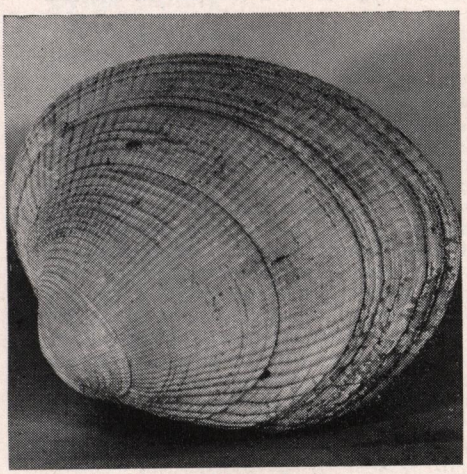
Washington State

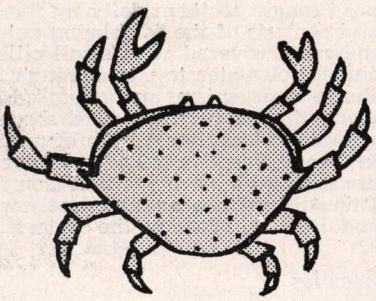
SHELLFISH

Puget Sound butter clam



Native little neck clam

Approximately one-fifth of the total annual seafood production in Washington State waters and one-third of total annual dollar value is derived from the stocks of shellfish that thrive along the Pacific ocean shore, the coastal harbors and the inland waters of Puget Sound. In economic importance oysters rank first, Dungeness crab second. The fishery for ocean shrimp is growing in importance since expansion of the fishery began in 1956. Razor and hardshell clams are harvested on a smaller scale, but experiments in the harvesting and cultivation of hardshell clams with the use of powered dredges indicates they may become more important. Minor fisheries are supported by scallops and octupus. Along with the food fish, principally salmon, halibut, cod, sole and smelt, they make Washington one of the nation's leading sources of quality marine foods.



Department of Fisheries

OLYMPIA, WASHINGTON

OYSTERS

Mainstay of the state's oyster industry is the Pacific oyster *(Crassostrea gigas)*, first introduced from Japan in 1902 and maintained by annual importations of seed. A native variety known as the Olympia *(Ostrea lurida)* formerly flourished on Willapa Bay but today is harvested in commercial quantities only in the harbors of southern Puget Sound. Four other transplants also have been given trials; the Kumamoto, Hiroshima and Fukaoka oyster from Japan, and the European flat oysters, *(Ostrea edulis)*, all of them fitting into a size gap between Olympias and large Pacifics. Of the trial oysters, the Kumamoto has become of minor commercial importance and is at present restricted mainly due to limited supplies of seed available from Japan. Earlier efforts by industry to transplant East Coast oysters to Washington were unsuccessful.

Characteristics

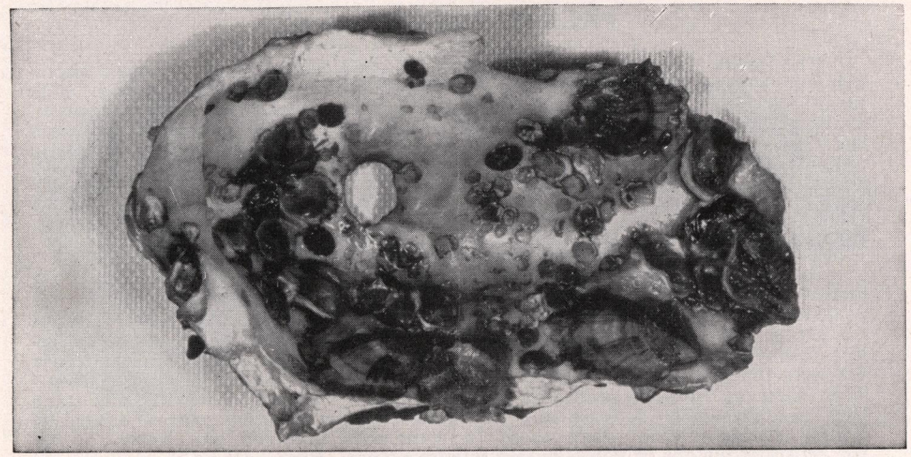
Sex reversal is common to both principal species. The female Pacific may spawn 200 million eggs in a season, expelling them into the water where they are fertilized by sperm from the male. The fertilized eggs develop into shelled larvae and spend 3-4 weeks swimming or drifting freely with the tide before instinctively seeking some clean, solid surface on which to attach themselves. The spat, as the minute oysters are then called, are pin point size but by the advent of winter become easily visible. The Pacifics may reach four inches in shell size by the age of two years, whereas the slower growing Olympia is only 1½ inches long when it reaches maturity at four years. For the first two years of their life, the Pacific oysters are about equally male and female. In subsequent years many reverse their sex. The Olympias vary this process, retaining their eggs for about a week after fertilization and releasing them after the tiny larvae have developed a protective shell. During the reproductive period, the majority of Olympia oysters begin the season as males, later become females, and still later on may revert to the male phase again. Their egg output is far less than the Pacific, averaging about 250,000. Despite enormous reproductive potential only a few larvae survive and find suitable setting surfaces. On an average of three years out of five, natural spawning from Pacific oysters accounts for about one-third of the commercial reseeding. During unusually warm years it may account for as much as two-thirds of the needed supply of seed. Best spawning conditions for the Pacifics occur at water temperatures above 65° and failure of the sea water to attain that heat has a direct effect on the success of the season's spawning. Our Washington oyster industry depends on importation of seed from Japan each year to maintain harvestable supplies at a level with market demand.

Food

Oysters are famous for their nutritional qualities; they are rich in proteins, vitamins and such trace elements as iron, iodine, copper, phosphorous, cobalt, and manganese, which individually or in combination are essential contributors to a healthy body. In feeding, oysters pump sea water through the body cavity and ingest virtually all of the microscopic animals, bacteria and tiny plants that are brought to them daily by the tide. The actual process is fairly well known and consists of the food being extracted from the water through seive-like gills: these are covered with small cillia, or hairs, whose rhythmic waving causes a current of water to pass through the oyster. As the water moves over the gills the food organisms are captured in strings of mucous which are then carried along the gill edges toward the mouth for ingestion. They are able to utilize organisms less than 1/50th of a millimeter in size. Many of these organisms are known as flagellates; however, even within this group of minute organisms there are some which provide nutrition for the oyster and some which probably do not. It is still unknown as to exactly which of the organisms are principally digested and utilized as food by the oysters.

Enemies

Natural oyster predators include marine snails or drills, starfish, shell worms, boring sponges, crabs, skates, ducks and red tide organisms. Japanese drills came in with the early imports of oyster seed. This deadly predator bores a small hole in the oyster shell with a tongue-like proboscis and consumes the oyster meat. A thin shelled oyster can be drilled and eaten in two days. Starfish



Pacific oyster seed (Ostrea (Crossotrea) gigas) Seed shell, size 4 inches. Seed spawned in Japan in summer, planted in south Puget Sound the following April and photographed 3 months later.

attack oysters with strong poison and devour them once the muscles relax and shell opens. Control of the Japanese drill is accomplished through compulsory inspection of oyster seed prior to its shipment from Japan. Transfer of oysters from one area to another within the state is also regulated; this applies to private individuals who wish to move even a few oysters from one oyster bed to another as well as to commercial oyster farmers. The cooperation of everyone is needed to prevent further spread of oyster drills. Certain methods for decontaminating infested grounds are known and these are applied wherever economically feasible or practical. Barriers of metallic copper are also known to be effective in preventing drills from migrating from one area to another. However, up to the present time there is no known pesticide which is effective against drills without, at the same time, causing damage to oysters themselves.

Oyster Culture

Farming practices for oysters vary with the species and with the area, depending upon conditions of growth, survival and fatness. Basically, all oyster farming follows the general steps outlined. Pacific and Kumamoto oysters are cultured on tideflats exposed at low tide and on certain grounds lying below low tide to a maximum depth of 20 feet. Olympia oysters are cultured wholly within the intertidal zone but the oysters themselves are protected from the effects of exposure and weather by dikes which create artificial tide pools. In order to carry out the regular oyster farming operation, seed must be procured locally through natural setting, or as oyster seed from Japan. The seed is usually planted on the ground in densities varying from 20 cases* per acre to more than 100 cases per acre. At the end of two years the clusters which develop are usually broken up and spread evenly in the area of the original planting or actually harvested and transplanted to growing grounds which are suitable for putting rapid growth on larger oysters but which are not safe for planting seed. As the oyster reaches maturity a process known as fattening will normally occur. Fatness of the oyster will differ by area, tide level, and season of the year and involves production and storage of glycogen in the tissues and firming of the body meat of the oyster. Oystermen desire to obtain a yield equal to about one gallon of drained meat to every bushel of oysters. Suitability of oysters for harvest is determined by examination of the beds following which the oysters are picked up by dredge or mechanical hand pickers, transplanted to the processing plant where they are either opened fresh, or steam-opened fresh, or steam-opened for canning. Size of oysters at maturity are usually about 4 inches in length for Pacific oysters and 1½ inches for Olympia oysters. Kumamoto oysters are usually harvested at a shell size from 1-2 inches.

* A case of oyster seed usually contains from 15 to 20 thousand spat attached to shell cultch made from opened oysters.

PACIFIC RAZOR CLAMS

The Pacific razor clam *(Siliqua patula)* is an exceptionally rich, meaty shellfish which grows from California's Pismo beach to the Aleutian islands. It is usually found on surf-pounded ocean beaches, but occasionally may occur in sheltered areas along the coast. In Washington it is most abundant between the Columbia river and Copalis rocks, west of Aberdeen. Smaller quantities are located to the north at Pacific Beach, Moclips, Tahola and Kalaloch. None grow in Puget Sound.

Reproduction and Growth

Razor clams reach sexual maturity at 2 years on Washington beaches and spawn annually in the late spring, apparently when the water temperature reaches 55 degrees. At that time the clams are fattest and in the best condition for eating. The spawn ripens in the foot or "digger" of the clam, and fertilization follows the discharge of eggs and sperm into the open water. For the next 6 weeks the young clams drift about or crawl on the bottom before "setting." They then dig into the sand and adopt the adult mode of living. At this stage they are extremely delicate and heavy mortalities may be caused either by winter storms which wash them in windrows high on the beach or by the crushing weight of vehicles and human beings. High natural mortalities are usually compensated for by the tremendous reproductive capacity of the species, whose females will develop 6 to 10 million eggs annually.

By the end of the first winter the clams are about 4/5 of an inch long. After two years they average four inches, and as 4-year-olds they will have a length of about 5 inches. Their life expectancy is highest in Alaska, 11-15 years, and least on Pismo beach, 4 years. The Copalis beach average is 8 years. Clams up to 19 years of age have been recorded in Alaska.

Interpretation of the rings on the shell is used to determine ages. Marked clams planted in October and November were examined the following year for ring formation and growth. This showed that growth was very slow between November and February, then became quite rapid. A dark, readily discernible winter-ring or annulus was invariably formed, generally in February. Other studies indicate that good rings are not formed so systematically each year.

Food

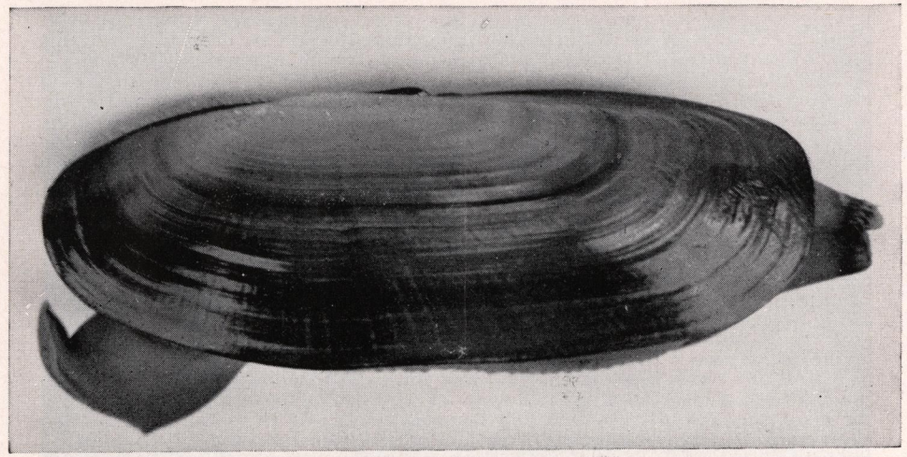
The diet includes diatoms and miscroscopic animals which commonly become so abundant they muddy the surf and beach. Food-bearing water is siphoned through one of the two neck orifices. Gills extract the food and pass it to the mouth near the hinge. From the mouth it moves through a gullet into the stomach. Extending from a pocket of the latter is a gelatinous transparent rod composed of a digestive enzyme similar to saliva. Waste products are excreted through the other neck orifice. The clams do not have to expose themselves to feed, for the cilia at the external openings allow feeding to be carried on below the surface of the sand.

Movement

Rapid movement is the razor clam's chief protection from man. Its shell is slender and thin and has a flexible lacquer-like coating. This, combined with its powerful digger, enables it to submerge several feet at a rate of up to 9 inches a minute in soft sand. Digging is much slower in hard packed sand.

The digger has a sharp, rigid tip. When quickly extended into the sand, a series of foot muscles forces water into it, flaring out the tip like the head of a nail. With this as an anchor the clam pulls itself downward with a second set of muscles.

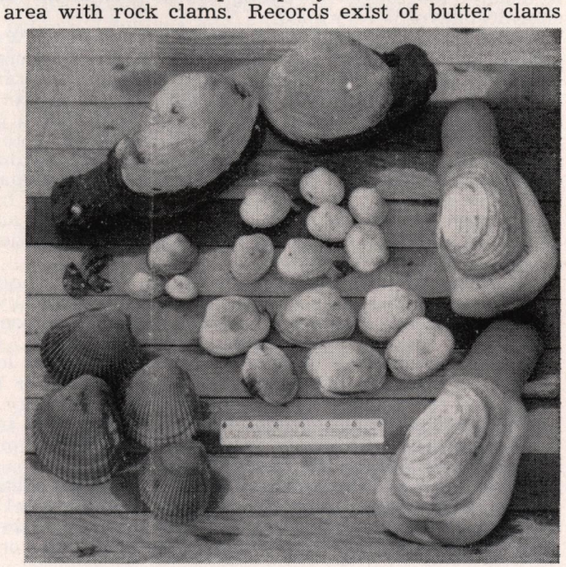
While it is able to negotiate vertically with ease, the razor clam does not migrate between areas to an appreciable extent, if at all. Numerous tests confirm this. During recent growth studies by the Department of Fisheries, clams marked by engraving a serial number on the shell were thickly planted in a 10 x 25 foot area on Twin Harbors beach at Grayland. The clams were dug, measured and replanted as many as four times, and in each instance were recovered in the original planting location.



Pacific razor clam (Siliqua patula). Shell size—4½ inches; age, 4-5 years, from Copalis Beach.

HARDSHELL CLAMS

Hardshelled species of bivalves most abundant on Puget Sound, Grays Harbor and Willapa Bay are the native little neck or rock clam *(Venerupis staminea)*, butter clam *(Saxidomus giganteus)*, horse clam *(Schizothaerus nuttalli)* and the Japanese little neck or Manila clam *(Tapes semidecussata)*. Little necks concentrate in the tidal zone between minus 3 and plus 4 feet in a porus mixture of gravel, sand and mud just firm enough to resist wave action. Most are found within six inches of the surface. These clams are the smallest of the major species and usually do not exceed 2¼ inches in shell size. They are distinguishable from butter clams by fine grooves which radiate from the shell hinge to the outer edge of the valve. Similar to Eastern quahaugs, butter clams have thick shells with fine growth lines which parallel the curvature of the valves. Indian mounds have yielded shell specimens up to 6 inches long, but 3-5 inches is a more common size. Shell color varies from white to a bluish gray, depending on the soil. These clams live principally below mean low tide and often share the same area with rock clams. Records exist of butter clams



WASHINGTON HARDSHELL CLAMS. Clockwise; top, horse clams, goeducs, cockles and mussels. In center, at top: Native little necks; left, Japanese little necks, below, butter clams.

which have been dredged from water more than 30 fathoms deep. Horse clams grow to an adult shell length of 6-8 inches and feed by extending their siphons up through the sand. They are usually found below the mean low tide zone and are 1-3 feet under the beach surface. The shells, relatively thin and easily broken, are white in color with dark brown patches. The neck is extremely long and cannot be fully retracted into the shell. Horse clams can be distinguished from goeducs by the fact that most have two leathery plates at the tip of the siphon; often covered with seaweed or barnacles.

Unlike the horse clam, the goeduc *(Panope generosa)* has a smooth siphon, usually light brown in color and without plates or growths covering the incoming and outgoing water passages. This clam is the largest of our hardshell clams, usually ranging from 2-4 pounds in weight, although specimens 12-14 pounds are occasionally reported. The environmental range is from the Queen Charlotte Islands to San Diego but the center of abundance is in Puget Sound. It inhabits sandy or muddy ground, usually below mean low tide. The goeduc has been much sought after and in many areas it is no longer found except near extreme low water. There is little fear of exterminating this animal however, since large beds of them have been observed below low tide to depths of 50 feet, while specimens have been dredged from water as deep as 30 fathoms and goeduc necks are commonly found in bottom fish taken at depths of 10 to 20 fathoms. The name goeduck is an easterner's error and was started by someone not familiar with the clam. Since it was first introduced in the nation's capitol it has been difficult to correct. The original and correct name is made up of an aspirated Indian GOE and a final TUCK through the teeth. For which goeduc is a reasonable equivalent. Meaning of the Indian word was "master clam."

A clam which is present throughout most of the Puget Sound area in small quantities and very abundant in the area of the Skagit River flats is the Eastern softshell or mud clam *(Mya arenaria)*. This clam, presumably introduced from the Atlantic Coast in the middle of the 19th century has not been appreciated by western clam diggers, even though it is recognized as the very choice clam of the Atlantic Coast. Shells of the Eastern clam are white to bluish gray in color, oblong in shape and have an average size of 3-4 inches. They are most frequently found in muddy or sandy bottoms, frequently high in the intertidal zone and have the general appearance of a small horse clam.

Other species of hardshell clams which are edible but relatively little used are the cockle *(Cardium corbis)* which is charactertized by a round, deeply corrugated shell of a variegated brown-red color. These clams lie close to the surface in the lower tidal zone and often are only partly buried. They have no siphon but a well-developed foot enables them to maintain position in sandy ground affected by wave action. The average size is about 3-4 inches, meat is usually too tough for eating unless ground or finely chopped and used in chowder; flavor is very good.

The largest piddock or boring clam found in Washington waters *(Zirfaea gabbi)* is occasionally very abundant in areas where hard clay banks extend onto the tideflats. The siphon has a similar appearance to that of the goeduc and is sometimes mistaken for it; however, in almost every case the clams are so firmly embedded in the hard clay surface that a pick is necessary to break up the ground and extract them. File-like teeth in the lower end of the oblong shell enables the boring clam to penetrate the hardpan. *Zirfaea gabbi* is also called a false goeduc. The inexperienced clam digger cannot tell the piddock from the goeduc and frequently jokers give the false goeduc to beach acquaintances. Since the piddock is usually inedible and always has a disagreeable taste and odor the unwary newcomer may decide he doesn't like "goeducs" in spite of popular acceptance.

The Puget Sound pink scallop *(Pecten)* is a unique swimming bivalve with jet propulsion. It is able to move through the water by closing its valves quickly and ejecting water through a small opening. A commercial fishery for these has existed in deep water using dredges or trawls. Occasionally, adults up to 2½ inches in size may be taken in shallow water at low tide.

The rock scallop *(Hinnites giganteus)* is another large, but non-commercial relative of the pecten. This is found mostly in rocky areas below low tide and has a rough shell that blends closely with the rock to which it is attached and is often covered with heavy growths of tube worms or barnacles. In some areas it is extensively taken for personal use.

Two species of mussels are also found in Washington waters although they are not often used as food. The common blue mussel *(Mytilus edulis)* grows to a length of three inches and is found mainly in sheltered waters attached to gravel and boulders. When steamed, the meat takes on an appearance not unlike

Goeducs (Panope generosa), showing size as compared to an ordinary hammer.

a fat Olympia oyster. The California mussel *(Mytilus californianus)* is taken from exposed rocks in the Straits of Juan de Fuca and the Pacific Ocean. It is a much larger species, having a shell usually 4-6 inches in length. Shellfish connoisseurs enjoy both of these species, raw or cooked, but during summer months the mussels found in the Straits of Juan de Fuca west of Port Townsend may contain dangerous quantities of toxin which causes paralytic shellfish poisoning.

Both squid and octopus are edible molluscs which swim and crawl about in our waters. The squid *(Lalligo opalescens)* is about 6-10 inches long, has 10 arms with suckers attached, and is often seen at night in vast schools in Puget Sound. The increase of SCUBA diving in Puget Sound waters has seen an increase in the capture of octopus *(Polypus hongkongensis)*. This eight-armed mollusc sometimes reaches a weight of more than 120 pounds. It occurs throughout Puget Sound, San Juan Islands, and Straits of Juan de Fuca. The white meat of the arms and body has a clam-like flavor and often requires tenderizing. Contrary to popular belief, the octopus is actually a shy retiring creature generally seeking to escape rather than attack humans.

Similar to the Pacific razor clam is a small relative called the jack knife clam *(Solen sicarius)*. This one has a long, narrow shell about three inches long and is found on sandy beaches of Puget Sound. It is occasionally abundant enough to be used as food.

Recent explorations by skin divers have also revealed moderate quantities of green abalone *(Halliotis kamschatkana)* in the Haro Strait area. These abalone are similar to, but considerably smaller than, abalone used commercially in California. They are found mostly on rocky areas in the vicinity of kelp beds where salinities are high and water temperatures below 60° F. Trial plantings of the large, California red abalone have also been made recently to ascertain the ability of this species to acclimate to Washington waters.

Imports

Several species of clams have been imported experimentally into Washington in an attempt to develop stocks of edible clams adaptable to sand or mud. Trial imports of the Japanese white clam, *Meretrix*, has so far been unsuccessful. A limited importation of Eastern quahaug *(Venus mercenaria)* has proven very successful. Techniques for artificially breeding clams are now available and the Department of Fisheries intends to apply these to developing seed stocks for further trial plantings.

ARTIFICIAL PROPAGATION OF CLAMS AND OYSTERS

Since man found out that shellfish, particularly clams and oysters, produced such a large number of eggs, he has been interested in some way of reducing the loss in incubation and metamorphosis. Nature has worked out a series of systems for assuring fertilization of the eggs. In some species, the eggs are held in the mantle cavity of the female until the eggs are fertilized and until the young have developed into shelled larvae and able to move about in the water. Such a method is usually associated with a lowered rate of egg production. Where larvae are not protected by the parent and the ova are discharged into the open sea water, fertilization takes place by chance encounter between egg and sperm. In this system the number of eggs is greatly increased.

Man has sought to insure fertilization by bringing eggs and sperm together in a tank or dish and to protect the larvae by providing a suitable media for them until they complete their free swimming larval life and change into their adult forms. In the U. S. A., the commercial crop of oysters in a single year would be provided by the offspring of one pair of parents if a fair percentage of all individuals survived. This fact makes artificial propagation an attractive proposition.

Each step in the culture of larvae is associated with complex problems. Suitable food in adequate quantities must be provided. The media must be kept sterile and well oxygenated. Pumps, water tubing and tank material must be of non-toxic material and function continually.

One by one these difficulties have been overcome by biologists and at present laboratories of the Department of Fisheries are turning out oyster spat and young clams which have come through the laboratory process. It is hoped that in the near future clam and oyster seed may be produced at will and in any reasonable quantity. A recent shipment of 80,000 artificially raised quahaugs from the New England coast was brought to Puget Sound in a glass bottle carried in a man's coat pocket.

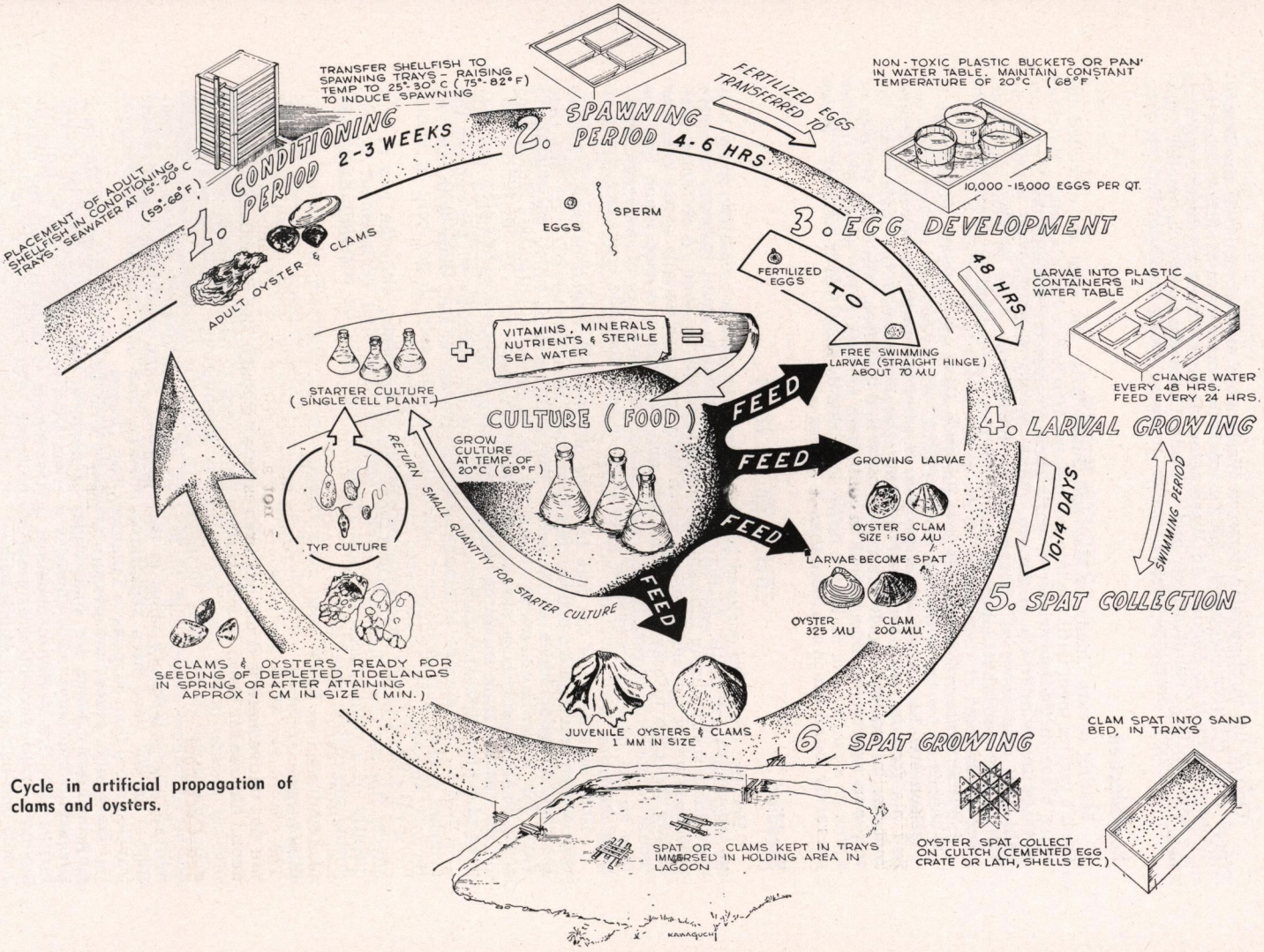
As each problem in the process is solved, the laboratory realizes an increasing survival of the developing shellfish and the vision of an adequate seed supply for our industries is near fulfillment.

SHRIMP

Although shrimp are a common marine animal, five kinds only are taken for food in Washington; spot shrimp *(Pandalus platyceros)*, the coon stripe *(Pandalus dani)*, the side stripe *(Pandalopsis dispar)*, and two species of pink shrimp *(Pandalus borealis* and *Pandalus jordani)*. The last named species forms a basis of an important fishery in the ocean off the Washington coast which has been exploited since 1956. On inside waters major shrimp beds are located in the San Juan Islands, Hood Canal and Elliott Bay, many other areas having been depleted by overfishing or other causes. The spot shrimp is also known as a prawn and is extensively used for frying and boiling. It is a large shrimp having a body size from 4-8 inches long. Large coon stripes and side stripes are also considered to be prawns, but the ocean and Puget Sound pink shrimp reach a body size of only 3-5 inches and their meat content is best suited for cocktail use. Other shrimp-like forms abound in Washington waters from microscopic plankton such as amphipods, copepods and euphausids to tiny pelagic shrimp of non-commercial size. These are fed upon by marine fishes, including salmon. The commercial varieties listed are not a source of food for salmon. Lobsters are not native here and periodic moves to artificially introduce them to Puget Sound have so far been unsuccessful.

Sea Cucumber

Another marine invertebrate that is utilized only by the initiated is the sea cucumber *(Stychopus californicus)*. Outwardly unappetizing, the skin has a warty, reddish coloration; however, upon opening, five bands of light colored muscle may be peeled away from the inside of the skin and ground for chowder or deep fat fried whole. Other edible shellfish include sea urchins and goose barnacles.



Cycle in artificial propagation of clams and oysters.

DUNGENESS CRABS

One of the most popular items on Washington seafood menus is the Dungeness crab *(Cancer magister)*. This hardshelled crustacean is fished from the Aleutian islands to Mexico. In Washington state, the most productive grounds lie between the Columbia river and LaPush. Crabs are present in smaller numbers on Puget Sound, the largest "inside" producer being the Point Roberts area.

Reproduction

Mating occurs chiefly in May and June. After the eggs are extruded the female carries them until the late fall months attached to her abdomen. Hatching takes place in the late winter or early spring, when the shrimp-like larvae are released to swim freely in the sea. While in this form they are attracted by light, and dense swarms often can be seen near the shore in May and June. The young crabs first appear in adult form on the bottom in June, 12 months after the mating.

Within a year of the time that the adult form is assumed, the young crab is 1½ inches across the widest part of the back. At 2 years the coastal crabs are 4 inches in width. After the second year most of the crabs are sexually mature, and a difference in the rate of growth appears between the males and the females. In the third year the males grow to 5¾ inches, while the females of the same age are an inch less in width. Most females never attain 6¼ inches although a majority of males are larger than this by their fourth birthday. Males are rarely found which are more than 10 inches wide.

Shedding

Because crabs are enclosed in a rigid exterior skeleton, they can grow only by shedding their shells. In Boundary bay adjacent to Point Roberts, the crabs shed their shells during the summer months, mostly in June. A soft new shell is formed under the old covering, which then splits horizontally at the rear and allows the crab to crawl out. The legs and abdomen are shed much like one would remove his fingers from a tight glove. The presence of discarded skeletons on the beaches frequently stirs false reports that the crabs are dying in large numbers.

Upon emergence of the crab from the old shell, its tissues become saturated with water and rapidly expand the new shell to a greater size. At this time the crabs remain hidden in the sand. The shell becomes fairly rigid within 2 days. For a month or two, the crabs are not in prime condition for market because an abnormally large part of their weight is water.

In coastal crabs moulting takes place about seven times during the first year of bottom life, the young crab increasing its width by 40 per cent at the first moult. The number of moults and the increase in size slows with age. At 6 inches a crab will moult once annually and gain only 15 per cent in width. Its bulk, however, will be increased by about 55 per cent.

Crabs have power to regenerate missing appendages, although loss of legs affects the survival chances of older animals. The first replacement is frequently of a smaller size but lost claws or legs may be completely restored during subsequent moultings.

Migration

The movement of crabs has been charted through the use of tagged specimens. Generally, there is a migration from deep to shallow water during the first six months of the year, and along the Washington coast there is an additional tendency at that time to move in a northerly direction. Crabs released on the 50 fathom curve about 15-20 miles offshore ultimately entered the commercial fishery within 5 miles of the coastline. Some specimens tagged inside Grays Harbor have been recaptured offshore, and one released off Westport traveled more than 80 miles to Tillamook bay, Oregon.

Only male crabs that measure at least 6¼ inches in width across the back may be legally taken for commercial or personal use. Sexes may be distinguished in two ways: most females are less than 6¼ inches wide at full maturity; also, the V-shaped abdomen of the female is broader than the male's, having a width two-thirds as great as its length. The stomach "V" of the male is only one-half as wide as it is long.

Red Crab

Another edible species of crab similar to the Dungeness, but smaller, is known as the red crab. Since it rarely reaches six inches across the back it is not generally utilized for food, even though the claws contain edible meat. When present in considerable abundance, this crab is a serious predator on both oysters and hardshell clams. In some areas methods of control have been necessary to prevent undue damage to clam and oyster crops.

REGULATIONS

Daily possession limits for shellfish taken for personal use are 6 male crabs, 24 razor clams, 3 goeducs, and an aggregate of 20 lbs. in the shell of other hardshell clams, or 6 pints of shelled meats, 12 rock scallops, 10 pounds of shrimp in the shell, and 36 oysters or 4 pints of shelled meats. Crabs must measure a minimum of 6¼ inches in width immediately in front of the most prominent points of the shell. Driving over clam beds is prohibited because of damage to seed clams. Many tidelands are privately owned and not open to the public unless permission is received from the owner. Oysters and clams may be taken legally only on publicly-owned tidelands that are not under sale or lease contract; however, for reasons of conservation or national security, certain government tidelands may be posted or designated as being closed to the public for the taking of shellfish.

PUBLIC BEACHES

In the State of Washington many tidelands are privately owned and not open to the public unless permission is received from the owner. Oysters and clams may be taken legally on state-owned tidelands that are not oyster reserves and not under sale or lease contract. They may also be taken on unrestricted county, city and federal lands. Several types of beaches have specifically been reserved for public use. Among these, the principal ones are:

Ocean beaches—These include most of the beaches along the Washington Coast that front on the Pacific Ocean.

Public clam and oyster beaches—A number of these are strategically located in various parts of the state in Willapa Harbor, south Puget Sound, Hood Canal and Island and San Juan counties and have been reserved for use by the public by legislative act. The State Highway Department has set aside a number of beaches adjacent to roadside parks where the tidelands are state-owned. Certain state parks are also located on salt water. Hardshell clams are present in varying abundance on most of these, subject to Park Department rules.

DIGGING TECHNIQUES

Hardshell Clams

A number of mechanical clam diggers have been tested and approved for use on privately owned or leased beaches in Washington. However, the majority of commercial digging is accomplished with rakes and forks. In some areas, due to its high abundance, the Manila clam which lies very near the surface is particularly well adapted to harvesting by means of an ordinary hand rake. Other commercial species are usually dug with a potato fork, which has a 2-foot handle and five tines bent at right angles to the direction of the handle. The clam digger uses this tool to dig through the ground and pick out market size clams, leaving smaller clams to bury themselves in the loosened gravel after the digger passes. Personal use diggers commonly utilize all types of hand digging tools.

However, the most satisfactory is usually a fork or a shovel. The important thing to remember in digging is that loosening of the ground has beneficial effects on the growth and survival of the remaining clam population; however, in order to achieve maximum survival it is necessary to fill in the holes so that no pile of gravel is left around the hole and no water-filled depression remains to provide an unsatisfactory habitat for the seedling clams.

Goeducs

Digging goeducs has become an art on State of Washington beaches. The most common legal procedure is to use a large stove pipe or open-ended goeduc can which is a device that can be pressed down through the bottom surrounding the goeduc and used to keep water, sand, and mud from filling in the hole as digging progresses. When the neck and top of the shell of the goeduc is exposed, the digger reaches down, grasps the base of the neck firmly in his hand and works the goeduc out of the ground by alternately wiggling and pumping up and down.

Razor Clams

Razor clams are located by looking for "shows" on the beach near the surf line while the tide is out. Clams can often be made to show by stamping with the feet. Shows are formed when the tip of the clam's neck, which is near the surface of the sand when feeding, is withdrawn producing a slight depression or small, oval-shaped hole. Size of the show is often indication of the size of the clam. Minus tides are best, but with a low surf clams can be dug on plus tides of one foot or higher. Dry digging away from the wave wash is usually more productive for the occasional personal-use digger. In any type of digging, it should be remembered that the clam's neck may be streached as much as a foot. When disturbed the neck is pulled in very quickly. This gives the impression the clam is going down very rapidly while actually it digs very slowly in some types of sand. The clam shovel and the "tube" are used for razor clam digging. A specialized clam shovel is designed for this purpose. The shovel is inserted about four inches to seaward of the clam with the blade pointing straight down rather than slanted toward the clam. Sand is then lifted out in one or more stages until the hole is deep enough to reach the clam and grasp its neck or shell and pull the clam out in an uninjured condition. Prying back on the shovel will smash the clam. Use of cylindrical tubes or pipes for digging razor clams is relatively new, but has been effective for the occasional digger. To start, the digger places the end of the tube to be sure the show is centered. The tube is then ready to be twisted or worked down into the sand. Because of the way in which razor clams are usually oriented, it is generally advisable to slant the tube so that the handle end is leaning slightly towards the sand dunes. Speed is not essential and it is easier to remove the clam by removing two or three cores of sand, each about 10 inches in depth. The air vent must be sealed with the finger when pulling the tube up. As the tube is worked down, the digger should be alert for the feel or sound of striking a clam. When the edge of the tube strikes a clam shell the tube should be raised slightly and started off at a new angle, or the clam should be removed by hand. If the clam has not been removed when the tube has gone the full depth, it may be lying at the bottom of the hole. Search the hole and also the sand that has been removed from the hole.

RED TIDE

Surprise, and often considerable alarm is excited by the presence from time to time of a striking, reddish discoloration of sea water. These so called "red tides" are formed by large masses of microscopic, single-celled animals. Several kinds may produce red tides, but only one of these *(Gonyaulax)* is presently believed to be a source of paralytic shellfish poisoning. It is confined to the open sea, or waters of high salinity and has never been found in dangerous concentrations of Puget Sound, even when bay water temperatures are high during the summer when most red tide blooms occur. Other forms, including *Gymnodinium* do not affect mortalities among fish or shellfish. So far as can be ascertained at present, the toxic effect of *Gymnodinium* and even of single celled animals which produce "green tides" is due to excessive amounts of metabolic products or to suffocation due to clogging of the gills.

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