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SHELLFISH RESOURCES OF THE NORTHWEST COAST OF THE UNITED STATES.¹

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INTRODUCTION.

During the summer of 1917 the writer was appointed as temporary assistant by the United States Bureau of Fisheries, which services were renewed during the summer of 1918 and continued at intervals through May, 1919. The specific purpose of the appointment was to make a survey of the shellfish resources of the northwest coast of the United States, including the shore line, bays, and rivers of the State of Oregon and the southern portion of Washington.

The undertaking being in the nature of a war measure, with the ultimate purpose of food conservation in view, it was considered advisable to first make a survey of the coastal region in order to determine the varieties of shellfish existing, their relative abundance, and their accessibility to markets or centers from which they might be distributed, and to encourage the more general use of such sea foods as clams, oysters, mussels, and other shellfish.

It was also deemed advisable to make studies of the spawning seasons of the common edible shellfish and learn, if possible, something of their rate of growth and the conditions under which they best thrive, that such information might be available in the future should it at any time be considered wise to undertake the cultivation of certain species of shellfish or to place further restrictions upon the present rate of destruction.

¹ Appendix III to the Report of the U. S. Commissioner of Fisheries for 1922. B. F. Doc. No. 920.

The first section of the northwest coast surveyed extended from the mouth of the Siuslaw River, in Lane County, Oreg., to Tillamook Bay, in Tillamook County, of the same State. This survey was made during a period of 17 days and included a hasty investigation of the location and distribution of beds of clams and mussels, the determination of the species of shellfish contained therein, and other information and observations which might serve as a basis for later and more intensive work.

Among the rivers and bays of more or less importance in shellfish resources, this stretch of coast line includes the Siuslaw River, one of the larger rivers of Oregon, the Yachats River with a small bay at its mouth, Alsea Bay, the Yaquina River and Bay, Siletz Bay, Nestugga Bay, Netarts Bay, and Tillamook Bay. Besides the above, long or short sand beaches alternate with rocky points and rugged headlands, each serving as habitats for certain forms of shellfish.

The above coast line was traversed, for the most part, on foot, as that seemed to be the most efficient means of acquiring the desired information relative to the location and distribution of species of shellfish. This region of the Oregon coast, as can be said of practically the entire length of it, is very sparsely settled, with public roads paralleling the coast line either in very poor condition or absent altogether. In not a few places the public highway is the sand beach, a splendid roadway at low tide but dangerous or quite impassable at high tide. Trails may usually be found leading over or around headlands, but frequently these are overgrown and indistinct, due to lack of use.

The principal villages and settlements throughout the extent of the Oregon coast from the Siuslaw River to Tillamook Bay include the town of Florence on the Siuslaw River, about 4 miles from its mouth, a few scattering houses at Heceta Head, the village of Yachats at the mouth of the Yachats River, the town of Waldport on Alsea Bay, Newport on Yaquina Bay, Taft on Siletz Bay, Pacific City on Nestugga Bay, Netarts on Netarts Bay, and Tillamook City on Tillamook Bay. Interspersed with the settlements mentioned above are a few ranch houses where the nature of the immediate coastal region permits farming on a small scale.

The physical conditions, the settlements, and the means of communication of the above section are mentioned in detail, as these facts have considerable bearing upon the accessibility or lack of accessibility, as the case may be, of certain shellfish resources on this coast, and their values as market products.

At later periods during the summer, fall, and winter of 1917 surveys were made of the southern shore of the State of Oregon to a distance of about 5 miles south of Bandon, a town at the mouth of the Coquille River, with special attention given to the Coos Bay region. Investigations of the northwest section of the coast of Oregon were also made during 1917 and also the following year. These latter surveys extended from Tillamook Bay northward, including the Nehalem coast beaches, Cannon Beach, the Clatsop County beaches, opposite the towns of Seaside and Gearheart, and on to the mouth of the Columbia River. Surveys were also made of the beaches on the Washington coast up to Willapa Bay. The shellfish resources of this bay were investigated, approaching it from both

the west side by way of Nahcotta and the east side by way of South Bend. Olympia, Wash., was visited for information relative to the shellfish resources of the southern Puget Sound region.

Since the coastal territory covered in these investigations is so extensive and so varied in character of its geography it naturally resolves itself into a number of more or less distinct shellfish centers, each with some characteristics peculiar to itself.

For purposes of system and convenience in this report, six more important shellfish centers or regions will be discussed under separate headings. Following these, consideration is given to localities of minor importance. The species of shellfish found in each region and their distribution, relative abundance, and importance are indicated, together with such other investigations and observations as were made during the course of the survey. The photographs included in the report are illustrative of some of the regions discussed and of the typical shellfish of the Northwest. A summary and conclusions are to be found at the end of the report.

SHELLFISH RESOURCES OF MAJOR IMPORTANCE.

THE COOS BAY REGION.

Coos Bay, in Coos County, Oreg., is one of the larger bays of that State. It is shaped like an inverted V with the apex directed northward and the outlet of the bay toward the lower end of the left arm. Near the head of the bay, Coos River and other smaller streams feed it with fresh water and much silt from the surrounding territory. In parts of the bay on either side of the navigation channel are broad mud flats, exposed or nearly so during reasonably low tides.

On these broad mud flats a number of species of edible clams have become well adapted to their surroundings. Extensive beds of *Mya arenaria* Linnaeus, the eastern mud clam, are to be found on the north side of the channel opposite the town of North Bend. During favorable conditions of weather the channel can be crossed by a row-boat and the clams transported to North Bend or Marshfield, an adjoining town. Here *Mya arenaria* grows to a fair size and is present in considerable abundance.

During 1917 and for several years previous to that date Frank LaRue supplied the local demands for this shellfish. No attempt was made by Mr. LaRue to develop outside markets for the clam, as he believed that *Mya* could not be obtained in sufficient quantities in Coos Bay for both local and export trade. In 1917 the local price received for *Mya* was \$0.75 per 5-gallon can of fresh clams, including shells.

Early in 1918 Samuel Terrill came to North Bend from Florence, Oreg., and established a market for shellfish and other sea products. This permanent place of business, with a supply of clams, crabs, etc., on display where the public might see them, was an apparent stimulus to their use as articles of food. Mr. Terrill was carrying on a good business locally during the fall of 1918. He made little or no attempt to place clams on the markets of Willamette Valley towns, although there is direct communication by rail with Portland and intermediate points, the time required for transportation by express from North Bend to Portland being about 12 hours. The

Willamette Valley, however, as is noted in a later section of this report, is supplied with shellfish from another source.

In Marshfield, a town adjoining North Bend but of greater population than the latter, the shellfish trade is also good, the hotels, restaurants, and other patrons being supplied by a local meat concern which employs its own clam diggers. Owing to its greater relative abundance, *Mya arenaria* is the only clam found on the markets in any quantity in and about the Coos Bay region.

Southward from Empire City, a small town on the west arm of Coos Bay, and especially on the east side of the channel are distributed other species of shellfish of edible quality, although not found in large numbers. Well up toward Empire City, in 1917 and 1918, small quantities of *Schizothaerus nuttalli* Conrad, the "great blue clam," were to be found. Few of these reach the markets of North Bend or Marshfield. *Paphya staminea* (Conrad) also occurs in small numbers below Empire City on the east side of the channel, extending into South Slough at the southern end of this arm of the bay. This species grows to a moderate size here but is nowhere abundant, and little profit would accrue in attempting to market the species from this source.

During the summer of 1918 a small shipment of *Paphya* was made from Coos Bay to the Siuslaw River, in Lane County, in an attempt to establish the species in that locality. The experiment was not successful. In Coos Bay the species lives just beneath the surface of ooze and is fairly well covered with masses of seaweed. In the Siuslaw River it was found necessary to plant it in a more exposed locality free from seaweed. Whether this greater drainage at low tide had a disastrous effect upon the species can not be determined, as no further attempts were made to transplant this clam.

Associated with *Paphya staminea* in this region is found *Cardium corbis* Martyn, the "cockle." It exists here under similar conditions as *Paphya* and is scattered in a very general manner. The species is a negligible factor as a food product in this locality.

The prospect for the success of oyster culture in Coos Bay is promising. Fourteen acres have been set aside by a group of local men interested in the enterprise and planted with the western oyster, *Ostrea lurida* Carpenter. The season of 1917 proved to be a successful one. A satisfactory amount of spat was collected, which gave encouragement to the project and led to the consideration of a material increase in the acreage. The season of 1918 was also reported to be successful. The writer was able to advise regarding materials for cultch and encouraged the extension of the plantation. He entered into correspondence with the U. S. Bureau of Fisheries relative to the planting of western oysters in Coos Bay on a larger scale than could be undertaken by the private parties of North Bend. It was not deemed advisable at that time, however, to undertake the project.

At one time Coos Bay evidently supported the western oyster in great abundance, if one can judge from the quantities of shells that are cast out of the bed of the bay by the activities of the steam dredgers. These oysters became extinct, however, many years ago. The cause of the extinction is not positively known. The Indians believe it was a result of a great forest fire which swept the Oregon coast nearly 100 years ago.

Cape Arago and Sunset Bay are a short distance south of the Coos Bay bar and, while included in this region, may be dismissed with brief consideration. The chief economic Mollusca of this rocky point and small bay, of which mention need be made, are two species of sea mussels, *Mytilus edulis* Linnaeus and *Mytilus californianus* Conrad, the latter being of much larger size, when adult, and possessing a rougher shell than the former. The larger species is the more characteristic of the outer rocks where the waves are strong. Although these two species are plentiful in the vicinity of Cape Arago they are seldom used as food.

Experimental investigations carried on in the Coos Bay region included studies concerned with the determination of the spawning seasons of certain clams and mussels inhabiting those waters. It was believed that microscopic examination of the ovaries and spermaries of large numbers of individuals of a given species through as many months or seasons of the year as possible would reveal the limitations of the spawning period or periods of that species. Such investigations in the Coos Bay locality comprised work upon *Paphya staminea*, *Cardium corbis*, and *Mytilus edulis*. As a result of these observations it can be said with assurance that *Paphya staminea* spawns in this region during the late summer and early fall, or during the months of August and September. No definite assertion regarding the spawning of *Cardium corbis* or *Mytilus edulis* could be made after many examinations at North Bend during the periods spent there in 1917 and 1918.

THE SIUSLAW REGION.

The Siuslaw River flows into the Pacific Ocean in western Lane County, Oreg. It is a broad, expansive river for more than 10 miles from its mouth and the influence of salt water is felt for about twice that distance during high tides. About 4 miles from the mouth of the river are the towns of Florence, on the north bank, and Glendale, on the opposite side. The village of Acme is a few miles up the river on the same side as Florence. Between these two towns, mostly on the north side of the channel of the river, are some excellent beds of *Mya arenaria*, the eastern mud clam. The writer has examined beds of this species in many localities of the northwest but no finer specimens of *Mya* have come to his notice anywhere than those found near Florence. The beds here occupy mud flats which are very accessible from the shore and are uncovered during a moderately low tide.

No other economic mollusk is associated with *Mya arenaria* here. In this respect the Siuslaw River flats differ from others of this State. Even *Schizothaerus nuttalli*, the "great blue clam," common both to the south and north of this region, has not gained a foothold here. *Mya arenaria* was carried to the Siuslaw River from Coos Bay by one David Morse more than 30 years ago and has done exceedingly well in this locality.

That food is sufficient for the mollusks may be indicated by the large size which they may attain in this environment. The author has measured numerous shells from these beds which were well over 6 inches in length. That the waters are well supplied with microorganisms which serve as food for the clams is shown by opening the

stomachs of the mollusks immediately after they have ceased feeding, as the tide recedes. Diatoms, Protozoa, and other microorganisms are found to make up a substantial portion of the stomach contents.

During the summer of 1917, when the writer first made observations on the clam beds of this region, Samuel Terrill, mentioned above, was engaged in digging clams for the local demand as well as for export to Willamette Valley towns. Four miles above Florence at Cushman, a station on the Siuslaw River, direct railroad connections may be had with Portland and intermediate points, the time required to Eugene, where a good many clams were shipped, being about three hours, and to Portland between seven and eight hours. Clams taken in the Siuslaw River during an early morning tide would be delivered to the market or consumer in Eugene, Albany, or Salem the evening of the same day, and early the next morning in Portland. This railroad connection had much to do with stimulating the shellfish markets of the Willamette Valley towns mentioned above.

Although certain portions of the clam beds near Florence had been systematically worked over in years previous to 1917, at this latter time areas comprising 25 acres or more on the north side of the channel of the river and about one-fifth that area on the south side were well stocked with clams. The mollusks were doing much better in the rich, deep mud well out in the middle of the beds than they were nearer the shore where the soil was more sandy in character and where a longer exposure between tides reduced the duration of feeding periods.

It was gratifying to find in 1917 that the clams were being used extensively by the people of that locality and of near-by towns. Mr. Terrill during that year was able to make a fair income by working the clam beds for local demands and for shipments to the markets of Willamette Valley towns. The 5-gallon oil can was used as a standard of measurement for clams, for which quantity 50 cents was the regular price. On a favorable tide Mr. Terrill was able to dig from five to eight cans of clams. It is estimated that the clam beds near Florence would net one who could devote most of his time to this industry from \$1,000 to \$1,500 annually. Early in 1918, Mr. Terrill, believing that he could do better financially in a larger town, established a permanent place of business in the town of North Bend, on Coos Bay, where he now supplies the local demand for clams and other sea foods.

The removal of Mr. Terrill left no responsible person in charge of the digging and marketing of clams from this region. Others took up clam digging on a small scale, but were not able to devote much time to it, and as a result in 1918 the export shipments of clams from the Siuslaw River were much curtailed. There was even a scarcity of this food product in Florence. It was observed here, as elsewhere, that many families will make use of clams if they are delivered at the door, but few will take the trouble to go and dig them, although conveniently at hand.

The writer made use of the clam beds of the Siuslaw River during the period from August, 1917, to May, 1919, for experimental work upon the spawning period, the growth, and the shipping qualities of *Mya arenaria*.

An estimated census of the clams was taken in 1917. In the most densely populated areas, from 25 to 30 clams per square yard were often taken, with the number frequently reaching 50. From the point of maximum yield in bed the number was reduced to few or none per square yard as the shore line was approached. Local residents who had observed the clam beds in the Siuslaw River for many years believed in 1917 that there was no appreciable reduction in the abundance of clams from season to season. It is the author's opinion, after viewing the beds at intervals for nearly two years that, although certain areas which in past years were systematically worked over and exhausted have not restocked themselves, the clams are holding their own fairly well.

Sudden catastrophies have occurred, however, and may occur again to inhibit the natural development of the clams in the Siuslaw River. The North Fork, a tributary of the Siuslaw River, flows into the latter about $1\frac{1}{2}$ miles above Florence, near the upper end of the clam beds. During December, 1917, and January, 1918, excessively hard rains filled all of the mountain streams tributary to the Siuslaw River and for nearly two months this river and the North Fork were overflowing their banks. An immense amount of silt was carried down the streams and deposited over the clam beds. During that time the clams were continuously under this flow of fresh water, and when next observed, late in January, 1918, it was found that large numbers of the young clams, which in the preceding December had measured from 10 to 25 millimeters in length, had perished. Medium-sized and large clams were uninjured, but the small ones situated near the surface could not maintain themselves. Their appearance was similar to that assumed by other clams of the same species killed in fresh water during experimental investigations. This destruction resulted in a noticeable reduction of half-grown clams in the beds in the following summer. Although heavy rains are characteristic in western Oregon during the winter months, rarely are floods of so long duration as they were in December, 1917, and January, 1918, and similar destruction of young clams probably seldom occurs.

That *Mya arenaria* spawns in late August and during September on the Oregon coast is well established. In the early part of September, 1917, an examination of the ovaries and spermaries of the species was made at Florence. The clams were found to be in spawning condition with mature ova and very active sperm. These observations were verified during the corresponding season of 1918. That spawning does not occur at other seasons of the year was also demonstrated by repeated microscopic examinations of the gonads of the species during nearly every month of the year.

Portions of the clam beds of the Siuslaw River were, in 1917, well covered with eel grass which gave support to the glochidia, as was apparent by turning over the upper layers of mud in which the eel grass was rooted. Here during late November and early December, 1917, were to be found large numbers of young clams from 10 to 25 millimeters in length in the surface of the ooze beneath patches of the eel grass. Spawning in late August or September, apparently young clams may reach a length of 25 millimeters by December if conditions are favorable.

It was also shown by repeated experiments on the rate of growth of *Mya* that young clams 25 millimeters in length will, in favorable positions in the bed, double their length in six months' time, or reach a length of 50 millimeters. How long the clams will continue to live and grow has not been demonstrated here. It is estimated, however, that the larger clams of these beds, those of a length of 6 inches or more, are probably more than 5 years of age.

Attempts were made to restock depleted areas of the beds by replanting young and medium-sized clams. These efforts were, for the most part, successful. It was demonstrated, however, that success could not be attained by planting too near the shore, or in too exposed areas, or in localities where the soil consisted of sand with small amounts of black mud. The lack of food was probably a deciding factor under these conditions. Young and medium-sized clams when transplanted in the rich, black mud readily took hold. The planting was accomplished by digging holes in the mud with a pointed stick and dropping the clams in with the siphons up. If large clams were planted, it was found advisable to set them about 1 foot below the surface, as they did not readily dig much deeper than they were placed, and if left too near the surface they usually perished.

Shipments of *Mya arenaria* were frequently made during all seasons of the year from Florence to Eugene in order to test the shipping and keeping qualities of the clam under varied conditions. If kept in a warm dry place, the clams will soon die, usually within 24 hours. By reducing the temperature of the container in which the clams are kept to near the freezing point, they have been found in good condition at the end of a week, and they have been kept alive for 14 days by being placed directly in contact with the ice. It is obvious that *Mya arenaria* is a good shipper under proper conditions. If transported in refrigerator cars properly iced, there is every reason to believe that *Mya* might be shipped several hundred miles and still be fit for the market.

The writer encouraged the use of *Mya* as a substitute for the red meats in various parts of the Willamette Valley and was gratified to find an increased response on the part of the public in spite of the widespread prejudice against "things that grow in the mud." A number of lectures were given by the writer on the sea-food resources of our northwest coast and the newspapers were used in stimulating an interest in shellfish as food.

The only other bivalve which may be considered of economic importance appearing in the Siuslaw region is *Mytilus edulis*. It is not uncommon on the rocks at the mouth of the river and advances at least 4 miles up the stream from its mouth. No attention, however, is given to the mussel in this locality.

THE YAQUINA REGION.

The Yaquina region includes the Yaquina River, Yaquina Bay, and the beaches immediately to the north and south of the latter. While the preceding region was characterized by the presence of a single edible clam, besides a sea mussel, here are no less than six species of mollusks besides the western oyster and two sea mussels,

which are used to a greater or less extent as articles of human food. The region is a large and extensive one, comprising long stretches of ocean beaches, a broad bay, and several miles of the Yaquina River with its muddy margins exposed at low tide.

No single clam can be said to be characteristic of this region. *Schizothaerus nuttalli*, the "great blue clam," is abundant on both sides of the river between the towns of Newport and Yaquina. It lives in the soft mud here and is easily removed, as it is quite near the surface, which is unusual for this species. The "great blue clam" is one of the principal clams used as food by local consumers.

In 1917, when the writer first made observations on the shellfish of this locality, Messrs. Reeves and Doig, fishermen who lived on the bank of the Yaquina River, chiefly supplied the people of the town of Newport with shellfish. Local fish markets also handled the product and there was a brisk demand and a supply always on hand.

Associated with "the great blue clam," but more abundant on the south side of the channel, are *Cardium corbis*, the "cockle," and *Paphya staminea*, the "little neck clam." These are also used by local consumers to a considerable extent. *Macoma nasuta*, the "bent nose clam," was quite abundant on the north side of the bay in 1917 and 1918. This clam was found to be used as food to a limited degree. Those who were accustomed to make use of it commended its flavor very highly, stating that it was more like the oyster than any of the others. For this reason it has been given a local name of "oyster clam." One of the chief objections to this small clam is that it ingests so much sand that it is somewhat disagreeable if prepared immediately after having been removed from the water. If the clam is placed in clean fresh water, however, a short time before it is to be prepared, most of the sand will be ejected and the clam will be much more desirable as food.

Mya arenaria is also found on the markets of Newport and is much sought after by shellfish consumers. The species is taken from the river above the town of Yaquina and brought down to the Newport markets at irregular intervals, but usually two or three times every week.

The beach immediately north of the mouth of the Yaquina River, known as Nye Beach, is abundantly supplied with a rock borer, *Pholadidea penita* (Conrad), which is considered a great delicacy by local consumers of shellfish. The soft sandstone rocks which parallel the beach and are exposed at low tide offer favorable habitats for this bivalve. The species occurs at other localities along the northwest coast, but this region may be considered a center of great production. Tourists who spend a few months at Newport during the summer frequent the beach at low tide to break out the rock borers with pick and crowbar. There is great destruction of the young mollusks as well as of the old, as a result, and the species in the rocks near the shore was apparently well depleted in 1918. How long the species will survive here is a question which can not now be answered as its life history and rate of growth have not been determined.

Sea mussels thickly cover the rocks of the north jetty at the mouth of the river, those that stand out from the shore at the north end

of Nye Beach and those about the base of Yaquina Head. They are also common on Seal Rocks 10 miles to the south of Yaquina Bay. Two species of mussels are found in this region, *Mytilus edulis* and *Mytilus californianus*.

Formerly the razor clam, *Siliqua patula*, was very abundant in the ocean beaches of the Yaquina region. As late as 1914 and 1915 large quantities of this clam were obtainable both north and south of the bay. No very satisfactory reason can be given for the rather sudden disappearance of the clam south of the Clatsop County beaches. After careful observation of the beaches formerly populated by the razor clam in this region and elsewhere the author is inclined to the opinion that the shifting of the sand has been a large factor in the disappearance of the clams either by smothering them or by washing them out into deeper water. A great many of the clams have been destroyed in the past few years as is evidenced by the quantities of shells that are cast up on the beaches. If they have been washed out into deeper water there is a possibility that they may return by inshore migrations. It was gratifying to find during the summer of 1919 that the razor clam was apparently coming back at a number of points along the Oregon coast, as will be noted in a later section.

The Yaquina River is the center of the oyster industry in Oregon. The most productive areas are about 1 mile above the town of Yaquina near Oysterville. They include both natural and private beds. The natural beds are under the control of the State Fish and Game Commission which prescribes rules and regulations for the protection of the beds and for the taking of the oysters. The closed season as to natural beds has been fixed by statute, being from the 15th day of June to the 10th day of September of each year.²

Certain areas are set apart and designated by law as beds for the artificial planting of oysters. Such beds are limited in size, not to exceed 2 acres in each plantation, and each holder of a claim is required to comply with local regulations fixed by the association of oystermen.³

Since the beds are, for the most part, located in the channel of the river, in 1917 the fishermen on the artificial plantations were having considerable difficulty, as had been the case in previous years, in preventing the oysters from being smothered by the sediment carried down the river. Frequent tonging was resorted to to keep the silt moving. Little or no artificial methods were resorted to in order to catch the spat. The old shells were considered, by those engaged in the industry, as sufficient cultch with the occasional help of the bark of trees.

In spite of the fact that the Yaquina oyster fishermen have certain natural difficulties to contend with, they made a fair profit during the season of 1916-17. At that time 15 men were engaged in oyster fishing. By working diligently each man was able to take from four to six sacks per week, the standard sack being 110 pounds, including shells. During that season the price realized in Portland, where nearly all of the oysters were marketed, was from \$6 to \$8 per sack. This price of the Yaquina oyster was somewhat

² Fish and Game Laws of Oregon, 1919-20, sec. 187, p. 76.

³ Fish and Game Laws of Oregon, 1919-20, sec. 186, p. 76.

in advance of that of previous years, due to the curtailment of the supply of oysters in the Northwest, resulting from a partial destruction of the beds of the Puget Sound region by freezing during a previous season.

In 1897 the eastern oyster was introduced into Oregon. The Yaquina River was selected as the most favorable locality for the growth and possible development of the species. Plantings were made near Oysterville and cared for under the direction of the State biologist for a number of years, during which time the oysters grew and matured. It was reported that spawning occurred, but the hope of collecting spat was given up after the failures of several seasons in the belief that the water was too cold.

Investigations looking toward the determination of the spawning seasons of the clams and mussels of this region were conducted at intervals during the summer, winter, and spring months with the result that *Schizothaerus nuttalli*, the "great blue clam," was found to be spawning during the month of March, the limits of the period probably being from the last of February or the first of March to well along in April. At no other season was the species found to be spawning although examinations were made during other months of the year in this locality and elsewhere.

Paphya staminea was found to be in a spawning condition during the month of March at Yaquina, while the species was found in a similar condition in Coos Bay during the late summer and early fall. The hermaphroditic character of *Cardium corbis* was first observed during the month of March in this locality. That spawning of this species occurs here in the spring months can hardly be doubted. No positive assertion could be made regarding the spawning periods of other species of clams and mussels investigated here.

The trial shipments of *Schizothaerus nuttalli*, *Cardium corbis*, and *Paphya staminea* were made from Newport to Eugene, Oreg., at intervals during the winter months of 1918. These were made to determine the shipping qualities of the different species and enabled the author to reach conclusions as to the marketable value of the clams, in fresh condition, at points some distance from the source of supply. The time required by express from Newport to Eugene is usually seven or eight hours, with one transfer.

Schizothaerus does not ship well. Its shell is quite brittle and is often broken into fragments in transit. The clam is a "gaper," the adductor muscles relaxing soon after the animal is removed from the salt water, permitting the shell to open widely. Cold-storage methods were not successful in preserving this clam in an edible condition for more than three or four days. Advice given to the public was to prepare the "great blue clam" for use as soon as possible after it was taken, otherwise it might prove to be a dangerous food.

Much of what has been said about the previous species may be said of *Cardium corbis*. The shell of the "cockle," however, will withstand the shocks of transportation, but the clam is also a "gaper" and can hardly be relied upon as food after being out of water for 24 hours, unless placed upon ice, which method may preserve it safely for another day. The species is an excellent one for local consumption, but can not be counted upon for shipment in a fresh condition.

Paphya staminea is a good shipper, but can not be taken in this locality in sufficient abundance to make it profitable for other than local use.

The conclusion arrived at in 1918 was that there were no species of clams or mussels in the Yaquina region that were obtainable in large enough quantities and that had the proper shipping qualities for purposes of commerce, in the fresh condition, beyond the local demand.

Messrs. Reeves and Doig, mentioned above, in 1917 carried on a small export trade in canned clams shipped direct to consumers in Willamette Valley towns, the method being to seal the edible portions of the clams in jars of fresh water, the cooking to take place when the destination was reached. This did not prove to be a very popular way of handling the product and was not long continued.

It was gratifying, however, to find that large quantities of shellfish, including clams, crabs, oysters, etc., were used locally in and about the Yaquina region. The people of that locality were, for the most part, fully aware of the value of the sea-food products conveniently at hand.

In the spring of 1918, after advising with the office of the U. S. Commissioner of Fisheries, a shipment of "pismo" clams was obtained from San Luis Obispo Bay, Calif., and planted in the Yaquina region between Nye Beach and Agate Beach. Through the efforts of the California Fish and Game Commission 750 pounds of the clams were secured and shipped. They arrived at their destination apparently in good condition and were planted on a beach which, in the author's judgment, was well suited to them. Several days after the planting occurred, a single clam was found about 200 yards from the place of planting. The clam was alive, in the edge of the water and half covered with sand. This led to the belief that more of the clams may have become scattered up and down the beach, although no others were located. In 1919, a year after the planting, no sign of any of the clams could be discovered, nor were any shells to be found along the beach. The success or the failure of the project can not be determined at this date.

NETARTS AND TILLAMOOK REGIONS.

These two shellfish centers in Tillamook County, Oreg., may be considered as one. Netarts Bay is a long but very shallow arm of the sea, with the outlet some miles north of Cape Lookout. The bay is so shallow that during an extremely low tide nearly all of the water runs out, leaving much of the bottom area exposed. The salinity of the bay is essentially that of the ocean, as practically no fresh water enters it.

The bay supports a number of species of edible shellfish, among the clams being *Schizothaerus nuttalli*, *Cardium corbis*, *Paphya staminea*, and *Saxidomus giganteus* Deshayes. *Schizothaerus* predominates and seems to show little or no evidence of depletion from year to year. The species occupies the gravel beds of several acres in extent at the north end of the bay near the outlet, which are very accessible from the shore. The clams are very abundant here, but are quite firmly embedded in the gravel, and are more difficult to remove than in those localities where they inhabit soft mud.

Cardium and *Paphya* are associated with *Schizothaerus*, but are much less numerous than the latter, their scarcity rendering them of small significance as food products in this region.

Saxidomus giganteus, a very excellent food mollusk, was formerly very abundant in Netarts Bay, but has become greatly depleted in recent years. This depletion was more apparent during the summer of 1918 than during the previous year. Excessive digging of the clam seemed to be the chief factor making for its extinction.

In former years the razor clam, *Siliqua patula*, was a familiar species along the ocean beaches outside of Netarts Bay as well as within the bay. In 1917 practically no razor clams were found along the open ocean beaches in this region, and the same conditions persisted in 1918, but each year a few have been taken from the sand beds in the bay proper.

This region is one of the most fertile in the production of the large sea mussel, *Mytilus californianus* Conrad, of any part of the territory surveyed. The coast north of Netarts Bay, in the vicinity of Cape Mears, is very rugged. Here large areas of the rocks are densely covered with masses of this large mussel. Aside from a very insignificant local consumption as food, the immense beds of sea mussels here and elsewhere along our northwest coast have not as yet been turned into any economic value.

During most of the year the village of Netarts, on Netarts Bay, consists of a few scattered houses of permanent residents, but in the summer season it becomes a tent town of considerable size. From June until September, during the years 1917 and 1918, many people from inland districts of Oregon and other States visited Netarts for periods of from one week to a month or more. While there, clams were a constant article of diet, and nearly every family canned quantities of the shellfish to be carried away for future consumption.

Netarts is in an isolated region and at times is almost or wholly cut off from communication with inland points, due to the bad condition of the highway. During the rainy season of 1918 the road from Tillamook City to Netarts was, at times, entirely impassable for wheeled vehicles. With the improvement of means of transportation from this region markets may more easily be established for such species of shellfish as are suitable for distribution at points some distance from the coast. The markets of Tillamook City, 9 miles from Netarts, are supplied in part from Netarts Bay, but the quantity of fresh clams shipped from Netarts to more distant points is not large. Portland is from 8 to 10 hours by rail from Tillamook City, and to reach the upper Willamette Valley towns requires an additional 4 or 5 hours, after one transfer is made.

On consideration of the quality of the clams that were available for export from Netarts Bay in 1918 and the uncertain means of transportation, it was not deemed wise to encourage the shipment of this product to inland markets.

Trial shipments of *Saxidomus giganteus* and *Schizothaerus nuttalli* were made from Netarts to Eugene at various times of the year. *Saxidomus* is a very good shipper. The shell is heavy and firm and the adductor muscles contract strongly when the clam is removed from the water and remain in that condition for a long

time. As far as the keeping qualities of this clam are concerned it could be marketed from Netarts Bay in many of the inland towns of the State within two days by express if the means of transportation from the source were more certain. The author has been able to keep *Saxidomus* for a week in good condition by placing it in an ice chest.

The depletion of *Saxidomus giganteus* in Netarts Bay during the summer of 1918, however, prevented any further attempt to secure markets for this species. Advice was given local diggers during August of that year to discontinue the taking of *Saxidomus* for a period of two or three years in order to give the clam a chance to restore itself. This was recognized by some as a proper method, but there was nothing to prevent many other people from taking the species whenever they had opportunity.

The conclusion formed after numerous shipments of *Schizothaerus* from Netarts to Eugene was that this species could not be depended upon to come through in good condition. The same limitations were found to exist as in case of shipments from the Yaquina region. Danger from slow and uncertain transportation, the fragility of the shell, and the gaping nature of the clam inhibited the possibilities of successfully placing the species on other than very local markets.

During the latter part of July, 1918, after securing a permit from the State Fish and Game Commission, the writer made a shipment of the razor clam, *Siliqua patula*, from the Clatsop County beach to Netarts Bay for the purpose of transplanting the same on the ocean beaches in that locality. The clams were carefully packed and iced in Seaside and transported by express to Tillamook City and from there to Netarts by stage. The clams were out of salt water for a period of about 30 hours and reached Netarts in good condition. They were immediately planted on a selected beach south of the outlet of Netarts Bay. Favorable reports came to the writer during the summer of 1919 relative to the appearance of razor clams on this beach.

Tests of the keeping qualities of *Mytilus edulis* and *Mytilus californianus* were conducted in the Netarts region. Neither of these species is a good keeper after having been removed from the salt water. The larger species may be kept alive for two or three days on ice, but neither is to be recommended as proper food for a longer period than 24 hours after having been taken from the rocks. The temperature with which they are surrounded will largely determine their keeping qualities.

Although this region is abundantly supplied with the larger sea mussel there is scarcely a probability of its soon becoming a common article of diet. Even if it were fully appreciated as food by the public, its inaccessibility would be a handicap to its possible market value. These sea mussels are used locally to some extent and the writer can bear testimony that when rightly prepared they are very palatable.

Much work looking toward the determination of the spawning period of *Saxidomus giganteus* was done while the author was in this region and later with clams shipped to Eugene. This spawning period was not positively ascertained, the gonads appearing about equally developed in March, June, and November. More investiga-

tion is necessary to determine with certainty the spawning season or seasons of this species.

The western oyster has existed in Netarts Bay for many years. Its productivity here, however, has never been large. In 1918 the supply was insufficient for local demands, and few, if any, oysters reached outside markets from this source. The statutes of the State define the limits of the natural and artificial beds of oysters in Netarts Bay and the regulations governing the same, as in case of the Yaquina River.⁴

Salt-water crabs are very plentiful in Netarts Bay in certain seasons of the year. The closed season, during which no crabs may be shipped out of the county or canned, has been fixed by statute from July 1 to September 30 of each year.⁵ During the open season shipments of crabs are frequently made to outside markets and many are consumed locally.

The Tillamook region comprises Tillamook Bay to the north and east of Netarts Bay. The most important clams of Tillamook Bay are *Mya arenaria*, which is inferior in size and quantity to the same species in the Siuslaw River, and *Cardium corbis*, which in 1917 was very plentiful opposite the town of Garibaldi on the north side of the bay. The species grows to a very large size here, and during 1917 was the chief, although not the exclusive, bivalve used by the clam cannery of Tillamook City. This clam cannery, the only one on the Oregon coast, is owned and operated by E. J. Bowers. The chief product of the cannery is minced clams put up in one-half and one-pound cans. The output in a normal year is from 500 to 1,000 cases, each of forty-eight 1-pound tins. A ready sale is found for this minced clam product and it is widely distributed. The activity of the cannery, however, is not constant, owing to the fact that the supply of clams is very irregular, it being difficult to get fishermen to devote their time to clam digging when more money can be made in the salmon boats. During the year of 1917 the cannery did a very good business, but its activity was not so great during the following year for the reason previously stated.

THE CLATSOP COUNTY REGION.

The northwestern coast of Oregon from Tillamook Head to the Columbia River consists of a long stretch of sand beach nearly 14 miles in length. It is, however, only the southern extremity of this beach that is of interest in connection with the shellfish resources of the Northwest. The beaches opposite the towns of Seaside and Gearheart, just north of Tillamook Head, are the principal sources of the razor clam, *Siliqua patula*, in Oregon.

As mentioned in a previous section, the razor clam during a period from 1913 to 1916 became almost totally extinct along the shores of this State south of Tillamook Head. But whatever may have been the cause or causes of the depletion to the south, no appreciable effect was made upon the species north of this headland.

Of all the species of clams on the Oregon coast the razor clam is the only one protected by law, and this protection is made applicable

⁴ Oregon Fish and Game Laws, 1919-20, sec. 194, p. 78.

⁵ Oregon Fish and Game Laws, 1919-20, sec. 198, p. 79.

to Clatsop County only. A closed season is here established, making it unlawful for one to take the razor clam for sale or canning or shipment out of the county during the period from June 20 to September 20 of each year. Anyone may take the clams, however, without limit at all times for his own use.⁶

The closed season does not prevent a considerable amount of wanton destruction and waste of the razor clams during the summer months. Seaside and Gearheart are summer resorts with a greatly increased population during the months of July and August. Hundreds of inexperienced clam diggers attempt to dig razor clams often for the novelty of it alone, and in so doing destroy a great many young or half-grown clams, or crush the shells of adults in trying to remove them from the sand and throw them away.

Siliqua patula is considered by many to be the best edible clam in the Northwest. It brings the highest market price, usually selling for 25 cents per dozen. During the open season it is almost constantly on the Portland markets, shipped either from the Clatsop County beaches or from the Washington shore north of the Columbia River. In former years this clam was to be found in the markets of many of the cities of northwestern Oregon, but in 1919 the species was rarely handled outside of Portland and Astoria. These cities are in direct connection by rail and boat with the sources of supply and markets here find a ready sale for all razor clams they can secure.

Siliqua patula is not a long-lived clam after having been removed from salt water. It is good for the Portland markets which can be reached from Seaside in five hours by express, but the clams would hardly be good for food after the second day even though thoroughly iced. The razor clam is a food to be consumed or canned locally, or marketed within a short distance from the source of its production.

That the razor clam spawns on the Clatsop County beach during the summer, from the latter part of June through July, has, it is believed, been well established. At no other season of the year was the writer able to discover the gonads in a mature condition. During the first and second weeks in September large numbers of young, ranging from 10 to 25 millimeters in length, may be found just beneath the surface of the sand. These are, without doubt, results of the spawning of the species during the previous June or July. The author was not able to determine the rate of growth of this species throughout an entire year or the age of the larger individuals. Owing to the fact that the razor clam travels about through the sand, more or less, it is impractical to attempt to judge the rate of growth by means of artificial plantings on the open beaches.

Shipments of razor clams for the purpose of restocking depleted beaches were made during the summer of 1918 from Seaside beach to Netarts Bay, as mentioned under the discussion of the preceding region, and also to Cannon Beach, immediately south of Tillamook Head. There is reason to believe that both of these plantings were successful.

⁶ Oregon Fish and Game Laws, 1919-20, sec. 143, p. 62.

THE SOUTHWESTERN WASHINGTON REGION.

This section of the survey included the ocean beaches north of the mouth of the Columbia River to the outlet of Willapa Bay, the latter body of water, and brief investigations of the resources of sections of Puget Sound in the vicinity of Olympia, Wash.

In 1917 the output of minced clams of the canneries of Nahcotta, a town on the west shore of Willapa Bay, was very limited, the reason ascribed for the unusual inactivities of the canneries being an apparent depletion of the supply. During the following year, however, the clams were much more plentiful and the output of the canned product was greatly enhanced. The Washington beaches are a source of supply of fresh clams for the markets of Portland and other cities of the Northwest.

Willapa Bay is one of the chief centers of distribution of the eastern oyster in the Northwest. Artificial plantations of considerable area have become established in these waters. The "toke-point" oyster is a familiar one in the markets of many cities of the Northwest.

It is customary for the oyster companies to ship young eastern oysters from the Atlantic seacoast in carload lots, plant them for periods of from two to four years, and then place them on the markets.

That there are prospects of inducing the eastern oyster to propagate on the west coast is indicated by the spawning of the species in certain localities in Willapa Bay during the season of 1917. Heretofore it was the general belief that the temperature of the waters of the Pacific coast was too cold to permit of the propagation of the eastern species.

The Long Island Oyster Co., with headquarters at South Bend, Wash., reported to the writer in 1918 that it was its belief that the degree of temperature of the water was not the deciding factor, but that a uniformity of temperature must be maintained to induce spawning. This belief was based upon careful observations of the spawning of the eastern species by the above company on certain of their plantations in Willapa Bay during the previous season.

The broad mud flats of the western shore of Willapa Bay maintain a good supply of the eastern mud clam, *Mya arenaria*, but this species is little used here as food except by a very few local consumers.

The gravel beds of the southern arms of Puget Sound supply the markets of many cities of Washington, of Portland, Oreg., and of many of the upper Willamette Valley towns with the "little-neck clam," *Paphya staminea*. *Paphya* is one of the best of shippers among the shellfish of the Northwest, having a hard shell which closes tightly when the clam is removed from the water.

Tests with *Paphya staminea* from this region and others in the course of the investigations indicate that the clam may be kept in an edible condition for at least a week after having been taken if it is well iced. It will remain good for several days without ice if kept in a cool place.

The oyster industry of southern Puget Sound waters was greatly handicapped by excessively cold weather during the winter of 1915, which froze large quantities of the oysters. The output from this region was curtailed during the following seasons while the beds were being restocked. This reduction of Puget Sound oysters increased the price of western oysters grown in the Yaquina River in Oregon, where no such calamity occurred. The latter region, however, could not supply the demand, and there was a noticeable scarcity of oysters throughout the Northwest. Three or four years were devoted by the Puget Sound growers to restocking their beds, but by the season of 1919 almost normal conditions prevailed in the oyster industry of the Northwest.

Pectens have not been taken from the open ocean in large amounts off the northwest coast. The writer has, however, seen quantities of them dredged in the San Juan Archipelago about 100 miles north of Seattle, Wash. Several species of these mollusks have been taken here while dredging was being done for other material. Enough have been taken, however, to indicate that they are well distributed in these waters and present in considerable numbers.

The author has been informed that pectens have occasionally been taken from the ocean off Yaquina Bay and have appeared on the Newport market. There seems, however, little attempt on the part of fishermen to make surveys along the northwest coast for pectens, and the boats are usually without proper dredges or trawls with which to take these mollusks.

SHELLFISH RESOURCES OF MINOR IMPORTANCE.

In addition to the regions discussed above, which represent the chief producing centers of shellfish in the territory surveyed, there are a number of other localities of minor importance which should be mentioned in order to make this report complete. They are, for the most part, in isolated regions and in thinly populated districts having inconvenient means of communication with outside points.

Shellfish, although frequently occurring in large quantities in these isolated regions, have, at present, little economic value except as they may supply a very limited local demand for sea-food products; or, the shellfish may be species not yet generally recognized as proper human food. To this latter group belong the mussels.

On the Oregon coast, among regions of minor importance, the following may be mentioned:

CANNON BEACH.

This locality, immediately south of Tillamook Head, at one time supported large numbers of *Siliqua patula*, the razor clam, but in 1918 the author was not able to find a single one throughout the entire length of the beach. *Mytilus edulis* and *Mytilus californianus* are common forms on the rocks standing out from the shore, but little importance is attached to them in this locality.

During August, 1918, plantings of the razor clam were made on this beach from a shipment from Seaside.

NESTUGGA BAY.

In Nestugga Bay, at the mouth of the Nestugga River, are to be found small areas well stocked with *Mya arenaria*. The species here is inferior in size to that of the Siuslaw River and plays little part in the food economy of the locality. Some slight use is made of the clam by the inhabitants of Pacific City, a small village near the mouth of the river. This local demand is larger during the summer months, when the population is increased by tourists, but this shellfish center is of slight importance, due to its isolation.

SILETZ BAY.

Siletz Bay, in Lincoln County, Oreg., is at the mouth of the river bearing that name. *Mya arenaria* and *Schizothaerus nuttalli* are to be found in some abundance on the mud flats of this bay, but, being in a very inaccessible region, little use is made of these shellfish except occasionally by the inhabitants of Taft, a small settlement on the bay.

About 10 miles north of Siletz Bay is a stretch of sand beach several miles in length, paralleled by a fringing chain of large rocks, now disconnected with the shore, but easily reached from it during low tide. Here covering the surface of the rocks are immense quantities of the large sea mussel, *Mytilus californianus*. In the region surveyed the productivity of this locality is rivaled only by that of the Netarts Bay region, mentioned above. Should a market be provided for this shellfish, there would still remain the difficulty of transporting it from a region so isolated and inaccessible as this one north of Siletz Bay.

ALSEA BAY.

This body of water, 14 miles south of Yaquina Bay, supports a good supply of *Schizothaerus nuttalli*, the "great blue clam." The demand for this clam here is wholly local, small quantities being used by the inhabitants of the town of Waldport and by the few ranchers in the immediate region.

WINCHESTER BAY.

Winchester Bay, at the mouth of the Umpqua River in Douglas County, Oreg., may be mentioned as another center well supplied with the "great blue clam," *Schizothaerus nuttalli*. A few tourists spend some time at this place during the summer, but the region about the bay is very sparsely settled. The chief means of reaching Winchester Bay is by motor boat from points farther up the river. Due to the isolation of the district and the inconvenient means of communication little value may be attached to this shellfish source.

THE BANDON BEACH.

From the mouth of the Coquille River southward the chief shellfish are the sea mussels which are very abundant opposite the town

of Bandon, at the mouth of the river, and elsewhere on rocky points and headlands.

Many of the sections of this portion of the coast are isolated and sparsely settled and, although the mussels are used to some extent locally, little economic value can be ascribed to the molluscan shellfish on the Oregon coast south of Coos Bay.

SUMMARY AND CONCLUSIONS.

1. Certain regions of the northwest coast are abundantly stocked with shellfish, some species of which have been widely recognized as excellent human food. Others, however, such as the sea mussels, have not yet gained that same recognition, and there remains to be devised in the future some plan or method to convert this vast quantity of sea product into economic usefulness.

2. The isolation of certain regions producing shellfish, especially in the coastal zone of the State of Oregon, and the lack of highways paralleling the coast or other means of transportation rendering sources of shellfish accessible has, in some places, proved a handicap and in others a complete prohibition against the general use of these sea-food products.

3. Demonstration has proved that certain species of shellfish, however excellent food they may be when prepared immediately after having been taken from the salt water, lack lasting qualities and, therefore, are not adaptable to markets at any great distance from the source of their supply.

4. Other species as *Mya arenaria*, *Saxidomus giganteus*, and *Paphya staminea* have lasting qualities and may be kept, under proper conditions, for many days in a fresh condition and marketed several hundred miles from the coast with perfect safety to the consumer.

5. Species not adaptable, in a fresh condition, to markets other than local should be prepared and consumed as soon as possible after they have been taken from the salt water, or they should be preserved by canning, pickling, or other methods insuring the destruction of harmful bacteria and at the same time retaining something of the qualities of the shellfish.

6. In many of the regions of the Northwest where shellfish are abundant the people are found to be very generally appreciative of the bivalves as food, especially if markets or centers of distribution have been established where the product can be obtained without too much effort.

7. A certain amount of indifference, sometimes amounting to antagonism, against the use of shellfish as food, was encountered in some localities. This was met as tactfully as possible and by conversation, lecture, and sane publicity the aversion to these sea products was in some measure dispelled.

8. The apparent depletion of an excellent food mollusk, *Saxidomus giganteus*, is taking place in Netarts Bay. It may be advisable to restrict or prohibit entirely the taking of this species for a number of years.

9. After the almost total disappearance of the razor clam from the Oregon beaches south of Tillamook Head, it was gratifying in 1919 to learn of and to observe its reappearance in a number of

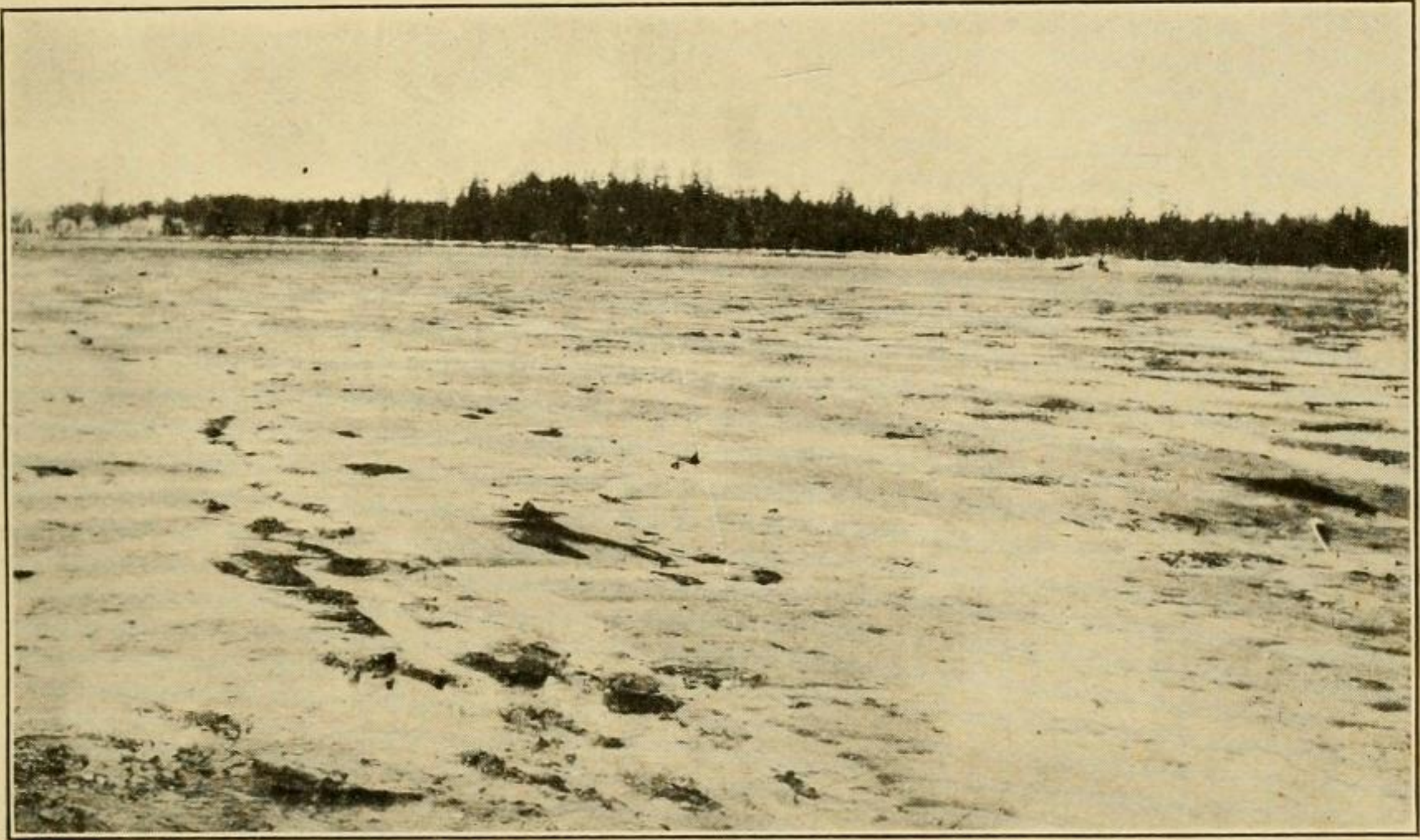


FIG. 3.—VIEW OF CLAM BEDS OF SIUSLAW RIVER, ON NORTH SIDE OF CHANNEL, LOOKING TOWARD FLORENCE.

Mya arenaria is abundant here. The beds are very accessible and the clams, in size and quality, are not surpassed by any of the same species in the Northwest.

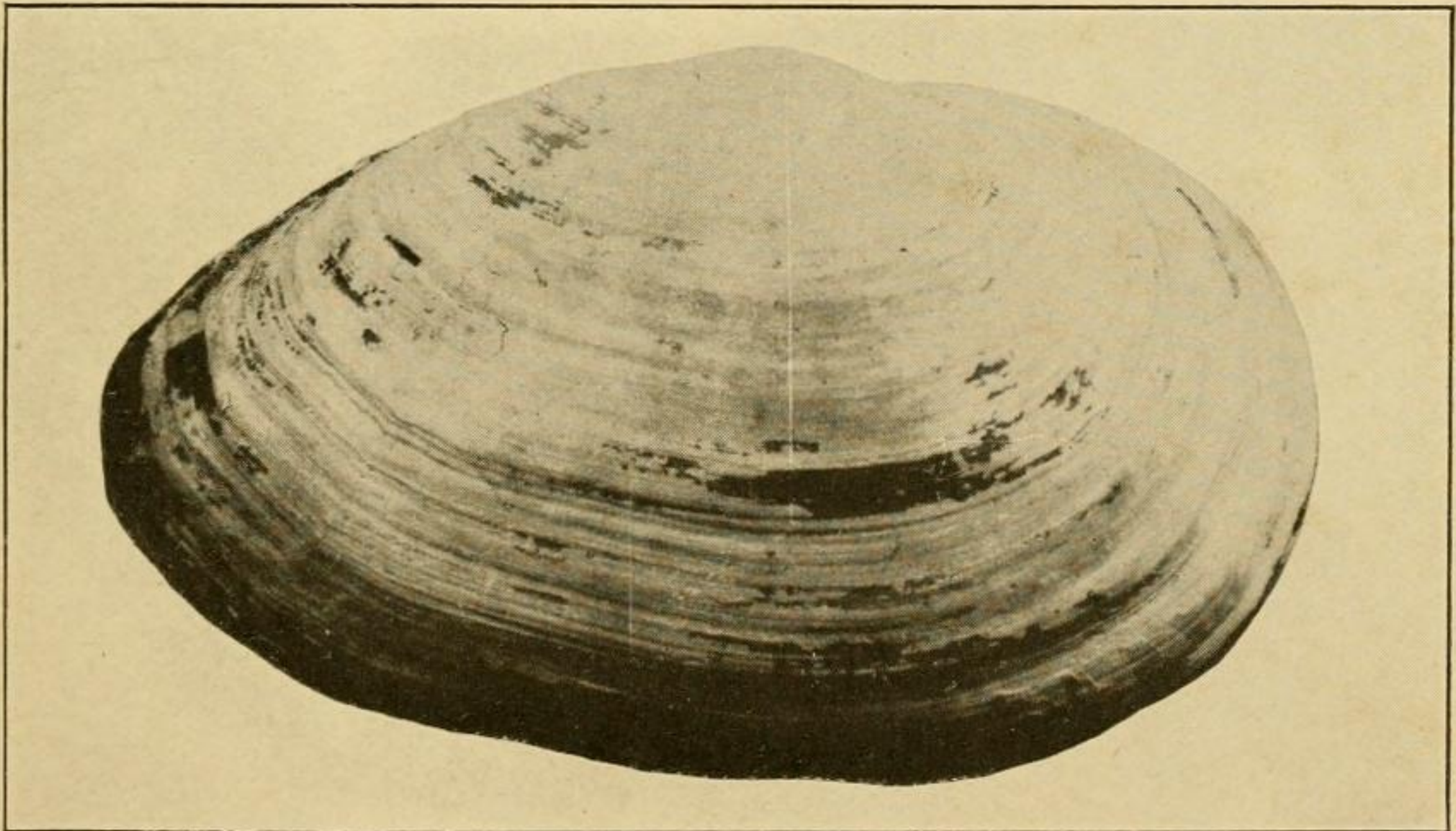


FIG. 4.—SHELL OF *Mya arenaria*, TWO-THIRDS NATURAL SIZE.

Mya is one of the best clams of the Northwest both for local consumption and for shipping. See discussion under The Siuslaw Region, beginning on page 5.

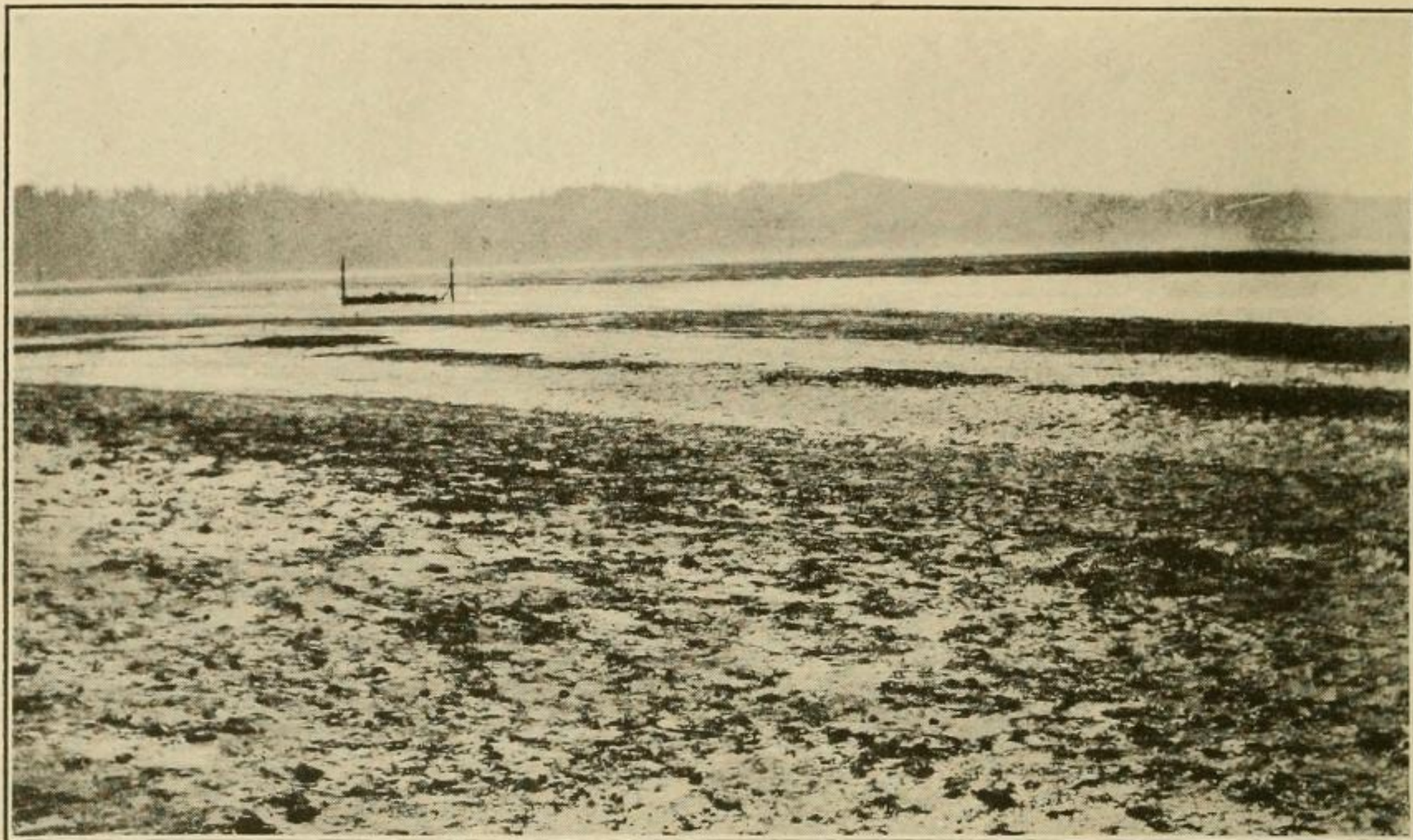


FIG. 5.—MUD FLATS OF NORTH SIDE OF YAQUINA RIVER, LOOKING TOWARD YAQUINA.

Here is a large supply of *Schizothaerus nuttalli*. The beds are accessible from Newport, and the clams are easily taken as they are not deeply imbedded in the mud. *Cardium corbis*, *Paphya staminea*, and *Macoma nasuta* are also found here. See discussion under The Yaquina Region, beginning on page 8.

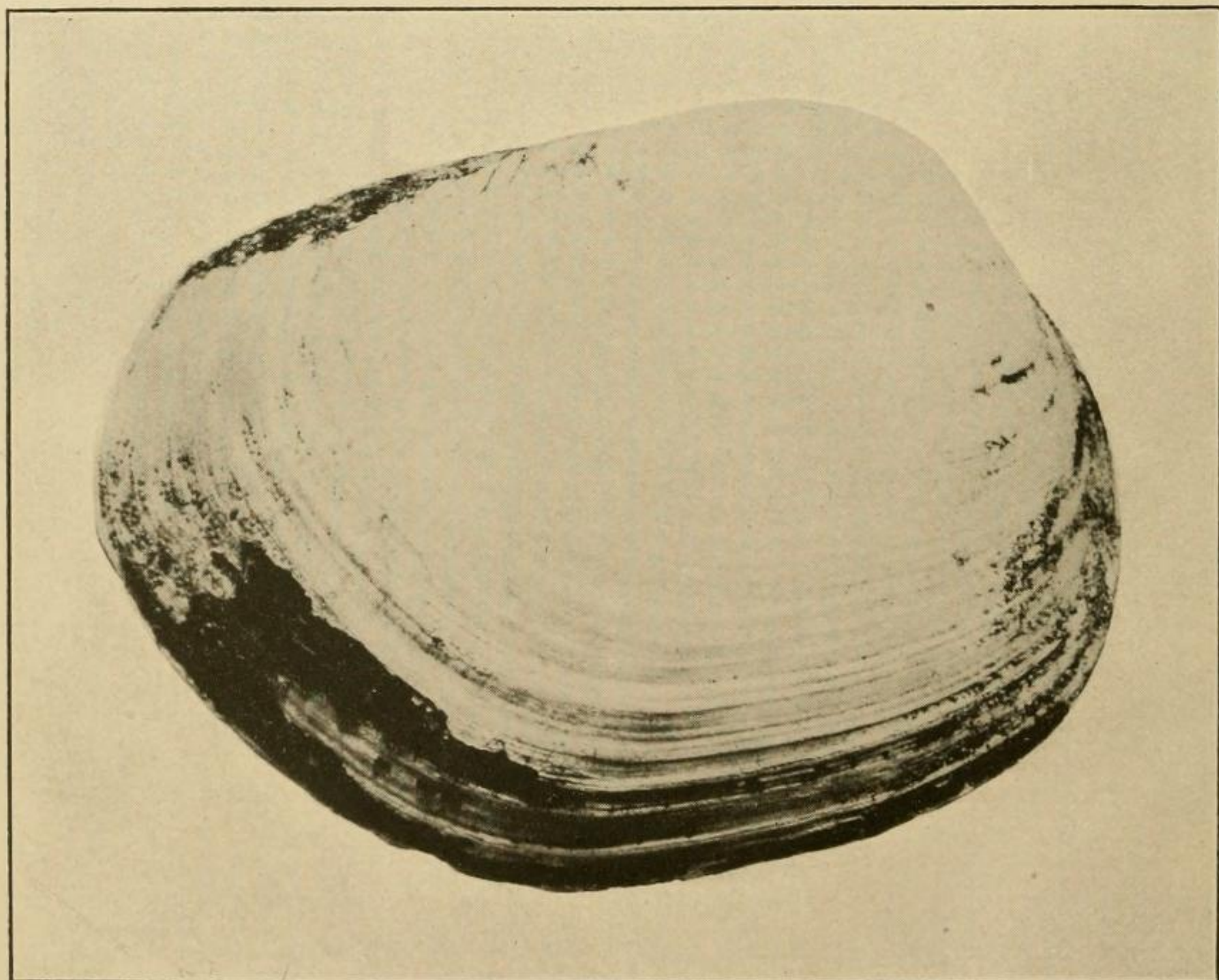


FIG. 6.—SHELL OF *Schizothaerus nuttalli*, THE "GREAT BLUE CLAM," TWO-THIRDS NATURAL SIZE.

This species is well distributed along the Northwest coast and is used as food locally to a greater or less extent wherever it occurs.

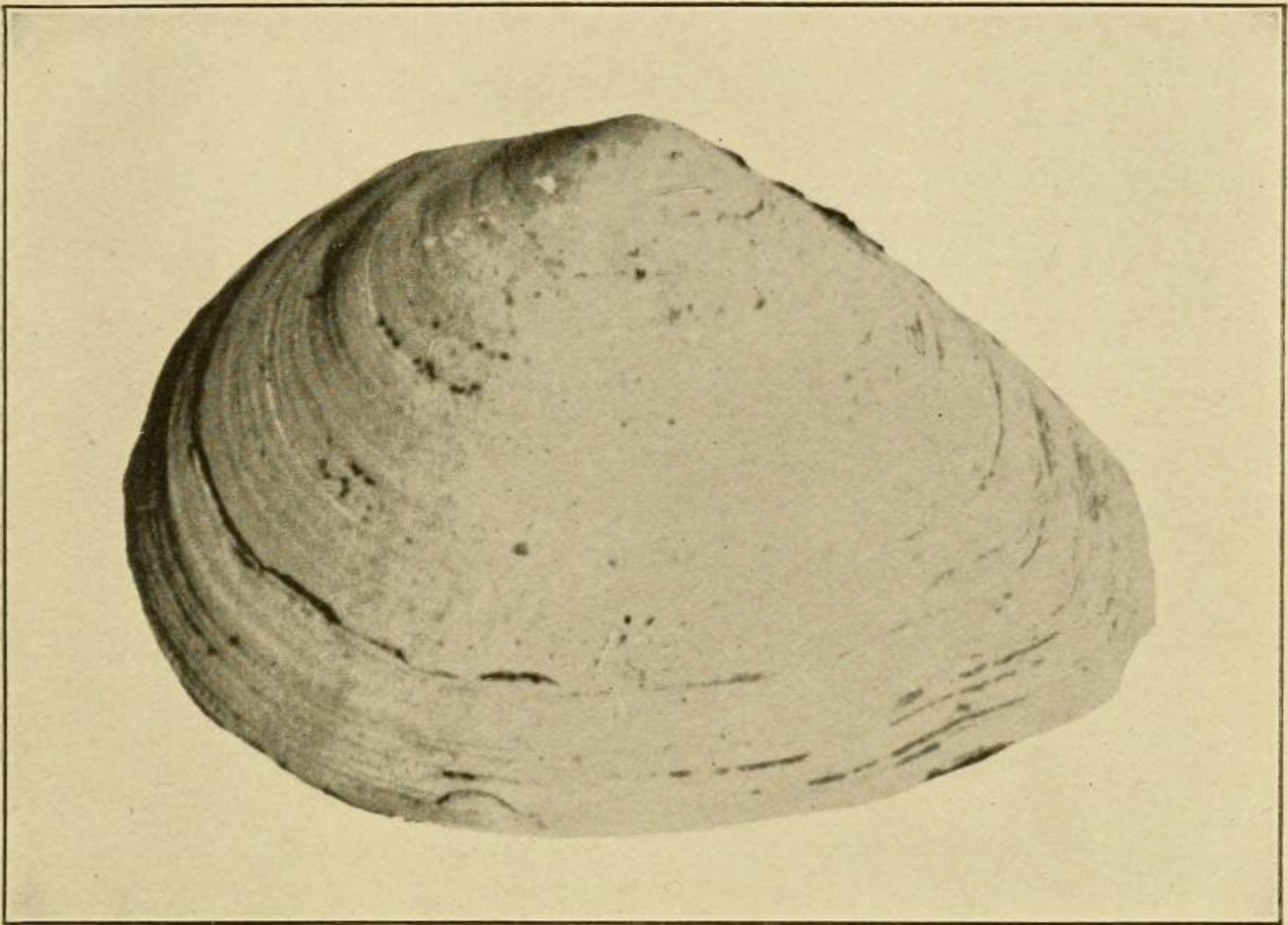


FIG. 7.—SHELL OF *Macoma nasuta*, NATURAL SIZE.

It is called the "oyster clam" at Yaquina, where it is used as food to a slight extent. The species was common on the north side of the bay in 1917. The photograph is of a shell from Winchester Bay and is somewhat larger than the average in Yaquina Bay.

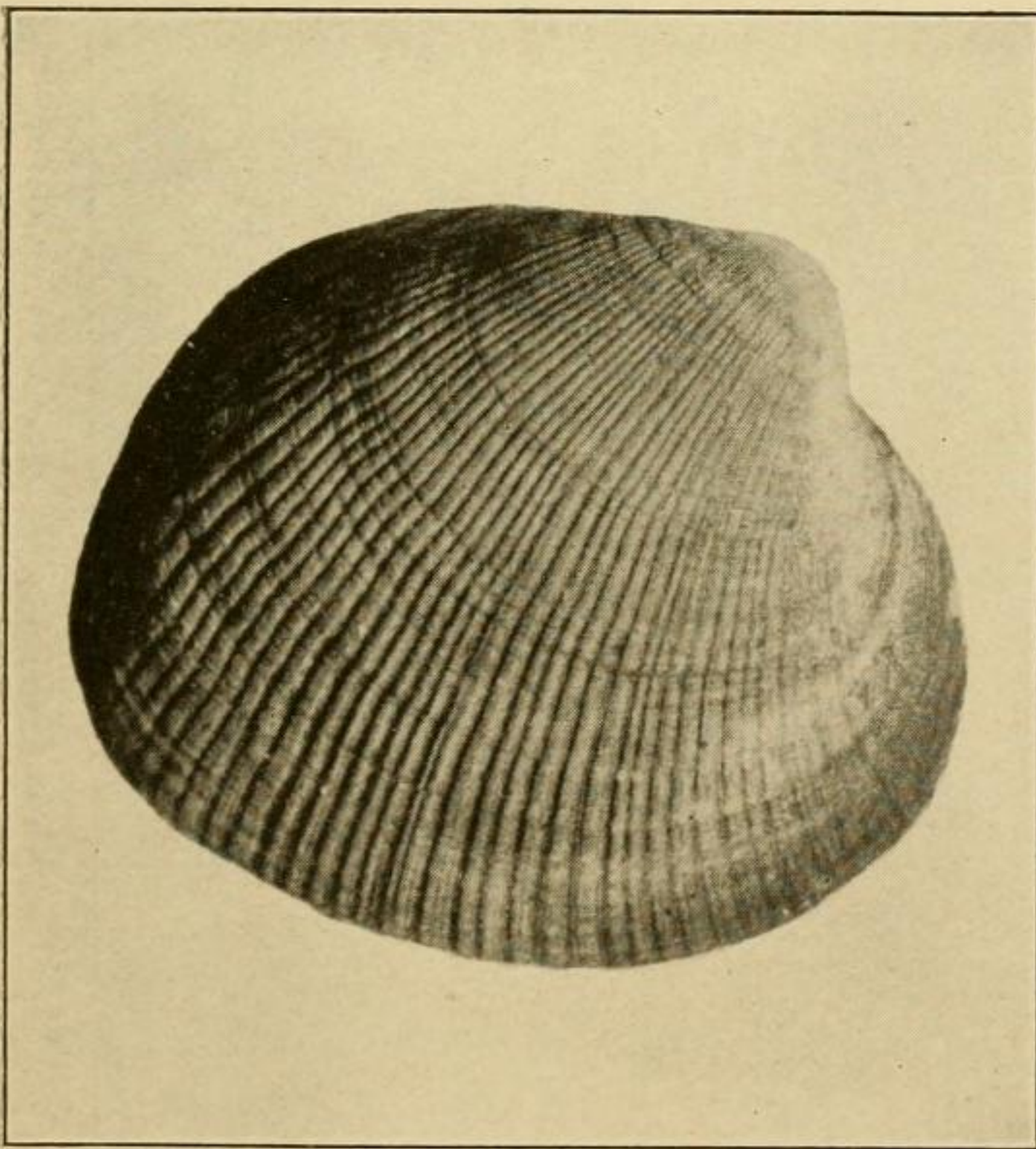


FIG. 8.—SHELL OF *Paphya staminea*, THE "LITTLE NECK CLAM," NATURAL SIZE, FROM YAQUINA BAY.

The species occurs in almost all of the bays of the Northwest. It is one of the best market clams.



FIG. 9.—SHELL OF *Pholadidea penita*, A ROCK BORER, NATURAL SIZE.

The species is characteristic of Nye Beach, on the ocean side of Newport, where it is plentiful.

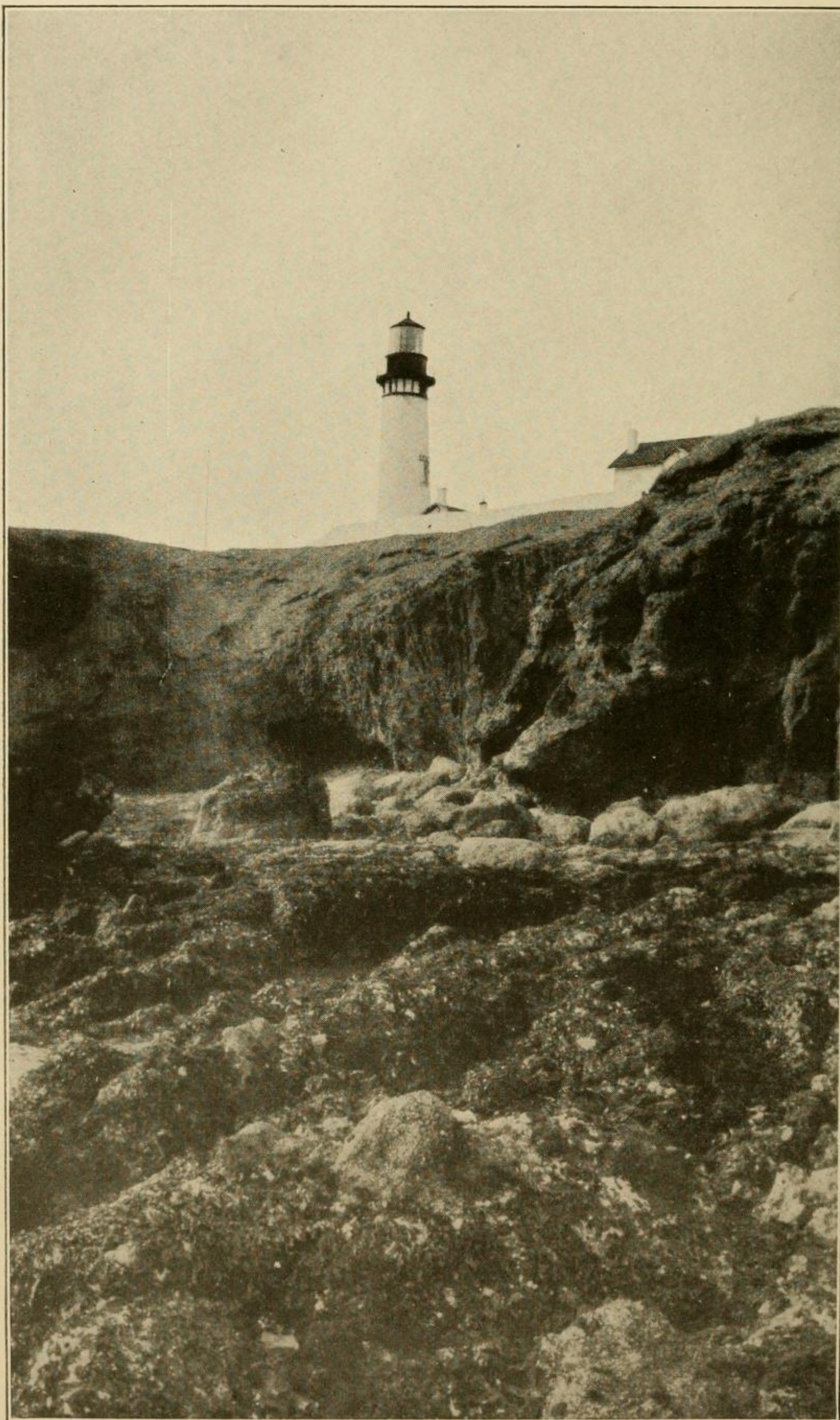


FIG. 10.—ROCKS ABOUT THE BASE OF YAQUINA HEAD, 4 MILES NORTH OF YAQUINA BAY.

These rocks are well covered with sea mussels, both *Mytilus edulis* and *Mytilus californianus* occurring here. Little use is made of them as food. See figure 13.

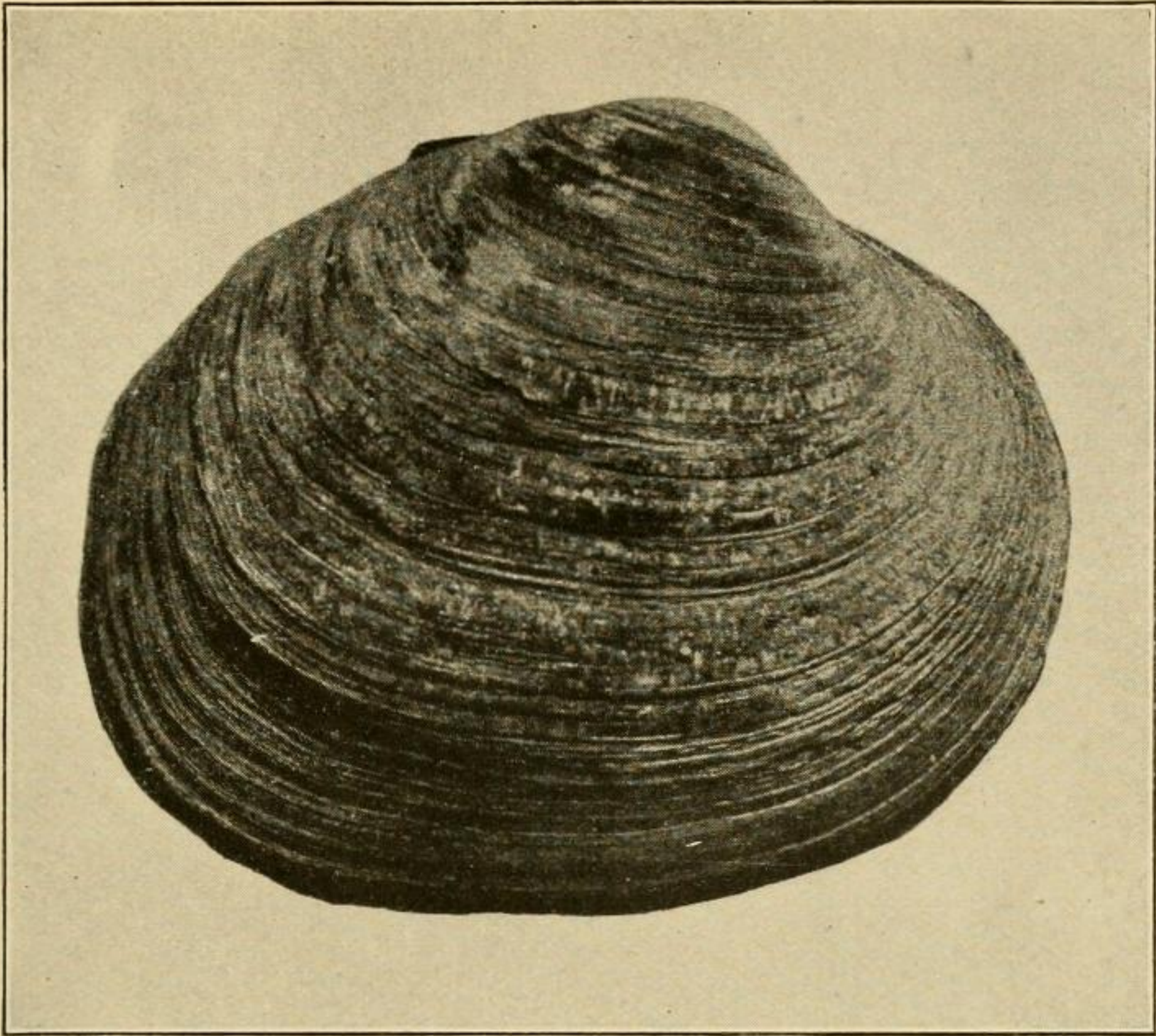


FIG. 11.—SHELL OF *Saxidomus giganteus*, TWO-THIRDS NATURAL SIZE.

This species is characteristic of Netarts Bay, but is not so abundant there as it was a few years ago. It is one of the best food clams of the Northwest and makes an excellent market clam as its shipping qualities are good. Its scarcity in Netarts Bay at the present time, however, precludes its shipment to outside markets. See discussion under Netarts and Tillamook Regions, beginning on page 12.

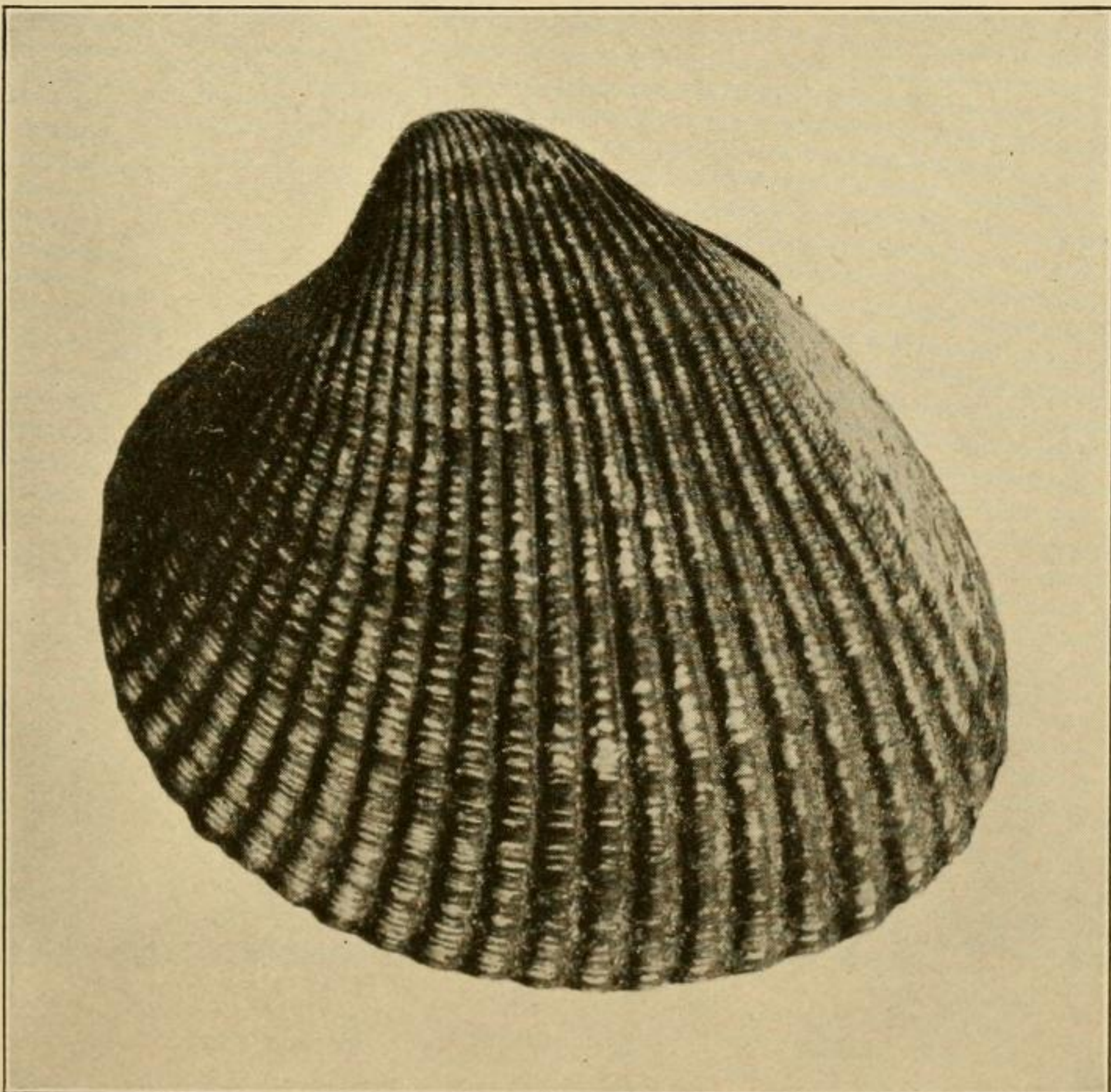


FIG. 12.—SHELL OF *Cardium corbis*, THE "COCKLE," TWO-THIRDS NATURAL SIZE.

This species is well distributed from Coos Bay northward along the Northwest coast, and is abundant in Tillamook Bay.

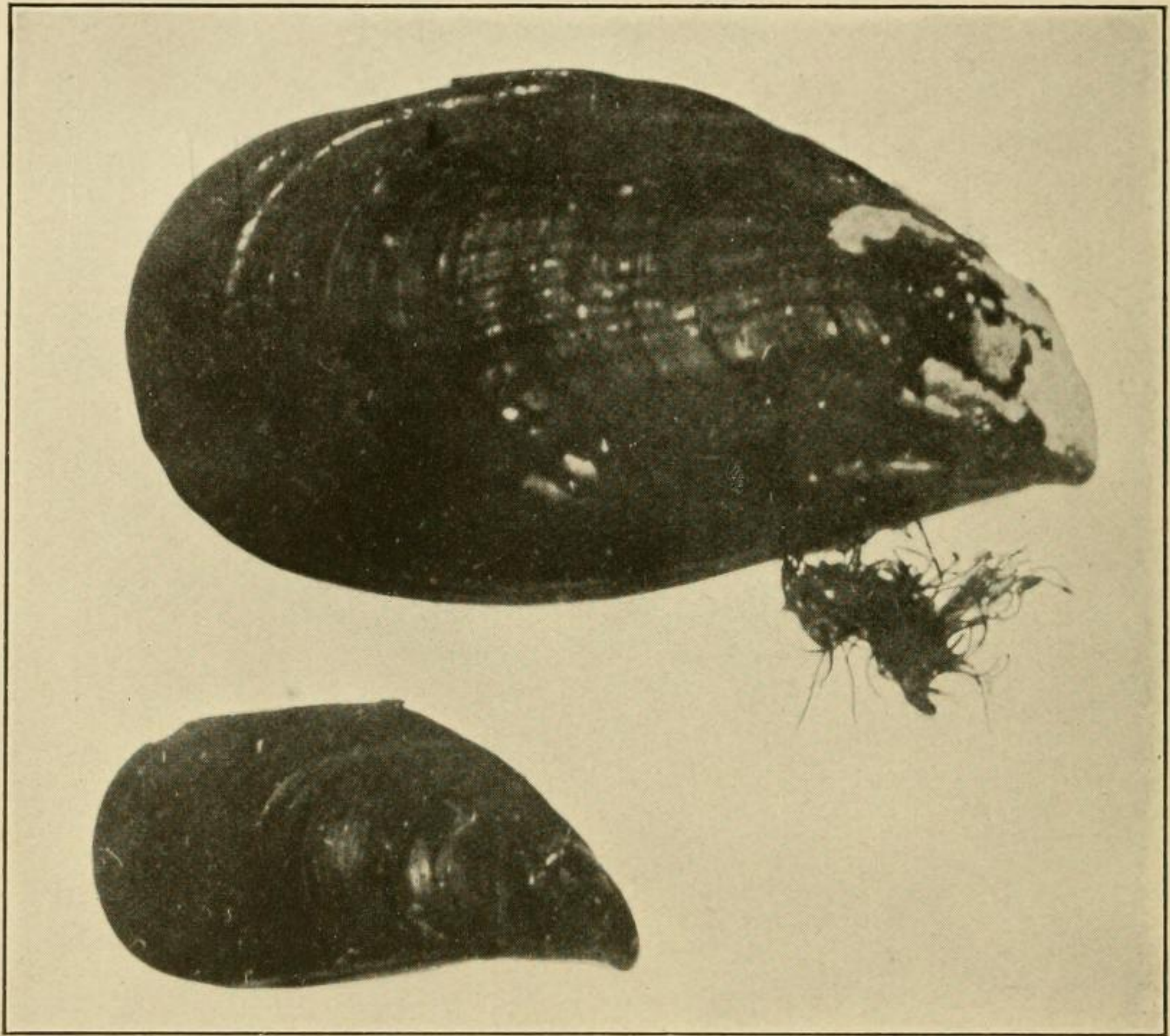


FIG. 13.—UPPER, *Mytilus californianus*, THE LARGE SEA MUSSEL; LOWER, *Mytilus edulis*, THE SMALLER SEA MUSSEL; EACH THREE-FOURTHS NATURAL SIZE.

Both species are very common along the Northwest coast.

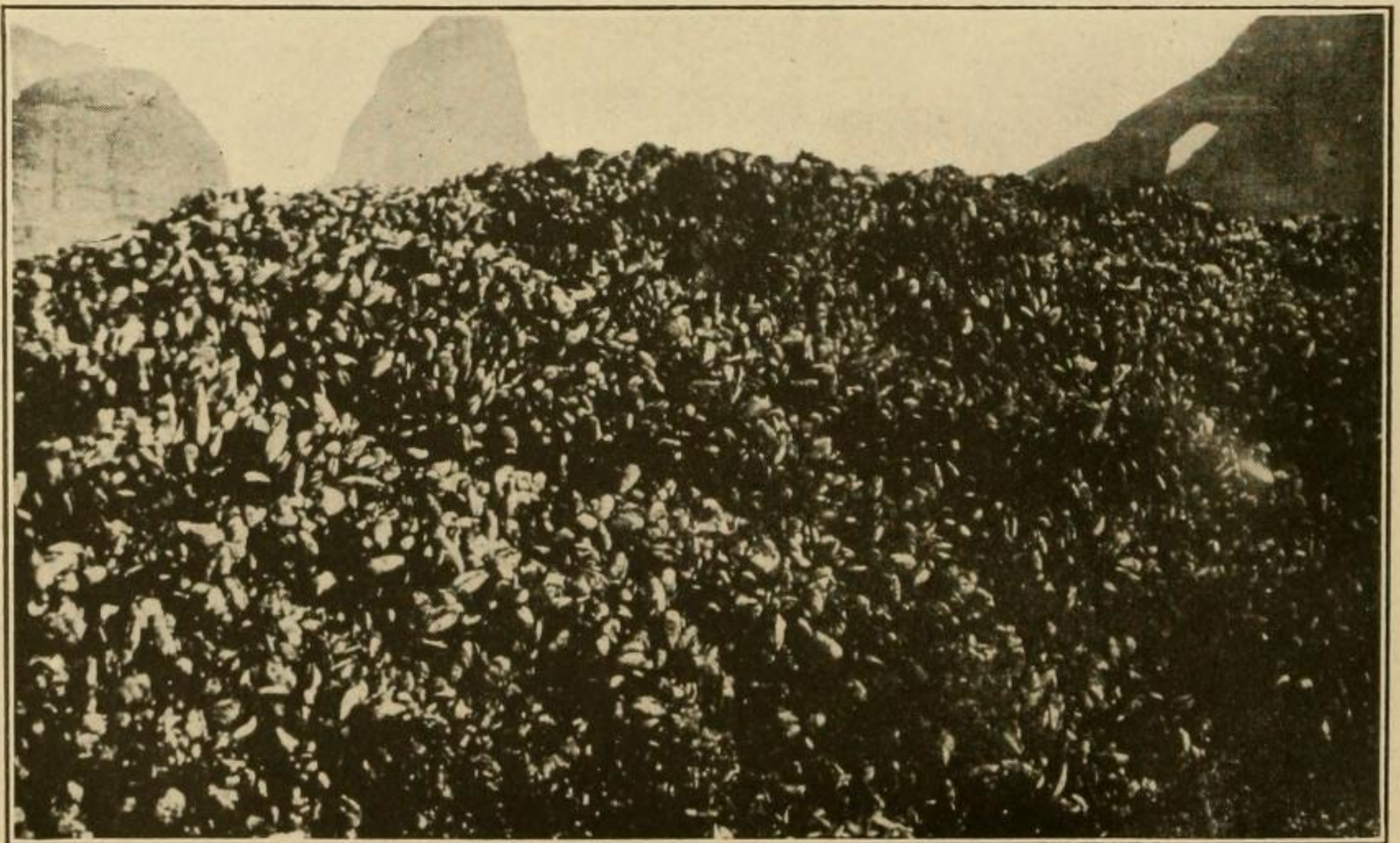


FIG. 14.—PORTION OF SURFACE OF A ROCK NORTH OF NETARTS BAY COVERED WITH *Mytilus californianus*.

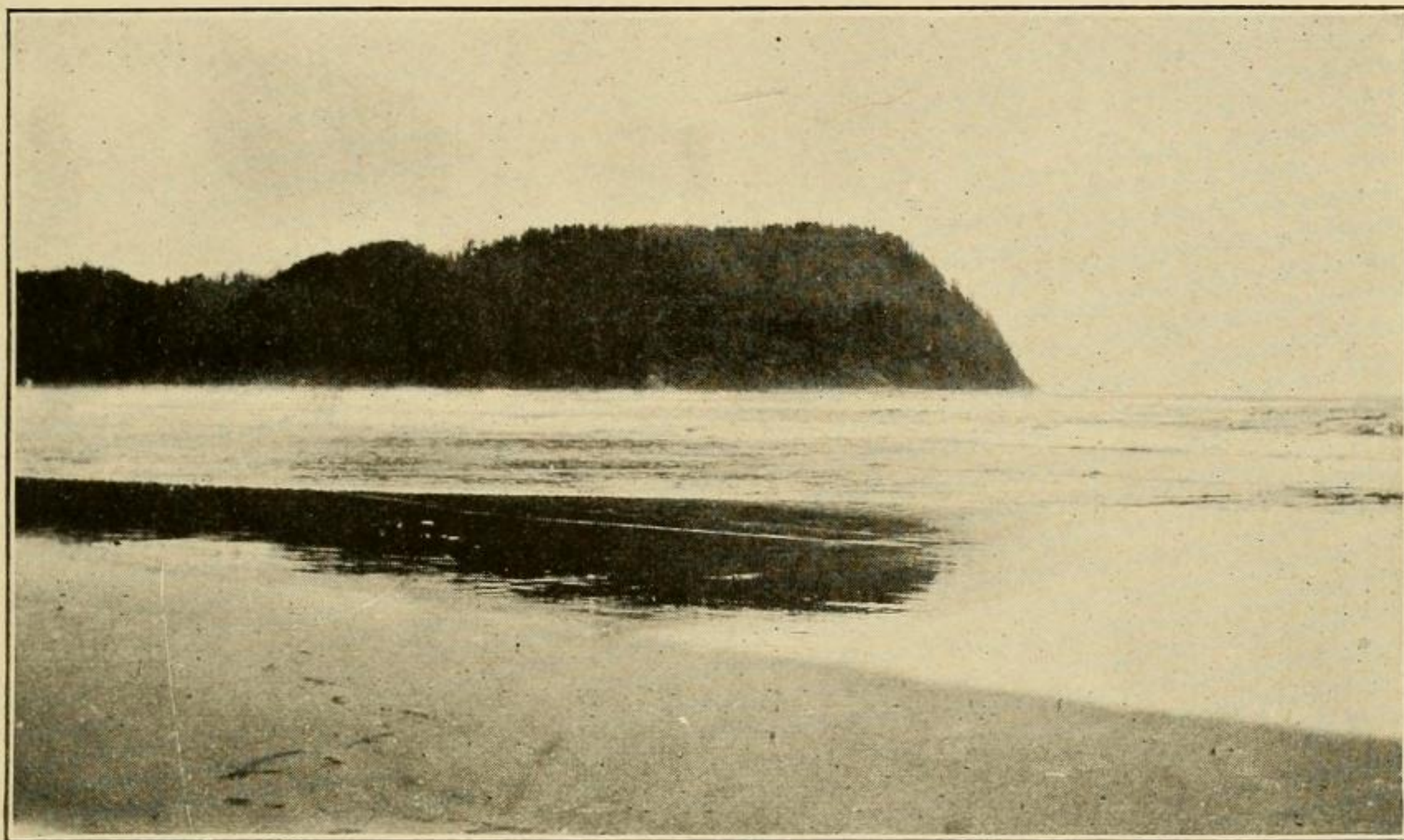


FIG. 15.—VIEW OF CLATSOP COUNTY BEACH OPPOSITE SEASIDE, OREG.,
LOOKING SOUTH TOWARD TILLAMOOK HEAD.

Although the razor clam, *Siliqua patula*, has almost disappeared elsewhere on the Oregon coast, it has maintained itself in abundance on this beach. See discussion under The Clatsop County Region, beginning on page 15.

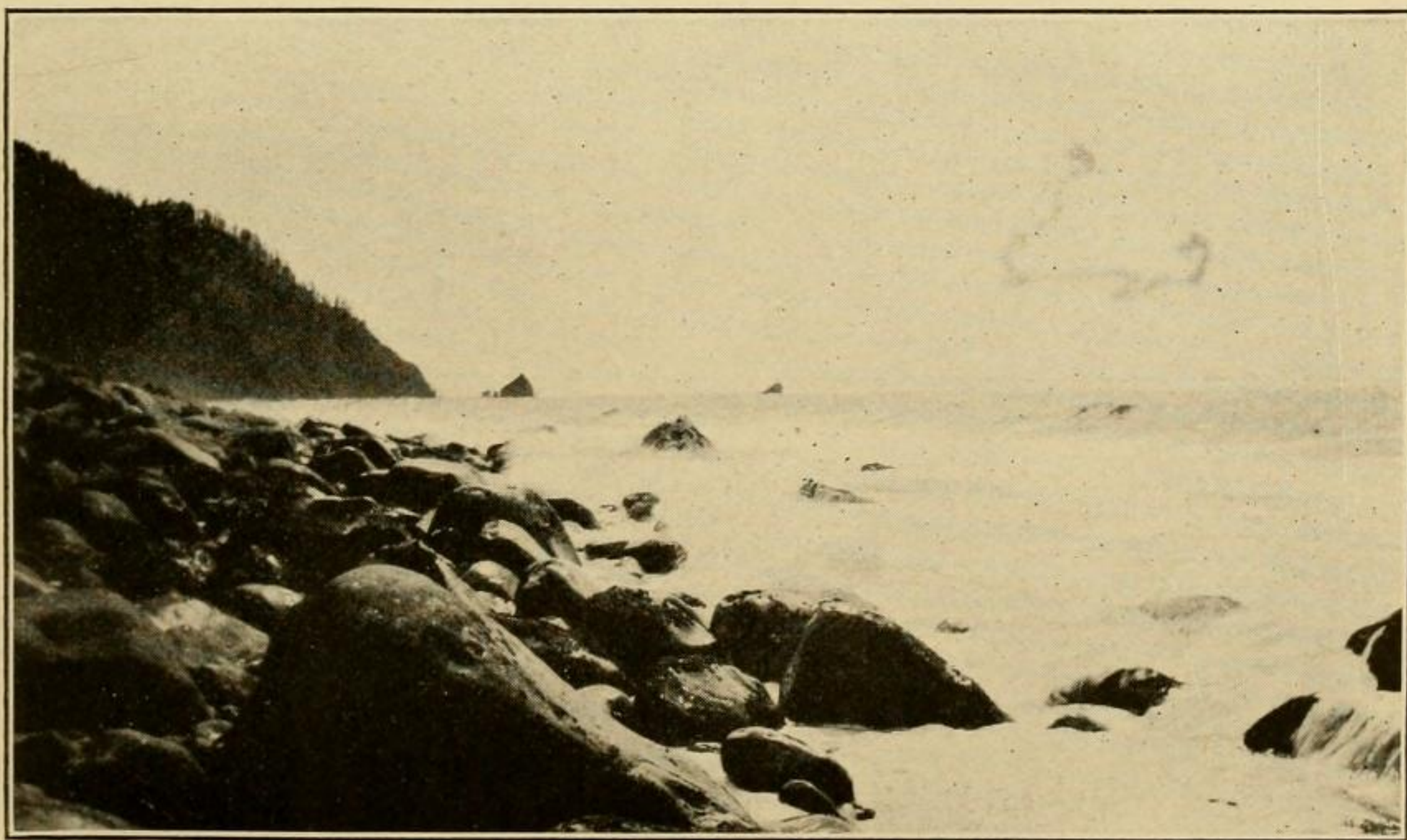


FIG. 16.—ROCKY COAST AROUND TILLAMOOK HEAD, LOOKING SOUTH.
Sea mussels are typical shellfish of rugged headlands such as this.

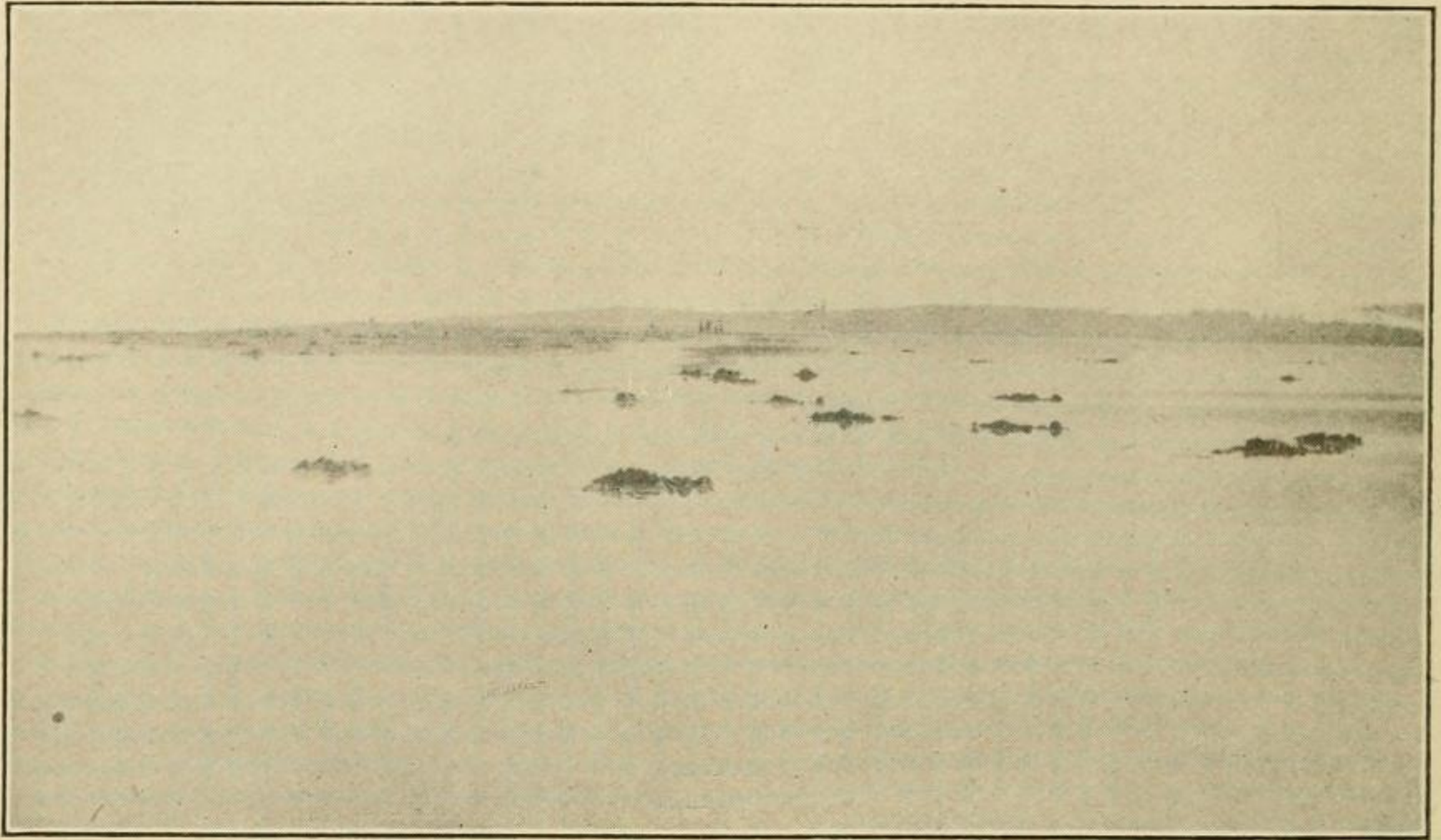
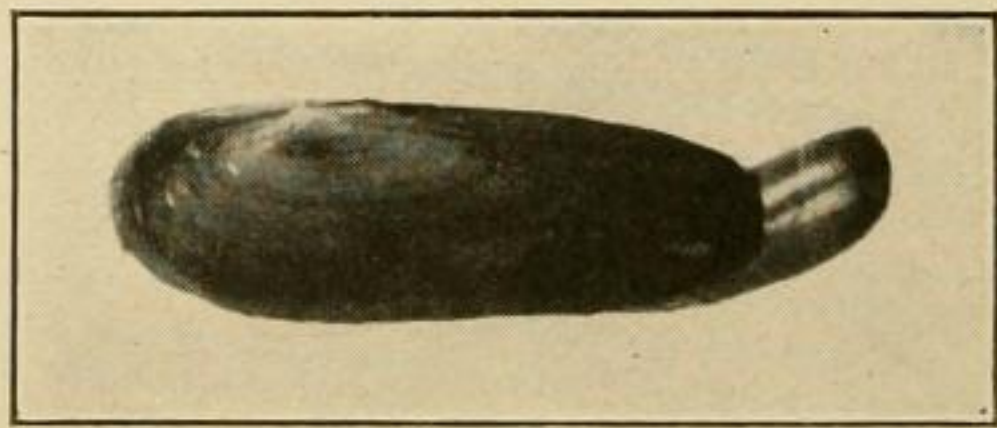
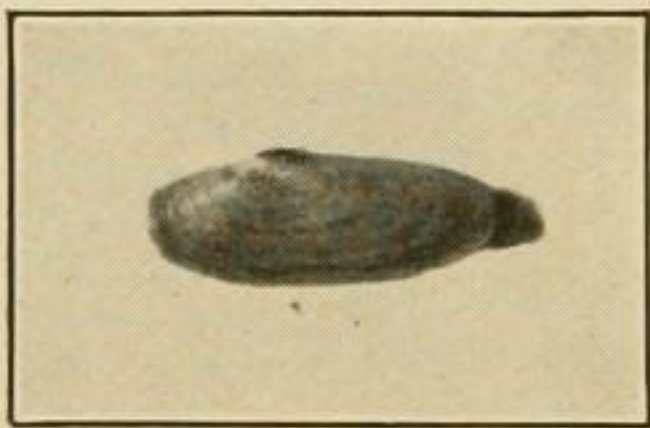


FIG. 17.—CLATSOP COUNTY BEACH, LOOKING NORTH FROM SEASIDE AT LOW TIDE.

The sand heaps represent places from which razor clams have been taken. This is the center of the razor clam production in Oregon at the present time.



FIGS. 18 AND 19.—YOUNG RAZOR CLAMS, NATURAL SIZE.

These were taken on the Seaside beach during the first and second weeks in September. The species spawns on this beach in midsummer.

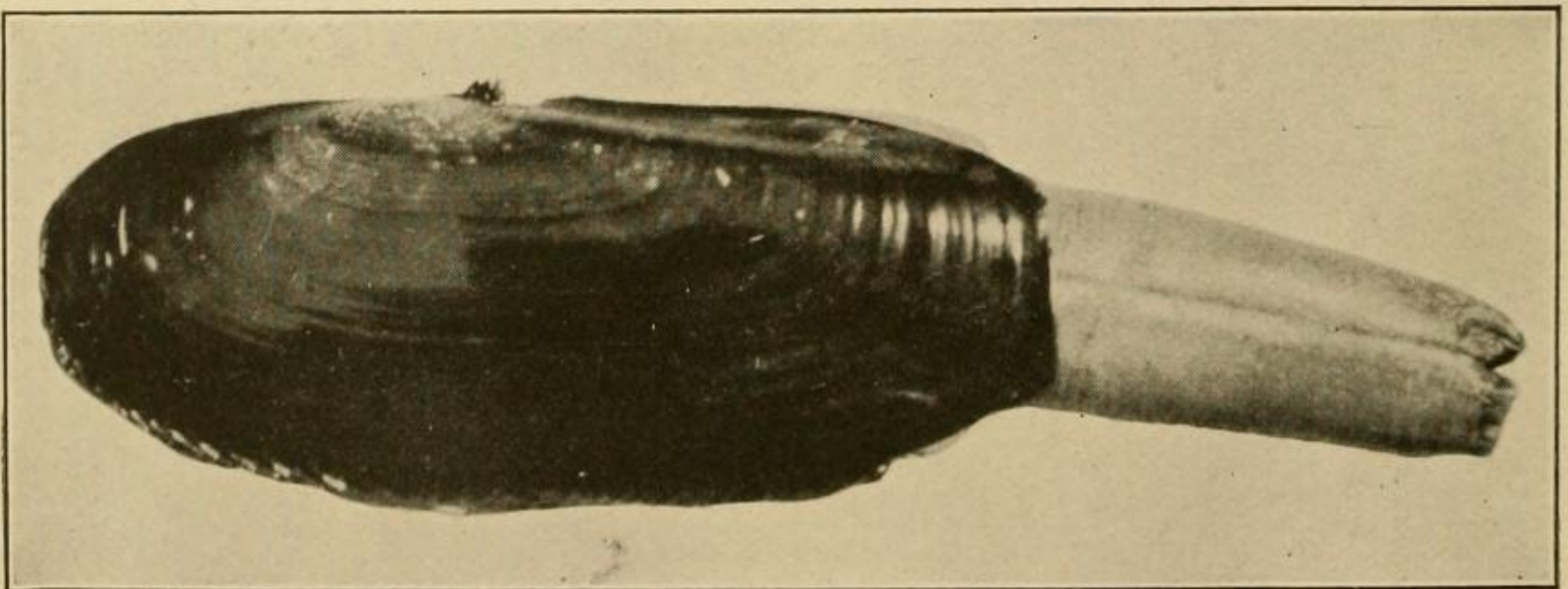


FIG. 20.—THE RAZOR CLAM, *Siliqua patula*, TWO-THIRDS NATURAL SIZE.

This species is considered one of the very best edible clams and is used as food extensively. The supply for the markets of the larger cities of the Northwest comes from Clatsop County, Oreg., and from the beaches of the Washington coast.

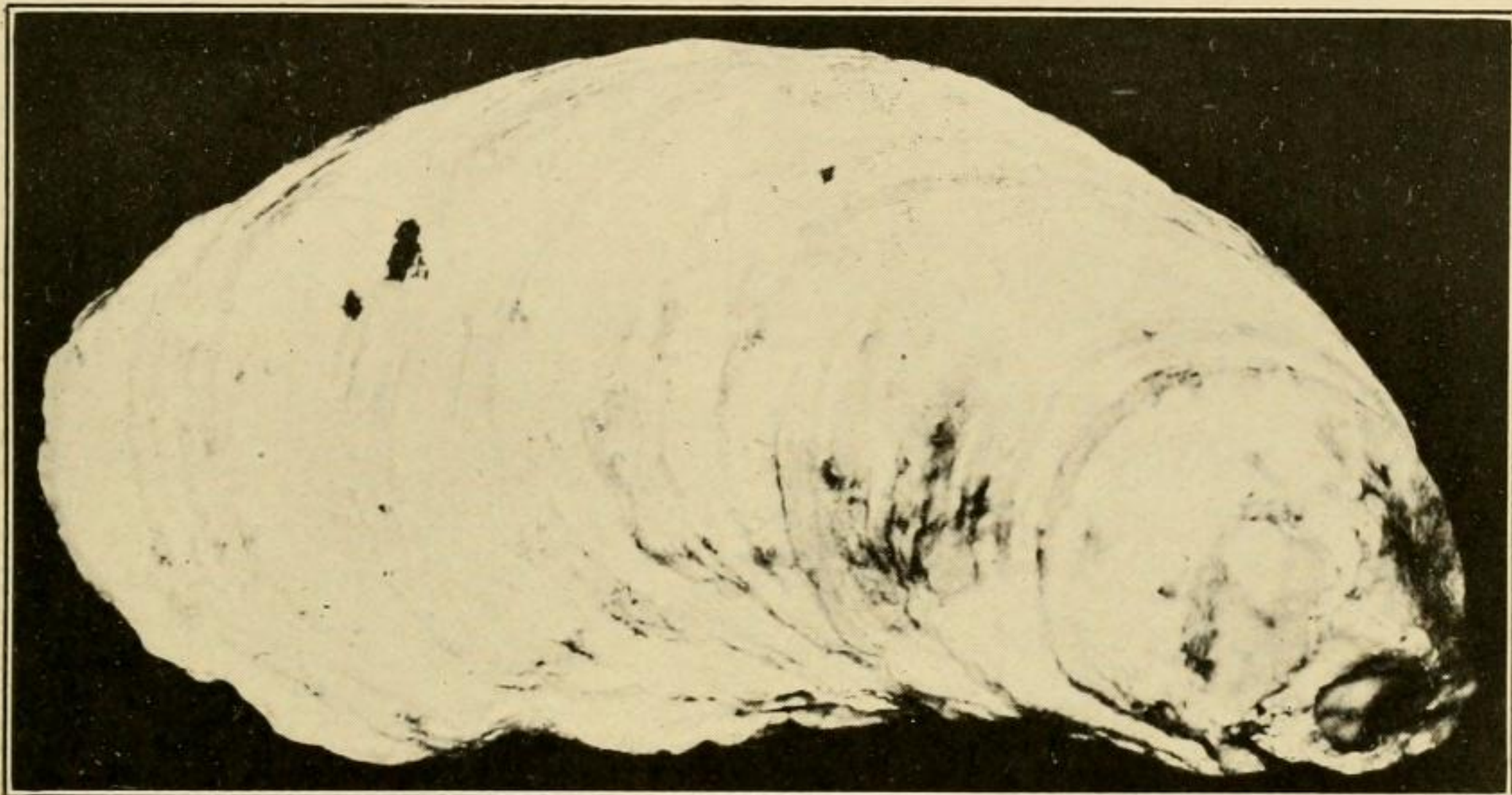


FIG. 21.—SHELL OF THE EASTERN OYSTER, *Ostrea virginiana*, TWO-THIRDS NATURAL SIZE.

This species is planted when young and grown to maturity in the waters of western Washington. The eastern oyster industry is not yet developed in Oregon. See discussion under The Southwestern Washington Region, beginning on page 17.

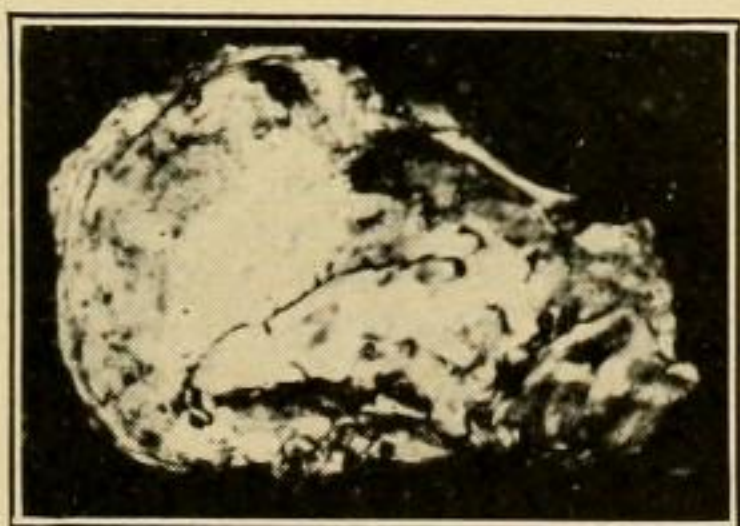


FIG. 22.—SHELL OF THE WESTERN OYSTER, *Ostrea lurida*, TWO-THIRDS NATURAL SIZE.

This species is grown in both Oregon and Washington. In Puget Sound the industry has become an extensive one.

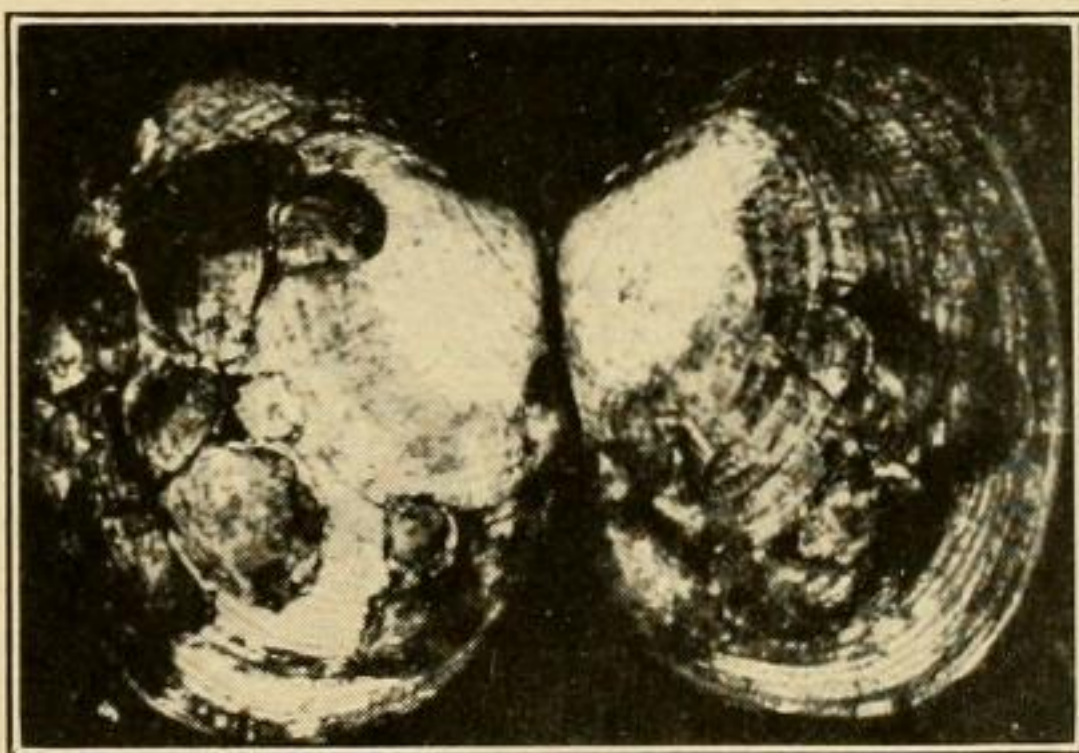


FIG. 23.—SPAT OF THE WESTERN OYSTER COLLECTED ON THE SHELL OF *Paphya staminea*, TWO-THIRDS NATURAL SIZE.

The spat was collected during the season of 1917 and was about five months old.

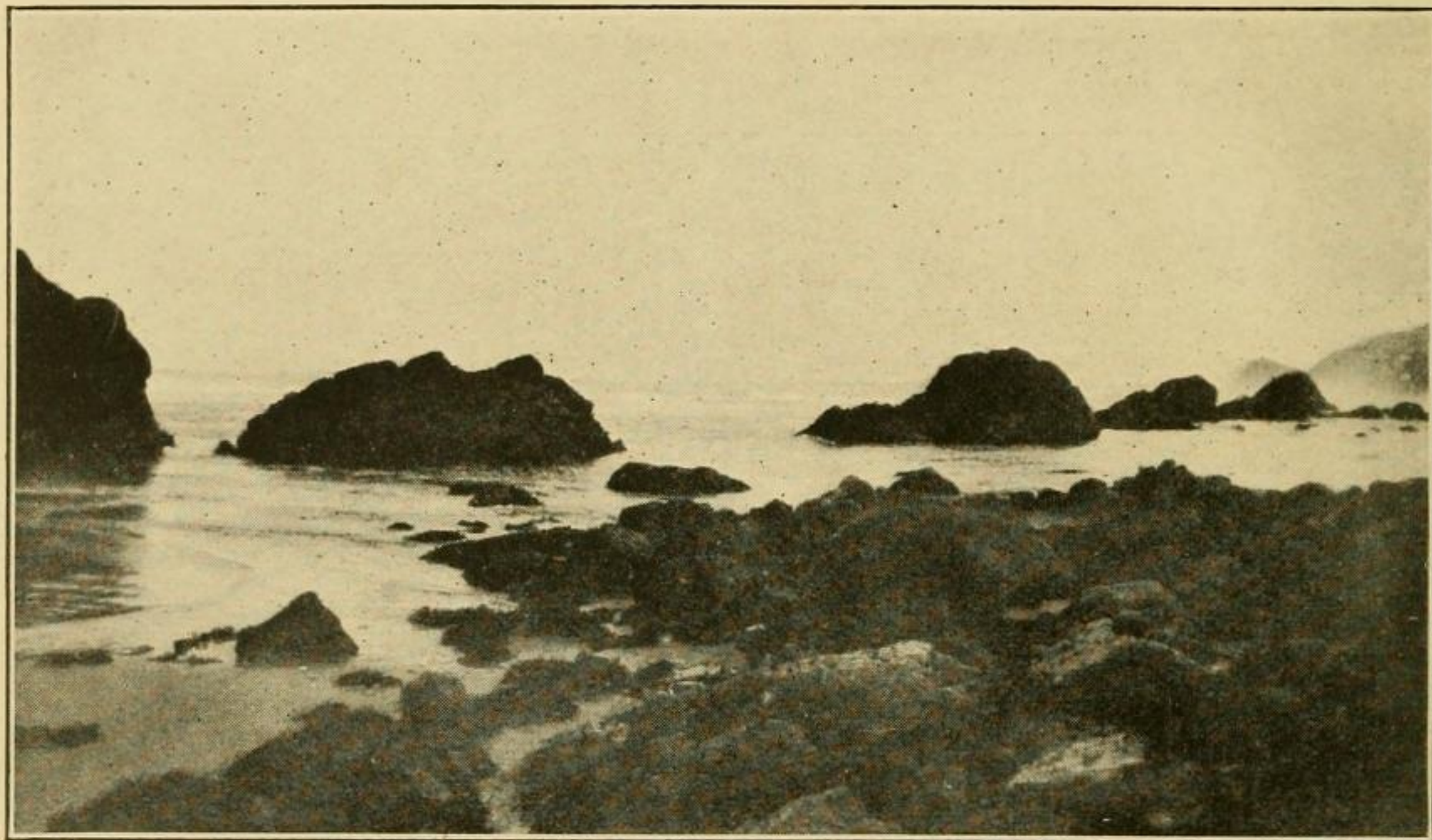


FIG. 24.—SECTION OF SHORE LINE 10 MILES NORTH OF SILETZ BAY.

The rocks paralleling the coast are densely covered with the large sea mussel, *Mytilus californianus*. This region is an isolated one.

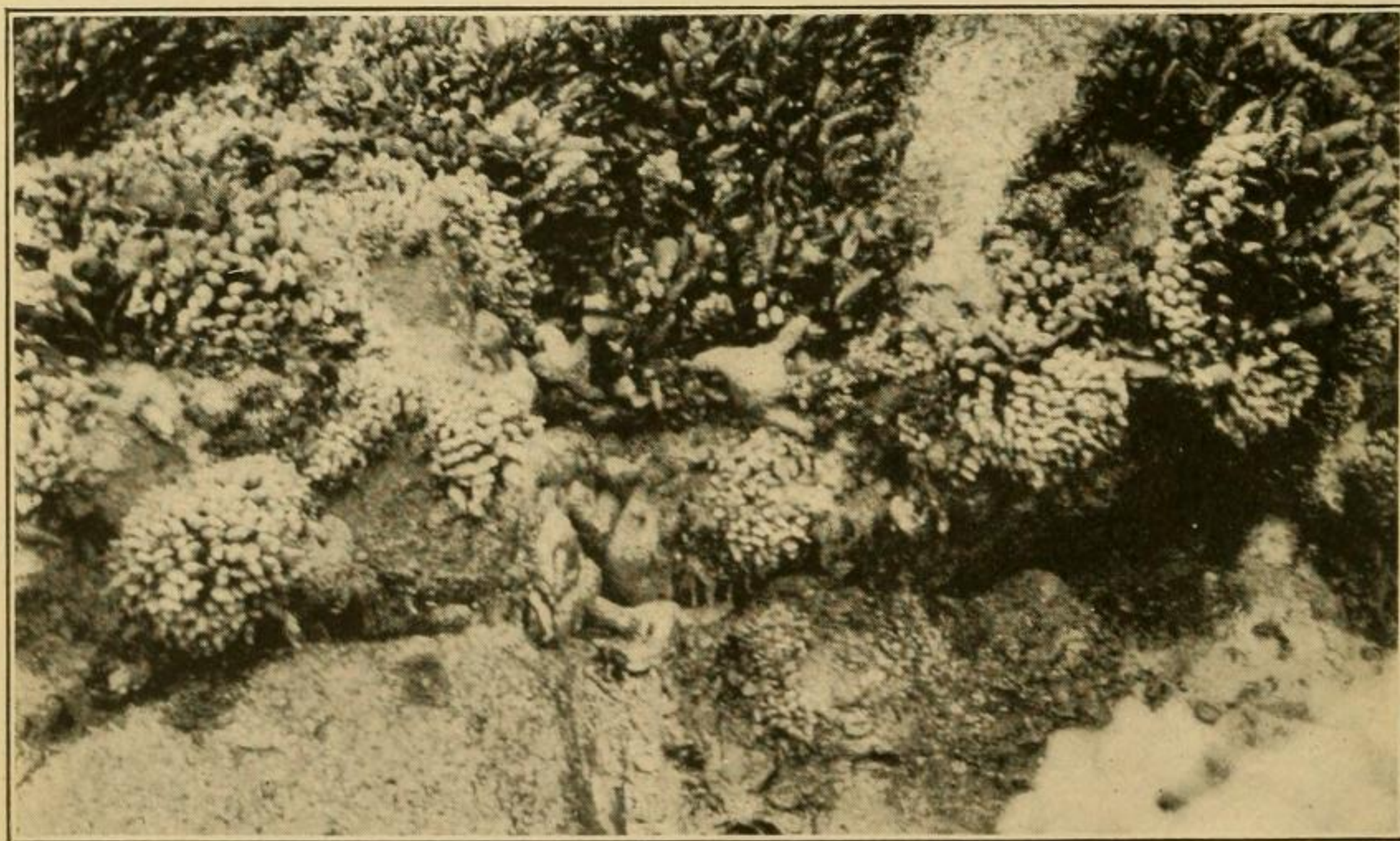


FIG. 25.—PORTION OF SURFACE OF ONE OF THE ROCKS IN FIGURE 24.

Masses of the large sea mussel are shown in the upper half of this picture.

localities on the coast of that State. A complete restoration of this important food mollusk is not impossible during the next few years. Successful transplantings of the razor clam from Clatsop County beaches to other points on the coast, made in 1918, were not wholly responsible for the reappearance of the species the following year, as it appeared on beaches other than those where plantings were made.

10. Information gained relative to the spawning seasons of certain food clams as *Mya arenaria*, *Siliqua patula*, *Schizothaerus nuttalli*, *Paphya staminea*, etc., may be valuable in the future should it be deemed wise to place restrictions upon the taking of the species.

11. Oyster culture has been an important industry in the Northwest for many years, especially in the waters of Puget Sound and Willapa Bay in Washington. In Oregon the industry, although of considerable importance, has never reached the proportions that it has north of the Columbia River. The success of recent plantings of the western oyster in Coos Bay gives promise of the development of this industry on a larger scale than heretofore in the State of Oregon.

12. Several species of pectens are known to exist in considerable quantities in certain parts of Puget Sound, namely, about San Juan Island. Whether or not species of pectens are sufficiently abundant off the northwest coast, other than in Puget Sound, to make them of commercial value has not yet been determined.

