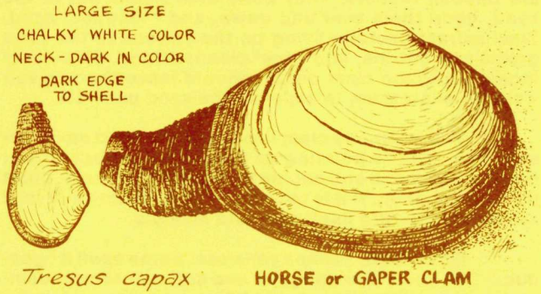
Here's how to tell a clam's left and right shells, its length, and siphon and foot ends. Hold the clam in your hand with hinge ligament away from you and on the upper edge of the shell. Hold it so that its longest dimension is straight up and down. The siphons will then point up and its foot will point down. The clam's right shell is on your right; its left is on your left. The clam's length is roughly parallel to the ligament and usually its longest dimension.

HORSE CLAM. Also called the gaper clam, there is one species in the Bay: *Tresus capax*. The horse clam is often mistaken for a geoduck since it is similar in size (maximum of about 8 in.), the depth at which it is found, and its location on the beach. You can tell them apart by looking at the siphon tips. The horse clam siphons usually have two leathery plates and a small bit of seaweed at the tip; the geoduck does not. The horse clam neck retracts further into its shell than the geoduck's.



Tresus capax **HORSE or GAPER CLAM**

Horse clams usually harbor a small crab near their gills, which may be a parasite of the clam. It lives inside the shell for protection and eats some of the same food as the clam, apparently causing only minor damage to the tissue of the host.

COCKLE. *Clinocardium nuttallii*, also called the basket cockle. The shell is reddish-brown with deep regular grooves radiating outward from the ligament area. It is usually found within 1 inch of the surface in the lower intertidal region in beds of eelgrass. It has a muscular foot, is the only really mobile clam of all the species in the Bay, and is a simultaneous hermaphrodite.

The cockle population of Garrison Bay is depleted each year because they live near the surface and are easily found by man and other predators. Take only larger ones, and only if you plan to use them for chowder.

Clinocardium nuttallii **COCKLE**

TRANSENNELLA. No common name. There is one species here: *Transennella tantilla*. These clams are very small and plentiful. They lie on the surface and may look like tiny white pebbles strewn across the beach. The shell is 2-6mm, white, and usually has a dark spot. *Transennella* brood their young inside their shells in the mantle cavity and release them into the Bay. Thus they are viviparous and sequential hermaphrodites.

Transennella tantilla **TRANSENNELLA**

CLAM DIGGING AND CONSERVATION

Studies on clam conservation are being conducted at Garrison Bay. Since opening of the beaches to the general public, some of the more accessible areas have been overdug. These are now closed to further digging and are the focus of scientific research. These areas are expected to be reopened in the near future.

Current research studies are monitoring the recovery of clam populations in the closed areas and developing a basis for predicting how many clams may be dug a year without depleting them. The knowledge gained may help improve shellfish management throughout the San Juan archipelago.

The clams of Garrison Bay are an important renewable natural resource for recreationists. There are some pointers about digging that will help conserve the clam resource of the Bay. Obey current harvest regulations of the Washington Department of Fisheries and dig only in areas posted.

Avoid using a shovel. A fork is best because it minimizes injuries to clams. As you dig, use your hands to sift through the sand to minimize shell breakage. This is also more efficient because you will find every clam. Sort the clams into two piles: one for those you will keep and one for those to put back.

Refill the hole this way. Put most of the sand back, stopping when there is about a one-inch shallow depression. Put in the clams with their siphon ends up. Spread them evenly to give them room. Discard any that are injured; animal predators will find them. Spread the remaining sand over them all, leaving none exposed, and let the sand lie loose. Don't pack it down. Do this and you will contribute to preserving the clam resource and maintaining the balance of populations that make up this ecosystem of Garrison Bay.

A FEW WORDS ON SAFETY

If there is a red tide alert, the clams and mussels in Garrison Bay may be toxic. Experienced clam diggers always inquire before digging and eating.

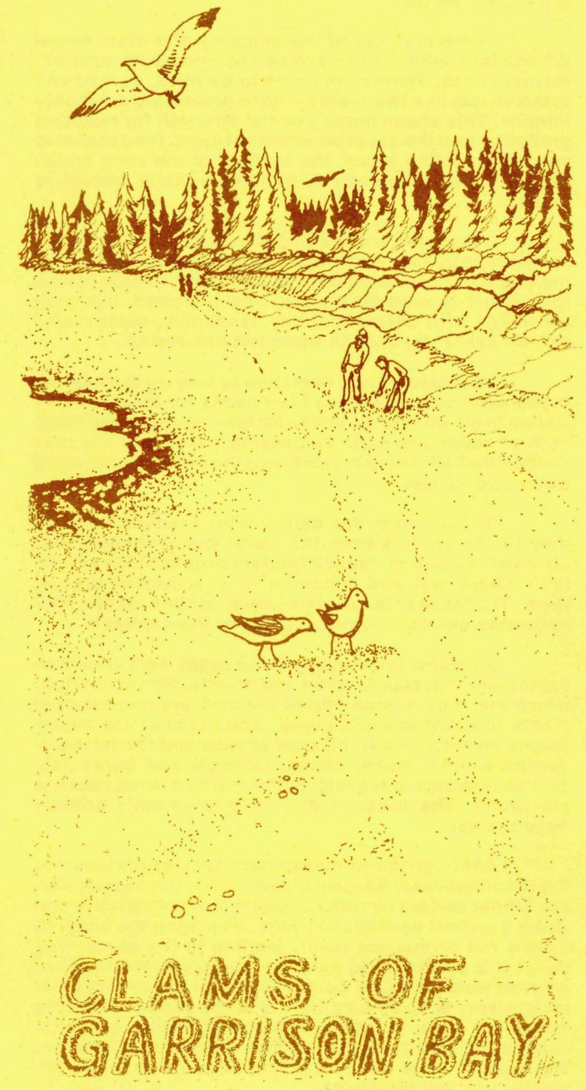
Along the beaches of Garrison Bay there are sharp rocks, barnacles and broken shells that can cause injury to bare feet. Wear sturdy shoes or boots for comfort and safety. The trails here are in a primitive condition and footing can be hazardous. Watch your step, please. Millions of people will visit America's National Parks this year and most will return home with pleasant memories and a greater understanding of our natural and historical heritage. Unfortunately, some will also go home with broken bones or worse. Don't join the injured. Be mindful of your personal safety and the safety of your family and friends.

If you are a boater, be sure to remember to check a tide table so that you will not be left stranded. Take care of yourself and your companions. We want you to enjoy your visit and we want you to come back again.

This pamphlet has been prepared for the National Park Service by Dr. Vincent F. Gallucci, School of Fisheries, University of Washington, with assistance from Friday Harbor Laboratories, the Washington Department of Fisheries, the Washington Sea Grant Program and the College of Forest Resources at the University of Washington. Editing was done by Robert A. Mowrey. Illustrations and layout are the work of artist Harold W. Street.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department for Natural Resources." The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States — now and in the future.

National Park Service
U.S. DEPARTMENT OF THE INTERIOR



CLAMS OF GARRISON BAY

As you explore the beaches around the Bay you become part of its natural cycle of life. Pick up a clam and we will explore its ecological role and our own place in this marine ecosystem.

CLAM ANATOMY AND ADAPTATIONS FOR SURVIVAL

To understand an ecosystem we need to know about its members: the animals, plants and microbes that interact with each other. We will look at one kind of animal, the clam, and try to gain some insight into how the system works.

Some features of the anatomy of a clam reveal adaptations which have evolved to cope with environmental stress. Their shells tend to be thick, curved and symmetrical like two sturdy arches protecting a delicate interior. This shape helps provide strength for resisting predators and the abrasive effects of sand. (You may also see worms living below the surface of the sand which have adapted differently by building vertical protective tubes.)

Uncovered on the beach, clams may resemble small rocks in their markings, colors and rounded forms, making it hard for predators to find them. Clams have a foot which is used for digging into the sand, but each clam digs with different ability. Generally, older clams cannot easily dig back in when left uncovered.

Most clams avoid detection by burying themselves in the sand and extending their necks for feeding. One siphon in the neck is the intake for feeding and respiration, both of which are done by passing water over the gills inside the shell. The other siphon is the outlet for expelling water and wastes.

Some clams are called filter feeders because they filter nutrients from the water above them. Other clams are known as deposit feeders because they extend their necks out and "vacuum" the sediment around them. The feces of these clams must contain much sand, and some sand is usually retained in the stomach.

All clams feed on tiny living organisms known as phytoplankton, zooplankton and detritis. Phytoplankton, which make up a large part of the diet, are microscopic plants like diatoms and algae. Zooplankton are microscopic animals like small crustaceans and the larvae of marine worms, crabs, clams, mussels and barnacles. Detritis is decaying organic matter in which living bacteria are found. The bacteria are the ecosystem's primary decomposers.

Although the clams eat many species of plankton, the dinoflagellate, *Gonyaulax catenella*, is of special interest. Under certain circumstances this dinoflagellate can reach a critical density, sometimes causing the water to have a red or maroon color, leading to the name "red tide." It is important to note that the appearance of red colored water is a rare occurrence, but the presence of toxic clams is quite common in some years. When the clams eat huge numbers of these plankton, a poison contained in the plankton reaches a high concentration. The poison does not affect the clams, but it can kill people who eat the clams.

In all, clams may eat mature or larval forms of hundreds of species. This unspecialized diet assures a regular food resource replenished with every new tide. The clam is a vital link in marine food chains between plankton and the carnivores that feed on clams. To study a clam and its adaptations for survival is to understand a little of the organization of the ecosystem in which it lives.

THE ROLE OF CLAMS IN THE ECOSYSTEM

Several different methods of reproduction are used by clams in their life cycle. Life usually begins when each clam releases millions of gametes, males release sperm and females release eggs. Two clams in Garrison Bay reproduce differently, however. The cockle is a simultaneous hermaphrodite and releases both eggs and sperm. In either case, sperm fertilize eggs and small planktonic larvae develop. These larvae or zooplankton are carried by tides and currents while they feed on smaller plankton and grow, and simultaneously are food for fish and other marine animals. All the clam species at Garrison, except *Transennella tantilla*, have this kind of life cycle. The tiny clam *Transennella* is also a hermaphrodite, but it changes sex from male to female. Juvenile clams develop in the female's shell, protected from many predators.

After about 2-4 weeks in the larval stage the clams settle to the bottom. If the bottom is soft, they dig in. When they settle, they are about ¼ millimeter (mm) long. This is very small as 1 mm is only about 4 hundredths of an inch. For comparison, a nickel is about 20mm, or ¾ of an inch, in diameter. The nickle is 2mm thick on its edge. Some clams here will grow one hundred-fold within their first year to a size of about 25mm.

Clams compete among themselves and with other organisms, such as barnacles, fish, mussels and worms, for the same planktonic and benthic (bottom organisms) foods. All these animals are part of marine food chains. An example of such a food chain is as follows: phytoplankton are eaten by zooplankton; the zooplankton are eaten by steamer clams; the steamer clams are eaten by seagulls and crabs; the seagulls and crabs die and are consumed by bacterial decomposers.

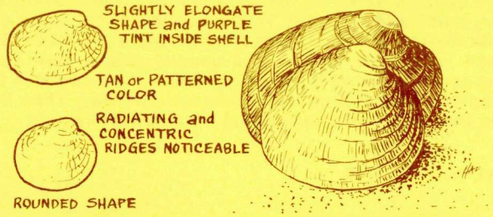
Microbes like bacteria write the final epitaphs of dead animals by decomposing their tissue and returning it to the sea in the form of nutrients. The cycle of life begins anew as plankton consume the nutrients and grow and reproduce. Although zooplankton take in many of these nutrients, the phytoplankton are fundamental because they combine nutrients and the sun's energy in photosynthesis. The sun is the primary source of energy in the ecosystem and is the basis for all life on Earth.

So we see that clams eat and are eaten. The clam's function in the ecosystem is maintained if its numbers are kept high enough to balance losses with gains added by reproduction. If we are careful about how many clams we dig or injure, we conserve the clam resource and the balance of populations that support this ecosystem of Garrison Bay.

TWELVE CLAM SPECIES OF THE BAY

LITTLENECK CLAM. There are two types at Garrison Bay: native littleneck or steam clam, *Protothaca staminea*, and the Japanese littleneck or Manila clam, *Venerupis japonica*. Both may have hard shells with attractive patterns or they may be a uniform tan color. They are found within 8 inches of the surface in firm sediment high in the intertidal region, the area between average high and low tide marks. Average adult length is about 2½ inches.

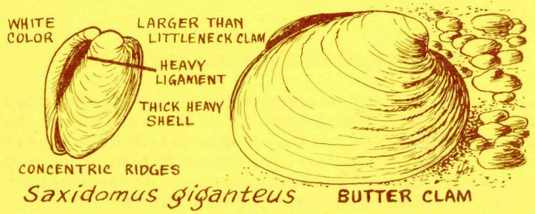
Venerupis japonica **JAPANESE LITTLENECK**



Protothaca staminea **NATIVE LITTLENECK**

With some clams, like the littleneck and butter clams, it is possible to easily estimate their age by counting the concentric ridges radiating outward from the hinge ligament. One major ridge is developed for each year of life. Mature clams are about 3 years old.

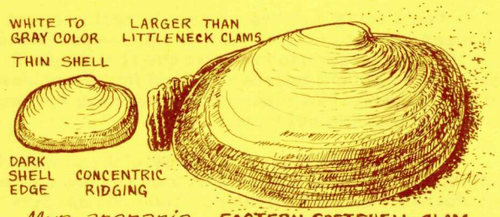
BUTTER CLAM. *Saxidomus giganteus*. It is also called the Washington clam. The shell is white to gray with a heavy long black ligament. Most live below the mean low tide mark. Maximum adult length is about 6 inches.



Saxidomus giganteus **BUTTER CLAM**

There were once many butter clams at Garrison Bay, but the population is now very low due to a combination of overdigging and an irregular reproductive pattern.

EASTERN SOFTSHELL CLAM. *Mya arenaria*, also called the mud clam. The shell is oblong and has a spoon-type structure near the hinge. It is white to gray in color with a brownish edge. The shell does not close fully. Maximum adult size is about 5 inches in length. This clam is found mostly in muddy sediment from the middle of the intertidal region to high on the beach.

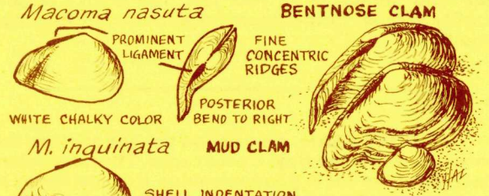


Mya arenaria **EASTERN SOFTSHELL CLAM**

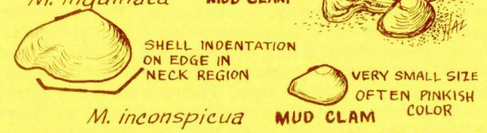
MUD CLAMS. There are four species of mud clams at Garrison Bay: *Macoma nasuta; M. inquinata (irus); M. secta; M. inconspicua (balthica).* The *M. nasuta* shell is flat with an upturned "nose" and is often called the bentnose clam. They are all found in mud, usually within 6 inches

of the surface. *M. secta* is usually in sandier sediment and lives deeper down. Maximum adult length for the first three species is about 2½ inches, while *M. inconspicua* is very small, with a pinkish shell, and only about 25-30 mm (1-1¼ inches) long.

Macoma nasuta **BENTNOSE CLAM**



M. inquinata **MUD CLAM**



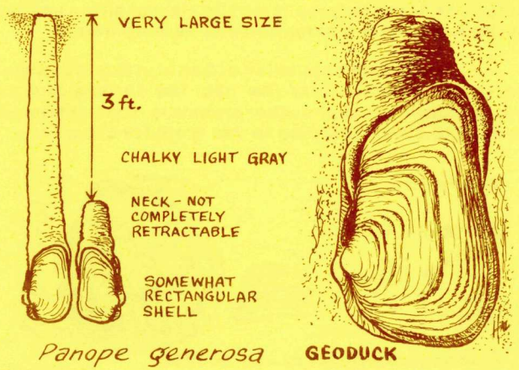
M. inconspicua **MUD CLAM**

Macoma clams have their siphons separated and are deposit feeders. They poke their necks out of the sand, bend them over and down, and "vacuum" sand. They extract bacteria living on the surface of the sand grains and detritis, and expel cleaned sand. Since they ingest sand, the clam digger should leave them in salt water to allow them to expel all the sand possible.

The bentnose clam lies under the sand on its left side with siphons pointing up toward the surface. If you dig up a small one and decide to return it to its hole, point the bent nose up. If it is put back with nose down, it may not be able to turn itself over and may die.

GEODUCK. *Panope generosa*. Some spell it "geoduc." The shell is rectangular and soft and cannot completely enclose the large body. It has a very long muscular neck and can extend it from as much as 3 ft. below the surface. It is found only during very low tides. It was never plentiful at Garrison Bay

Use care in digging for geoducks since the shell is easily split and the neck can be torn off as you try to pull it up. Dig deep next to the neck and use your hands to reach through the side of the hole to pull it out. There is no need to hurry, for the geoduck cannot dig further to escape.



Panope generosa **GEODUCK**