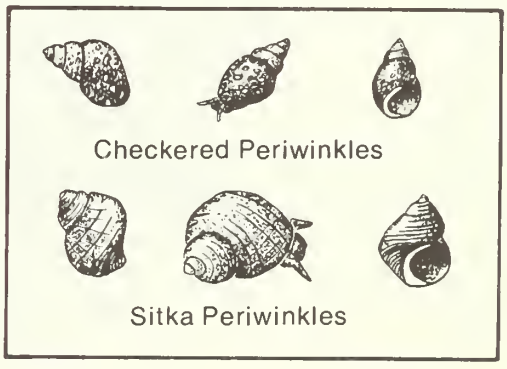


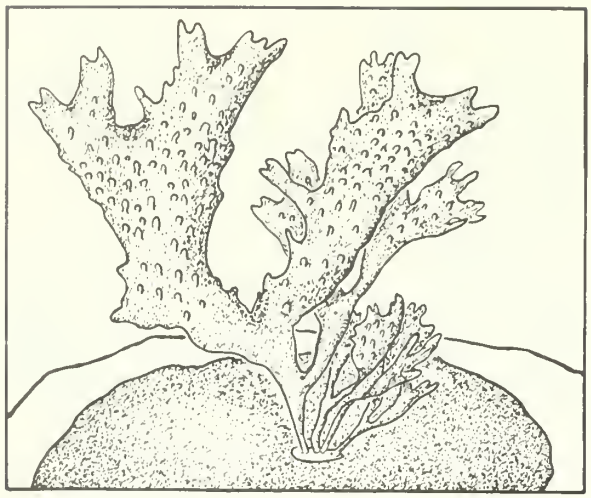
Limpets are marine snails with a conical shell under which is a broad foot used for movements. There are several different kinds of limpets in the intertidal zone. Two examples are the mask limpets *(Notoacmea persona)* and the ribbed limpets *(Collisella digitalis).* When not covered by sea water a limpet seldom moves, using its muscular foot to clamp down on a rock surface. If you want to examine the animal's foot, head and tentacles, care must be taken to quickly lift the animal off the rock with your fingers. If you simply disturb it, the snail will clamp down so tightly that when you pry it off, you may break the shell which may result in the limpet's death. Be sure to replace the animal gently.

Ribbed limpets, with their strongly ribbed, wavy-margined shells prefer vertical or overhanging surfaces. Sometimes in the same vicinity, but usually lower in the tide zone, one finds the mask limpets. These smooth, olive-shelled snails prefer the undersides of boulders or moist crevices. For food, ribbed and mask limpets scrape microscopic algae from "bare" rocks. Many of these algae are single-celled *diatoms.*

Although they can occur lower in the intertidal zone, both the mask limpets and the oldest and largest ribbed limpets are most commonly seen clustered in the upper portions of zone 1, in areas affected by the higher tides and ocean spray. Because of their choice to live so high above water, some limpets become very dry and die; but by producing a mucus sheet between their shell margin and the rock surface, or inhabiting moist, sun-shaded areas, they may avoid the fate.

In most marine snails, including limpets, there is a pair of toothed ribbons called a *radula* which serves as a food-getting tongue. Limpets, periwinkles and turban snails all use their radula to scrape algae. Occurring in zone 1 are the checkered periwinkle *(Littorina scutulata)* and Sitka periwinkle *(Littorina sitkana)* which eat mostly microscopic diatoms. These periwinkles also occur among barnacles and rockweed in zone 2. The checkered periwinkle is able to live in drier and more exposed areas than the Sitka periwinkle and thus is more common.

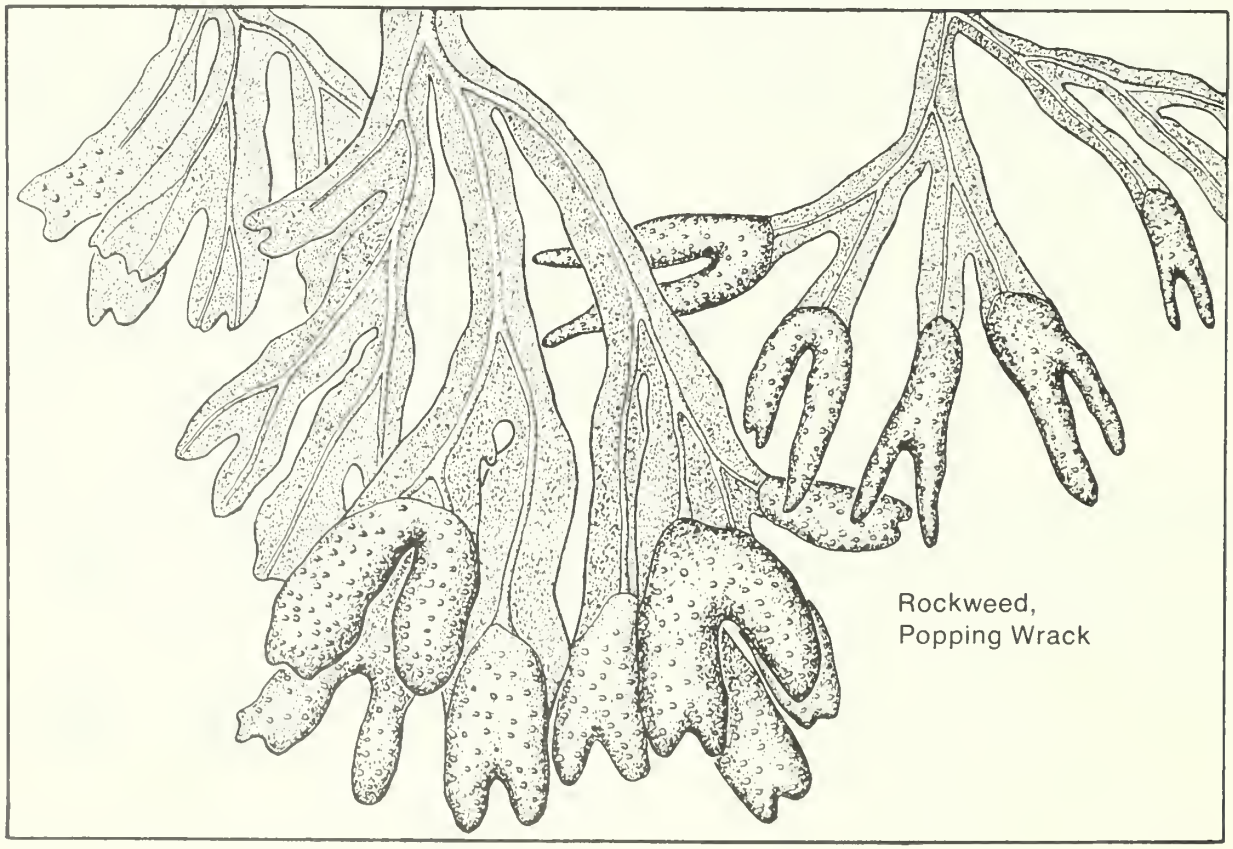




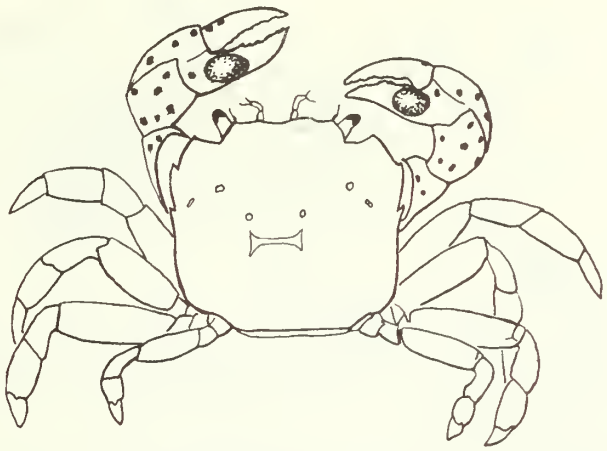
Grapestone and Tar Spot

Algae are different from the flowering plants because they are much simplier in structure and they do not produce seeds. Until a few years ago it was not known that the red algae, grapestone *(Gigartina papillata)* and tar spot *(Petrocelis franciscana)* are forms of the same plant because both the shiny, black tar spot, and the dark, blackish-red grapestone seem to grow spontaneously. When conditions are right, grapestones will grow out of tar spot, although botanists are unsure why this happens. Both are commonly found above rockweed, but they also can intermingle, or be found below rockweed into zone 3.

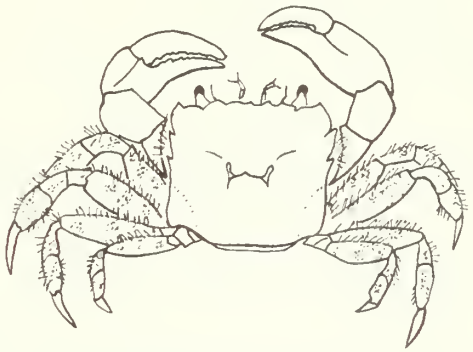
Rockweed *(Fucus* spp.) is the most abundant and easily seen brown alga of the protected outer coast, from just north of the Hoh Head to the mouth of the Ozette River. The swollen tips of mature rockweed are called *receptacles,* and the little bumps on them house reproductive structures. Stepping on these receptacles produces noisy "pops" giving rockweed its alternative name, "popping wrack." Since rockweed like most algae is very slippery, *do not run or move quickly in the intertidal zone.* Should you lose your footing sharp barnacles may cut you and a soaking is usually unpleasant.



Rockweed,
Popping Wrack

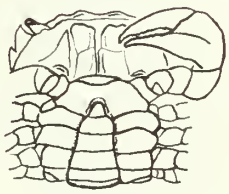


Purple Shore Crab

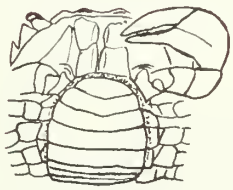


Green Shore Crab

The purple shore crab *(Hemigrapsus nudus)* often reaches great numbers in zone 2 where loose rock abounds in sizes from cobbles to boulders, and where there is an abundance of shoreline drift algae. Sometimes where the loose rocks overlie muddy sand you can find the smaller green shore crab *(Hemigrapsus oregonensis)* although on the Olympic seashore they are much less common than the purple type. Both occur in zone 3 in lesser numbers. Though both are variable in color, the top side of the purple shore crab is generally dark reddish or purplish with *characteristic purple spots on the pincers.* The green shore crab is generally grayish-green with rust mottling. Its legs are *characteristically hairy*. There is a rounded patch of soft hairs on the inside pincers of males of both shore crabs (shown above on the purple shore crab). Both crabs are *omnivores,* feeding on either living or dead plants and animals. They are a food source for certain fish, birds and mammals.

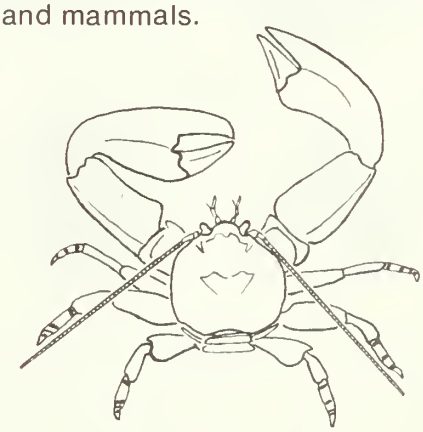


Male



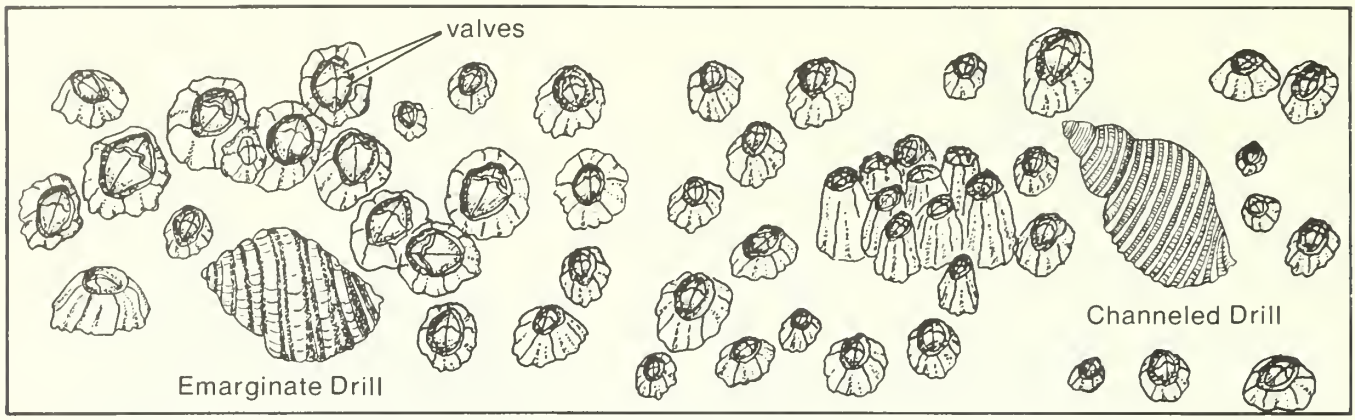
Female

If you turn over either kind of shore crab (or other crabs, too) you will be able to tell whether it is a male or female, by the width of the abdomen. The male's abdomen is narrower—about 1/3 the width of the female's.



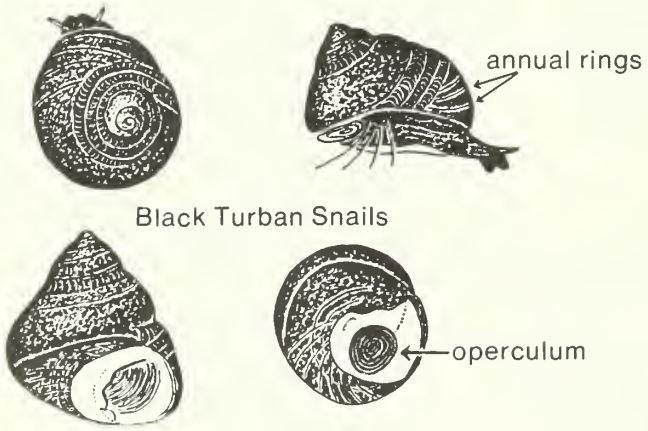
Porcelain Crab

The small, flat, brick red porcelain crab *(Petrolisthes cinctipes)* can also be found under rocks in zones 2 and 3 as well as in mussel beds. It will voluntarily cast off a limb (autotomize) if handled carelessly, as do some other crabs.

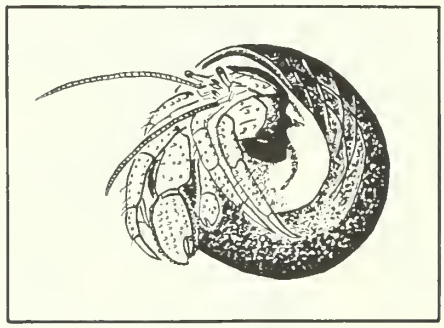


Acorn Barnacles and Drills

Acorn barnacles *(Balanus glandula)* are the most common barnacles in the intertidal zone from Alaska to Baja California. They live throughout the intertidal zone, but often do not exist in great numbers except on rocks in zones 1 and 2, due mainly to *predatory* (animal eating) snails called emarginate drills *(Nucella emarginata)* and channeled drills *(Nucella canaliculata).* These drills eat most of the acorn barnacles except in the part of zone 2 where the drills can no longer live without drying out. Drills bore holes through the shells of barnacles and mussels by alternately using their radula and a shell softening chemical. Then they inject a muscle relaxant into their *prey* (the animal to be eaten) so that the valves open, allowing the snail to reach its food.



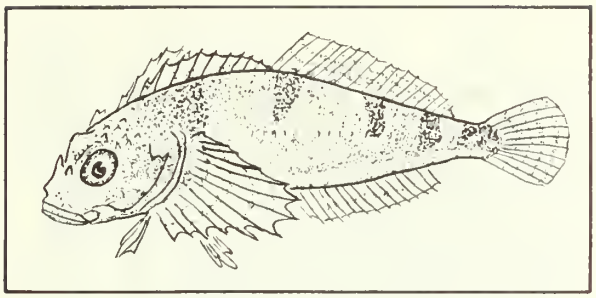
Black Turban Snails



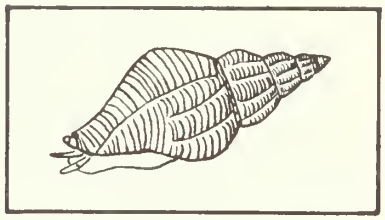
Hermit Crab 2 times natural size

Black turban snails *(Tegula funebralis)* live only in the intertidal zone. They are most numerous in protected pebbly or rocky situations in zones 2 and 3, locally from Toleak Point northward. They are *herbivores* (plant eaters) feeding on diatoms, visible attached algae, and subtidal drift algae. These snails produce annual rings so that age estimates can be made. Some of the oldest black turban snails are about 30 years old. These snails, drills and many other marine snails have an *operculum,* a plate, which serves as a door when the snail is withdrawn into its shell, helping it keep out fresh water, some predators, and to resist drying out.

The empty shells of many different marine snails become occupied by hermit crabs (*Pagurus* spp.) each of which needs a separate shell for protection. Two hermit crabs are often seen fighting over a preferred shell which one is "wearing," with the winner getting the "better" shell.



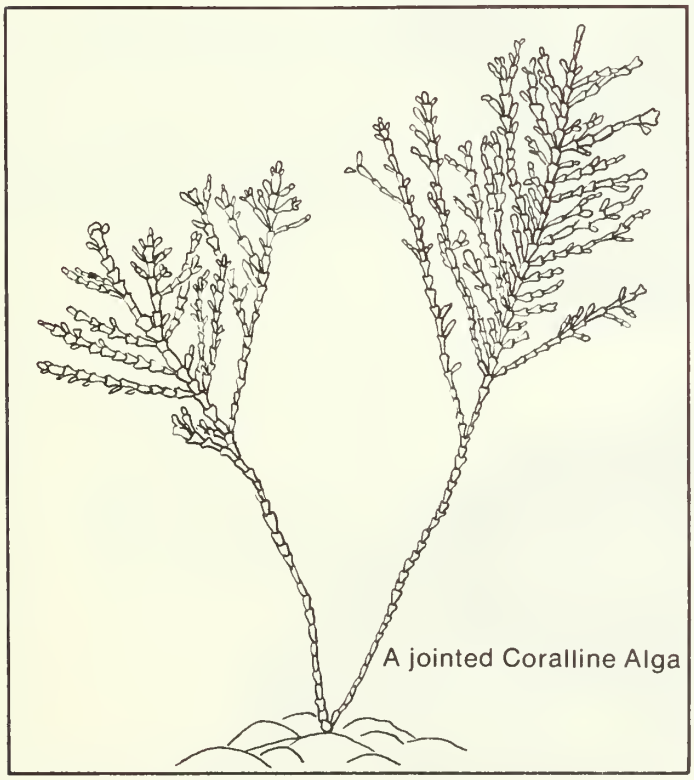
Tidepool Sculpin



Spindle Shell

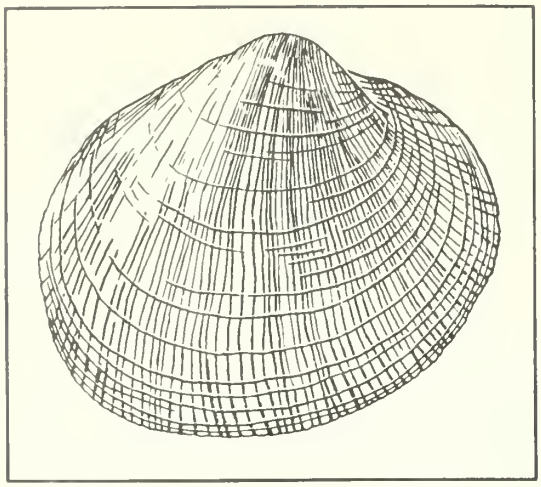
The tidepool sculpin *(Oligocottus maculosus)* is abundant in the upper portion of zone 2 and the spindle shell *(Searlesia dira)* is common in the lower portion of that zone. Sometimes they both can be seen in the same tide pool. When part or all of the intertidal zone is covered by water, many kinds of small fish come into it to feed. There are several kinds of small fish with large heads and bodies tapering toward their tails which are permanent residents of the intertidal zone: these are *sculpins.* Tidepool sculpins can be seen making quick jerks or "hops" with the use of their fanlike side fins on the bottom of tide pools. By this method they can quickly hide by blending in with their surroundings, making it difficult for you to find them again.

The gray colored spindle shells use a siphonlike tube located above their heads to find animal food. They scavage on weakened or dead animals, but sometimes they take live prey. The spindle shell is a *carnivore,* only eating the flesh of animals including barnacles, periwinkles and black turban snails. Those spindle shells which are as large or larger than the one shown above are probably 10-15 years old.

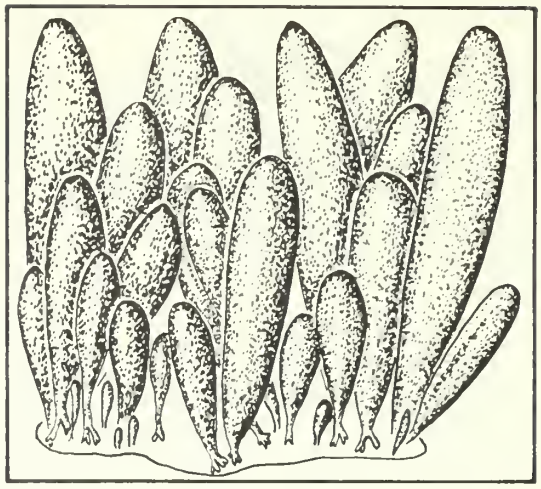


A jointed Coralline Alga

Coralline algae form and maintain tropical reefs and atolls. Other species of these algae are found at the Olympic seashore. Shells and coralline algae, like limestone, are composed primarily of calcium carbonate. The coralline red algae consist of two basic groups: *erect* and *jointed* types, and nodular, closely adhering, mostly flattened, *encrusting* forms. Living coralline algae are an unmistakable shade of pink, but after death, they become white. When present in the beach drift, the dead jointed ones are easily spotted. The jointed type shown here *(Corallina officinalis)* is regularly present in zone 4. Large encrusting, and smaller jointed forms are typical of tide pools in zone 2 and 3. Many pink-coated rocks in these zones owe their color to encrusting coralline algae.



Littleneck Clam,
Steamer Clam

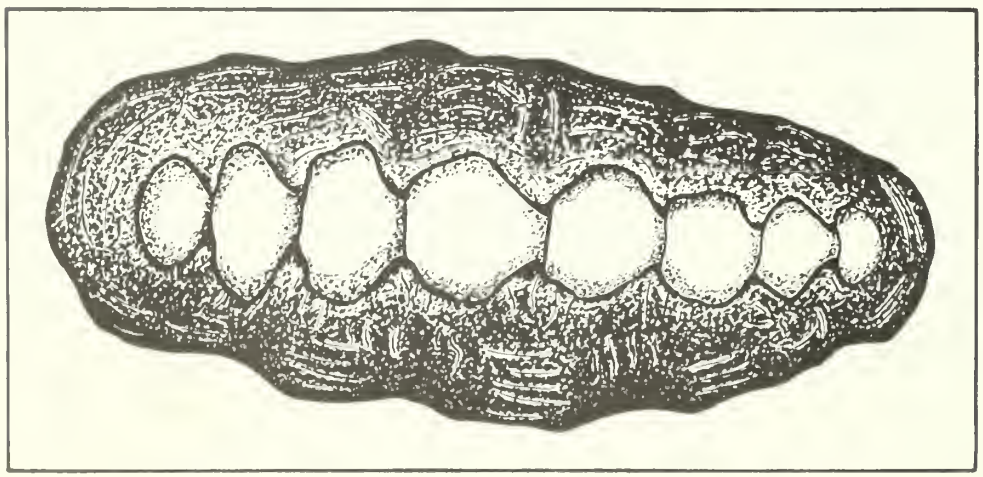


Sea Sac

Three regular members of zone 3 are the native littleneck clam *(Protothaca staminea),* sea sac *(Halosaccion glandiforme),* and the black chiton *(Katharina tunicata).* The native littleneck clam or "steamer" has two tan shells or *valves,* each with a partial, filelike inner rim. The littleneck clam prefers to live in bottoms composed of gravel mixed with mud or sand, just below the surface. All clams, mussels, and oysters have two valves and are called bivalves. If you dig for clams, remember to *fill the holes* you've dug and obey the regulations of the Washington State Department of Fisheries. *All Pacific Ocean beaches are closed to clamming and mussel collection from April 1–October 31 each year due to the possibility of paralytic shellfish poisoning.* (The season for razor clams is different, and is closed July 1–September 30). People can contract paralytic shellfish poisoning by eating bivalves which have consumed large amounts of a tiny toxic organism. The disease can cause paralysis and even death.

The red alga, sea sac, that clusters on rocks is often found just below, or partially mixed in with rockweed. Grapestone is likely to be in the vicinity also. Sea sac is yellowish-brown or brownish-red. It is hollow, but filled with water, and when it is squeezed, water squirts through little holes in several directions.

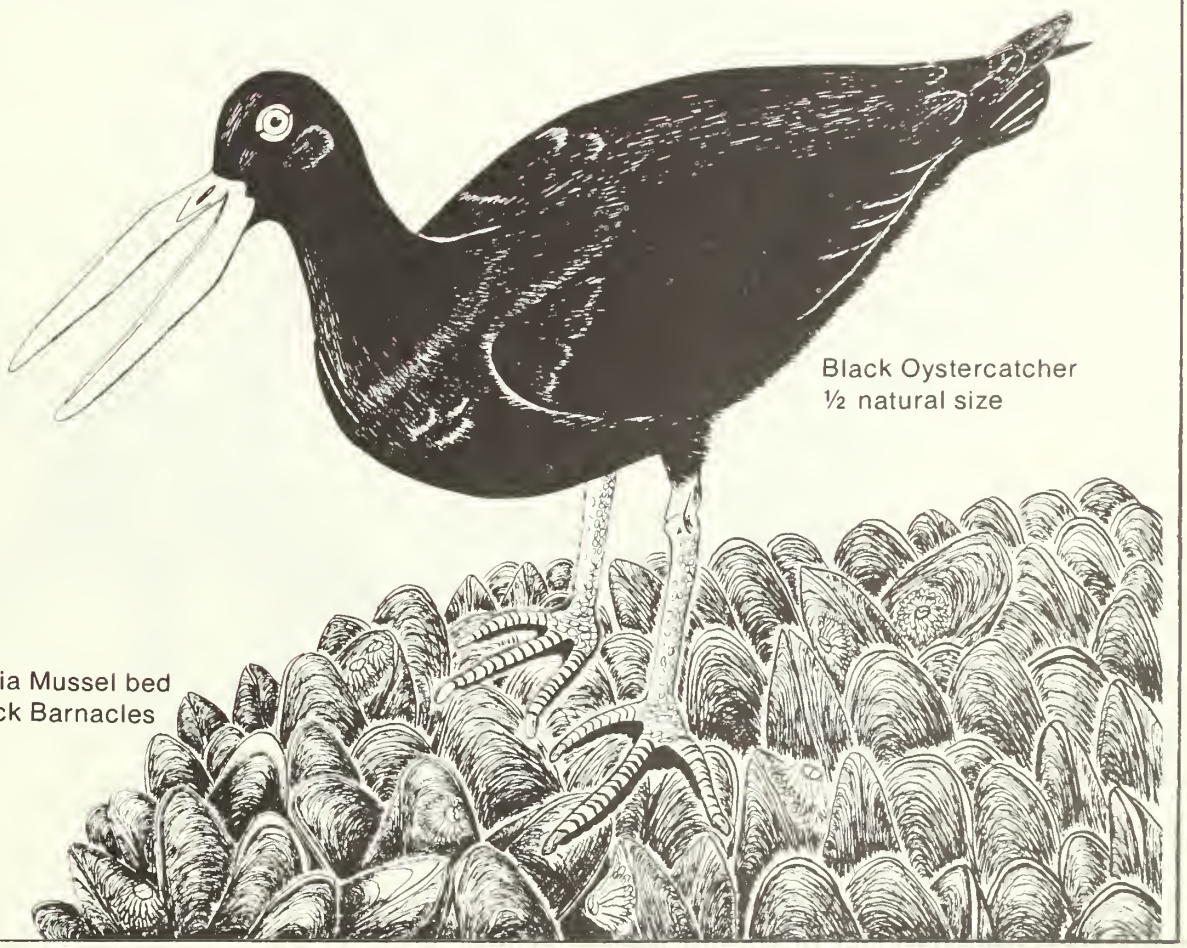
The black chiton has a long, tough body with 8 overlapping shell plates. It's a herbivore that scrapes algae off rocks with a radula which owes its hardness to iron compounds. (Limpets also have iron in their radulae). This chiton often can be found in wave-swept areas below mussel beds.



Black Chiton

The black oystercatcher *(Hameatopus bachmani)* is a large, black shorebird with a red bill and pink legs. They will often see you first and emit their high, piercing call which will help you spot them. When resting they often stand on one leg or lie flat on their bellies, hiding their bright bills under a wing. When the tide is high they cannot feed, but when the tide is low they fan out along the intertidal zone to feed. The food of the black oystercatcher consists of mussels, limpets, gooseneck barnacles, and to a lesser extent, chitons and marine worms. It does not eat oysters. At high tide in the spring and summer they congregate in small groups on beaches or rocks, whereas in winter during high tide they can be seen in flocks of 30 or more. Unlike most shorebirds which are migratory, black oystercatchers are year-round residents.

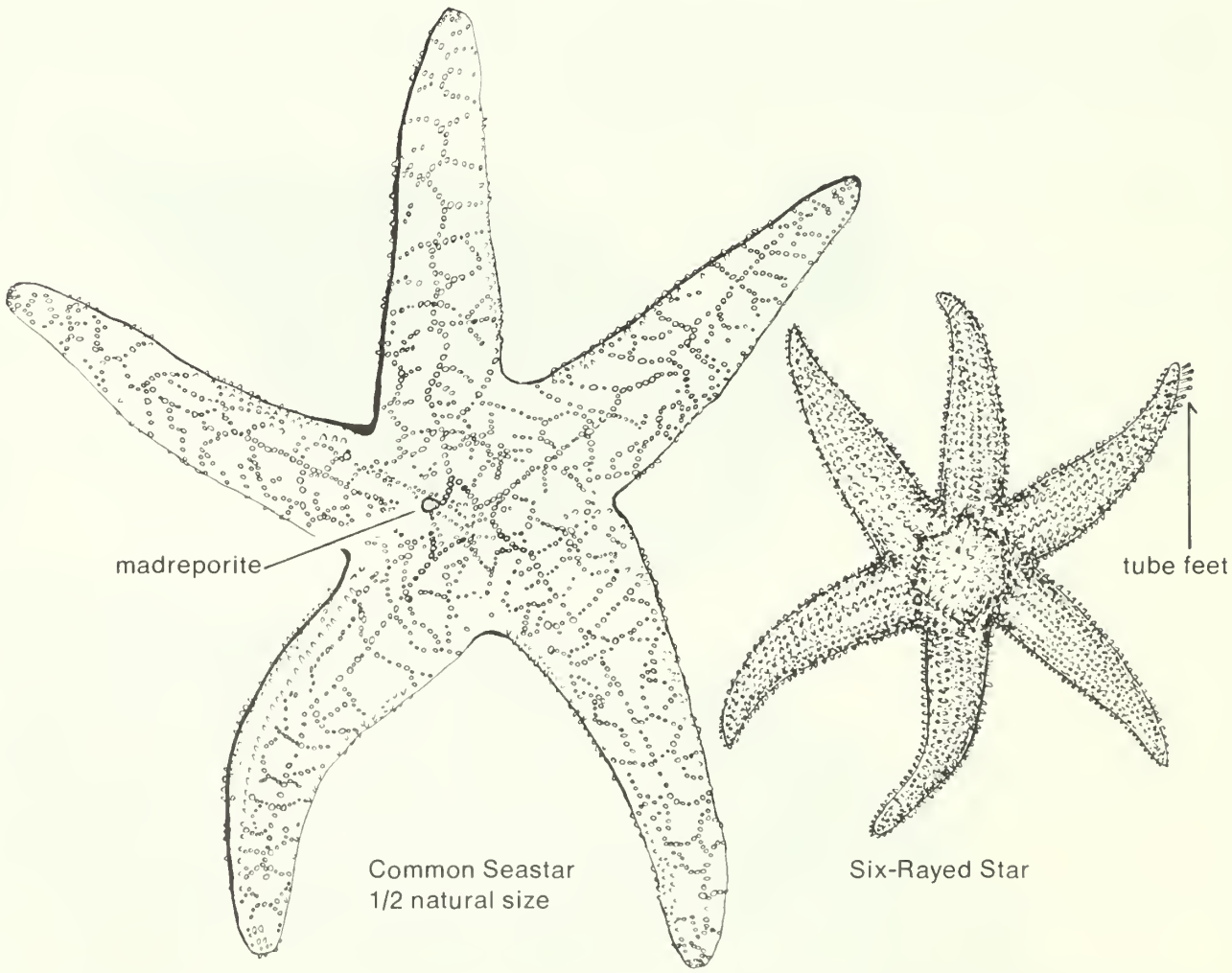
The California mussel *(Mytilus californianus)* forms sizeable patches or bands in favorable surf-swept areas, frequently in zones 2 and 3, ranging the Pacific coast from Alaska to Baja California. The well defined, lower intertidal limit of these mussel beds is caused mainly by the presence of the common seastar *(Pisaster ochraceus)* which is at its upper limit there. California mussels are able to win primary space ("bare" rocks) over all other intertidal plants and animals, which would reduce marine life diversity and allow the mussels to overtake the intertidal zone if the common seastar did not find them such a good food source. But, losses of mussel beds also can be caused by logs smashing into them and waves ripping them off rocks. A variety of other animals prey on these mussels, including: black oystercatchers, sea gulls, fish, crabs, drills and anemones.



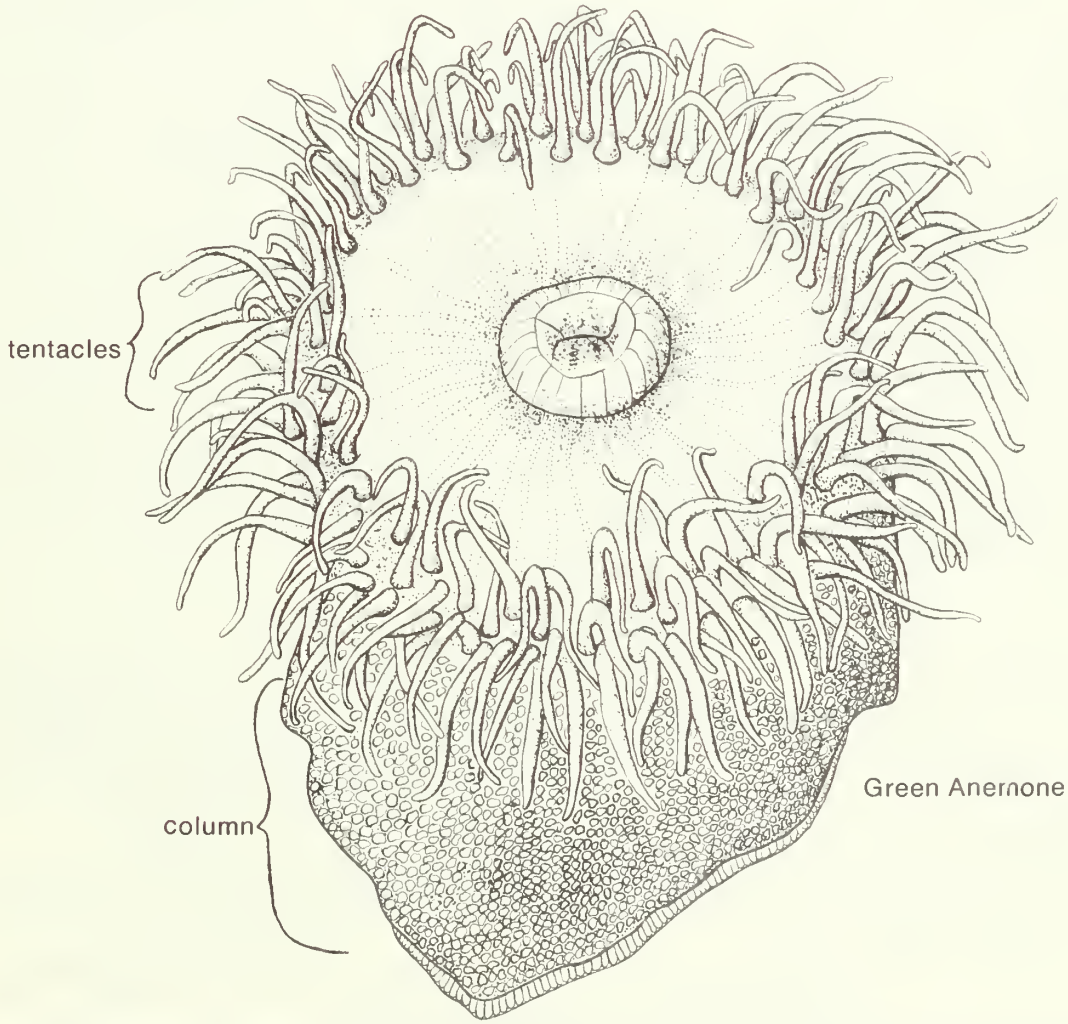
Black Oystercatcher
½ natural size

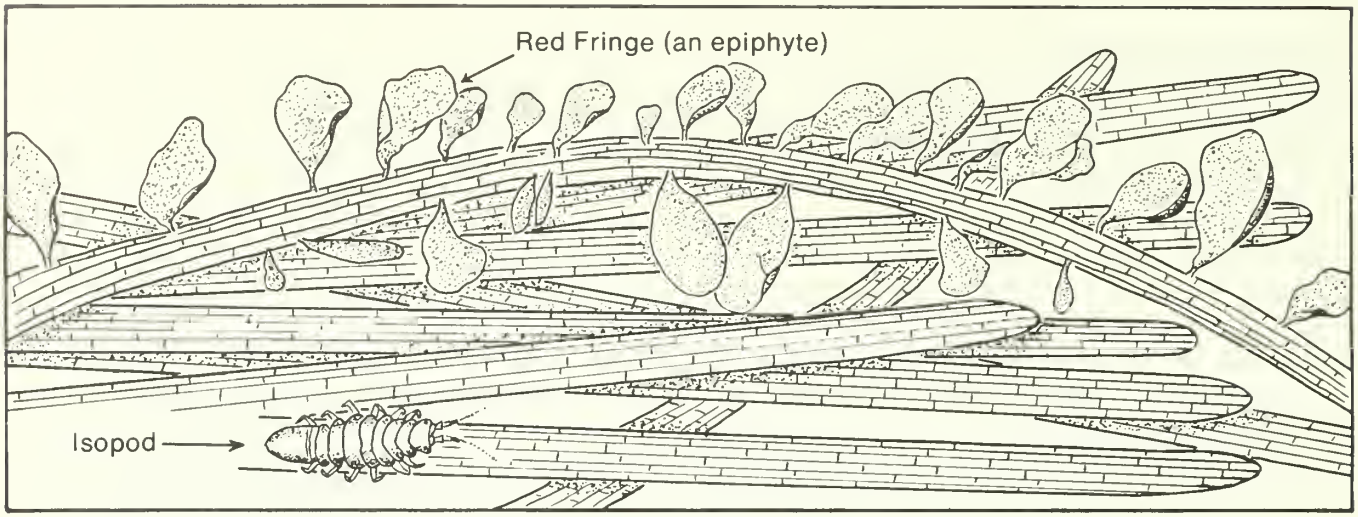
California Mussel bed
with Rock Barnacles

Sea stars, or starfish if you prefer, have a series of connecting canals in their bodies through which water moves. On the topside of both the common seastar *(Pisaster ochraceus)* and the six-rayed star *(Leptasterias hexactis)* there is a madreporite, a small plate with tiny holes in it, through which water is sieved for the canal system. Under each arm in grooves are the tube feet which are the end of this canal system. Tube feet are used for respiration, to move, to sense things, and to cling tightly to rocks and prey. Sea stars do not change color. The common seastar is either purple, orange or brown, and the six-rayed star is generally dark green or grayish. Both the common seastar and the six-rayed star occur in zone 3 down to subtidal depths. Both stars have remarkably similar feeding cycles and diets which include mussels, barnacles, limpets, chitons, periwinkles, turban snails, drills and other snails. Acorn barnacles are the most common food item in their diets, although not the most preferred. The common seastar is more important to the intertidal community than the six-rayed star, because it helps contain the space dominating acorn barnacle and California mussel to well-defined areas, thus opening the intertidal zone for a greater variety of organisms to thrive. *Please leave sea stars at the shore where you find them.*



Sea anemones have bodies composed of a cylindrical column, at the top end of which is an oral disk, bordered by tentacles equipped with stinging capsules. When expanded, the usual brilliant green of the tentacles gives the green anemone *(Anthopleura xanthogrammica)* its flowerlike appearance. The column is usually olive or dark greenish-brown and covered with warty bumps which are sometimes studded with bits of shell or gravel. Tiny algae living in the tissues of the green anemone give it most of its color. This beautiful anemone is most common on rocks in zone 4 just below mussel beds, in areas with strong wave action, and ranges in the United States from Alaska to California. When the common seastar takes a large mussel from its bed, it often knocks others loose. The action of drift logs and waves rip out more patches of mussels. In these ways green anemones are supplied with mussels, their major food. These anemones also eat barnacles, crabs, urchins and fish. The green anemone also lives in tide pools of zone 3, often with the smaller, pink-tipped anemone *(Anthopleura elegantissima)* so named because its tentacles are usually tipped with pink. This variety is the most common anemone on the west coast. In places where sand is abundant these anemones can occur in large patches on the exposed surfaces of rocks. They often cover their columns with bits of sand or shell which keeps them cooler and damper during low tides.

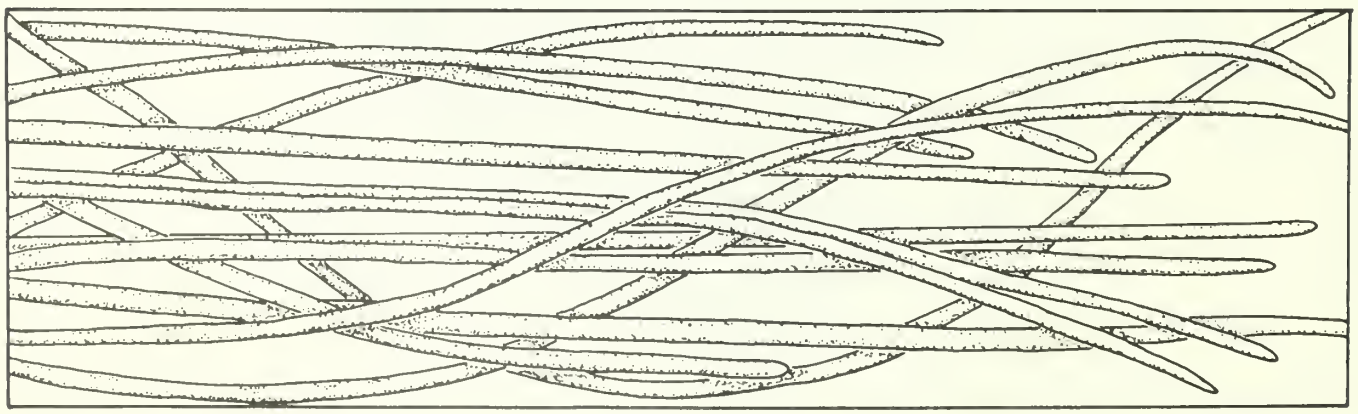


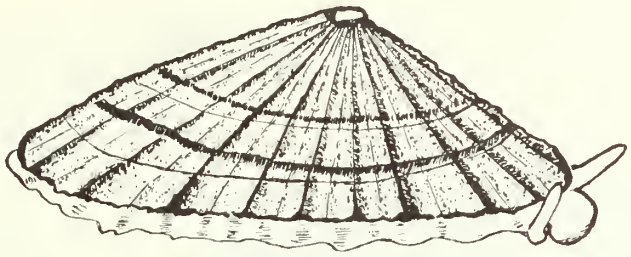


Eelgrass

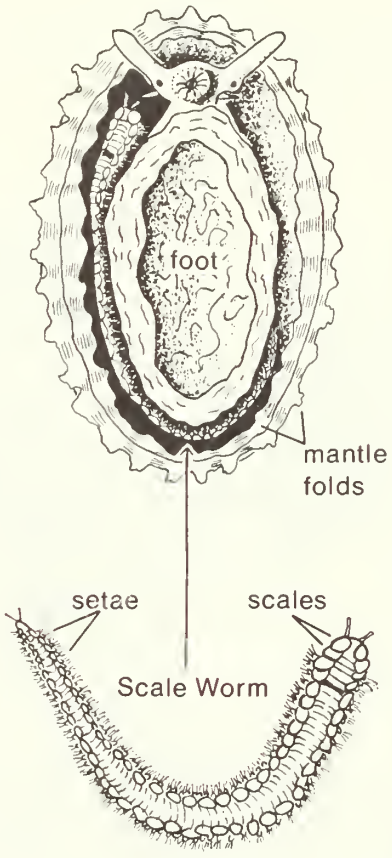
Eelgrass *(Zostera marina)* and surfgrass *(Phyllospadix* spp.) are the only two marine flowering plants within the coastal area from Alaska to Mexico. Along the coast eelgrass grows in sand mixtures in protected situations, whereas most surfgrass coats rocks in exposed areas. The leaves of surfgrass are usually a more brilliant green, one half or less the width, and lack the easily visible veins of eelgrass. Both these grasses occur in zone 4 and below, as well as in tide pools higher up the shore. In the spring and summer the pinkish or purplish-red blades of red fringe *(Smithora naiadum)* can be found exclusively on some of the leaves of surfgrass or eelgrass. A plant (like red fringe) that grows on another plant, using it as a place to attach itself is called an *epiphyte*. Another example of such plants are the mosses and lichens found growing on trees. These sea grasses also provide a home for small animals called isopods. They are crustaceans that are flattened from top to bottom and have 7 pairs of similar legs. The one shown *(Idotea wosnesenskii)* occurs in shades of green, brown or black. It is most numerous under rocks where there is abundant decomposing plant material the isopod uses for food. Eelgrass supports a large community of organisms, some of which people use for food. For example, black brant, a game species of goose, relies heavily on eelgrass for its food. Because it is so important to a variety of life, eelgrass deserves more protection than it now receives from pollution and coastal developments which bury it.

Surfgrass





Keyhole Limpet

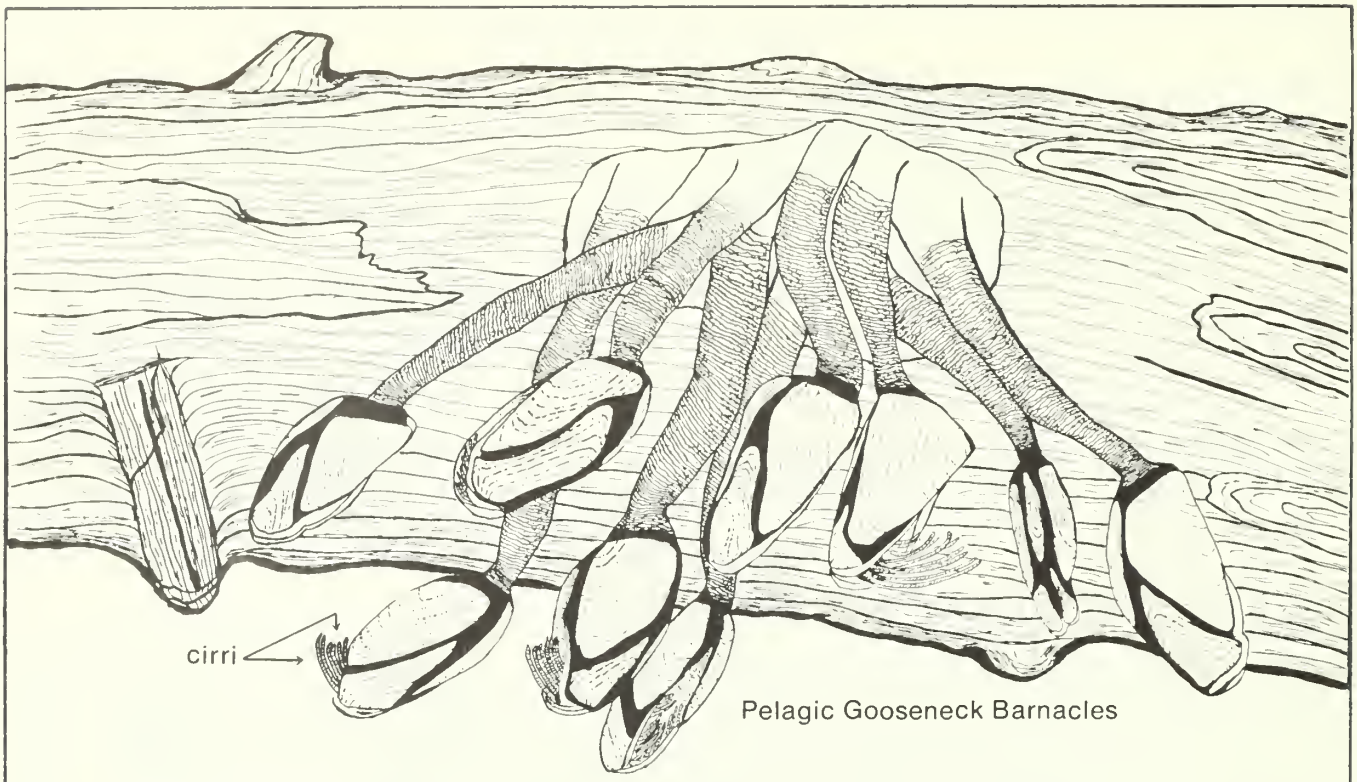


In order to find the herbivorous keyhole limpet *(Diodora aspera)* you will have to look carefully in the cracks and crevices of rocks in the low intertidal zone (zone 4). This limpet is even more common subtidally, and it can be found from Alaska to Baja California. A keyhole limpet can live as long as 10 years. Underneath the shell you can find the head. Water enters openings on both sides of this head, passes over gills (structures that absorb oxygen from water) and then flows out through a hole in the shell, carrying waste material with it. True limpets lack the hole that is characteristic of keyhole limpets. The circulation process in true limpets is different.

Almost every keyhole limpet has an ivory colored scale worm *(Arctonoe vittata)* curled between its foot and *mantle folds*. The life span of this creature is about 4 years. Like most marine worms this one is a *polychaete,* meaning "many-bristled," which refers to the many bristlelike *setae* on each segment.

It is common in the marine environment for unrelated organisms to live together. In this case the scale worm gains at least some protection under the limpet's shell, while the limpet neither benefits nor is harmed by the worm. Biologists call this type of sharing "commensalism." This scale worm can be found living with other hosts including sea stars, and the giant chiton *(Cryptochiton stelleri)* whose leathery, red skin hides its shell plates. (It too can be found in zone 4). The scale worm prefers the keyhole limpet if given a choice of hosts. Each host limpet houses only one large scale worm, but sometimes several small worms may move in simultaneously.

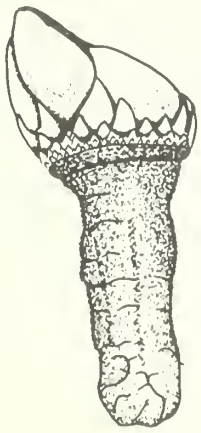
It has been observed in the laboratory that when the common seastar is close by, the keyhole limpet will extend one of its mantle folds over most of its shell, thus preventing the sea star from eating it, because the seastar's tube feet cannot attach to the mantle fold.



Pelagic Gooseneck Barnacles

Pelagic gooseneck barnacles *(Lepas anatifera)* are found throughout most of the world's oceans, attached to floating objects such as wood, kelp or bottles. "Pelagic" means to live at the surface of the ocean, far from land. You may occasionally see these barnacles stranded high on the beach, left by a storm or high tide where they will die within a few days.

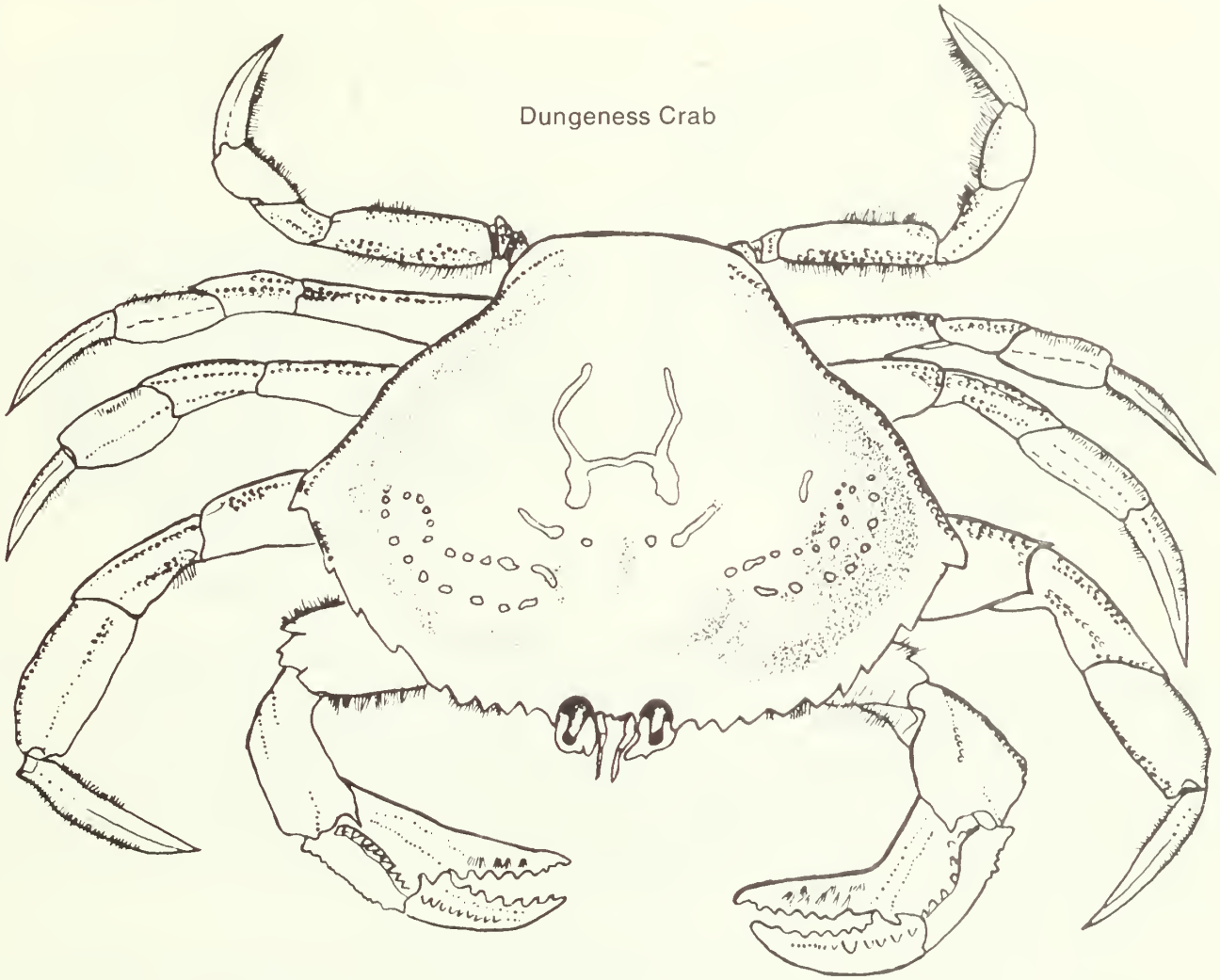
You will be able to find gooseneck barnacles *(Pollicipes polymerus)* attached and growing in clusters, on or near California mussel beds in zone 3. They range between Alaska and Baja California. The largest individual may be 20 years old. Gooseneck barnacles have a long stalk or drawn-out front of their head, which gives them a much different appearance than acorn barnacles.



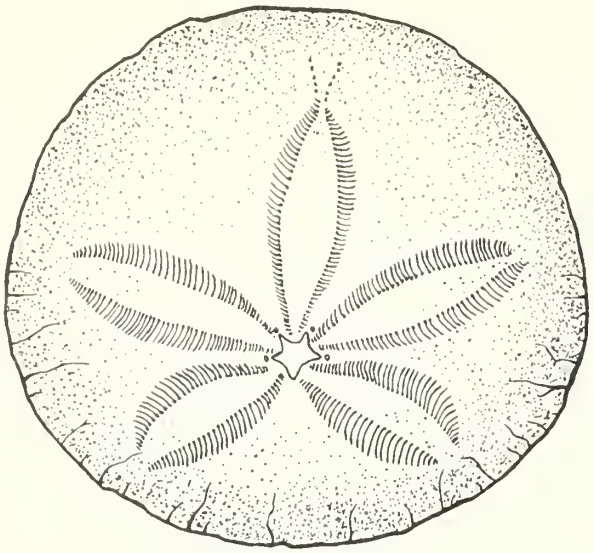
Gooseneck Barnacle

Barnacles are *hermaphroditic:* that is, each individual has both male and female reproductive parts within its body. In most instances, two individuals must be present for fertilization to occur. This is made possible by means of a long retractable tube.

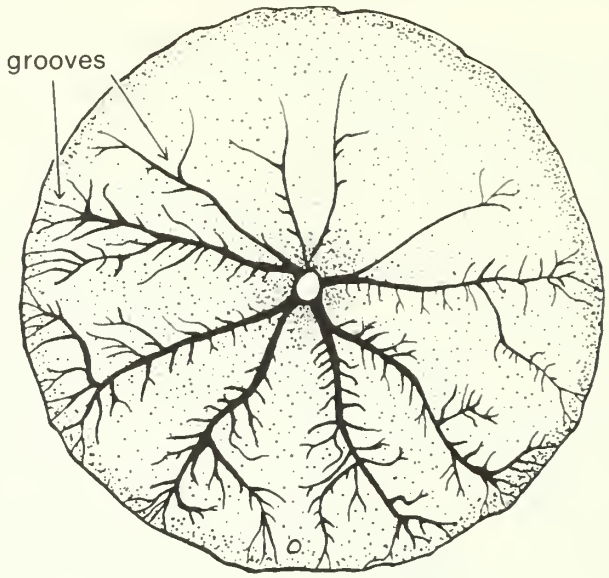
Most barnacles filter food into their mouths by periodic movements of six pair of plumelike legs called *cirri*. Gooseneck barnacles, however, do not expend energy unnecessarily by moving their food-gathering cirri regularly. Instead, each clump of barnacles orients itself to the different directions of local wave run off, and simply leaves its cirri out to strain small crustaceans and other food from the water as it moves by.



The Dungeness crab *(Cancer magister)* received its common name from the small fishing village of the same name located east of Port Angeles on the Strait of Juan de Fuca in Washington State. At Dungeness the first commercial harvesting of this crab was done. Through most of its range from the Aleutian Islands in Alaska south to San Francisco, this high protein, delicious-tasting crab is commercially harvested. Dungeness crabs inhabit eelgrass beds and muddy to sandy bottoms, from the low intertidal zone to depths in excess of 183 m (600 ft.). Along the outer coast they eat mostly razor and hard-shell clams, and in turn, they can be eaten by halibut, lingcod, octopuses and their own kind. Dungeness crabs, like other crustaceans (amphipods, barnacles and crabs) must shed or *molt* their hard, outer body covering in order to grow. At times thousands of these crab shells may line the beaches, especially in the Kalaloch area. Along the Olympic coast located in eelgrass beds, you are more likely to see the red crab *(Cancer productus)* a look-alike cousin of the Dungeness. The red crab has a red shell and black-tipped claws, rather than the grayish-brown shell and white-tipped claws of the Dungeness.



Sand Dollar—topside



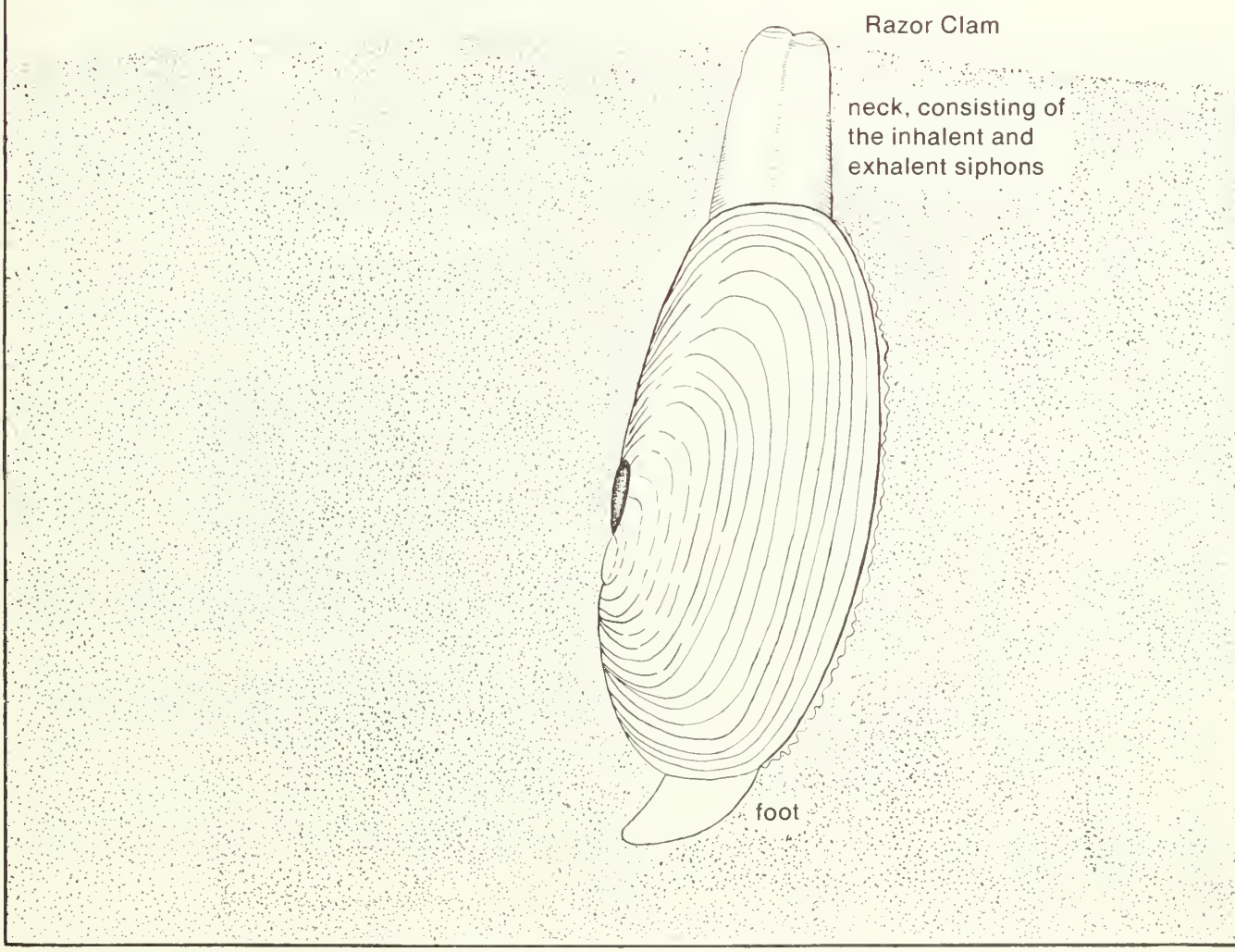
Sand Dollar—underside

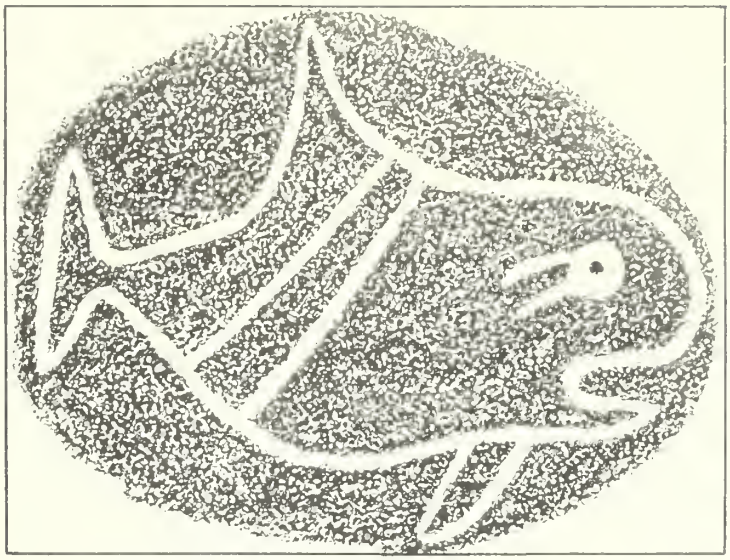
Sand dollars *(Dendraster excentricus)* occur from British Columbia to Baja California, most frequently in groups on sandy bottoms. They can live from the low intertidal zone to depths of about 90 m (300 ft.). In inland waters such as bays and sounds, sand dollars often are associated with eelgrass beds, being found within or near these beds on shallow, sandy bottoms. Sand dollars are more numerous on the outer coast, where they reach their greatest densities just seaward of the breaker line. One giant bed of sand dollars includes an estimated 100 million individuals off Zuma Beach in southern California! The shells of sand dollars, called *tests,* are frequently found locally along beaches near Kalaloch and occasionally on the south side of Sand Point.

A beautiful pattern on the topside of bare sand dollar tests is formed by a flowerlike arrangement of *petals*. When the sand dollar is alive specialized tube feet used for respiration stick out the pore pairs (which form the petal design) and these are connected by a groove. Starting from the topside and extending to the bottomside of the sand dollar test are food grooves that run from the outer edge to the center. Food is passed along these grooves to the mouth, located near the center of the underside. When alive, sand dollars are covered by a dense coat of small spines which gives their topsides a purplish-gray color. On their underside the spines located around the mouth serve as a major means of locomotion for adults. They have the ability to bury themselves when exposed at low tide or to stay buried when exposed to heavy surf. When conditions suit them, they commonly stand on edge, something like plates in a dishrack, with 2/3 of their bodies exposed. In this inclined position they face the major current or water surge which brings food to them. Sand dollars feed on diatoms and small broken pieces of other algae and marine animals. They are eaten by certain fishes, sea stars and crabs. You can often find them washed ashore after storms.

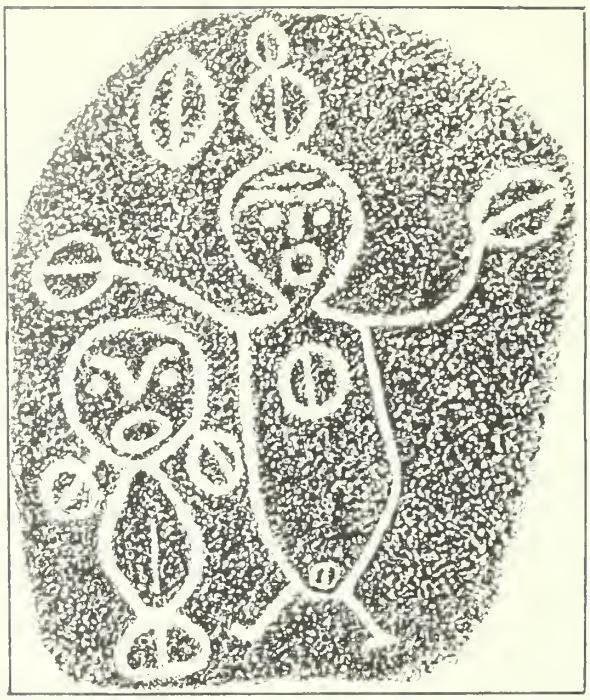
The polished, thin-shelled, razor clam *(Siliqua patula)* typically inhabits broad, gently sloping, surf-swept, sandy beaches along the exposed outer coast from California to Alaska. Razor clams grow faster at their southernmost occurrence in California but have shorter lives (maximum of 5 years) than their slower growing relatives in more northerly latitudes. The oldest razor clams recorded came from Alaska and were 19 years of age. Locally, the beach adjacent to Kalaloch has the largest population of these animals.

In Washington the most productive razor clam beaches extend for 80 km (50 mi) north from the mouth of the Columbia River. Razor clams occur from the mid-intertidal into the shallow subtidal zone. Their diet consists of diatoms. Besides people, Dungeness crabs, sea gulls, fish and a few types of ducks enjoy eating this flavorful clam. To protect itself from predators and from its unstable sandy environment, the razor clam digs deeply into the sand by repeated rapid movements of its foot. It can extend its foot the length of its shell, while inflating the tip with water to 3 times normal size, thus forming an anchor to pull itself toward. *Make sure you know the season and daily limit regulations for the taking of razor clams before you start digging.*





Killer Whale 1/7 of petroglyph size



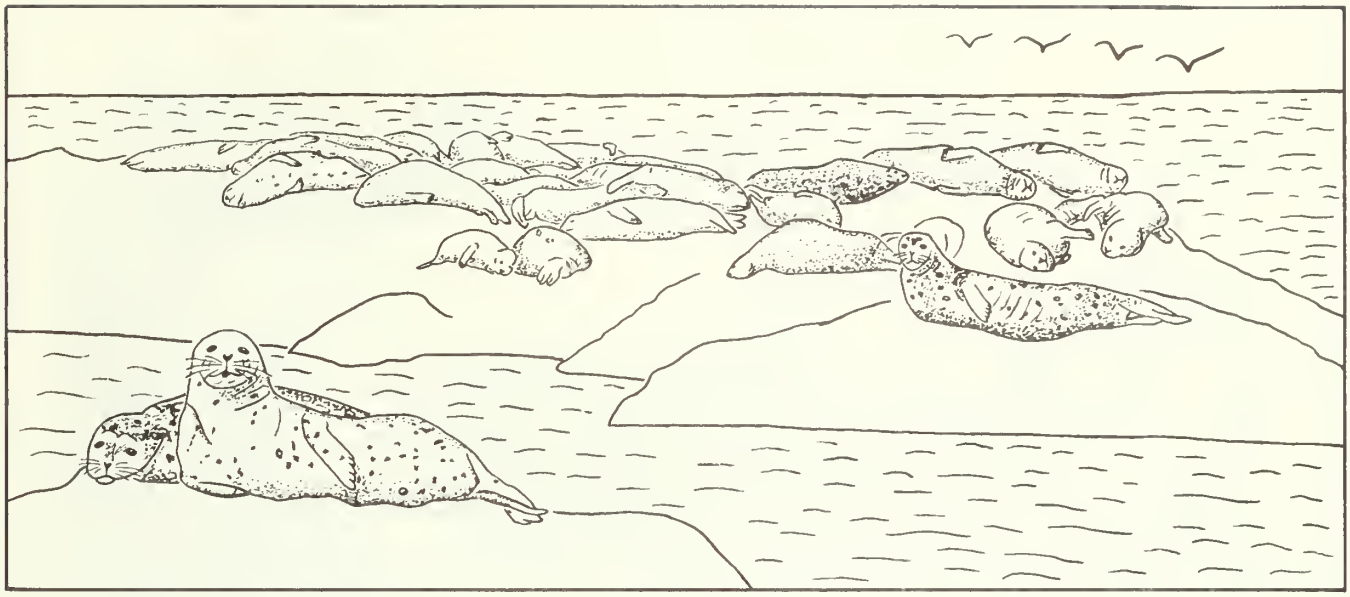
"Wedding Scene" 1/10 of petroglyph size

These drawings represent two of the several *petroglyphs* that can be found about 1.6 km (1 mi) south of Cape Alava, at a place called Wedding Rock. A petroglyph is a carving in rock. These may be several centuries old and were probably carved by the Ozette Indians. Petroglyphs are important cultural records. You are welcome to look and touch them, but *please do not carve the rocks*. It is fun to make your own drawings in wet sand, and you might try to draw the petroglyphs shown here to actual size.

One petroglyph is popularly referred to as the "Wedding Scene," because it portrays two people. We can only guess what was really in the carver's mind. Maybe he or she was describing a religious rite.

Several petroglyphs are fine representations of specific whales. The Ozettes were very familiar with certain whales since they hunted them off the coast from hollowed-out log canoes, using harpoons the points of which were made from sharpened California mussel shells! They hunted the more abundant, slower whales such as the gray whale *(Eschrichtius robustus)* much more often than the swift, smaller killer whale *(Orcinus orca)* which they took only occasionally. The killer whale is the largest member of the dolphin family. It reaches lengths of about 9 m (30 ft.). Bringing in a whale from a log canoe was truly a remarkable achievement, requiring great courage and strength. Whales provided the Indians with abundant food and oil. Only a few other aboriginal groups on the Olympic Peninsula, Vancouver Island, Alaska, and the Arctic coasts have hunted whales.

Contrary to popular belief, there has never been a proven attack on a human by a killer whale. It has received its reputation as "killer" because of its large appetite and frequent feeding on seals, dolphins and whales. Its primary food consists of squid and fishes, of which salmon make up only a small part. If you are fortunate, you might spot a *pod* (group) of killer whales offshore near Cape Alava or Giants Graveyard, south of La Push. Watch for gray whales off 1st Beach in March and April. They are commonly spotted in the summertime between Destruction Island and the mainland, from Ruby Beach to Kalaloch.

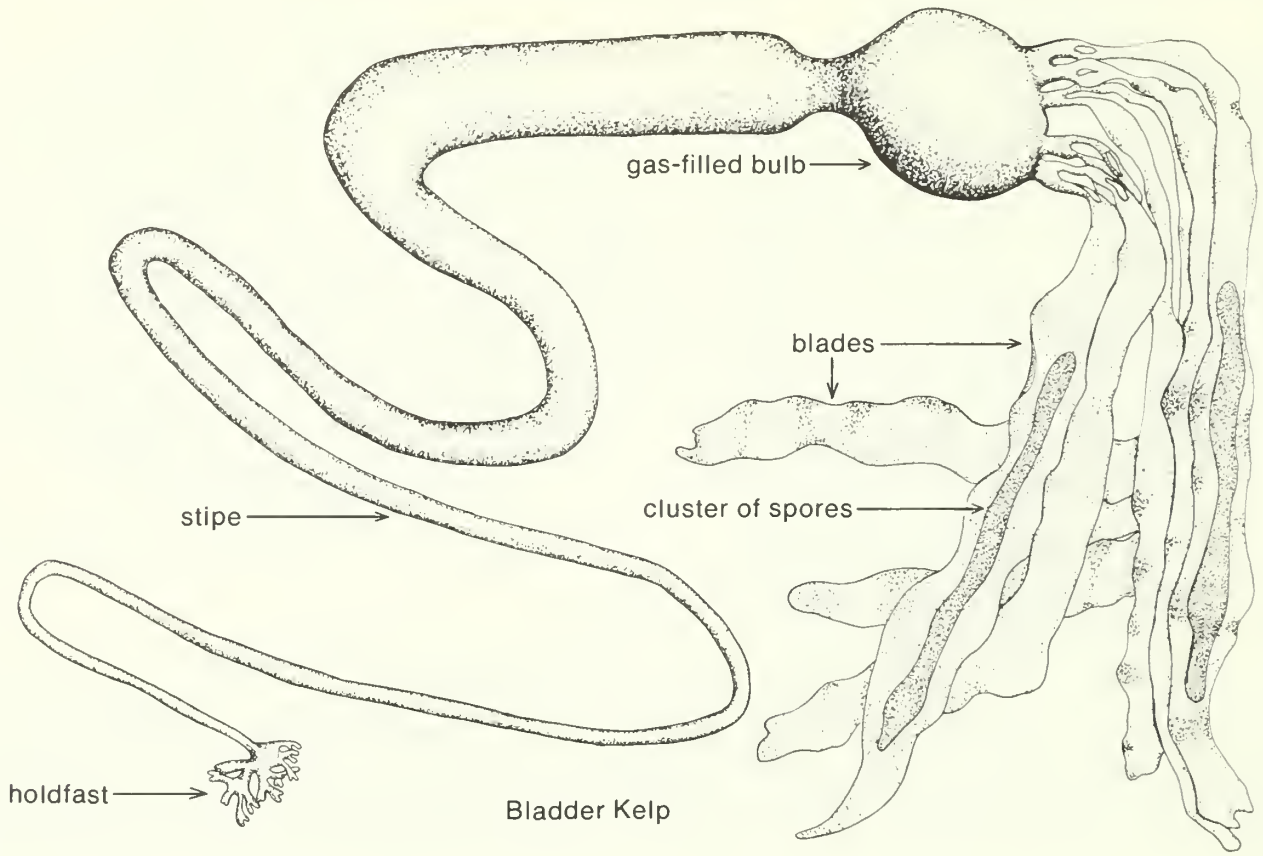


Harbor Seals

The Pacific harbor seal *(Phoca vitulina richardi),* also known as the common seal, spotted seal and hair seal, ranges from the Bering Sea to Baja California. They live along the coast, seldom swimming more than 8 km (5 mi) offshore, although they can be found in protected inland waters, sounds and bays, at the mouths of rivers, and occasionally, in accessible rivers and lakes. A variety of fish including sole, flounder, sculpin, hake, herring, candlefish, rockfish and salmon (in the fall) constitute the diet of harbor seals. They are preyed upon by killer whales and large sharks.

Using their front flippers with caterpillarlike body movements, harbor seals can haul themselves out of the water to rest, bask in the sun, or give birth. Locally, they haul out on islands and reefs or rocks normally exposed only during low tides. Because they are non-migratory and year-round residents, harbor seals often return daily to their favorite hauling-out spots, spending about equal amounts of time on land and in the sea. Actual and estimated counts of at least 100 or more harbor seals have been made between and around each of the following coastal locations: Cape Alava to Sand Point, Norwegian Memorial to Cedar Creek, Cape Johnson to the mouth of Goodman Creek and Destruction Island. The observant coastal visitor or hiker is very likely to see some harbor seals in these areas.

Taking a "lost" baby seal home or skinning any dead marine mammal found along the beach is illegal under the Marine Mammal Protection Act of 1972. This Act also makes it a federal crime to kill, capture or harass *any* marine mammal, although exceptions are made for scientists, aquaria and commercial (not sport) fishermen by special permit. Eskimos and Indians who take marine mammals for food and clothing are also exempt. If you find a beached marine mammal, dead or alive, call the Washington State Department of Game.



Bladder Kelp

Bladder kelp *(Nereocystis luetkeana)* is a large, annual, brown alga that can be found from Alaska to the coast of central California. Growing in clustered groups known as ***kelp beds,*** bladder kelp lives below the lowest tide mark in rocky subtidal areas where there are swift water currents. The largest bladder kelp plant measured to date was at Pacific Grove, California. It had a remarkable total length of 38.4 m (nearly 120 ft.)! In this area of the Olympic Peninsula, the longest bladder kelp plants are usually 1/3 to 1/2 that size. Because of its long range, large size, and frequent beaching in late spring and summer it is probably the best known alga to west coast beachcombers, and has picked up many common names: sea otter's cabbage, sea whip, seal head kelp, bull kelp or, simply, kelp.

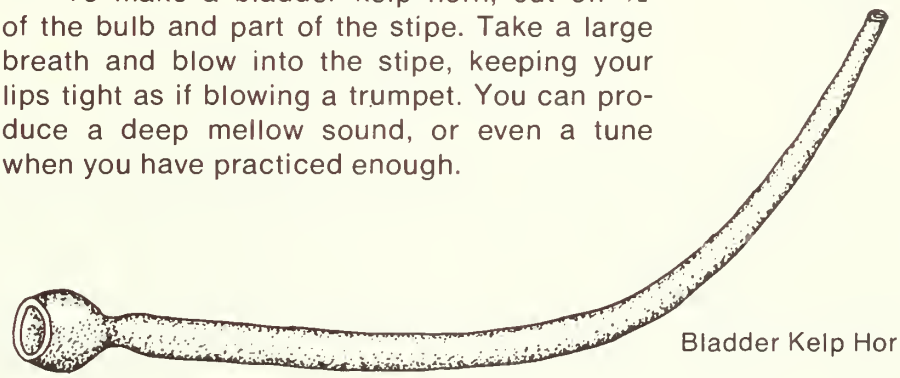
Algae do not have roots, stems or leaves, although many, like bladder kelp, have similar looking parts known as the *holdfast, stipe* and *blades*. Algal tissues are simpler and do not function in quite the same manner as plants with roots, stems and leaves. When mature, pieces of bladder kelp blades with clusters of spores attached will drop to the bottom and some spores will form microscopic female and male plants. These tiny plants overwinter. Eventually female eggs are fertilized by male sperm, forming zygospores from which the more familiar, larger bladder kelp plants grow in early spring.

Often found locally are the beached, brown-tangled masses of giant kelp *(Macrocystis integrifolia)*. Unlike bladder kelp, each giant kelp plant has several uniformly thin stipes, off of which regularly branch single floats and blades. Both types of kelp provide habitat and food for many marine organisms.

Kelp Carving Activities

You can carve the bulb of bladder kelp as you would a pumpkin. Try using a knife, stick or broken shell. Experiment to make different faces and designs.

To make a bladder kelp horn, cut off ½ of the bulb and part of the stipe. Take a large breath and blow into the stipe, keeping your lips tight as if blowing a trumpet. You can produce a deep mellow sound, or even a tune when you have practiced enough.



Bladder Kelp Horn

Krazy Kelp Kandies

Find a newly beached bladder kelp plant whose stipe, when cut, has the texture of a crisp, hard apple. Cut off about 30.5 cm (1 ft.) of the stipe where the diameter is 2.5-5 cm (1-2 in.). Store it in a moist plastic bag in a cool place until you get home.

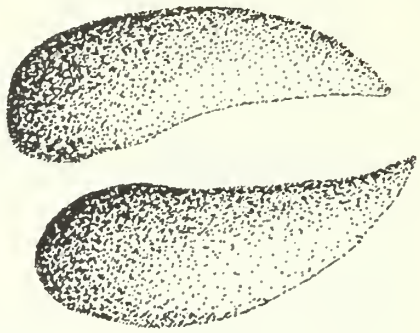
At home cut the stipe into 6 mm (¼ in.) "Life Saver" circles—enough to make 2 cups. Place pieces in a pan and cover with vinegar (do not use wine vinegar). Cover and boil for 15 minutes to remove bitterness and to soften the kelp. Drain. Mix 2 cups kelp, 2 cups brown sugar, ¼ cup water. Bring mixture to a boil, stirring until sugar dissolves. Add 2 teaspoons ground cinnamon, turn heat down and let mixture cook very slowly, uncovered for one hour.

Using a slotted spoon, or fork, lift the kelp from the syrup, draining over the pan a few seconds, and place in a shallow pan with 6 mm (¼ in.) brown sugar on the bottom. Using a fork, coat kelp with brown sugar and spread to dry and cool on a plate. You and your friends will enjoy krazy kelp kandies! Any remaining syrup may be used on pancakes, waffles, French toast, or over ice cream.

Algae have been used by Chinese, Japanese and American Indians for thousands of years and will probably continue to be used by people for as many more years to come. *Aquaculture* is the intentional rearing and harvesting of fish, algae, or other foods in water. It is practiced now off the southern California coast with giant kelp *(Macrocystis pyrifera)* a different species than our local common one. This giant kelp is the world's fastest growing plant, sometimes achieving more than 61 cm (2 ft.) per day! *Algin* is one product extracted from giant kelp. It is used in salad dressings, paints, cosmetics, medicines and even to make ice cream smoother.

River Otter

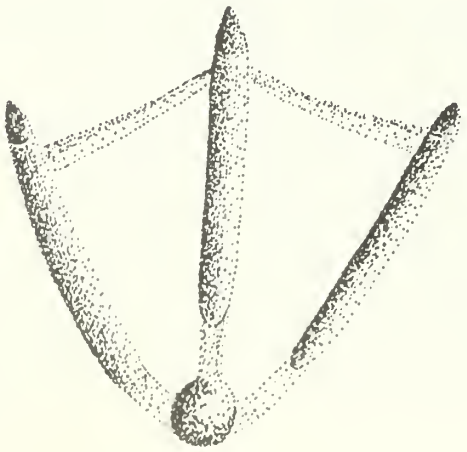
Dog: *Remember pets are not allowed on Olympic National Park trails.*



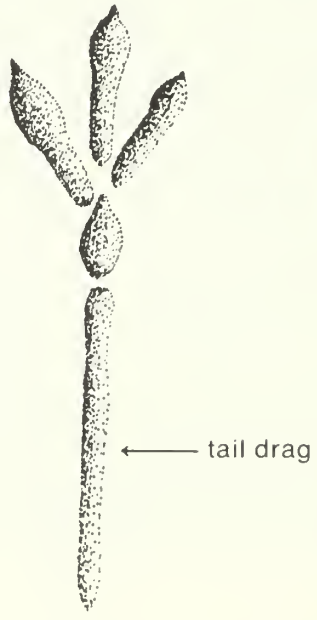
Deer

Footprints left in the soft sediments of the intertidal zone or on moist sandy beaches are exciting clues to the numbers and kinds of animals that have been there. Shown here are a few of the more common animal tracks you can find along the seashore. Contrary to the implication of its name, river otters do swim and feed in the ocean. They are common locally and are often seen scampering or swimming along the shore. In contrast, sea otters are *rare* locally and seldom come close to shore. The footprint of a dog looks something like that of the river otter, but it has one less toe print and a triangular shaped heel. *(Please remember, though, that pets are not allowed on Olympic National Park trails).* Coastal deer also walk along the beach. Sometimes they venture into the intertidal zone, probably to seek salt. People coming to the ocean should take the time to run along a sandy beach in bare feet and wiggle toes in the sand. Its a great feeling.

Both sea gulls and crows are noisy and abundant along this seashore. Sea gulls are superb flyers, skillful at maneuvering on the wind. Many hours of delight await those who take time to watch them and to observe all the types of life that flourish here.



Sea Gull



Crow

Yours? 1/3-1/2 natural size

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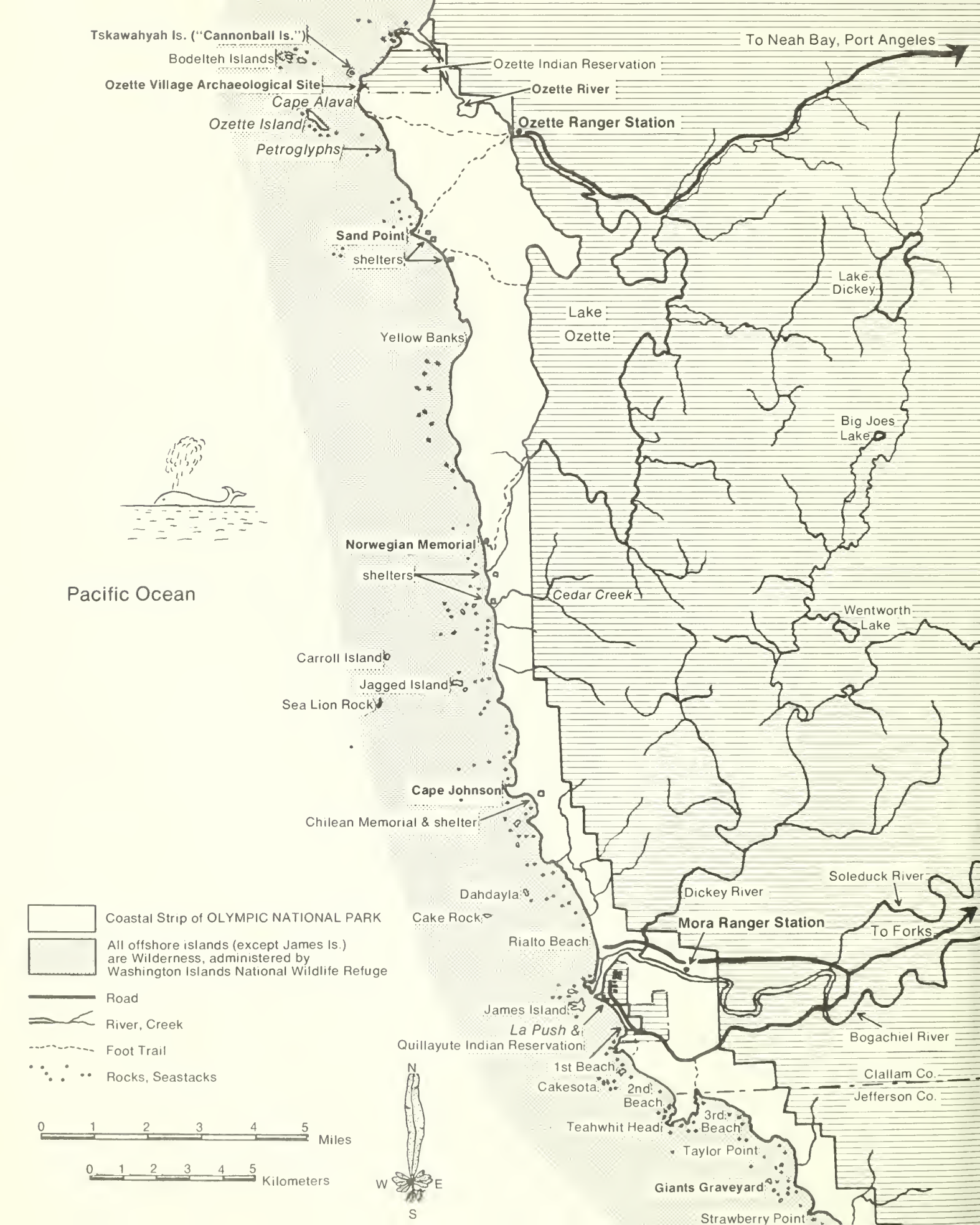
Tskawahyah Is. ("Cannonball Is.")
Bodelteh Islands
Ozette Village Archaeological Site
Cape Alava
Ozette Island
Petroglyphs
To Neah Bay, Port Angeles
Ozette Indian Reservation
Ozette River
Ozette Ranger Station
Sand Point
shelters
Lake Dickey
Lake Ozette
Yellow Banks
Big Joes Lake
Norwegian Memorial
shelters
Pacific Ocean
Cedar Creek
Wentworth Lake
Carroll Island
Jagged Island
Sea Lion Rock
Cape Johnson
Chilean Memorial & shelter
Soleduck River
Dickey River
Dahdayla
Cake Rock
Rialto Beach
Mora Ranger Station
To Forks
James Island
La Push &
Quillayute Indian Reservation
Bogachiel River
1st Beach
Cakesota
2nd Beach
Clallam Co.
Jefferson Co.
Teahwhit Head
3rd Beach
Taylor Point
Giants Graveyard
Strawberry Point
Coastal Strip of OLYMPIC NATIONAL PARK
All offshore islands (except James Is.) are Wilderness, administered by Washington Islands National Wildlife Refuge
Road
River, Creek
Foot Trail
Rocks, Seastacks
0 1 2 3 4 5 Miles
0 1 2 3 4 5 Kilometers
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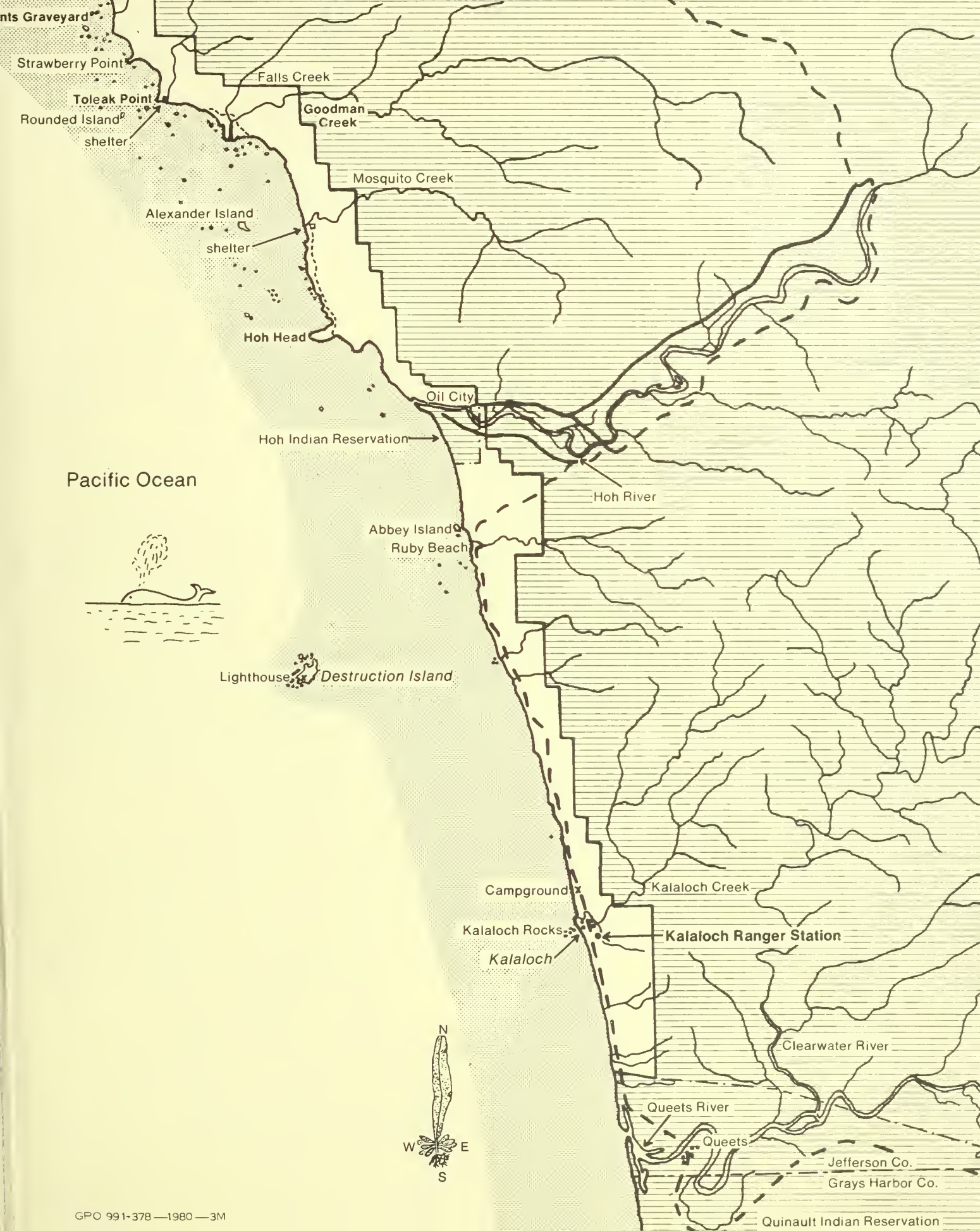

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