The Layman’s Guide to OSU Marine Science Center Invertebrates

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Preface

One of our duties at the Marine Science Center was to answer visitors’ questions about the animals on exhibit at the center. In order to be effective in this capacity, we found it necessary to familiarize ourselves with the life histories of the animals. This was not an easy task, as it meant searching through a multitude of books in order to find the desired information.

There was no one source available that would provide us with complete, yet simple, answers to the most commonly asked questions. Therefore, in order to complete the academic requirements for our internship, and as a service to future interns and summer aquarium aides, we decided to lay the foundation for a layman’s guide to the Marine Science Center animals.

By no means is this booklet complete. Due to time limitations, we could only cover the invertebrates -- the animals without backbones -- most commonly displayed at the Marine Science Center. However, it is our hope that future interns will see the value of undertaking research on the remaining animals and by doing so fulfilling the ultimate goal of a complete guide to Marine Science Center animals.

We wish to thank Anne Seaman, whose nimble fingers made the typing of this project a joy to behold rather than a nightmare.

Kathy Wagner
Sally Booth
Phylum coelenterata - Coelenterates

Three classes are found under the phylum Coelenterata. They are:

- Class Hydrozoa - hydroids, siphonophores
- Class Scyphozoa - jellyfish
- Class Anthozoa - sea anemones, sea pens, sea pansies, corals

This text will include only information on the sea anemones in the class Anthozoa.

Class Anthozoa - Sea Anemones

Range: Worldwide
Habitat: All marine, in bays or along the shore, attached to pilings, rocks, etc. Some species burrow in the sand. One species is free-swimming.
Size: Up to 2 feet in diameter
Color: All colors

Distinguishing characteristics: Radially symmetrical. Soft, cylindrical shaped animals, with only one body opening, the mouth

Senses: Body covered with sensory hairs which are in turn connected to scattered, unorganized nerves.

Locomotion: Can move, although only very, very slowly. Sometimes if watched for several days, one can notice that an anemone has changed positions. One of the speedier species has been clocked at moving 3-4 inches per hour.

Food and Food Habits: Most anemones are equipped with stinging tentacles which are used to paralyze and capture small mollusks, crustaceans, other invertebrates and fish that contact them. These anemones can engulf animals as large as themselves. *Metridium* is unusual in that it feeds on microscopic animals rather than larger animals. Anemones have only one body opening, so after eating, any remains or wastes are expelled back out through the mouth.

Respiration: No respiratory system. Oxygen is absorbed directly through body tissues.

Reproduction: Sexes are separate in anemones. Sperm and eggs are released into the surrounding water. After fertilization the egg develops into larvae and after 2 or 3 days it settles down to a fixed existence.

Natural Defenses: Tentacles equipped with sting cells. When touching a sea anemone that sticky feeling is actually the anemone injecting poison into your skin. Unless a person has very sensitive skin this will not harm them. And even those with very sensitive skin will only react with a little rash or swelling. Anemones have one other familiar means of protection. When poked they will contract and pull all their tentacles inside.

Predators: The Giant Sunfish
Phylum coelenterata - Coelenterates

Use to Man:          None
Harm to Man:         None

Aggregate Anemone (Anthopleura elegantissima)
Common names:        Rough Anemone, Small Colonial Anemone
Range:               Alaska to southern California
Habitat:             Rocky shores
Size:                4 inches high, 1-2 inches across
Color:               Gray-green with delicate pink-tipped tentacles when open underwater. The green color is due to a symbiotic alga which lives within its tissues.
Distinguishing characteristics: This anemone is most often seen during low tide when they are closed up and look like squasy green blobs. They are often found in huge colonies and covered with bits of sand and shells.
Natural Defenses:    The particles of sand and shell fragments help to protect this anemone from drying out when the tide is out.
For photographs See:
  Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Plate IV.
  Ricketts, Edward F. and Jack Calvin. Between Pacific Tides. Pg. 44.

Green Anemone (Anthopleura xanthogrammica)
Range:               Alaska to southern California. Also found along shorelines of Asia.
Habitat:             Rocky shores
Size:                6-10 inches high, 8 inches across
Color:               Actually colorless. The bright green color is due to a symbiotic alga which lives within its tissues.
Distinguishing characteristics: Same as general characteristics of anemones.
For photographs See:
  Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Plate IV.
Pile Anemone (Metridium senile)

Range: North Atlantic and Pacific.

Habitat: Subtidal on pilings, boat docks, and rocks of estuaries and continental shelf

Size: 18 inches high, 6 inches across

Color: Usually white. Also can be tan, brown, orange, or gray.

Distinguishing characteristics: Tentacles fluffy, feathery. Tall smooth column When closed looks like an old wrinkled lump.

Food and Food Habits: Most anemones live on crustaceans, mollusks, and fish, whereas Pile Anemone feeds on small organisms floating in water.

For photographs See:
Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Pg. 67 and Plate II.

No Common Name (Tealia Species)

Range: Alaska to southern California

Habitat: Subtidal on rocky shores

Size: 4 inches high, 4 inches across

Color: Column bright red or with streaks of green or white. Top surface and tentacles green with red tints. A very brightly colored genus.

For photographs See:
Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Plate III.
Phylum Echinodermata - The spiny-skinned animals

Five classes are included under the phylum Echinodermata. They are:

- Class Asteroidea - starfish
- Class Ophiuroidea - basket stars, brittle stars
- Class Echinoidea - sea urchins, sand dollars
- Class Holothuroidea - sea cucumbers
- Class Crinoidea - sea lilies, feather stars

This text will include classes Asteroidea, Echinoidea, and Holothuroidea. Of the 8,000 species of echinoderms known to man, all of them are marine animals. Although appearances vary widely, echinoderms have many things in common. Echinoderms are all radially symmetrical except for sea cucumbers which are bilaterally symmetrical. Most animals are symmetrical, the organs and appendages of one side of the body duplicating those of the other side. But in echinoderms and coelenterates (sea anemones) the similar structures radiate outward from the central axis of the body.

Tube-feet operated by a water vascular system also distinguishes echinoderms from other animals. Echinoderms depend on their tube-feet for madreporite, or sieve plate located near the center on the upper surface of starfish and sea urchins (internal on the sea cucumbers). Water enters the body of echinoderms through this sieve plate and is transferred through small vessels to internal ampulla.

The tube-foot is a hollow, tube-shaped membrane with a small suction cup located at the end. In order to use a tube-foot, the echinoderm must force water from the ampulla into the tube-foot to make it firm. Muscles operate the tube-foot much as we use our own legs. Other muscles operate the suction cups at the end of each tube-foot. If the tube-foot is to be withdrawn, the water from the tube-foot is forced back into the ampulla.

With the exception of sea cucumbers, most echinoderms possess spines of varying lengths as well as pedicellariae. Pedicellariae are small pincerlike structures which close in response to stimulus of contact with foreign objects. These pedicellariae help to protect echinoderms from predators and keep the surface clean of foreign objects and minute larvae. This is the reason why one will never find a barnacle or other creatures growing on the surfaces of echinoderms. These pedicellariae can be seen on the 24-rayed star (Pycnopodia helianthoides) with magnification.
Class Asteroidea - starfish or seastars

Note: Most zoologists today prefer the common name sea star, instead of starfish because these animals are invertebrates, not fish. But since the name starfish is such a widely accepted common name, we will refer to them in this text as starfish.

Range: Worldwide. 2000 species known. More species and individuals found along the Pacific Coast than anywhere else in the world.

Habitat: Shoreline or continental shelf

Size: 1/2 inch to 5 feet

Color: Found in all shades of colors; plain, striped, or blotchy

Distinguishing characteristics: Starfish possess five or more rays radiating from a central disc and a protruding calcareous (hardened) structure with sharp or blunt spines. These spines are actually only the surface extensions of their internal structure (like the tips of icebergs). Most starfish possess pedicellaria and tube-feet with suction cups. The mouth is centrally located on the undersurface and anus centrally located on the upper surface.

Senses: Starfish, like other echinoderms, are capable of feeling, seeing, and tasting their environment. All tube-feet are sensitive tactile organs. Eyespots with specialized tube-feet are located at the tip of each ray. With the eyespots starfish can detect the difference between light and dark. Many starfish have a very good sense of taste, or some ability to sense the presence of food chemically. This ability to taste is attributed to specialized tube-feet surrounding the mouth.

Locomotion: Starfish may not look like they are very mobile, but if given reason they can move in any direction.

Food and Food Habits: Starfish are carnivores, scavengers, and cannibals. They eat barnacles, shellfish (mussels, oysters, clams, etc.), sea urchins, dead creatures and other starfish. Each species usually has its own favorite foods. Starfish capture and eat their prey in several different ways. If the shellfish or other food is small enough, the starfish will ingest it whole and spew out the shell later.

If the prey is too large or is attached to a rock, the starfish will climb on top of its prey, eject its stomach, digest the food, then pull its stomach back inside. To open a shellfish the starfish will hump its body over the creature and attach tube-feet to either side of the shellfish and pull the shell open just enough (0.3 mm) for its jellylike stomach to wrap around the soft tissue of the shellfish.

Waste products are released through the anus or through the skin gills.

Respiration: The primary means of respiration is trough small fingerlike projections called skin gills or papilae, covering the upper surface of starfish. These skin gills have such thin walls that oxygen can diffuse in, and carbon dioxide and other wastes can diffuse out. These skin gills can easily be seen on the Leather Star (Dermasterias imbricata) that has been left untouched for a period of time. Rub a small area on the surface of an undisturbed Leather Star and watch the skin gills withdraw. The tube-feet are also used for respiration.
Reproduction: The sexes are separate in starfish. Most reproduce in spring or summer. Vast numbers of sperm and eggs are released through genital pores located in the angle between each ray. Fertilization takes place in the water. The fertilized egg quickly develops into a free-swimming larvae which looks nothing like a mature starfish. The rate of growth depends entirely upon the availability of food. If there is a good food supply, the young starfish will reach a size of two inches across in eight weeks, and in one year, will be sexually mature. Several species brood their young. See Blood Star (*Henricia leviuscula*) and Six-rayed Starfish (*Leptasterias hexactis*).

Natural Defenses: The strong suction of starfish's tube-feet protect them from being tossed about in the waves. Two-jawed pedicellariae protect starfish from predators. Regeneration of lost parts is also an important natural defense.

Predators: Starfish have few predators when mature except man. In the larval stage, starfish are eaten by many larger creatures and form a part of the ocean's zooplankton.

Use to Man: None except scientific study and decoration.

Harm to Man: Starfish cause great destruction to commercial oyster beds. To get rid of the starfish, man takes advantage of the starfish's protective organs, the pedicellariae. When huge mops are dragged over the oyster beds, the starfish will attach their pedicellariae to the fibers. When the mops are removed the starfish will remain attached. The starfish may then be destroyed. For many years the starfish caught this way were cut up and thrown back into the water until it was found that the starfish would increase in number by regenerating lost tissues.

**Bat Star (Patiria miniata)**

Other common name: Broad Disk

Range: Whole west coast of North America.

Habitat: Found in low minus tide to deep water in rocky or sandy beaches.

Size: 10 inches

Color: Bright red, orange, purple, or mottled green and purple.

Distinguishing characteristics: Five triangular rays radiate from a broad disk. Somewhat resembles leather stars but has a rougher upper surface. Small plates on upper surface are crescent-shaped with the concave side of the crescent facing the center of the disc.

For photographs See:

Furlong, Marjorie and Virginia Pill. *Starfish*. Pg. 34
**Blood Star (Henricia leviuscula)**

Range: Alaska to California.

Habitat: Can be found in a good low tide hidden in cracks of rocks or under seaweed.

Size: 3-6 inches

Color: Bright red above. Yellow below. Young sandy colored or mottled.

Distinguishing characteristics: Five long slender rays. Smooth texture due to lack of pedicellaria and spikes. Skeletal framework very stiff due to abundance of lime in body. Madreporite not well marked.

Reproduction: The female of this species will collect her eggs after they have been fertilized in the normal starfish manner and will brood the eggs in a pocket around the mouth. During this time the female will stay hidden in dark crevices.

For photographs See:
- Furlong, Marjorie and Virginia Pill. *Starfish*. Pg. 38
- Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate XV.

**Common Sea Star (Pisaster ochraceus)**

Range: Alaska to Baja California.

Habitat: Rocky beaches, floating docks of pilings.

Size: 12 inches

Color: Shades of purple, brown, and orange. In the southern part of its range Common Sea Stars are dominantly orange colored, whereas in the northern part of its range the Common Sea Stars is dominantly purple colored.

For photographs See:
- Furlong, Marjorie and Virginia Pill. *Starfish*. Pg. 34
- Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate XIII.
Phylum Echinodermata - The spiny-skinned animals

Equal-rayed Starfish (Mediaster aequalis)
Other common name: Vermilion Star
Range: Alaska to southern California.
Habitat: Found during extreme low tides in several kinds of beach such as sand, gravel, rocks or shell.
Size: 3-7 inches
Color: Bright red above, orange below. Tube feet red with flesh-colored suction cups. Upper surface covered with mail of raised calcareous plates. Pedicellariae present on both surfaces.

For photographs See:
Furlong, Marjorie and Virginia Pill. Starfish. Pg. 28

Leather Star (Dermasterias imbricata)
Range: Alaska to California.
Habitat: Rock areas at low tide. Prefers sheltered bays.
Size: 8-10 inches
Color: Blue-green and mottled with dull rusty red. Much variation. Underside yellow.

Distinguishing characteristics: The disc is extremely broad and thick, and is not well marked off from the five short rays. Leather Stars are smooth and slimy because the bony internal structure does not protrude to the surface of the skin. Leather Stars also excrete a mucus coating. The yellow madreporite is very conspicuous on this species (many people think it is an injury).

Another characteristic of the species is the upturned tips of the rays. In the water, the Leather Star's upper surface looks like corduroy because of the skin gills. These skin gills are retracted at the slightest hint of danger.

For photographs See:
Furlong, Marjorie and Virginia Pill. Starfish. Pg. 32
Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Plate XV.
**Pink Sea Star (Pisaster brevispinus)**

Other common names: Pink Short-spined Starfish, Giant Pink Star

Range: Alaska to California.

Habitat: Below low tide areas. Found in rocky, sandy, muddy areas on the ocean floor or in estuaries.

Size: 2-3 feet. The 1968 World Starfish Grapple on Hood Canal judged this starfish species as the largest but the 24-rayed Star (*Pycnopodia helianthoides*) is also quite large.

Color: Rose pink, sometimes with sage green or purple shadings.

Food and Food Habits: Sand dollars are this species favorite food. Sand dollars know it, too, for if a Pink Sea Star is put into their midst, all the sand dollars in an area two to four feet from the starfish will quickly burrow into the sand. Strangely enough, sand dollars can distinguish between starfish species. Those starfish species that do not prey on sand dollars can move right over them and will not disturb them.

For photographs See:
Furlong, Marjorie and Virginia Pill. *Starfish*. Pg. 65

**Six-rayed Starfish (leptasterias hexactis)**

Range: Puget Sound to southern California.

Habitat: Rocky beaches or in eelgrass beds.

Size: 2 inches.

Color: Usually dull green or gray above, sometimes rosy pink. Pale yellow below.

Food and Food Habits: Feeds almost exclusively on the small snail *Lacuna* found in eelgrass beds.

Reproduction: From December to March, mature individuals congregate in groups of one dozen or more under rocks. Both sexes spawn more or less spontaneously. As the female releases her eggs from the genital pores, she collects them again after fertilization with her tube-feet and draws them underneath her humped up body. For sixty days, the mother does not eat while she broods her young. By the end of this period the young will have attained a size of 1 mm and the mother leaves them.

For photographs See:
Furlong, Marjorie and Virginia Pill. *Starfish*. Pg. 57
Phylum Echinodermata - The spiny-skinned animals

Slender-rayed Star (Evasterias troschelii)

Other common name: Mottled Star

Range: Rocky beaches, floating docks and pilings.

Size: 2 feet

Color: Mottled shades of brown, blue, green, or red.

Distinguishing characteristics: Slender-rayed Stars usually have a small disc with five long slender rays. When picked up, their skeletal framework is fairly stiff and if left out for long the papulæ are withdrawn leaving deep pitlike areas because of their internal skeleton. This species' madreporites are also fairly conspicuous.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate XIII.

Sun Star (Solaster stimpsoni)

Range: Alaska to California.

Habitat: Beyond low tide on rocky shores.

Size: 5-15 inches

Color: Bright orange with a gray disc and a gray line extending down the center of each ray. Upper surface is gray with a central white stripe.

Distinguishing characteristics: Eight-ten slender rays. Upper surface covered with evenly spaced, short, blunt spines.

Food and Food Habits: Favorite food is other starfish, especially Slender-rayed Stars.

For photographs See:
Furlong, Marjorie and Virginia Pill. *Starfish*. Pg. 43
**24-rayed Star (Pycnopodia helianthoides)**

Other common names: Sunflower Star, Many-rayed Star

Range: Alaska to California.

Habitat: Found only during low minus tides on rocky beaches or on the ocean floor.

Size: 2-3 feet. One of our largest starfish, along with the Pink Sea Star.

Color: Purple to mottled gray on disc down the center of the rays. The rest of the body is salmon pink. Many times these starfish will have an orange blush to them.

Distinguishing characteristics: 20-24 rays. Young 24-rayed Stars begin life with six rays and grow additional rays between existing ones. Rays break easily. Thick clusters of pedicellariae found on upper surface. Skeleton not rigid, very limp when picked up.

Food and Food Habits: Voracious feeder. Will eat anything it can find. Many invertebrates definitely fear this starfish. The normally lethargic California Sea Cucumber (*Parastichopus californicus*) will go into a writhing gallop to escape the 24-rayed star. Some bivalves, stimulated by the prospect of being eaten will quickly burrow into the sand. Sea urchins will extend their pedicellariae and direct their spines towards the attacker.

Locomotion: The 24-rayed Star is sometimes described as the "fastest thing on tube-feet." This starfish's ability to move so quickly is due to its estimated 40,000 tube-feet.

For photographs See:

Furlong, Marjorie and Virginia Pill. *Starfish.* Pg. 55

**Class Echinoidea - Sea Urchins**

Range: Worldwide

Habitat: Rocky shores, oceans bottoms

Size: 2-10 inches

Color: White, brown, black, green, purple, red

Distinguishing characteristics: A live sea urchin is usually globular in shape and covered with long thin spines. Often the remains of a dead sea urchin can be found along our beaches in the form of a test (skeleton or shell). It is interesting to examine the test of a sea urchin. The little bumps, or tubercles, are the points from which the spines articulate. The five double rows of pin-point holes are where the tube-feet peek out from inside the body. The rounder side is the top with the anus located in the center, and the flatter side is the both with a centrally located mouth.
Phylum Echinodermata - The spiny-skinned animals

Senses: All tube-feet on urchins are used not only as locomotor organs but also as tactile organs. Urchins also have specialized organs for seeing and tasting. Located on the top of the urchin near the center are five ocular plates with small tube-feet specially adapted for sight. Specialized tube-feet for tasting are found on the lower surface near the mouth.

Locomotion: It may not appear that urchins would be capable of movement, but like the starfish, urchins can move fairly rapidly in any direction. Both the spines and tube-feet are used for locomotion, but depending on the species, one organ may be used more than the other. The urchin’s spines are easily identified appendages, but their tube-feet are not always readily visible. To locate these appendages simply watch an undisturbed urchin in the water. The thin hairlike appendages which extend beyond the spines are the tube-feet. To see how tube-feet operate see general information on echinoderms.

Some species depend more on their spines for locomotion than they do on their tube-feet. The muscle-operated spines articulate with small bumps or tubercles on the test, forming a ball and socket-like joint. If broken off, these spines cannot be regenerated, so sea urchins should be handled with care.

It is fun to hold an urchin. Most people will pick one up and remove it from the water. Try holding the urchin on the palm of your hand underwater and watch the tube-feet come out. Can you feel its suction cups attach to your hand. Another interesting thing to do is to turn an urchin over on its back and watch it right itself. You may wonder how the urchin can tell it is upside down. Modified spines called spheridia function in maintaining the urchin’s equilibrium.

Food and Food Habits: Sea urchins feed on seaweed and minute organisms. The mouth on the undersurface if the body consists of five toothed plates which chew food into bite-sized pieces. The food is then swallowed and digested internally. Waste products are released through the anus located in the center on top of the urchin.

Several methods are used by urchins to attain food. One method is to simply climb on top of the food and begin eating. Urchins can also find food using their spines and tube-feet. Try feeding an urchin a piece of fish. Hold the food near the urchin’s spines on its upper surface. Watch as the urchin grabs hold of the food using the suction cups on its tube-feet and its spines as chop sticks. Once the urchin has a hold on the food it will slowly "pass the buck" from tube-foot to tube-foot until the food reaches the mouth on the under surface.

Respiration: Respiration is the process of taking in oxygen and releasing carbon dioxide. Urchins do this in two ways. The primary means of respiration is five groups of modified tube-feet located around the mouth which serve as gills. The thin walls of these gills allow an exchange of gases to take place. Regular tube-feet used for locomotion provide a secondary means of respiration.
Reproduction: Reproduction in sea urchins usually takes place in spring or summer. A rise in temperature will cause one urchin to spawn and this in turn will stimulate other urchins to follow suit. The sexes are separate but not distinguishable externally. Male and female urchins will release their sexual products into the water through genital pores located around the anus. Male products are white and female products are colorless.

A fertilized egg becomes free-swimming within 12 hours. For several months the free-swimming larva will feed on microscopic plankton, then it will settle to the bottom and within one hour it will metamorphose into a miniature urchin. This little urchin will gradually increase in size by depositing a new layer of shell on the outside of the test and by absorbing the old shell from within.

Natural Defenses: Strong suction of tube-feet protect from wave action. The hard test, spines and three-jawed pedicellaria protect urchins from many would-be predators. Regeneration of tube-feet is also helpful in protecting the life of a sea urchin.

Predators: Starfish, fish, sea otters, seagulls, crows (during low tide) and man.

Use to Man: All species are edible. They are commonly eaten by people in Europe, the West Indies, Australia, and the Orient. Some American Indian tribes included urchins in their diet also. The roe (eggs) or gonads are eaten either raw or cooked. See "Edible? Incredible!" by Furlong and Pill.

Harm to Man: Urchins are a menace to commercial kelp beds in California because they eat through the stalks of young plants. Some tropical species are poisonous.

**Red Urchin (Stronglycentrotus franciscanus)**

Range: Alaska to California

Habitat: Deep water. Seldom seen at lowest tides.

Size: 8 inches

Color: Red or purple.

Distinguishing characteristics: The Red Sea Urchin is much larger in size and has longer spines than the Purple Sea Urchin.

Purple Urchin (Stronglycentrotus purpuretus)

Range: Washington to southern California
Habitat: Very common on rocky beaches.
Size: 4 inches
Color: Purple. Young specimens sometimes greenish.

Distinguishing characteristics: Small in size. Spines shorter than Red Urchin.

For photographs See:


Class Echinoidea - Sand Dollars

Sand Dollar (Dendraster excentricus)

Range: Alaska to California
Habitat: Sandy beaches or bays.
Size: 4 inches
Color: Dark purple brown. Turn green when out of water for long.

Distinguishing characteristics: A live sand dollar is much like a flat sea urchin. The body is covered with delicate short spines making it soft to the touch. Most people are more familiar with the sand dollar shell or test than they are with the live animal. Looking at the sand dollar test the mouth can be found in the center of the flat undersurface. Unlike the sea urchins, the anus is found on the same side as the mouth and is located near the edge of the sand dollar. When a sand dollar test is shaken the little “doves” inside are actually the sand dollar’s teeth.

Senses: Like the sea urchins, sand dollars use their tube-feet as tactile organs. Sand dollars also have specialized tube-feet on their upper surface for seeing, and feet around the mouth for tasting. The combined abilities of these sensory organs apparently protect sand dollars from their predators.

Locomotion: Sand dollars use both their spines and tube-feet for locomotion. The short delicate spines articulate with small tubercles or bumps on the surface of the sand dollar test, and are controlled by muscles. Sand dollar tube-feet are much more delicate than those of the sea urchin. Unlike the tube-feet openings on the sea urchin tests, the holes are hardly visible on sand dollar tests. Also unlike sea urchins, sand dollars only move in one direction, that is in the direction away from the anus.
Food and Food Habits: Sand dollars feed on microscopic organic matter. As sand dollars move through the sand or mud which is their home, small hairlike cilia on their spines collect mud and sand particles. The cilia move the particles to the mucus covered body of the sand dollar, then down small grooves on the undersurface to the mouth. These grooves are readily visible on the test of a sand dollar. Indigestible material is either excreted from the anus or through the thin membranes of the tube-feet.

Respiration: The sand dollar’s means of breathing is different than the sea urchin’s because of its habit of hiding under a layer of sand or mud. Specialized tube-feet located on the upper surface of the sand dollar extend through the covering layer of silt to the oxygen rich water above.

These tube-feet are much larger than all the locomotor tube-feet, thus the tube-feet holes in the test are readily visible. These holes form the flower design on the upper surface of the sand dollar test.

Reproduction: See reproduction of sea urchins.

Natural Defenses: The sand dollar had several means of protection. Its coloration and habit of burying itself are the sand dollar’s major means of protection. As other echinoderms, sand dollars also possess spines and pedicellaria.

Predators: Starfish, crabs, fish, man.

Use to Man: Can use to make indelible ink.

Harm to Man: None

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago.* Pg. 214.

**Class Holothuroidea - sea cucumbers**

Range: Worldwide

Habitat: Some burrow in sand or mud, some hide in rocky crevices. One species is pelagic.

Size: 1 inch to 3 feet

Color: White, brown, orange, red, green, black

Distinguishing characteristics: Sea cucumbers vary in shape. Some are nearly spherical, many are long and wormlike. All are very soft and saclike. Unlike most echinoderms, Sea Cucumbers are bilaterally symmetrical rather than radially symmetrical. The mouth is located at one end and the anus at the other. Most Sea Cucumbers possess 10 to 30 retractable, featherlike tentacles around the mouth.

Longitudinal lines divide the body into five sectors. These lines correspond to the five rays of a starfish. Each longitudinal line has a row of tube-feet connected to it. Many Sea Cucumbers possess only three rows with functional tube-feet. This side is the Sea Cucumber’s underside. Some Sea Cucumbers had modified upper surface tube feet which function as tactile and respiratory organs.
Phylum Echinodermata - The spiny-skinned animals

Senses: Sea Cucumbers, like all other echinoderms, are sensitive to light and dark. Photoreceptive cells are scattered over the body. The tube-feet also serve as tactile organs.

Locomotion: Sea Cucumbers move by using their tube-feet and muscular movements similar to those of an earthworm.

Food and Food Habits: Some Sea Cucumbers collect detritus and plankton with their mucus covered oral tentacles. Periodically, the tentacles are retracted and the food particles are licked off inside the mouth. Other Sea Cucumbers, lacking these tentacles, use their tube-feet to collect food.

Respiration: The respiratory process begins at the anus. Water is pumped through the anus to a muscular organ called the cloaca. A madreporite, or sieve plate, is located on the cloacal wall. Water is forced through the madreporite into a pair of minutely branched vessels called the respiratory trees. These respiratory trees bring oxygen to all parts of the body. Sea Cucumbers that possess dorsal tube-feet will also use these organs for respiration. If the water has a low oxygen content, Sea Cucumbers will move to the surface and position their anal end near the surface to breathe.

Reproduction: The sexes are separate in Sea Cucumbers, as in other echinoderms. The sexual products are released into the water through genital pores near the oral tentacles. The rest of the process is much the same as for starfish and sea urchins. Some species (none native to the Pacific Coast) brood their young.

Natural Defenses: Sea Cucumbers, unlike other echinoderms, lack pedicellariae, spines, or a hard shell. Instead, some Sea Cucumbers excrete poison, and some expel their internal organs. By expelling their internal organs, some Sea Cucumbers entangle their would-be predators. This process of expelling internal organs is called evisceration. It is caused by the contraction of the Sea Cucumber. Contracting puts pressure on the body wall because, even though the body wall contracts, the water inside does not. Thus the wall ruptures near the anus and the internal organs fall out.

Oregon Coast species can expel their organs. Some believe that this adaptation is a means of protection, hopefully the predators will be too busy eating the expelled organs to bother the Sea Cucumber. After expelling its internal organs a Sea Cucumber is able to regenerate the lost organs in one to two months.

Predators: Rarely eaten by any animal besides man.

Use to Man: Muscle fibers used as food by Orientals, South Sea Islanders and Northwest Indians. The Chinese boil, then dry the muscle fiber, and market it as a "trepang" or "beche-de-mer". It is commonly used in soups and has a reputation of being an effective aphrodisiac.

Harm to Man: None
California Sea Cucumber (Parastichopus californicus)

Range: Alaska to Mexico
Habitat: Rock crevices.
Size: 15 inches
Color: Dark reddish brown above, lighter below

Distinguishing characteristics: Body surface covered with pointed, fleshy warts. Possess only three rows of tube-feet. Several branched, disc-tipped, white feeding tube-feet surround the mouth. These tube-feet collect detritus and are periodically inserted into the mouth to be licked clean.

Use to Man: Animals of this species were once canned and marketed in this country under the name of "sea rollops".

For photographs See:
Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Plate XVII.

White Sea Cucumber (Eupentacta quinquesemita)

Range: Alaska to California
Habitat: Found on floats or hidden among tube worms and mussels in rock crevices.
Size: 3 inches long
Color: White to cream-colored with tinges of orange.

Distinguishing characteristics: Possess all five rows of tube-feet. The three rows on the lower surface are used for locomotion and the other two rows are used for feeling and breathing. The White Sea Cucumbers also possess retractable oral tentacles used in feeding.

For photographs See:
Ricketts, Calvin, Hedgpeth. Between the Tides. Pg. 271.
**Red Sea Cucumber (Cucumaria miniata)**

<table>
<thead>
<tr>
<th>Range:</th>
<th>Alaska to California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat:</td>
<td>Found on floats or in rock crevices. Many times only the red oral tentacles are visible between the rocks.</td>
</tr>
<tr>
<td>Size:</td>
<td>6-10 inches</td>
</tr>
<tr>
<td>Color:</td>
<td>Body reddish or reddish brown. Oral tentacles bright orange.</td>
</tr>
<tr>
<td>Distinguishing characteristics:</td>
<td>Posess all five rows of tube-feet. The three rows on the lower surface are used for locomotion and the other two rows are used for feeling and breathing. The White Sea Cucumbers also possess retractable oral tentacles used in feeding.</td>
</tr>
</tbody>
</table>

For photographs See:

- Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate XVII and XVIII.
- Ricketts, Calvin and Hedgpeth. *Between Pacific Tides*. Pg. 271.
Phylum Mollusca - The Soft Bodied Animals

Six classes are included in the phylum Mollusca. They are:

- Class Amphineura - chitons
- Class Monoplacophora - Neopilina. These are newly discovered deep water mollusks that somewhat resemble the chitons.
- Class Gastropoda - snails, whelks, conches, nudibranchs, limpets
- Class Scaphopoda - tuck or tooth shells
- Class Bivalvia (also known as Plicypoda) - clams, mussels, oysters, scallops
- Class Cephalopoda - octopuses, squids, cuttlefish, nautili

This text will include information on classes Amphineura, Gastropoda, Bivalvia, and Cephalopoda.

With over 80,000 living species having been described, the phylum Mollusca is second in size only to the arthropods (crabs, lobsters, spiders, etc.). Most mollusks are marine animals, living along seashores or in shallow waters, but some occur down to 35,000 feet. Various snails and bivalves inhabit brackish water and fresh water, while other snails and slugs are terrestrial.

A concise definition of a mollusk is difficult to state, because although they share many common characteristics, the animals in this group differ greatly in appearance. However, it can be said that most mollusks are bilaterally symmetrical animals characterized by soft unsegmented bodies. The body generally consists of an anterior head (except in Scaphopoda and Bivalvia), a ventral foot, and a dorsal visceral mass which contains most of the animal's organs. Surrounding the body is a thin fleshy mantle that, in most species, secretes a protective external shell. In a few species the shell is internal, while in other it is completely lacking.

If the shell is in one piece, the animal is known as a univalve (snails, limpets). An animal with a hinged shell consisting of two halves is called a bivalve (clams, oysters, etc.). The chitons' shells are made up of eight separate overlapping plates. As a mollusk grows, it increases the size of its shell by secreting a liquid from a complicated system of glands around the edge of the mantle. The liquid contains carbonate of lime and other inorganic materials which harden when discharged.

Periods of rest most always follow periods of growth. During inactive periods, the animal thickens the edge of its shell to protect it against injury. When it begins to build again these thickened edges appear as raised lines of growth.

Mollusks possess a muscular foot. In some species such as the snails and chitons, it is a broad, flat organ upon which the animal creeps along. Clams, on the other hand, have a wedge-shaped foot which is an effective digging or burrowing tool. The muscular foot of the octopuses and squids is modified into long sucker-bearing tentacles.

A unique molluscan characteristic is the radula. This tongue-like organ is not present in all mollusks, but it is found nowhere else in the animal kingdom. The upper surface of the radula is covered with rows of teeth that the animal uses to scrape bits of food off of rocks. The pattern formed by the radular teeth in each species is usually characteristic and serves as a test for accurately distinguishing between species.
Class Amphineura - Chitons

Range: Worldwide. Approximately 600 species known.

Habitat: Occur at all depths up to about 4000 meters. Some live high in the intertidal zone, moistened only at full tide, but are especially abundant in shallow water in rocky areas.

Size: 1/2 inch to over 12 inches

Color: Mostly drab, dull shades of red, brown, black and buff, though under a lens they often turn out to be beautifully patterned.

Distinguishing characteristics: The chiton shell is divided into eight overlapping plates. The loose spaces between the plates allow the chiton to roll up in a ball when picked up. The plates are kept in place by a leathery girdle encircling the margin of the chiton. In the Gumboot Chiton, the girdle completely covers the shells.

Senses: Sense organs are poorly developed in the chitons. Under the anterior margin of the girdle is the small head which contains the mouth, but no eyes or tentacles are present. The only specialized organs are the subradula organ which is used to detect food, and mantle sensory cells called aesthetes.

In some species the aesthetes are merely tactoreceptors which make the chiton sensitive to touch. Other chitons possess more complex aesthetes consisting of bundles of sensory cells that form an ocellus or “shell eye.” These shell eyes, which number in the thousands on an individual’s anterial shell plates, are responsible for some young chitons’ negative response to light. As the animals grow older, this response may disappear as the aesthetes become covered by organisms encrusting the shells.

Locomotion: The chiton’s broad flat foot occupies most of its ventral surface and is used for attachments to rocks as well as for locomotion. Chitons are very sluggish animals and if adequate food is available, they may remain in one spot for an extended period of time.

Food and Food Habits: Chitons are herbivores. The subradula organ is first protruded and then applied against the rock. If food is present, the radula projects from the mouth and begins to scrape off small bits of seaweed. Chitons do most of their feeding at night or in foggy weather.

Respiration: Between the mantle and the foot is what is known as the mantle cavity. Within this cavity, on either side of the chiton, is a row of gills. The edge of the mantle is lifted slightly in front allowing water to enter.

The mantle wall is covered with small hairs or cilia which draw the water in and pass it posteriorly between the gills and the mantle. Cilia on the gills create currents that sweep water over them. The water continues to flow posteriorly and departs at one or two points at the rear where the mantle is slightly lifted.
Reproduction: The sexes are separate in chitons, but females deposit their eggs in various ways. In one species, as soon as the male has liberated the sperm in a tide pool, the female begins to shoot eggs into the sperm. She discharges eggs at a rate of 1 to 2 per second for 15 minutes, making a total of 15,000 eggs, each 1/100 inch in diameter.

In seven days, young chitons, measuring 1/20 of an inch in length are hatched. Some species lay their eggs separately, each one enclosed in a sort of sac. In other species, the eggs are in gelatinous strings which are attached to various objects. A few species retain the eggs in the mantle cavity while they undergo development, and in one species the eggs develop in the oviduct of the mother. The eggs of all species hatch into free-swimming larvae. After several weeks the animal settles to the bottom.

Natural Defenses: The chiton’s broad flat foot enables the animal to cling tightly to smooth rocks so as to avoid being washed away by wave action. Another defense mechanism is the chiton’s ability to roll up in a ball when dislodged, its eight plates forming a protective shell. Finally, the chitons’ drab coloration helps them blend with the rocks on which they live.

Predators: Man

Use to Man: Chitons are edible either raw or when ground up for chowder or patties. They were used widely by Northwest Indians for food, as well as by Russian settlers in Southeast Alaska. In the West Indies, chitons are eaten as "sea beef."

Harm to Man: None
Lined Chiton (Tonicella lineata)

Range: Alaska to central California
Habitat: Rocky shorelines, in crevices of in burrows of sea urchins.
Size: 1-1/2 inches long, 1 inch wide
Color: Background color light buff or yellow, marked with wavy dark brown lines, occasionally plates are an even brown.

Distinguishing characteristics: The eight plates marked with regularly spaced wavy lines.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate VII.

Black Leather Chiton (Katharina tunicata)

Range: Alaska to central California
Habitat: Undersides of rocks at low water mark and in shallow water in tide pools.
Size: 3-1/2 inches long, 1-1/2 inches wide
Color: Exposed part of plate is brown, foot and other soft parts are salmon colored.

Distinguishing characteristics: The black leathery girdle nearly covers the plates, leaving only about 1/3 of the width of the shell exposed.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Pg. 140.

Gumboot Chiton (Cyptochiton stelleri)

Range: Alaska to central California
Habitat: Rocky intertidal areas, found crawling on reefs among rocks and seaweed.
Size: 8-13 inches long, 4 inches wide
Color: Dull red.

Distinguishing characteristics: Its large size (the largest of all chitons) and its color. Also, the thick, red, leathery girdle completely covers the shell plates.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate VII.
Class Gastropoda - Snails, Whelks, Conches, Nudibranchs, Limpets, Abalone

Range: Worldwide. Over 35,000 species have been described. The largest of the classes of mollusks.

Habitat: Marine species occur on ocean bottoms, along shores, and in open waters. Other species inhabit fresh water, while some have adapted to terrestrial life with the elimination of gills and the evolution of the mantle cavity into a lung.

Size: Range from nearly microscopic size to over 20 inches in length and height and 15 pounds in weight. The majority are less than 3 inches in length and height.

Color: Found in all colors, wither plain or with stripes, spots, or blotches.

Distinguishing characteristics: The most obvious external feature of most gastropods is the shell which is usually coiled and often beautifully colored and marked. The head is distinct and usually bears one or two pairs of tentacles.

Senses: The eyes of the gastropod may be near the base of its tentacles or halfway out of them, but marine gastropods never have them at the tips of the tentacles as land gastropods do. The eyes of the various species shown great differences in complexity of structure. Some are simple depressions in the skin, lined with pigmented, retinal cells, while others are complex eyes comparable to those of fish. Most gastropods are light sensitive, but do not form images.

Tactile cells are scattered all over the surface of the gastropods’ body, but are concentrated in regions of high sensitivity, such as the head, the margin of the foot, and sometimes the edge of the mantle. The tentacles are also well supplied with tactile cells. A patch of sensory cells, the osphradium, occurs at the base of the cach cell. The osphrodia apparently function in an olfactory capacity and seem to be the sense organs that test water flowing into the mantle cavity that is used in respiration. Osphradia also aid the gastropod in detecting enemies and in finding food.

Most gastropods possess tiny fluid-filled sacs called otocysts. Located in the gastropod’s foot, the otocysts, which are lined with sensory cilia, enable the gastropod to preserve equilibrium and a sense of direction.

Locomotion: Gastropods possess a broad, flat foot upon which they can creep. Glands located in the foot secrete a rich supply of slimy mucus that lubricates the surface over which the gastropod is travelling, thus making movement easier.

Food and Food Habits: Gastropods exhibit widely varied eating habits. The herbivorous gastropods possess a radula with which they scrape the file of plant growth off the rocks on which they live. A few gastropods possess jaws which they use to eat larger seaweeds.
Several types of snails bore through the shells of oysters and other mollusks to obtain food. Boring is accomplished by using both the radula and a secretion from glands in the foot. A spot on the shell of the prey is soaked with the secretion, softening it, so that the radula can rasp more effectively. Throughout the boring process the shell is alternately soaked with the secretion and rasped until an opening is made in the shell, thus exposing the meat inside.

A few gastropods are parasites. They have no radula or jaw, but possess a highly developed proboscis, used to attach to the host and pump body fluids from it for nourishment.

Respiration: Most gastropods possess plume-like gills for respiration. They are located in a cavity within the mouth of the shell, above the animal’s head. Water is pumped in and out over these gills by means of cilia. Since in most gastropods the cavity is a dead end at the top, the water passes in, makes a turn and flows out again through a single opening near the head.

Most carnivorous gastropods have a more or less closed tube called a brachial siphon that channels water to the gills. Many shells have a tubelike prolongation of the shell called the canal for protecting the siphon.

Reproduction: About half the gastropods are hermaphroditic, each individual having a complete set of male and female organs. In these species, reproduction is preceded by a mating performance between two individuals, during which a calcoreous (hardened) "dart" from each is fired into the body of the other.

Reciprocal copulation follows, the penis of each being inserted into the vagina of the other for transfer of the sperm; the two animals then separate. Each later deposits one or more batches of gelatinous-covered eggs. Development takes many days, the ova first hatching then passing through two larval stages before taking their final adult form.

Of the remaining gastropods, certain families or genera may be hermaphroditic, but there is often great variation within a group, for one species of a genus may be hermaphroditic and anothe unisexual.

Natural Defenses: Most gastropods have a hard shell into which they can withdraw for protection, and may have a permanent plate (operculum) to cover the opening. If the shell is damaged, it can be repaired with deposits of lime from the mantle.

Gastropods, like all mollusks, can regrow a portion of a foot, a lost eye or a tentacle. Certain species are said to deliberately amputate an injured part of the body if it is hurt beyond repair.

Predators: Fish, aquatic birds and mammals, man

Use to Man: Various species, such as the abalone and certain snails, are utilized as food.

Harm to Man: Some species are carriers of a type of parasite that infects man and domesticated animals. The predatory habits of other species cause tremendous damage to oyster beds.
**Black Turban Snail (Tegula funebralis)**

Range: British Columbia to Baja, California  
Habitat: Rocky shorelines  
Size: 1-1/2 inches across  
Color: Black, sometimes with a purple tinge  
Distinguishing characteristics: The top of the shell is nearly always eroded away exposing a pearly surface. The shell is a low, depressed spire.  
For photographs See: Rice, Tom. *Marine Shells of the Pacific Northwest*. Pg. 35.

**Northern Moon Snail (Polinices lewisi)**

Range: British Columbia to lower California  
Habitat: Continental shelf and muddy beaches  
Size: 3-4 inches in diameter  
Color: Shell is grayish-beige, sometimes covered with a thin layer of greenish algae.  
Distinguishing characteristics: The foot is of enormous size and when fully extended seems to be far too large to ever be stowed away in the shell. Also, the growth lines are distinct, forming six convex swirls on the shell.  
Food and Food Habits: The moon snail is a pure carnivore, feeding on clams, mussels, and other mollusks. The radula, with the aid of secreted enzyme, drills a hole in the shell and sucks the tissue out.  
Reproduction: During the spring and summer, the moon snail secretes a continuous gelatinous sheet in which the eggs are embedded. As fast as the sheet emerges, it is covered with sand grains cemented together with a slimy secretion. The sheet of eggs takes the form of a collar, the molding of it done over the snail's large foot. The eggs are so minute, that they can't be distinguished from the sand grains. When the collar is finished, the moon snail moves out from under it, leaving the egg case on the sand. The collar is so well made, that it withstands the beating of the tides for several weeks. Eventually it disintegrates and the young moon snails swim away in the currents by means of cilia. In moon snails, male and female products are in the same animal, which spawns according to the moon and tides.  
Predators: Other moon snails and the many-rayed star.  
For photographs See: Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Pgs 215, 216.
**Opalescent Nudibranch (Hermissenda crassicornis)**

Range: Alaska to southern California

Habitat: Rocky shorelines, among seaweeds, pilings

Size: 1-2 inches long, 1/2-inch wide

Color: Plume-like projections are reddish-brown with a bright red spot at the tip of each. Projections are iridescent at the base.

Distinguishing characteristics: The coloration of the plume-like projections on its back as described above. Also, the lack of a protective shell.

Senses: The nudibranch has tentacles around its mouth that have the ability to discriminate in taste and smell. The tentacles on the dorsal surface lack this ability.

Food and Food Habits: Most nudibranchs live on seaweeds, but some feed on other mollusks, eggs of various sorts, pieces of fish, and tube-like animals called hydroids.

Respiration: Nudibranchs have no true gills. Respiration is carried on through plume-like projections on the dorsal surface called cerata.

Reproduction: Nudibranchs are hermaphroditic -- copulation being reciprocal. Eggs are laid in a gelatinous cord-like ribbon which it hangs over a rock or on eelgrass. Although nudibranchs lose their shell as adults, embryos always possess a small coiled shell.

Natural Defenses: Some of the stinging capsules the nudibranch ingests with the hydroids it feeds upon are concentrated in the tips of its plume-like gills. This phenomenon probably serves as a defense mechanism for the nudibranch. Color adaptation also serves as protection.

Predators: Larger sea slugs (Navanax).

Use to Man: None, except that the nudibranch’s soft body and delicate colors make it very pleasing to the eye.

For photographs See:

Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate VIII.
### Red Abalone (Haliotis rufescens)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>California to Mexico</td>
</tr>
<tr>
<td>Habitat</td>
<td>Rocky shorelines below tide level</td>
</tr>
<tr>
<td>Size</td>
<td>10-12 inches</td>
</tr>
<tr>
<td>Color</td>
<td>Maroon, green, pink, orange, black. Growths encrusting the shell often obscure its color.</td>
</tr>
<tr>
<td>Distinguishing characteristics</td>
<td>The Red Abalone has a large, flattened spiral shell that is less convex than those of other abalones. The outside of the shell is sculptured with low irregular radiating waves.</td>
</tr>
<tr>
<td>Locomotion</td>
<td>The Red Abalone is a sedentary species, spending most of its time clinging to rocks with the aid of its large muscular foot.</td>
</tr>
<tr>
<td>Food and Food Habits</td>
<td>The abalone uses its radula to scrape seaweed off of the rocks on which it lives, and also consumes quantities of larger seaweeds. The abalone had long tentacles projecting from the edge of its mantle that are sensitive to food. If a piece of seaweed touches any of them, the animal whirls around to grasp it with the anterior end of its foot, which is tapered and prehensile. The seaweed is then drawn under the forward half of the foot where it is held while the animal eats it.</td>
</tr>
<tr>
<td>Respiration</td>
<td>The abalone’s mantle cavity is located on the left side of its body. The shell above the cavity contains a line of holes. The mantle is divided along the line of perforations, and the edges of the mantle fit together and project into the shell openings to form a lining for each hole. Water is brought in at the anterior of the body by the action of the cilia lining the gills. The gills divide the mantle cavity into two chambers, a lower one into which the water flows (inhalant) and an upper one from which the water is expelled from the abalone’s body (exhalant). The water flows into the inhalant chamber, through the gills and into the exhalant chamber from which it is expelled through the perforations in the shell.</td>
</tr>
<tr>
<td>Reproduction</td>
<td>The Red Abalone reproduces in much the same manner as as the limpets. The abalone discharges its spawn through the line of respiratory vents in its shell.</td>
</tr>
<tr>
<td>Natural Defenses</td>
<td>The abalone, like most other gastropods, possesses a hard protective shell.</td>
</tr>
<tr>
<td>Predators</td>
<td>Man</td>
</tr>
<tr>
<td>Use to Man</td>
<td>Abalones are used as food in the western United State and Japan. The colorful pearly layer inside the shell is used for making jewelry.</td>
</tr>
<tr>
<td>Harm to Man</td>
<td>None</td>
</tr>
</tbody>
</table>

For photographs See:  
Rough Keyhole Limpet (Diodora aspera)

Range: Alaska to lower California

Habitat: Rocky shorelines

Size: Length to 3 inches

Color: Drab gray, sometimes white with brown rays.

Distinguishing characteristics: The Keyhole Limpet has a high, arched shell with a small oval or nearly circular hole at the apex.

Locomotion: Limpets glide about in search of food, but always return to their original home when the tide begins to go out. The greatest distance a limpet is known to have wandered from its home is three feet, but no matter which direction it moves, it always finds its way back again. Definite scars on the rock mark the limpet's home.

The outline of the scar corresponds exactly to the shape of the shell, so the limpet always orients itself facing the same direction. The scar is created by mechanical action of the limpet's foot. It is unknown where the limpet's sense of direction lies. The trail of slime it leaves behind when it moves may help it retrace its "steps".

Food and Food Habits: The limpet feeds on seaweed, and it has been estimated that a limpet one square inch in diameter will need about 75 inches of encrusting seaweed to sustain it during one year of life.

Respiration: Keyhole Limpets have a hole at the top of the shell so that the water can come in near the head and go out through the hold, making an almost straight passage across the gills. Wastes are also discarded through the perforation, and thus, contamination of the in-current water is avoided.

Reproduction: Little is known about the reproductive habits of limpets. The sexes are separate and young are hatched as free-swimming larvae. Unlike snails that enclose their eggs in gelatinous capsules, female limpets simply throw their eggs into the water.

It is not certain as to whether the eggs are fertilized inside or outside the female's body. Young larvae drift in surface plankton for some time before settling down on rocks. Apparently all young limpets are males, later becoming females.

Natural Defenses: When the limpet is exposed on the rocks above the tide-mark, moisture is retained in a little groove just inside the shell. This water helps keep the gills bathed until the tide returns.

Class Bivalvia (Pelecypoda) - Clams, Mussels, Oysters, Scallops

Range: Worldwide. 20,000 species known

Habitat: All aquatic, mostly marine. A few species creep slowly on the bottoms of estuaries and along rocky shorelines. Most burrow in sand or mud, or attach to solid objects.

Size: Shells range in size from tiny seed shells of a certain fresh water bivalve, which generally doesn’t exceed 2 mm in length, to the giant clam of the South Pacific which attains a length of over four feet and may weigh over 500 pounds.

Color: All colors and combinations of colors exist.

Distinguishing characteristics: Bivalves are all laterally compressed and possess a shell with two hinged valves. The foot is also laterally compressed and the head is greatly reduced in size.

Senses: Most of the bivalves’ sense organs are located on the margin of the mantle. In many species, the mantle edge bears pallia (the area where the shell is attached to the mantle) tentacles which contain tactile and chemoreceptor cells. The entire margin may bear tentacles, or more commonly, they may be restricted to the inhalant or exhalant siphons.

A pair of statocysts, which help the animal maintain its equilibrium and sense of direction, is usually found in bivalves and is located in or near the foot.

Ocelli or "shell eyes" may be present along the mantle in certain species. In Pecten, these ocelli are well developed with each eye consisting of a cornea, a lens, and a retina. The eyes of Pecten probably can’t form images, but they can detect sudden changes in light intensity.

The scallop has developed an escape response to a certain predatory sea star. Even a small bit of the sea star brought near the mantle margin will trigger rapid swimming movements by the scallop.

Locomotion: Many bivalves can move over the mud or sand by extending the foot and then contracting the muscles violently so that the foot acts as a spring. Other bivalves can dig rapidly. The foot is extended and the tip worked into the mud. The foot is then contracted in such a manner that the end becomes bulbous and serves as an anchor while the body is being pulled into the mud or sand.

A few bivalves, mostly the pectens, or scallops, can swim. The pecten swims with the open edge of the shell forward. After the shell is opened and water is taken in, the mantle edges close the opening but the two valves are left apart. When the valves are brought together quickly, the water is forced out through openings near the hinge and the animal is propelled though the water.

Food and Food Habits: Bivalves secrete a sheet of mucus over their gills so that respiratory water propelled by cilia has to flow through the mucus as it enters the gills. The mucus acts as a strainer, letting the water flow through, but trapping particulate matter from it. Other cilia transport the particles to the mouth where they are ingested as food.
Phylum Mollusca - The Soft Bodied Animals

Respiration: In most species of bivalves, there are two well-developed siphons for controlling incoming and outgoing water currents. Through the lower of the two siphons, water flows into the mantle cavity and is carried into the gills by the beating of numerous cilia. From the gills, it flows out through the other siphon carrying waste products with it.

Reproduction: The sexes are separate in most bivalves. However, in some the animal may be male one season and female the next. In marine bivalves, the sex products are discharged into the water through the excurrent siphon, with fertilization taking place by chance. The fertilized egg develops into a free-swimming larva that eventually settles as it begins to change into its adult form.

Natural Defenses: In some cases, the bivalves' ability to burrow rapidly in mud or sand may save them from predators. For others, like the scallops, the ability to swim is effective in helping them escape from predatory starfish.

Predators: Fish with the ability to crush bivalve shells with their jaws, shore birds, drilling snails, man, and in some places, even monkeys use bivalves for food.

Use to Man: Most bivalves are used as food. The oyster is a source of valuable pearls.

Harm to Man: Some species may be the source of shellfish poisoning if eaten during the wrong season.

California Mussel (Mytilus californianus)

Range: Aleutian Islands to Baja, California
Habitat: Rocky shorelines.
Size: Up to 10 inches.
Color: Black, blue, brown.
Distinguishing characteristics: California mussels live in great clusters, and are frequently so numerous that they grow several layers deep, smother and poisoning one another by the accumulation of waste products. They are marked with irregular rings and conspicuous radiating ribs. Mussels are always attached in such a manner that the valves point downward.

Locomotion: Mussels are relatively stationary, but can move short distances by means of byssal threads. The foot is provided with what is called the byssal gland which secretes though fibrous threads that are glue-like when discharged, but harden in water. Threads are thrown out in the direction the animal wishes to go, then by contracting the muscle controlling the byssus, or group of threads secreted by the foot, the animal is drawn forward.

Reproduction: Mussels deposit as many as 100,000 eggs annually. Sometimes the whole body of the mussel, including the gills, mantle and foot is completely filled with the tiny yellow eggs. The eggs hatch into free-swimming larvae which find shelter among the holdfasts of seaweed. A young mussel can grow from an egg to 3-1/2 inches in length in one year.
Predators: Starfish.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Pg 136.

**Pacific Oyster (Crassostrea gigas)**

Range: Japan, introduced from Japan to waters between Alaska and California
Habitat: Mudflats.
Size: Up to 8 inches in length and 4-5 inches wide.
Color: Shells fluted in gray or white, new shell growth is black or purple.

Distinguishing characteristics: Shell very irregular - no two specimens are quite alike. A dark blue blotch is found on both valves at the point where the adduelor muscle (which holds the shell tightly shut) is attached.

Reproduction: When summer water temperatures are favorable for spawning, the Pacific Oyster reproduces naturally. The female can lay up to 500,000 eggs in one season, with the fertilized eggs developing into free-swimming larvae. After awhile they settle down on shells or rocks where they grow to maturity.

Commercial growers periodically stock their beds in the Spring with imported young oysters ("spat") that have settled on empty shells. These shells are placed on racks or floats in muddy tidal flats. The Pacific Oyster can tolerate water less saline than that of sea water, so it grows well in estuaries.

Use to Man: Source of food.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Pg 228.
Rock Scallop (Hinnites multirugosus)

Range: Alaska to Baja, California
Habitat: Sheltered bays and eelgrass.
Size: 5 to 6 inches in length and width.
Color: Many colors.
Distinguishing characteristics: The left valve is generally somewhat irregular and may be grossly misshapen.
Respiration: The scallop has no respiratory siphons. Instead, the edges of the mantle are held together except for two slits that open between the shells and permit water to enter, pass over the gills, and flow out again.
Reproduction: Rock scallops are free-swimming when young and have nearly symmetrical shells. However, when a scallop is 3/4 inch long, it attaches itself to another shell or rock and settles down permanently. If the object to which the scallop adheres is irregular, the shell becomes more and more irregular as it grows.
Predators: Octopuses, drilling snails, starfish.

For photographs See:
Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Pg 191.

Class Cephalopoda - Octopuses, squids, cuttlefish, nautili

Range: Found in all oceans of the world. 600,000 species known.
Habitat: All marine. Live along rocky shorelines in crevices and empty shells. Often the entrance to their lair is partially closed with large stones and empty shells from past meals.
Size: 2 inch to 28 foot spread.
Color: Have the ability to change color depending on the animal’s environment and mood.
Distinguishing characteristics: The characteristic Molluscan foot is modified into prehensile tentacles or arms. The head is large, the eyes are conspicuous and complex.
Squids are distinguished from octopuses by having 10 arms instead of eight and by having a long cylindrical mantle that tapers to a point. On the posterior end of the mantle are two long triangular fins.
The squid’s arms are unequal in length. One pair used in grasping, is very long and has four rows of suction cups near the ends. The other arms have two rows of suckers along their entire length.
The sense organs of cephalopods are highly developed. Particularly well developed are the eyes which in squids, cuttlefish and octopuses can form images. In fact, most cephalopods hunt down their prey by sight. The structure of the cephalopod eyes bears a striking resemblance to that of the vertebrate eye, in that it contains a lens, cornea, iris, retina, and optic nerves.

Cephalopods have elaborate receptors called statocysts which help them maintain a sense of direction. There is no evidence that cephalopods react to sounds, although a certain structure within the statocysts is potentially capable of detaching sound waves.

The tentacles of cephalopods are liberally supplied with chemical and tactile receptor cells located on the rims of the suckers. It is because of these receptor cells that octopuses, at least, are able to "taste" things by touching them.

Octopuses and some squids can creep about on their arms. The octopus normally swims with its body forward and the arms trailing behind. It takes water into its mantle cavity and forcibly ejects it through its siphon. This creates a jet that propels the animal through the water.

Squids swim leisurely forward by means of the fins located on either side of its body. A squid also swim by jet propulsion as the octopus does, but because it has a more streamlined body, the squid can actually dart through the water. An octopus swims slowly, though jerkily because of the intermittent jets.

Most cephalopods are carnivorous and predaceous. They live on fish, crustaceans, other mollusks and worms. A radula is present, but more important is the pair of beak-like jaws that enable the animal to bite and tear its prey.

The gills of squid and octopuses hang free within the mantle cavity. Water is drawn into the mantle cavity, along the sides of the "neck". As the mantle id contracted, flap-like valves raise to close off the opening where the water enters, and the water is forced out through the siphon tube located just below the head at the edge of the mantle.

Routing of the water along the sides of the neck and out through the siphon makes a constant flow of water over the gills from which oxygen is taken.

The sexes are separate in all of the cephalopods. One of the arms of the male is modified for the purpose of transferring bundles of sperm called spermatophores to the female. During copulation the male, using a modified tentacle, takes spermatophores from the genital opening and places them inside the mantle cavity of the female.

In some cephalopods the entire modified arm of the male is actually detached and left inside the female’s mantle cavity. In other species only the tip of the arm is detached. Female cephalopods lay eggs that vary with each species is size and the manner in which they are deposited.
Natural Defenses: Cephalopods are equipped with the ability to change color so that they blend in with their surroundings. These color changes are regulated by an elaborate neuromuscular mechanism. Embedded in the skin are many chromatophores, each a pigment-filled sac controlled by tiny muscles that can stretch the colored sphere into a flat plate.

The distribution and extent of expansion of each chromatophore is controlled directly from centers in the brain. Since there is commonly more than one type of chromatophore (yellow, orange/red, brown, black), the total range of possible color patterns is very great.

Coupled with the ability to change color, octopuses can also change the texture of their skin to match that of the surface they are gliding over. Like the color changes, changes in skin texture are produced by a set of muscles embedded in the octopuses skin.

Cephalopods have the capacity to produce powerful jets of water that enable them to move quickly backwards and away from an enemy, but this alone isn’t a very effective means of escape. Therefore, most cephalopods are also equipped with a supply of ink that they use as a distraction while escaping.

The ink is secreted through the siphon. The ink cloud is generally mixed with mucus, so a small black cloud that hangs together for a while in the water is produced. There is some evidence that the ink confuses the predator’s sense of smell.

Predators: Moray eel, fish, whales

Use to Man: Squids are used for fish bait, particularly cod fishing. Both squids and octopuses are used for food in many areas of the world, but have not gained widespread acceptance in North America as a food source.

Harm to Man: Because of their sinister appearance, cephalopods have gained a reputation for being extremely deadly. However, the vast majority of cephalopods are generally harmless, and any attacks by them on humans are probably accidental - either because the animal has mistaken a human arm or leg for something else or because of its instinctive reaction to seize moving objects that come within reach.
Pacific Octopus (Octopus dofleini)

Range: Alaska to Oregon

Habitat: Rocky crevices.

Size: Up to 18 feet across.

Color: Variable, depending on mood -- rose, yellow, brown, gray.

Distinguishing characteristics: The largest species of octopus. It has eight tentacles surrounding a bulbous head. An external shell is lacking.

Food and Food Habits: The octopus glides across the bottom exploring holes with tentacles in search of food. When it finds a clam, crab, r scallop, it envelops the animal in the webbing between its tentacles. It then secretes a poisonous substance from its mouth that quickly kills the prey. The powerful pair of jaws, which closely resemble a parrot's beak, are then used to tear the animal apart and extract the meat.

Reproduction: Male octopuses make no obvious sexual display. The affair is conducted at a distance, the two octopuses sitting apar and the male extending its specialized arm, the hectocotylus arm, to caress the female. The insertion of the hectocotylus into the mantle is generally resisted at first, but later the female lies quietly and copulation may continue for several hours.

The female lays eggs in strings which are attached to the roof of the home in which she lives. A very large number of eggs (about 150,000) is laid over a period of about a week, and female remains to brood them. During the brooding period, which may last six weeks, the female keeps the eggs clean and well aerated by means of jets of water from her siphon. She feeds only rarely, if at all, and dies after the eggs have hatched. The eggs hatch into minute octopuses that are merely tiny versions of their adult form.

For photographs See:
Ricketts, Edward F. and Jack Calvin. *Between Pacific Tides*. Pg 147.
Phylum Arthropoda - The joint-footed animals

Five major classes are included under the phylum arthropoda. They are:

- Class Crustacea - barnacles, shrimp, crabs, lobsters
- Class Insecta - insects
- Class Arachnida - spiders, scorpions, ticks
- Class Chilopoda - centipedes
- Class Diplopoda - millipedes

This text will only deal with the class Crustacea. With the exception of only a few animals (freshwater crayfish and terrestrial pill bugs), all crustaceans are marine. The crustaceans are divided into six orders. They include:

- Order Brachiopoda - brine shrimp
- Order Copopoda - copopods
- Order Cirripedia - barnacles
- Order Isopoda - isopods
- Order Amphipoda - amphipods, sand hoppers
- Order Decapoda - shrimp, lobster, crabs

Of these six orders, only the Cirripedia and the Decapoda are included in this booklet. It may seem strange to include barnacles in the same phylum as the complex shrimp, lobsters and crabs. For many years, zoologists classified barnacles in the phylum Mollusca (clams, oysters, mussels) because of their simple structure and hard shell. In 1830, zoologists discovered that the larval stages of the barnacle are very similar to the larval stages or arthropods, so it was reclassified.

Class Crustacea, Order Cirripedia - Barnacles

Range: Worldwide. 800 species.

Habitat: Attached to rocks, pilings, boats, other animals, etc. Different species prefer different substrates and different depths.

Size: 4 inches across and 4 inches tall

Color: White, gray

Distinguishing characteristics: Barnacles may be divided into two general categories: acorn barnacles and gooseneck barnacles. Acorn barnacles look like miniature volcanoes. Five or six plates form the sides of the volcano, and the base of the barnacle shell is directly attached to the substrate. The gooseneck barnacles also have a hard shell portion, but the shells overlap like the leaves of a bud and is supported by a rubbery stalk, called a peduncle.

A characteristic common to all barnacles is the six pair of featherlike appendages called cirri which extend from the inside of the barnacle shell. These cirri are constantly unfolding from within the shell, then quickly curling back up and withdrawing back inside.
Senses: Sensory hairs on the cirri are the barnacles’ only sense organs. These hairs are attached to a set of five ganglia and a simple brain.

Locomotion: Adult barnacles have no means of locomotion. The larval stages of barnacles are capable of locomotion.

Food and Food Habits: To eat, barnacles open their shell and thrust their cirri into the water, they quickly withdraw the cirri again. This creates a current of water which carries plankton and other food particles to the mouth. Most of the body cavity is filled with the stomach.

Respiration: No special respiratory organs.

Reproduction: Barnacles are hermaphrodites. This means both male and female organs are found in each individual. Each barnacle has an extensible penis (or cirrus) that can be protruded out of the shell. This organ transfers sperm to the surrounding barnacles. It may be possible for a barnacle to fertilize its own eggs, but this is doubtful. Each barnacle possesses a pouch which contains the eggs.

After the eggs have been fertilized, the barnacle will brood the eggs until they become free-swimming larvae. The larvae are then free to swim in the ocean, feeding and growing for 80 days. Then they settle down and attach to an appropriate substrate such as rocks, logs, etc. and grow shells. Barnacles may live for several years.

Natural Defenses: The barnacles’ hard shell and strong attachment to the substrate protect them from the crashing waves. These shells also protect the barnacle from drying out when the tide goes out. At the top of the barnacle are two small plates which open to allow the cirri to extend, and close to protect the cirri and internal organs from predators.

Predators: Worms, snails, starfish, fish, birds

Use to Man: All species are edible, but most acorn barnacles are so difficult to remove from the rocks, they are not used. The stalks, or peduncles of the gooseneck barnacles are much more worth the effort. If steamed the flavor is much like that of lobster or crab. West coast Indians even today include gooseneck barnacles in their diet.

Harm to Man: Nuisance on boats.

**Acorn Barnacles (Balanus species)**

Range: Worldwide.

Habitat: Rocks, logs, pilings, ships, etc.

Size: 3/4 inch as base, 1/2 inch high.

Color: White.

Distinguishing characteristics: Like miniature volcanoes. Found in very dense colonies.

For photographs See:

Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Pg 129.

Phylum Arthropoda - The joint-footed animals

Class Crustacea, Order Decapoda - Shrimp, Lobster, Crab

Range: Worldwide
Habitat: All marine except for freshwater crayfish.
Size: Microscopic to the eight-foot giant crabs of Japan
Color: All colors.

Distinguishing characteristics: The most obvious characteristic of decapods is their hard shell or exoskeleton. The body of the decapod is divided into two areas, the head-thorax or cephalothorax and the abdomen. The shell that covers the top part of the decapod is referred to as the carapace.

The name decapod means ten legs. These legs are attached to the head-thorax. The first pair of legs is modified into claws which are used for defense and offense. The other four pairs of legs are used for locomotion, handling food and cleaning the body.

Many small appendages are located on the head. The pair of stalked, movable eyes are easily identified, as are the pair of long antennae. The shorter pair of branched antennae-like structures are called antennules. These organs are important for finding food.

In addition to these structures, decapods have many mouthparts. They have a pair of mandibles which is used to crush food, two pair of maxillae and three pair of maxillipeds which are used to manipulate food.

Moving on down the body of the decapod, the swimmerets can be found on the underside of the abdomen. These three or four paired appendages are used to swim forward. The swimmerets also have other purposes.

On the females, they are the egg holding organs and on the males one pair of swimmerets is modified into copulatory organs. At the very end of the abdomen is the tail fin which is used as a paddle for rapid backward swimming. The tail fin on the female has the additional purpose of egg production.

All decapods have the above basic characteristics, but are different enough to be further divided into three suborders:

- Suborder Macrura - shrimp, lobsters
- Suborder Anomura - hermit crabs, box crabs, porcelain crabs
- Suborder Brachyura - true crabs

The suborder Macrura has all of the above characteristics. The abdomen is always long and thin, as in shrimp and lobsters, and always ends in a tail fin.
The suborder Anomura is a little different. None of the members of this suborder possess tail fins and they all have a fifth pair of rudimentary legs. The Hermit Crab also has a soft abdomen which curls to the right. This crab has adapted to this by hiding from predators inside shells. The Box Crab also has an abdomen which is slightly off center to the right. The Porcelain Crab tucks its small abdomen under its carapace for protection.

The suborder Brachyura include all the "true crabs" which are the most highly developed of the crustaceans. The body is composed mainly of carapace. The abdomen in this suborder is reduced to a small flap which folded under the body.

The true crabs are usually rounded or squarish in outline and always possess five pairs of legs. The true crabs include the Decorator Crab, Dungeness Crab, Kelp Crab, Oregon Cancer Crab, Purple Shore Crab and the Red Rock Crab.

Senses: The decapods all possess highly developed sensory organs. Probably the most important organs are the movable, stalked eyes. Another important sense is touch or feeling. The entire body is covered with bristles sensitive to touch. The pincers, mouthparts, abdomen underside, and edge of the tail fin are also sensitive touching organs.

Chemically sensitive hairs are found on the antennules, tips of antennae, mouthparts and tips of pincers. These sensory hairs make it possible for decapods to taste or smell nearby food.

Locomotion: Forward movement is made possible by the movement of the swimmerets. Rapid backward movement is due to the rapid movement of the tail fin. The five pair of walking legs also used when on the ocean bottom.

Food and Food Habits: Most decapods are scavengers of dead animals and plants. Some eat small copepods and some are predatory on small animals. The mandibles crush the food and the other mouthparts and legs manipulate the food. After the food is swallowed and digested, waste products are released in two places. The anus is located ventrally on the tail fin and a bladder is located at the base of each antennae.

Respiration: Attained by the use of gills located under the carapace next to the base of each leg.

Reproduction: In decapods, the sexes are separate and easily distinguished. Usually the female’s abdomen is broader than that of the male. The female’s sexual organs open to the exterior between the bases of the third pair of walking legs. The males copulatory organs are located on the abdomen anterior to the swimmerets.

Fertilization is internal and often must take place while the female is molting. When the female lays her eggs she attaches them to her swimmerets and uses the sperm to fertilize them. After the eggs hatch, the larvae will remain attached to the mother for several days before venturing out on their own.

In order for the decapod larvae to grow, they must shed their restrictive shells. This shedding process is called molting. As soon as the old shell is removed, the decapod grows very quickly, then the new shell quickly hardens.
A decapod is rather helpless during this time and usually hides until the shell hardens. While walking the beaches often many "dead" crabs can be found. Actually these are not dead crabs but only the discarded old shell of a molted crab. Usually when an appendage is lost, it will be regained after molting.

Natural Defenses: Hard exoskeleton and pincers.
Predators: Man, octopuses, fish.
Use to Man: Very important food source.
Harm to Man: None

**American Lobster (Homarus americanus)**

Range: Not native to our coast. Labrador to North Carolina.
Habitat: Muddy or sandy ocean floor where they live in burrows.
Size: 2 feet long. 1-3 pounds.
Color: Blue and black above. Light colored below.

Distinguishing characteristics: Huge pincers. For years people have tried to introduce lobsters to the West Coast. There are records of attempts to establish lobsters in Yaquina Bay as far back as the 1800s. In the years 1968-1970, Oregon State University and the State Fish Commission again tried some experiments to see of the American Lobster could be established.

They found that the American Lobster could not be established here because:

1. The waters are too cold for the larvae to develop (lobster larvae need better than 60 degrees water)
2. Oregon does not have enough of the rocky habitat preferred by lobsters
3. Lobsters carry a disease that can be harmful to Dungeness Crab. You may ask "why aren't they raise in hatcheries?" This is possible, but the expense of such an undertaking apparently does not make this feasible. The lobsters found at the Marine Science Center are the remains of the 1968 experiments.
**Box Crab (Lopholithoides formaminatus)**

Range: Alaska to California.

Habitat: Sandy areas of the continental shelf.

Size: 8 inches.

Color: Light brown with orange-red tinges above, purple markings below.

Distinguishing Characteristics: Heavy external skeleton covered with bumps. Has ability to fold legs up against body so that it appears to be a bumpy rock. Claws short and stout with many spines. Claw and adjoining leg each with a semi-circular hole so that when all legs are curled up underneath, the two holes form a circular hole. Several other characteristics show that the Box Crab is not a true crab but closely related to the Hermit Crab and the Porcelain Crab. The abdomen is flexed to the right, swimmerets absent on the right side of the abdomen, four pair of legs with the fifth pair being tiny rudimentary legs which are usually tucked up under the body.

Food and Food Habits: The Box Crab feeds in two ways. By stirring the mud with their claws, the Box Crab can extract food particles from the mud with feathery appendages located near the mouth. These crabs are also equipped with strong mandibles which are used to crush small clams. It is very unusual to find these two types of feeding behavior in one animal.

Respiration: The Box Crab breathes in the same manner as other crabs, except for the ability to breathe while covered with mud or sand. These crabs burrow into the mud backwards, so that only their front legs remain at the surface. The crab then uses the hole described above as a passageway for oxygen-rich water to reach the gills.

For photographs See:
Furlong, Marjorie and Virginia Pill. *Edible? Incredible!* Pg 47.

**Decorator Crab (many species)**

Many separate species have this habit of decorating themselves. They include: *Oregonis gracilis, Pugettis gracilis, Loxorhynchus crispatus, Loxorhynchus large,* and *Seyra acutifrons*.

Other common names: Masking Crab, Graceful Kelp Crab

Range: Alaska to California.

Habitat: On or around floating docks and pilings, or rocky shores, or in eelgrass beds.

Size: 2-3 inches.

Color: Reddish brown, mottled.

Distinguishing Characteristics: These crabs ornament themselves with seaweed, sponges, bryozoans or anything else that is available. By using their sticky saliva the Decorator Crabs paste to their bodies using their small slender legs.
Phylum Arthropoda - The joint-footed animals

For photographs See:

**Dungeness Crab (Cancer magister)**

Nick-named Dungeness for a locality in Washington

Range: Alaska to California.
Habitat: Buried in sand of ocean floor and estuaries.
Size: 12 inches. Oregon's largest crab.
Color: Bluish brown above, yellow below.
Distinguishing Characteristics: Eat small clams, opened by chipping away at the shell with its heavy pincers.
Reproduction: Sexual maturity reached in 4 to 5 years. Average life span 8 to 12 years.
Use to Man: Most important and famous crab of the West Coast. Fished both commercially and for sport. Crabs can be caught by using a fish baited trap called a crab pot, or by scuba diving. The commercial season is from December through August; only males 6-1/4 inches across and larger may be taken. Sports fishermen may take male crabs as small as 5-1/4 inches. It is not desirable to take crabs while they are molting (called soft-shelled crabs). The flesh of these crabs will be soft and watery and of poor flavor.

For photographs See:
Kozloff, Eugene N. Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago. Page 253.

**Hermit Crab (Pagurus species)**

Range: Alaska to California.
Habitat: Intertidal rocks or continental shelf.
Size: Depends on species.
Color: Depends on species.
Distinguishing Characteristics: Hermit crabs are easily identified because they can practically always be found in a shell or other suitable home. This creature has a soft abdomen so it must protect itself. The abdomen is equipped with hooks which are attached to the inside of the shell. As the hermit crab grows it must find a larger shell for protection. Often hermit crabs will fight over a particularly desirable shell. Another characteristic of hermit crabs is the difference in size of their claws; the right claw is bigger than the left.
Food and Food Habits: Scavengers.
Reproduction: In many species of hermit crabs the male is larger than the female. There is much competition among the males for the females. The male will grab the edge of the female hermit crab’s shell and drag it around for several days, waiting for the female to molt her shell. When she does, the male will immediately deposit sperm of her abdomen. The female later uses the sperm to fertilize her eggs as she lays them.

For photographs See:

**Kelp Crab (Pugettia producta)**

Other common name: Northern Kelp Crab

Range: British Columbia to Baja, California.

Habitat: Hidden among brown seaweeds of intertidal rocks or on pilings.

Size: 3 inches.

Color: Shiny, smoother, olive green above, light tan or red below.

Distinguishing Characteristics: Small bodies, long spider-like legs.

Natural Defenses: Hidden among brown seaweed, the Kelp Crab’s color perfectly camouflages it from its enemies. Sharp points on the Kelp Crab’s shell catch on the seaweed and prevents the crab from being washed away by the waves.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Pg 194.

**Oregon Cancer Crab (Cancer oregonensis)**

Other common name: Hairy Cancer Crab

Range: Alaska to California.

Habitat: Hidden in very small holes of intertidal or estuaric rocks. Also found in empty shells of giant barnacles.

Size: 3/4 to 1 inch.

Color: Brick red, black-tipped claws.

Distinguishing Characteristics: 12 to 13 notches along front edge of carapace. Surface of carapace irregular. Fringe of hairs around carapace and on legs.

Food and Food Habits: Scavenger.

For photographs See:
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate XXI.
**Porcelain Crab (Petrolisthes cinctipes)**

Range: Alaska to California.

Habitat: Subtidal rocky beaches. Found under rocks, mussels, and seaweed. They like very secure abodes such as holes left by boring clams or narrow crevices in rocks.

Size: 1/2 to 1-1/2 inches.

Color: Shiny brown, with flecks of blue.

Distinguishing Characteristics: Extremely flat-bodies, so they can creep into crevices. Claws also flat and huge in comparison to size of body. Fifth pair of legs is small and tucked under body. More closely related to Hermit Crabs and Box Crabs than to "true" crabs. Small circular carapace. Long whiplike antennae.

Food and Food Habits: Scavenger. Fan plankton or detritus from water by means of their mouth parts (second maxillipeds).

Natural Defenses: Very flat bodies, so they can creep under rocks. To escape enemies, the legs come off easily when they are grabbed (hence the name). Other crabs have this ability also.

For photographs See:


**Purple Shore Crab (Hemigraphus nudus)**

Range: Alaska to California.

Habitat: Intertidal rocks. Oregon’s most common crab.

Size: 2 inches.

Color: Dark purple carapace with white mottlings. White on underside. Most identifiable characteristic are their purple spotted front pincers.

Distinguishing Characteristics: Flat. No hair on legs. Smooth nearly rectangular carapace.

Food and Food Habits: Scavenger.

For photographs See:

Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago*. Plate XX.

**Red Rock Crab (Cancer productus)**

Other Common Names: Red Cancer crab, Red Crab, Japanese Crab.

Range: Alaska to California.

Habitat: Ocean floor, rocky beaches, estuaries. Particularly likes eelgrass beds.

Size: 5 inches.

Color: Brick red above, light below. Dark tips on claws. Juveniles can be white, mottled or striped.

Distinguishing Characteristics: Front of carapace has five equal scallops between the eyes.

Food and Food Habits: Scavenger.

Use to Man: Red Rock Crabs are as tasty as the Dungeness Crabs, but are not commercially fished because they are smaller and the carapace is too heavy in comparison to body size. There are no limits to the numbers or size taken.

For photographs See:

Furlong, Marjorie and Virginia Pill. *Edible? Incredible!* Pg 47.
Kozloff, Eugene N. *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago.* Pg 253.
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