GREAT INTERNATIONAL FISHERIES EXHIBITION.

LONDON, 1883.

UNITED STATES OF AMERICA.

D.

CATALOGUE

OF THE

ECONOMIC MOLLUSCA

AND THE

APPARATUS AND APPLIANCES USED IN THEIR CAPTURE AND PREPARATION FOR MARKET,

EXHIBITED BY THE

UNITED STATES NATIONAL MUSEUM.

BY

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INTRODUCTION.

It is proposed to give, in the following pages, a brief account of the economic mollusca of the United States, together with a description of the manner of conducting the various fisheries and their dependent industries. Minute detail of matter, whether of biological or economic interest, is not attempted; the design is to supplement the molluscan exhibit by an explanatory pamphlet, which will be illustrated by the objects exhibited. The information given is obtained chiefly from Professor Verrill's papers on the Invertebrates of Vineyard Sound, published in the Report of the United States Commissioner of Fish and Fisheries, and from the advance sheets of the Reports of Mr. Ernest Ingersoll on the Shell-Fish Industries of the United States, published by the Census Bureau. Many other authorities, too numerous to mention, have also been consulted.

The total annual product of the shell-fish industries of the United States amounts to 24,859,044 bushels, valued at $14,629,187. This total is divided among the various fisheries according to the following table:

Name.	Number bushels.	Value.
Oyster fishery	22, 195, 370	$13, 438, 852
Clam fishery	1, 955, 580	996, 305
Mussel fishery	600, 000	37, 500
Scallop fishery	108, 094	28, 825
Abalone fishery	....	127, 705

While the oyster industry, on account of its importance, deserves the most and first attention, yet, as the collection on exhibition is part of that of the National Museum, it is deemed best to maintain the original systematic arrangement, and therefore the most highly organized of the the mollusca, the Cephalopods are first considered.

MOLLUSCA CEPHALOPODA.

The most recent authorities assign thirty species of cephalopods to the fauna of the eastern coast of North America. While so numerously represented, however, only a few of the species are found in sufficient abundance to make them of commercial value. These comprise *Ommastrephes illecebrosa*, *Loligo pealii*, *Loligo brevis*, and the gigantic squids (*Architeuthis*) of Newfoundland and adjacent coasts; of these, the most abundant and widely distributed is

Loligo pealii, Lesueur.

This is the common squid of the Atlantic coast of the United States; it is found from South Carolina to Cape Ann, Massachusetts, but is most abundant in Long Island and Vineyard Sounds. In depth it ranges from low-water mark to 50 fathoms; it is one of the Decapods or ten-armed class, of the *Dibranchiata*, or free-swimming cephalopods with but two branchiæ. As indicated by its classification, it has ten arms, two of which are tentacular, club-shaped at the extremities, and longer than the other eight. In the male the left ventral arm is modified to subserve the peculiar reproductive process characteristic of the cephalopods, and under the head of the female is a horseshoe-shaped tubercle for the same purpose. In this, as in other species, the integument of the body is provided with numerous little sacs, containing pigment granules of different colors, and called cromatophores; by contracting and expanding these, the animal can change its color with great rapidity. Professor Verrill describes a male specimen of *Loligo pealii* as having the upper surface of body, head, and caudal fin covered with rather large, circular cromatophores, but towards the margin of the fin and on the head the spots are smaller and less numerous, and the bluish-white body color more perceptible. Over most of the dorsal surface the cromatophores are arranged in circular groups, the center being a large, round spot of dark purple; this is surrounded by a circle of ground color, a circle of cromatophores of lake-red and pink, and a deeper lying circle of pale canary-yellow ones. When expanded the cromatophores are light to dark red, varying to purplish-red and pink; when contracted they become small points of brownish-purple. On the lower side the cromatophores are thinly scattered, and the dominant color is the blue-white of the body. The general appearance of the animal is reddish-brown. The arms are marked similarly to the lower part of the body; the eye is covered with a transparent membrane, and the pupils are brown or deep bluish-black. The body is somewhat elongated in form, and the caudal fin is long-rhomboidal, the outer angles obtusely rounded, and, in large specimens, its length is about two-thirds that of the body; when full grown the animal is from 6 inches to 1 foot long. The sexes are separated and reproduction is accomplished by means of the hectocotylized arm and horseshoe-shaped sucker. The spawning season lasts throughout the summer, but most of the eggs are laid in June and July. They are contained in long, gelatinous capsules, which are attached in clusters, often 6 and 8 inches in diameter, to seaweed, stones, and shells, or other common support. Each capsule is from 2 to 3 inches long, and contains from 20 to 200 eggs. Like the other species, this is nocturnal and gregarious in its habits. The schools are usually composed of individuals of the same size and age; when this is not the case the larger and older squids have been observed actively engaged in destroying and devouring their smaller companions. They also prey upon many of the smaller fishes and crustaceans, and in turn are sought and eaten by the blue-fish, tautog, sea bass, striped bass, king-fish, and many other large market fishes, of whose food supply this squid forms an important item. It is also secured, when possible, by the fishermen along the coast and used for bait; but in this particular it is not so important as *Ommastrephes illecebrosa;* its range, not much north of Cape Cod, being more remote from the scene of the cod-fisheries. There are two varieties of the *Loligo pealii;* viz., *borealis* and *pallida.* In the former the only difference of much importance is the relatively smaller suckers. In the latter (var. *pallida*), the distinguishing characteristics are a shorter and stouter body, broader and larger caudal fin, and larger size of suckers. It feeds, probably, upon the menhaden principally, and is, when adult, like *Loligo pealii*, food for large fishes, and when young is likewise devoured by numerous animals. The typical variety, *Loligo pealii*, is the only one exhibited.

Ommastrephes illecebrosa, Verrill.

This is the most common squid north of Cape Cod. It is abundant in Massachusetts Bay, the Bay of Fundy, and northward to Newfoundland. It is also found along the coast as far to the southward and westward as Newport, and in deep water as far south as Cape Hatteras. Its range in depth is probably as great if not greater than that of *Loligo pealii* it having been taken in 372 fathoms. It is known as the "short-finned squid," the "sea arrow" and the "flying calamary" and, like the *Loligo pealii*, is one of the Decapods of the class *Dibranchiata.* The extreme length of the adults, from tail to tip of tentacular arms, is from 12 to 17 inches, and the length of the body from 7 to 10 inches. The body measures from 4 to 6½ inches in circumference. The caudal fin is transversely rhomboidal, or broad spear-shaped and is one-third wider than long. The anterior margins are convexly rounded, and the fin is generally shorter and broader than in *Loligo.* The general appearance is long and slender. In the male, either the right or left ventral arm is modified, or hectocotylized, for purposes of reproduction. The ground color is of bluish-white, with green, blue and yellow irridescence on the sides and lower surface. The whole body, head, outer surface of arms and fins are more or less covered with small, unequal, circular, orange-brown and dark-brown spots, which are continually contracting and expanding, the contraction darkening and the expansion lightening the colors. On the lower surfaces the spots, or cromatophores, are less crowded than on the upper surfaces, where they are frequently in different and partially overlaying planes. The suckers on the arms are pure white. The eyes are dark, blue-black, and are provided with lids. The changing tints are described by Professor Verrill as passing over the body like a series of blushes. They usually appear in the water of a reddish-brown color or a pale, translucent bluish-white.

The reproductive process of this species has not yet been studied, nor as yet have we any definite information regarding the time, place, or manner of spawning. It is probable that they spawn in the open sea and that the eggs will be found floating at the surface. Neither has any information as to the length of time required to reach maturity been obtained, but it probably lives several years. This squid is an exceedingly active creature, moving in any direction, with great velocity, by means of the reaction of the ejected jet of water from the siphon or funnel. When darting rapidly, the lobes of the caudal fin are wrapped about the body and the arms are held closely, in an acute bundle, in front, the animal thus being sharp at both ends and passing through the water with the least resistance. They are predatory, gregarious, and nocturnal in habits, swimming mainly at night, in schools, and attacking and devouring small fishes and crustaceans, especially shrimp, herring, and young mackerel. They change their color and appear translucent and pale when in pursuit of prey; and when that pursuit is so active that the young fish disappear, the squid will sink to the bottom, assume the color of the sand, and thus ambuscaded will await the return of its victim. They frequently, in their search for food, ground on the flats, and, as they pump out water from the funnel with great force under such circumstances, thus throwing themselves higher on the beach or shoal, they perish in great numbers. At such times they also discharge their ink in great quantities. This squid, like *Loligo pealii*, is eagerly pursued by the cod and other voracious fishes, and while young an especial enemy is the full-grown mackerel. Also like the *Loligo*, it devours its own young.

The *Ommastrephes* is a very important item in the bait supply of the codfishery, fully half the bank fishermen using squids or cuttles as bait. Mr. Ingersoll states over 500 sail are engaged in capturing them for that purpose. They are taken, generally accidentally, in the pounds and wiers, and more frequently by seeking them on flats and beaches where they have been left stranded by gales or receding tides. They are also captured by using "jigs" or groups of hooks which are moved up and down in the water and to which the squids cling. Their nocturnal habits and tendency to gaze at a bright light are also taken advantage of, and the fishermen go out on dark nights with torches in their boats, and, as the squids swim backward, they are gradually driven ashore. On account of its availability for bait for the cod-fisheries, its abundance and the proximity of its range to the fishing banks, this is the most valuable of the Cephalopods of the American coast.

Loligo brevis, Blainville.

This is the common squid or calamary of the southern coast of the United States. It ranges northward to Delaware Bay, is common from South Carolina to Florida and is found also along the Gulf coast. It is a smaller, shorter-bodied species than *Loligo pealii*, has short rounded caudal fins, very short upper arms, and large chromatophoric spots.

The body is short, thick, well rounded, and rather blunt posteriorly. The fins are broad and short, with posterior end very obtuse. The arms are all short, the two upper pairs being much shorter than the two lower. The tentacular arms have the "club" well developed. In the female there is no tubercle on the buccal membrane for attachment of spermatophores. The male has not been described, and consequently nothing is known of the methods, periods, or times of spawning. The adults are about 6 inches in total length, and sometimes larger. The chromatophores are large, of a dark purple color, and are regularly scattered on a pale ground-color. Above the eyes they are so closely crowded as to form dark blotches. The under side of the caudal fin is white. Though extensively distributed, this species is not very abundant, nor of much importance economically. It is used as bait, and is also sold as food in New Orleans markets.

Architeuthis.

GIANT SQUIDS.

These Squids frequent the waters of Newfoundland and the Newfoundland Banks, but apparently do not exist in great numbers, as Professor Verrill in his paper on the "Cephalopods of the Northeastern coast of America" mentions but twenty-six specimens of which he could obtain any definite knowledge. It is not unusual for them to be cast up on the Newfoundland beaches after gales, and occasionally they are found dead or dying on the surface of the water in the neighborhood of the Banks. Verrill expresses the opinion that they inhabit the colder fiörds of Newfoundland, and are rarely seen at the surface unless disabled or incapacitated by disease from pursuing their customary life. So few specimens have been obtained for study and so seldom have these gigantic Squids been observed, that very little is known of their anatomy, or biography and still less of their sexual characteristics. All that is certain is that in many points they resemble the smaller species; that they swim by means of the jet of water from the funnel; that they have the ability to discharge large quantities of "sepia" or "ink," and that they are probably carnivorous. Whenever found they are used for bait, for dog-food and as manure.

The model exhibited is of a specimen of *Architeuthis princeps*, Verrill, cast ashore on the coast of Newfoundland in 1877. It is not the largest specimen that has been seen, but was the one most perfectly preserved when it reached the hands of scientific observers.

Octopus punctatus, Gabb.

OCTOPUS, OF DEVIL FISH.

This species exists on the northwest coast of the United States, and attains a large size, being probably the largest species of *Octopus* in existence. Very little is known of it, though as a bait it is of considerable importance in the cod-fishery at the Shumagin Islands. The flesh is also eaten by the Indians.

In addition to this species there are several species of squids on the west coast that are occasionally eaten by the Chinese, especially one allied to *Ommastrephes*. The flesh is dried and exported to China, but the industry is not of sufficient importance to justify particular mention.

Mollusca encephala.

GASTEROPODA.

Like the *Cephalopoda*, the *Gasteropoda* of the American coast, while very numerously represented, are not of much importance economically. The abundance of more palatable, bivalve shell-fish, such as the oysters and clams, has prevented the univalves, even when edible, from receiving much attention. Doubtless many species, especially those of large size, like the *Fulgur carica* and *Buccinum undatum*, have been eaten in the past by the Indians and, indeed, the shell-heaps along the coast contain evidence of such having been the case; but in recent times the appropriation of this class of mollusks to the uses of man, with the exception of the genus *Haliotis*, has been so slight that it is impossible to obtain any statistics bearing upon the subject. A number of the Gasteropods have been catalogued as used for food or bait; but, with the exception above noted, they form a possible rather than a real food supply. Even their consumption as bait is inconsiderable, and nowhere is their pursuit reduced to any systematic or organized method. As, however, many of the Gasteropods are carnivorous and predatory, doing, at times, much damage to oyster beds and destroying numbers of other valuable mollusks, they become of consequence in any consideration of shell-fisheries and in their destructive relation they will be noticed in detail.

Buccinum undatum, Linné.

This animal is known, generally, as one of the "sea-snails," and sometimes as the "whelk." It has not a very wide distribution on the American coast, being uncommon south of Cape Cod, except in deep water. It is common in Massachusetts Bay and abundant further north, to the coast of Greenland. As a fossil it is common in the Post-Pliocene deposits of Maine, Canada, and Labrador. Though the ordinary American specimens, from shallow water, differ considerably from the European types, yet, as it is not difficult to form connecting series, and as the deep-water specimens differ very little from the European form, Professor Verrill decides that the two species are identical. This Gasteropod is available for food; but, though probably eaten by the Indians, is not at present sought, except occasionally as bait. It usually inhabits rocky bottoms, but is occasionally found elsewhere.

Littorina littorea (Linné), Menké.

PENNYWINKLE.

This species is not an indigenous one, having been introduced from Europe, probably with ballast, during the last fifteen or twenty years. It first appeared on the coast of Maine in 1868, and since then has spread gradually to more southern waters. In 1872 it was seen in the vicinity of Provincetown, Mass. In 1875 it was seen at Wood's Holl, but was abundant at Provincetown; and in 1880 had become abundant at Wood's Holl. It is now found as far west as Stonington, Conn. Though not used as food it is available for that purpose.

Ilyanassa obsoleta, Stimpson.

This small univalve has no distinctive common name, and goes by the general term of "sea-snail." It is found on the entire eastern and southern coasts of the United States, though not abundant south of Cape Cod, and is local in the Gulf of Saint Lawrence. It is found fossil in the Post-Pliocene of Massachusetts, Nantucket Island, Virginia, and South Carolina. The *Ilyanassa obsoleta* is, probably, the most abundant Gasteropod of the American coast. While it is naturally an inhabitant of muddy bottoms and flats, yet it lives and flourishes on sandy shores, among eel-grass, and on the piles and timbers of wharves equally well. It is found alike, far up estuaries and on the open coast and its crooked trail and burrows can be observed on every beach and shore. As the tide leaves the mud flats the animals are seen in immense numbers, especially in and about the pools. They perform the useful duty of scavengers, and are also sought and used for bait; but are not considered edible.

HALIOTIDÆ.

Genus **Haliotis**.—EAR-SHELLS, SEA-EARS, OR ABALONES.

There are four species of *Haliotis* that are of commercial importance: The "White Sea-Ear," or *Haliotis cracherodii;* the "Splendid Sea-Ear," or *Haliotis splendens;* the "Rough Sea-Ear," or *Haliotis corrugata;* and the "Red Sea-Ear," or *Haliotis rufescens*. One other species, *Haliotis kamchatkana*, is found on the coast of Alaska, but is rare. These Gasteropods are distributed along the whole North Pacific coast from San Francisco to the southward, including the peninsula of Lower California, though they decrease in abundance in the region of Cape Saint Lucas. They are also found in the Gulf of California, and along the Mexican coast. The "White Sea-Ear" (*Haliotis cracherodii*) is the most abundant, and is the one generally known in commerce. The "Splendid" and "Rough" species (*Haliotis splendens* and *Haliotis corrugata*) are most abundant in the neighborhood of San Diego. The shell of *Haliotis* *rufescens* was the one principally used by the Indians in making their shell money, but is now rare and is usually found to the northward of San Diego. All the species are known on the coast as "Abalones," a name originated by the Spanish-Americans.

The Abalones dwell upon weed-grown rocks, and feed upon marine *algæ*. They have a broad, flat, muscular foot, adapted rather for holding than for locomotion, by which they cling to the rocks with great tenacity. Through the small, circular holes, near the margin of the shell, the animal, when clinging to its support, receives its supply of oxygen and, by means of the small tentacles which protrude through them, is warned of the approach of danger. No species of the genus *Haliotis* are found on the eastern coast of the United States, but on the western coast the trade in both shells and flesh is of considerable value.

The fishery is carried on mainly by the Chinese inhabitants, who preserve and eat the flesh, which is said to be nutritious but indigestible. The method of preserving is the simple one of drying and salting, after which the major portion of the crop is exported to China. It is estimated that about six tons of living animals must be gathered to obtain one ton of flesh, and as there were some 388 tons of meats gathered in 1879–'80, that amount indicates that nearly 2,400 tons of living Abalones were taken during the season. The fishery has of late years become so severe that the coast of California has been swept and the fishermen are compelled to resort to the islands lying off the peninsula. The usual method is for Americans to supply the necessary capital and transportation to the islands and the Chinese fishermen to do the work, the former taking the shells and the latter the flesh obtained from the season's fishery. The tenacity with which the animal clings to the rocks by means of its muscular foot is so great that it is not always easy to remove it. Several methods are used; a trowel or spade is employed, usually, to slip under the animal and so dislodge it; and another method, not so generally used, is to pour hot water over them and then push them suddenly adrift with the foot.

The fishery is, however, not very laborious and in no way hazardous. The animals live but a little below low-water mark, and the islands and coasts on which they are at present found are remarkable for equability of climate. The growing scarcity of the animals alone prevents the fishery from assuming greater importance. The shells are exported in large numbers to Europe, and are there used in various ways. A smaller number are retained and used in ornamental manufactures in this country.

The value of the fishery for the year 1879 was:

	Value.
Meats, 777,600 pounds	$38,800
Shells, 3,833,500 pounds	88,825
Total	127,625

Fulgur carica, Conrad.

This species is found along the eastern coast of the United States from Florida to Cape Cod. It is abundant in Vineyard and Long Island Sounds, in from 1 to 10 fathoms. It occurs in the Miocene formation of Maryland, and in the Post-Pliocene of Virginia, North and South Carolina, and Florida.

Sycotypus canaliculatus, Gill.

This is found on the eastern coast of the United States from Florida to Cape Cod, also on the west coast of Florida and the northern shores of the Gulf of Mexico. It is abundant in Vineyard and Long Island Sounds, in from 1 to 8 fathoms of water. It occurs in the Post-Pliocene of Virginia, North and South Carolina and Northern Florida, and in the Miocene of Maryland and Virginia.

As these species generally exist in company, and in habits have a close relationship, they are considered together, though the former is found in greater abundance in more southern waters than the latter, and has structural and other distinguishing peculiarities. Both species are occasionally found on sandy flats and in tide pools, especially during the spawning season, but they generally live in deeper water and off shore. They are found, also, on rocky shores but usually are met with on gravelly and shelly bottoms, where they find a larger amount of sustenance. These large shells are readily recognized by the fishermen and inhabitants of the coast, who have assigned them various designations. On the borders of Long Island Sound and Long Island they are called indiscriminately "Periwinkles"; while on the coast of New Jersey this is abbreviated to "Winkle," or corrupted into "Wrinkle." The *Sycotypus canaliculatus* is also called the "Hairy Whelk," a designation due to its hairy epidermis. This species varies in color very much, and may be found of a light orange or livid brown. The *Fulgur carica* also varies with advancing age or with the climate.

The eggs of both species are deposited in capsules, which are strung together in strings frequently a foot or more in length. Each capsule contains some twenty or more eggs, and from fifty to one hundred capsules are found in a string. There are marked differences in the character of the capsules of each species by which they may be distinguished; that of *F. carica* being smaller, thicker, and having truncate edges; while *S. canaliculatus* has larger, thinner capsules, with a thin, sharp, outer edge and radiating ribs on the sides; but both are peculiar and will be readily recognized after inspection of the specimens exhibited. As both the *Fulgur* and *Sycotypus* are predatory and carnivorous, destroying by means of the teeth on the lingual ribbon any unfortunate bivalve they may meet; as they are especially enemies of the oyster and clam; and as they are in the present day of little or no use to man, both they and their curious egg-cases had best be destroyed whenever met.

Urosalpinx cinerea, Stimpson.

This is the "Drill" or "Rough Whelk," and is abundant along the whole eastern coasts of the United States from Massachusetts Bay to Florida. It is also found on the west coast of Florida and in the Gulf of Mexico. It is more rare and local north of Massachusetts Bay, but extends to the Gulf of Saint Lawrence. It occurs in the Post-Pliocene deposits of Massachusetts, Nantucket, Virginia, North and South Carolina, in the Pliocene of South Carolina, and Miocene of Maryland.

Purpura lapillus, Lamarck.

The shell of this animal resembles somewhat that of the preceding species, and the animal itself has similar carnivorous habits, but is a more arctic type, living in the colder waters north of Cape Cod and inhabiting exposed rocky headlands, while the *U. cinerea* is found at all points. The *Purpura lapillus* is extremely abundant on the coasts of Maine and Nova Scotia, and extends to Long Island Sound. It has been found in the Post Pliocene of Maine, but is not a common fossil.

The *Urosalpinx cinerea* is more abundant in brackish water and on shelly bottoms than elsewhere, but is found indiscriminately wherever there is suitable food. The *Purpura lapillus*, though like the "Drill," a borer, confines itself to the barnacles growing on the rocks; but the *Urosalpinx* is much more harmful and is an inveterate enemy of the oyster, boring, by means of the sharp, flinty teeth that cover its tongue, round holes through the oyster-shell and sucking out the contents. It is particularly destructive to young oysters in Chesapeake Bay, and a shell has been observed having fifty-four young attached to it, of which fifty had been destroyed by the "Drill." On some of the beds fully 50 per cent. of the young perish from this cause. It is probable that the *Purpura lapillus* only lacks opportunity to effect similar results, and both the animals and their curious vase-shaped egg-capsules, attached to stones and rocks by a short stalk, should be destroyed whenever met.

Lunatia heros, Adams.

Is found from Georgia to the Gulf of Saint Lawrence. It is abundant on the coast of New Jersey and southern coast of Long Island from low water to 10 fathoms. Occurs in the Miocene formation of Maryland, Virginia, and South Carolina, in the Pliocene of South Carolina, and in the Post Pliocene of Canada and South Carolina.

Neverita duplicata, Stimpson.

Exists on the eastern coast of the United States from Florida to Massachusetts Bay, and on the northern and western shores of the Gulf of Mexico. It is abundant from Long Island Sound southward, and is found as a fossil in the Miocene and Post Pliocene deposits of Virginia, North and South Carolina, in the Miocene of Maryland, and in the Pliocene of South Carolina. Like the *F. carica* and *S. canaliculatus*, *Lunatia heros* and *Neverita duplicata* are generally found in company; having the same habits and appearance, to the casual observer, they are frequently confounded one with the other, and are usually known to the fishermen and long-shoremen as "Sea-Snails," and sometimes as "Winkles" or "Periwinkles." On account of their similarity in distribution and close relationship in habits, they are considered together.

The *Lunatia heros* is found on nearly all sandy shores, in pure water, and apparently prefers the open coast and heavy surf, growing under those conditions to a larger size than elsewhere. It is by no means as large as the *Fulgur* or *Sycotypus*, but has been known to reach five inches in length by nearly four in breadth. When in motion the foot and soft parts of the body are protruded to a remarkable extent, and spread out so broadly as to almost conceal the shell. The foot is large, concave below when expanded, and when extended beneath the sand affords the animal a secure anchor or hold; it is the organ by which the animal burrows for protection or prey. Both the *Lunatia heros* and the *Neverita duplicata* are destructive, boring round holes through bivalve shells by means of small teeth on the lingual ribbon, and then sucking out the contents of the shells. Nor do they confine their operations to the bivalves, but attack univalves, not excepting their own young, as well. *Neverita duplicata* differs from its usual associate in being found less frequently on the outer beaches and growing more abundantly, though not to so large a size, elsewhere. It is a more southern species than the *Lunatia heros*, and is not common north of Cape Cod. The egg cases of both species are often met on mud and sand flats at low water, and are very curious. They consist of a broad, thin ribbon of sand, coiled in a circle. The ribbon is composed of innumerable little cells, each containing eggs, and surrounded by fine sand cemented together by mucus. The cells can easily be seen by holding the ribbon to the light, and for the same reason given for destroying the egg-capsules of the *Fulgur* and *Sycotypus*, these egg-cases should meet a similar fate when encountered.

While both *L. heros* and *N. duplicata* are found on sandy and gravelly shores, their natural ground, where they exist in greatest abundance, is the shelly bottoms of oyster beds and similar areas.

Crepidula plana, Say.

Crepidula fornicata, Lamarck.

These two species are neither directly useful nor harmful, but when present in large numbers they form one of the indications of the health of an oyster-bed and are therefore exhibited. The former is known as the "Slipper-Shell" and the latter as the "Boat-Shell." Both are found from Massachusetts to Florida, and on the northern shores of the Gulf of Mexico.

Ostrea virginica, Gmelin.

This, the most important mollusk of American waters, is known also as *Ostrea virginiana*, Lister, *Ostrea borealis*, Lamarck, and *Ostrea canadensis*, Bruguière. It is the common American oyster, and the many various forms of shell met along the coast are due to local and peculiar conditions, and are by no means constant either in the locality or shell itself; nor is there any structural difference in shell or body in any of the varieties which have received specific names. This is shown by the series illustrating the variations of *Ostrea borealis* and *Ostrea virginica*. The specimens in this series are from all parts of the coast, and in some of them the change from one form to the other and back is very marked. The series of specimens illustrating the peculiarities of the different species, *Ostrea virginica*, *O. borealis*, *O. lurida*, and *O. edulis*, will afford the observer a means of comparing the dissimilarities which exist between well-defined species, such as the *virginica*, *lurida*, and *edulis*, with those existing between *O. virginica* and *O. borealis*, which are only nominal varieties.

Oysters are found along the entire east and west coasts of the United States with the exception of the lower part of the peninsula of Florida and the coast of Maine. Their absence from the southern waters of Florida is due probably to the absence of fresh-water streams; and their disappearance from the coast of Maine, where the shell-heaps testify to their existence in large numbers in the past, is the result of climatic changes, coupled, most likely, with the inordinate fishery of the aborigines. The shells are found, fossil, in the Post-Pliocene deposits of Massachusetts, Nantucket, and Gardiner's Island, in the Pliocene of South Carolina, and in the Miocene of Virginia and South Carolina. The distribution of this species will be best understood and appreciated by viewing the charts, showing the areas and positions of the beds. The most noticeable feature about them is the contrast between the cultivated areas of the Northern and Southern States.

BIOLOGY.

It was long supposed that the American oyster resembled the European species (*Ostrea edulis* and other varieties) in its method of reproduction and sexual characters; and on that account no attempts were made to adapt to the oyster the methods of artificial impregnation. In 1879, however, Dr. W. K. Brooks made the initial experiments and proved the possibility of impregnating the eggs and maintaining the embryos alive for some time, without the aid of the parents. The experiments were so interesting and important, that Dr. Brooks' description of the manner of conducting them is here reproduced:

"BREEDING HABITS OF THE AMERICAN OYSTER.

"Our knowledge of the development of the oyster is derived from the fragmentary observations of various German, French, English, and Russian embryologists, whose work will be noticed at length farther on. While the subject has received the attention of a number of observers, no one has been able to get anything like a complete series of the early stages of development, and I approached my work without hope of accomplishing much of purely scientific value, although I did expect to obtain some information as to the time and conditions of spawning, and other questions of economic interest. My uncertainty of success was increased by the total failure of an attempt which I had made the summer before.

"All the published papers upon the subject state that the eggs are fertilized inside the body of the parent, and that the young are carried inside the parent shell until they are quite well advanced in development, and provided with shells of their own; that they swim about after they are discharged from the parent until they find a place to attach themselves, but that they undergo no change of structure between the time when they leave the parent and the time when they become fixed. Misled by these statements, which are not true with our species, I opened numbers of oysters during the summer of 1878, and carefully examined the contents of the gills and mantle chambers, but found no young oysters. I concluded that the time during which the young are carried by the parent must be so short that I had missed it, and I entered upon the work this season with the determination to examine adult oysters every day through the breeding season in search of young, and at the same time try to raise the young for myself by artificially fertilizing the eggs after I had removed them from the body of the parent.

"I met with complete success with the second method from the beginning, and succeeded in raising countless millions of young oysters, and in tracing them through all their stages of development until they had acquired all the characteristics which the European embryologists have described and figured in the young of the European oyster at the time it leaves its parent to become fixed for life.

"I reached Crisfield on the 19th of May, and established myself about three miles from the town and about half a mile from Pokamoke Sound, and on Monday, the 21st, I opened a dozen fresh oysters, and found three females with their ovaries filled with ripe ova, and one male with ripe spermatozoa.

"I mixed the contents of the reproductive organs of these four oysters, and within two hours after the commencement of my first experiment, I learned by the microscope that the attempt at artificial fertilization was successful, and that nearly all of my eggs had started on their long path towards the adult form.

"I made careful microscopic examination of the gills and mantles of all these oysters, but neither at this time nor afterwards did I find any fertilized eggs or young inside the parent shell, although I examined more than a thousand adults during the season. During the summer I found females with the ovaries so distended with ripe eggs that they were oozing from the openings of the oviducts; others where the ovaries were half emptied, and others which had discharged almost all their eggs, and others at all the intermediate stages, but in no case did I find a single developing egg inside the shell of the parent.

"ARTIFICIAL IMPREGNATION OF THE OYSTER EGGS.

"If a number of oysters are opened during the breeding season, a few will be found with the reproductive organ greatly distended and of an uniform pure opaque white color. These are oysters which are spawning or nearly ready to spawn.

"If the point of a knife be pushed into the reproductive organ a milk-like fluid will ooze out of the cut, and a little of it may be taken up on a knife blade and transferred to a glass slide for examination. The drop of fluid should be thoroughly mixed with a drop of sea water and placed on the slide, and gently covered with a cover-glass, and examined with a magnifying power of about one hundred diameters. If the specimen is a female, this power will show that the white fluid is almost entirely made up of irregular pear-shaped ovarian eggs (Fig. 49), each of which contains a large circular transparent germinative vesicle surrounded by a layer of granular slightly opaque yolk. It is almost impossible to describe the slight differences which distinguish the perfectly ripe egg from those which are nearly ripe but not capable of fertilization, although a very little experience will enable one to tell whether it is worth while to attempt the fertilization of the eggs of any given female.

"When the drop of fluid is thoroughly mixed with the sea water, the eggs should appear clean, sharply defined, separate from each other, and pretty uniformly distributed through the drop, as shown in the figure. It they adhere to each other, or if their outlines are indistinct, or if their is much finer granular matter scattered between the eggs, it is probable that the attempt at artificial fertilization will at best be only partially successful.

"When a perfectly ripe female is found, it should be set aside and the search continued for a male. The question of the sex of the oyster has long been a matter of dispute, and the subject will be fully discussed in another place. All that concerns us now is to know that for all practical purposes the sexes are separate in the European as well as the American oyster. At the breeding season each individual is either exclusively a male or exclusively a female. Out of several thousand which I examined, I have not found one which contained both eggs and male cells, and all the best authorities upon the European oyster make the same statement, although there is some reason for the belief that an oyster may give rise to eggs one season and to male cells another year. When a drop of the milky fluid from a ripe male is mixed with a little sea water and examined with a magnifying power of one hundred diameters, it is seen at a glance to be quite different from the fluid of a female. There are no large bodies like the eggs, but the fluid is filled with innumerable numbers of minute granules (Fig. 48), which are so small that they are barely visible when magnified one hundred diameters. They are not uniformly distributed, but are much more numerous at some points than at others, and for this reason the fluid has a cloudy or curdled appearance. By selecting a place where the granules are few and pretty well scattered, very careful watching will show that each of them has a lively dancing motion, and examination with a power of five hundred diameters will show that each of them is tadpole shaped (Fig. 50), and consists of a small, oval, sharply defined 'head' and a long, delicate 'tail,' by the lashing of which the dancing is produced.

"It is more difficult to decide whether the male cells are perfectly ripe than it is to decide in the case of the eggs. With a magnifying power of five hundred diameters, each 'head' should have a clear, well-marked outline, and they should be very uniform in size, and separated from each other, as in Fig. 50. Under very favorable circumstances this power should also show the 'tails' as very faint undulating lines.

"If the 'heads' vary much in size, or if they are aggregated into bunches, with the 'tails' radiating from the bunches in all directions, or if there is much granular matter so small that the outlines of the particles are not visible when magnified five hundred diameters, the fluid is not perfectly ripe, and fertilization with it will not in all probability be very successful.

"NUMBER OF EGGS.

"As the male cells are infinitely more numerous than the eggs, the ripe fluid from even one small male is enough to fertilize all the eggs of five or six large females.

"The number of male cells which a single male will yield is great beyond all power of expression, but the number of eggs which an average female will furnish may be estimated with sufficient exactness. A single ripe egg measures about one five-hundredth of an inch in diameter, or five hundred laid in a row, touching each other, would make one inch; and a square inch would contain five hundred such rows, or $500 \times 500 = 250,000$ eggs. Nearly all the eggs of a perfectly ripe female may be washed out of the ovary into a beaker of sea water, and as they are heavier than the sea water, they soon sink to the bottom, and the eggs of a medium sized female will cover the bottom of a beaker two inches in diameter with a layer of eggs one-twentieth of an inch deep. The area of the bottom of a beaker two inches in diameter is a little more than three square inches, and a layer of eggs one-twentieth of an inch deep, covering three square inches, is equal to one three-twentieths of an inch deep and two square, and as a single layer of eggs is one five-hundredth of an inch thick, a layer three-twentieths of an inch thick will contain seventy-five layers of eggs, with 250,000 eggs in each layer, or 18,750,000 eggs. It is difficult to get the eggs, perfectly pure, and if we allow one-half for foreign matter and errors of measurement, and for imperfect contact between the eggs, we shall have more than nine millions as the number of eggs laid by an oyster of average size, a number which is probably less than the true number.

"Möbius estimates the number of eggs laid by an average European oyster at 1,012,925, or only one-ninth the number laid by an ordinary American oyster, but the American oyster is very much larger than the European, while its eggs are less than one-third as large, so the want of agreement between these estimates does not indicate that either of them is incorrect.* Another estimate of the number of eggs laid by the European oyster is given by Eyton (History of the Oyster and Oyster Fisheries, by T. C. Eyton. London, 1858). He says, p. 24, that there are about 1,800,000, and therefore agrees pretty closely with Möbius.

"An unusually large American oyster will yield nearly a cubic inch of eggs, and if these were all in absolute contact with each other, and there were no portions of the ovaries or other organs mixed with them, the cubic inch would contain 500^3, or 125,000,000. Dividing this, as before, by two, to allow for foreign matter, interspaces, and errors of measurement, we have about 60,000,000 as the possible number of eggs from a single oyster.

"Although each male contains enough fluid to fertilize the eggs of several females, there does not seem to be much difference in the number of individuals of the two sexes. When a dozen oysters are opened and examined there may be five or six ripe females and no males, but in another case a dozen oysters may furnish several ripe males but no females, and in the long run the sexes seem to be about equally numerous. Oystermen believe that the male may be distinguished from the female by certain characteristics, such as the presence of black pigment in the mantle, but microscopic examination shows that these marks have no such meaning, and that there are no differences between the sexes except the microscopic ones. It is not necessary to use the microscope in every case, however, for a little experience will enable a sharp observer to recognize a ripe female without the microscope. If a little of the milky fluid from the ovary of a female with ripe or nearly ripe eggs, to be taken upon the point of a clean, bright knife-blade, and allowed to flow over it in a thin film, a sharp eye can barely detect the eggs as white dots, while the male fluid appears perfectly homogeneous under the same circumstances, as do the contents of the ovary of an immature female, or one which has finished spawning. When the eggs are mixed with a drop of water, they can be diffused through it without difficulty, while the male fluid is more adhesive and difficult to mix

*"Möbius' measurement, from 15 to 18 millimeters, is given (Austern und Austernwirtschaft, 1877), as the diameter, not of the egg, but of the embryo, but his figures show that the European oyster, like the American, does not grow much during the early stages of development, but remains of about the same size as the egg."

with the water. By these indications, I was able in nearly every case to judge of the sex of the oyster before I had made use of the microscope.

"In order to fertilize the eggs, all that is necessary is the mixture of the ripe eggs with a little of the ripe male fluid in a drop of water. If the point of a knife-blade be dipped in the fluid from a female and touched to a glass slide, and then dipped into the fluid of a male, and touched to the same part of the slide, and a drop of sea water be added, to cause the two to meet, most of the eggs will be fertilized, and their early stages of development can be studied in a single drop of water, but to secure the fertilization and healthy development of large numbers of eggs, several precautions are necessary, as well as a few instruments and pieces of apparatus.

"The following is a list of the things needed for procuring, fertilizing, and hatching the eggs: A pair of sharp-pointed scissors; a pair of small forceps; half a dozen watch crystals; a set of about half a dozen glass beakers, or tumblers, of different sizes, from half a pint up to half a gallon; two or three dipping tubes, or glass tubes six or eight inches long, open at both ends, but with one end drawn out to a fine point; a small glass or rubber siphon for drawing the water out of the beakers. For tracing the development of the eggs, a microscope, magnifying at least one hundred diameters, and half a dozen glass slides and thin glass covers are wanted.

"After the oysters have been opened, and at least one ripe male and one ripe female found, cut off the mantle lobes and gills of the male with the scissors, close to the visceral mass, and tear them out with the forceps and throw them away. Cut around the adductor muscle with the scissors, so that the visceral mass may be lifted out of the shell and transferred to a small saucer or to a watch crystal. Holding the visceral mass with the forceps, cut out with the scissors as much as possible of the digestive organs and liver and throw them away, and then chop up the reproductive organs with the scissors, picking out and throwing away any fragments of the liver, digestive organs, mantle or gills which may present themselves. In order to have the young oyster thrive, the water must be kept free from fragments of the various organs of the adult, as these would soon decay and destroy the embryos, and it is therefore important to remove them as completely as possible. After the mass has been chopped up as fine as possible, fill up the watch crystal with fresh sea water, stir it up, and then allow it to run into one of the smallest beakers, which has been nearly filled with sea water. As the water runs out of the watch crystal, be careful to allow as few of the fragments as possible to run with it."

"Now fill up the watch crystal with water again, and stir and pour off as before, and repeat the process until nearly all of the male fluid has been washed out of the fragments and poured into the beaker. Stir the contents of the beaker for a short time, and then allow it to stand about five minutes, to allow any fragments to settle to the bottom, then pour the fluid, which should be quite milky, into another small beaker, leaving behind, to be thrown away, any particles which may have settled to the bottom. The male cells retain their full vitality for several hours after they have been mixed with sea water, so the beaker may be set aside to wait until the eggs are ready. The eggs swell up and break to pieces within a very few minutes after they are mixed with water, unless they are fertilized at once, so it is much better to add the eggs to a previously prepared mixture of male cells and water than it is to put the eggs into the water to wait until the male fluid is got ready.

"Taking now one of the females, remove and chop up the ovary in the same way in another watch crystal, observing the same precautions in removing all portions of the body. Fill the watch glass with water, and stir and pour off into the beaker as before, giving the contents of the beaker a good stirring after each lot of eggs is added, in order to diffuse them through the water at once, and thus insure the speedy contact of each of them with some of the male cells.

"Fill the crystal with water again, and stir and pour off, and repeat until all the eggs have been washed out of the fragments of the ovary."

"Another female may now be cut up, and the eggs may be added to the contents of the same beaker; but if the females are large, and yield many eggs, it is not best to use more than one, for although there are enough male cells to fertilize a very great number of eggs, the eggs are heavier than water and soon sink to the bottom, and if they form a very thick layer, only those which lie near the surface have room to develop.

"The beaker should now be allowed to stand for about ten minutes, and in the mean time some of the eggs may be picked out with a dipping-tube, for examination under the microscope. In using the dipping-tube, cover the large end with the tip of the finger, and run the small end down close to the bottom of the beaker, and then take the finger off the top, and as the water runs in at the bottom it will carry some of the eggs with it. When the tube is filled, place the finger on the top again, and draw it out of the water, and, holding it perpendicularly on the center of a glass slide, and taking the finger off the top, allow a good-sized drop to run out into the slide.

"If things are working properly, each egg should now have a number of male cells attached by their heads to its outer surface, with their tails radiating from it in all directions, as shown in Fig. 51.

"It is not necessary that more than one male cell should fasten on to each egg, but they usually cover them in such numbers that the lashing of their tails causes the eggs to rotate and move through the water.

"As soon as all the eggs have male cells attached to them, it is necessary to get rid of the superfluous male fluid, for it would soon decay and pollute the water if it were allowed to remain, and if it is not drawn off from the eggs while they are at the bottom, it is almost impossible to remove it after the embryos have begun to swim, without loosing them as well.

"After a final stirring, the beaker should be allowed to stand for about five minutes, to allow the eggs to settle to the bottom, and the fluid above them should then be drawn off through a siphon, reaching nearly but not quite down to the eggs. A fresh supply of sea-water should then be added, and the eggs stirred and allowed to settle, and the water drawn off as before; and this should be repeated until the water, after the eggs have settled to the bottom, remains clear.

"The beaker may now be set aside where it will not be exposed to sudden changes of temperature, and the eggs will require no further attention until the embryos begin to swim, which will be in from two to six hours, according to the temperature. The little oysters must of course be supplied with fresh sea-water from time to time during their development, and as they are so small that the water cannot be drawn off after they begin to swim, they must be supplied with fresh water by transferring them from time to time to larger and larger beakers. In two hours or so after the eggs are fertilized the embryos begin to swim, and crowd to the surface of the water in great numbers, and form a thin stratum close to the surface. This layer of embryos may be carefully siphoned off into a very small beaker, and a little fresh sea-water added. In an hour or so there will be a new layer of embryos at the surface of beaker No. 1, and these should also be siphoned into No. 2, and this should be repeated as long as the embryos continue to rise to the surface of the first beaker. Every five or six hours a little fresh sea-water should be poured from a height of a foot or more into beaker No. 2, until it is filled. The contents should then be poured into a larger beaker, and sea-water added four or five times a day as before. In this way the embryos may be kept alive for a week, although they have by this time got into such a large vessel that it is almost impossible to find any of them for microscopic examination.

"THE DEVELOPMENT OF THE EGGS.

"I will now attempt a brief, popular account of the changes through which the fertilized egg is gradually converted into the complex body of the adult oyster.

"The body of the oyster, like that of all animals, except the very simplest, is made up of organs, such as the heart, digestive organs, gills, and reproductive organs; and these organs are, at some period in the life of the oyster, made up of microscopic cells. The eggs shown in Figs. 49 and 53 will answer to illustrate the character of the cells which compose the body; each of these consists of a layer of protoplasm around a central nucleus, which, in the egg, is a large, circular, transparent body known as the germinative vesicle. Each cell of the body is able to absorb food, to grow and to multiply by division, and thus to contribute to the growth of the organ of which it forms a part. The ovarian eggs are simply the cells of an organ of the body, the ovary, and they differ from the ordinary cells only in being much larger and more distinct from each other; and they have the power, when detached from the body, of growing and dividing up into cells, which shall shape themselves into a new organism like that from whose body the egg came. Most of the steps in this wonderful process may be watched under the microscope, and, owing to the ease with which the eggs of the oyster may be obtained, this a very good egg to study.

"About fifteen minutes after the eggs are fertilized they will be found to be covered with male cells, as shown in Fig. 51. In about an hour the egg will be found to have changed its shape and appearance. It is now nearly spherical, as shown in Fig. 1, and the germinative vesicle is no longer visible. The male cells may or may not still be visible upon the outer surface. In a short time a little transparent point makes its appearance on the surface of the egg, and increases in size, and soon forms a little projecting transparent knob—the *polar globule*—which is shown in Fig. 3 and in succeeding figures.

"Recent investigations tend to show that while these changes are taking place one of the male cells penetrates the protoplasm of the egg and unites with the germinative vesicle, which does not disappear, but divides into two parts, one of which is pushed out of the egg and becomes the polar globule, while the other remains behind and becomes the *nucleus* of the developing egg, but changes its appearance so that it is no longer conspicuous. The egg now becomes pear-shaped, with the polar globule at the broad end of the pear, and this end soon divides into two parts, so that the egg (Fig. 6) is now made of one large mass and two slightly smaller ones, with the polar globule between them.

"The later history of the egg shows that at this early stage the egg is not perfectly homogeneous, but that the protoplasm which is to give rise to certain organs of the body has separated from that which is to give rise to others.

"If the egg at the stage shown in Fig. 6 were split in the plane of the paper, we should have what is to become one-half of the body in one one part and the other half in the other. The single spherule at the small end of the pear is to give rise to the cells of the digestive tract of the adult, and to those organs which are to be derived from it, while the spherules at the small end are to form the cells of the outer wall of the body and the organs which are derived from it, such as the gills, the lips, and the mantle, and they are also to give rise to the shell. The upper portion of the egg in this and succeeding figures is to become the ventral surface of the adult oyster, and the surface which is on the right side in Fig. 6 is to become the anterior end of the body of the adult. The figure, therefore, shows the half of the egg which is to become the left half of the body. The upper portion of the egg soon divides up into smaller and smaller spherules, until at the stage shown in Figs. 24, 25, and 26 we have a layer of small cells wrapped around the greater part of the surface of a single large spherule, and the series of figures shows that the latter is the spherule which is below in Fig. 6. This spherule now divides up into a layer of cells, and at the same time the egg, or rather the embryo, becomes flattened from above downward, and assumes the shape of a flat oval disk. Figs. 29 and 30 are views of the upper and lower surface of the embryo at about this time. In a sectional view, Fig. 31, it is seen to be made up of two layers of cells; an upper layer of small transparent cells, *ec*, which are to form the outer wall of the body, and which have been formed by the division of the spherules which occupy the upper end of the egg in Fig. 25, and a lower layer of much larger, more opaque cells, *g*, which are to become the walls of the stomach, and which have been formed by the division of the large spherule *a* of Fig. 25.

"This layer is seen in the section to be pushed in a little towards the upper layer, so that the lower surface of the disk-shaped embryo is not flat, but very slightly concave. This concavity is destined to grow deeper until its edges almost meet, and it is the rudimentary digestive cavity. A very short time after this stage has been reached, and usually within from two to four hours after the eggs were fertilized, the embryo undergoes a great change of shape, and assumes the form which is shown in three different views in Figs. 32, 33, 34, and 35.

"A circular tuft of long hairs or cilia has now made its appearance at what is thus marked as the anterior end of the body, and as soon as these hairs are formed they begin to swing backwards and forwards in such a way as to constitute a swimming organ, which rows the little animal up from the bottom to the surface of the water, where it swims around very actively by the aid of its cilia. This stage of development, Fig. 32, which is of short duration, is of great importance in raising the young oysters, for it is the time when they can best be siphoned off into a separate vessel and freed from the danger of being killed by the decay of any eggs which may fail to develop. On one surface of the body at this stage, the dorsal surface, there is a well marked groove, and when a specimen is found in a proper position for examination, the opening into the digestive tract is found at the bottom of this groove. Fig. 33 is a sectional view of such an embryo. It is seen to consist of a central cavity, the digestive cavity, which opens externally on the dorsal surface of the body by a small orifice, the primitive mouth, and which is surrounded at all points, except at the mouth, by a wall which is distinct from the outer wall of the body. Around the primitive mouth these two layers are continuous with each other.

"The way in which this cavity, with its wall and external opening, has been formed will be understood by a comparison of Fig. 33 with Fig. 28. The layer which is below in Fig. 28 has been pushed upwards in such a way as to convert it into a long tube, and at the same time the outer layer has grown downwards and inwards around it, and has thus constricted the opening. The layer of cells which is below in

Fig. 28 thus becomes converted into the walls of the digestive tract, and the space which is outside and below the embryo in Fig. 28 becomes converted into an inclosed digestive cavity, which opens externally by the primitive mouth.

"This stage of development, in which the embryo consists of two layers, an inner layer surrounding a cavity which opens externally by a mouth-like opening, and an outer layer, which is continuous with the inner around the margins of the opening, is of very frequent occurrence, and it has been found, with modifications, in the most widely separated groups of animals, such as the star-fish, the oyster, and the frog, and some representatives of all the larger groups of animals, except the Protozoa, appear to pass during their development through a form which may be regarded as a more or less considerable modification of that presented by our oyster embryo. This stage of development is known as the *gastrula* stage.

"Certain full-grown animals, such as the fresh-water hydra and some sponges, are little more than modified gastrulas. The body is a simple vase with an opening at one end communicating with a digestive cavity, the wall of which is formed by a layer of cells which is continuous around the opening with a second layer which forms the outer wall of the body. This fact, together with the fact that animals of the most widely separated groups pass through a gastrula stage of development, has led certain naturalists to a generalization, which is known as the 'gastrula theory.' This theory or hypothesis is that all animals, except the Protozoa, are more or less direct descendants of one common but very remote ancestral form, whose body consisted of a simple two-walled vase, with a central digestive cavity opening externally at one end of the body.

"Hæckel, who is the originator and leading advocate of this hypothesis, has proposed to call this ancestral form a 'Gastræa;' and the gastrula stage of development he regards as a trace or indication of this distant ancestry, which is still retained and passed through during the early stages of the development of animals which are now very widely separated.

"The gastrula theory cannot be regarded as one of the established generalizations of science, and the evidence which has so far been accumulated by embryologists is not by any means straightforward or satisfactory. The theory is one of the most interesting embryological problems under discussion, however, and any new information which bears upon it is of value.

"The fact that the oyster goes through a very well marked and very slightly modified gastrula stage is therefore of great theoretical interest, and more so since Salensky, a distinguished Russian embryologist, has proposed in place of the gastrula theory another theory, which is based, in part, upon erroneous observations upon the development of the oyster, which Salensky says does not pass through the gastrula stage of development at all, but forms a digestive cavity in another way.

"The edges of the primitive mouth of the oyster continue to approach each other, and finally meet and unite, thus closing up the opening, as shown in Fig. 36, and leaving the digestive tract without any communication with the outside of the body, and entirely surrounded by the outer layer. The embryo shown in Figs. 32 and 36 are represented with the dorsal surface below, in order to facilitate comparison with the adult, but in Fig. 37 and most of the following figures the dorsal surface is uppermost, for more ready comparison with the adult. The furrow in which the primitive mouth was placed still persists, and soon a small irregular plate makes its appearance at each end of it. These little plates are the two valves of the shell, and in the oyster they are separated from each other from the first, and make their appearance independently.

"Soon after they make their appearance the embryos cease to crowd the surface of the water and sink to various depths, although they continue to swim actively in all directions and may still be found occasionally close to the surface. The region of the body which carries the cilia now becomes sharply defined, as a circular projecting pad, the *velum*, and this is present and is the organ of locomotion at a much later stage of development. It is shown at the right side of the figure in Fig. 37, and in Fig. 45 it is seen in surface view, drawn in between the shells, and with its cilia folded down and at rest, as they are seen when the little oyster lies upon the bottom.

"The two shells grow rapidly, and soon become quite regular in outline, as shown in Figs. 37 and 44, but for some time they are much smaller than the body, which projects from between their edges around their whole circumference, except along a short area, the area of the hinge, upon the dorsal surface, where the two valves are in contact.

"The two shells continue to grow at their edges, and soon become large enough to cover up and project a little beyond the surface of the body, as shown in Fig. 44, and at the same time muscular fibers make their appearance and are so arranged that they can draw the edge of the body and the velum in between the edges of the shell, in the manner shown in Fig. 45. In this way that surface of the body which lines the shell becomes converted into the two lobes of the mantle, and between them a mantle cavity is formed, into which the velum can be drawn when the animal is at rest. While these changes have been going on over the outer surface of the body other important internal modifications have taken place. We left the digestive tract at the stage shown in Fig. 36, without any communication with the exterior.

"Soon the outer wall of the body becomes pushed inwards, to form the true mouth, at a point (Fig. 37) which is upon the ventral surface, and almost directly opposite the point where the primitive mouth was situated at an earlier stage. The digestive cavity now becomes greatly enlarged, and cilia make their appearance upon its walls, the mouth becomes connected with the chamber which is thus formed, and which becomes the stomach, and minute particles of food are drawn in by the cilia, and can now be seen inside the stomach, where the vibration of the cilia keep them in constant motion. Up to this time the animal has developed without growing, and at the stage shown in Fig. 36 it is scarcely larger than the unfertilized egg, but it now begins to increase in size. The stages shown in Figs. 44 and 45 agree pretty closely with the figures which European embryologists give of the oyster embryo at the time when it escapes from the mantle-chamber of its parent. The American oyster reaches this stage in from twenty-four hours to six days after the egg is fertitized, the rate of development being determined mainly by the temperature of the water.

"Soon after the mantle has become connected with the stomach this becomes united to the body-wall at another point a little behind the mantle, and a second opening, the *anus*, is formed. The tract which connects the anus with the stomach lengthens and forms the intestine, and, soon after, the sides of the stomach become folded off to form the two halves of the liver, as shown in Fig. 44.

"Various muscular fibers now make their appearance within the body, and the animal assumes the form shown in Figs. 44 and 45.

"All my attempts to get later stages than these failed through my inability to find any way to change the water without losing the young oyster, and I am therefore unable to describe the manner in which the swimming embryo becomes converted into the adult, but I hope that this gap will be filled, either by future observations of my own or by those of some other embryologist.

"In my attempt to raise the oyster embryo from the egg, I found that continuous warm weather was essential to success. As my observations upon the developing eggs occupied all my time, I was not able to make any record of the temperature of the water of the ocean, but during June there were a number of cold, windy days and nights, and two hail-storms, and on each of the cold days all the embryo which I had in the house died."

Since 1879, though several persons have been employed upon the work, and Dr. Brooks has also continued his investigations, no material advance in artificial oyster culture has been made, and beyond the additional knowledge of the reproductive process of the oyster, Brooks's experiments have been without practical result.

Concerning the influences to which the eggs, spermatozoa, and spat are exposed, and the conditions necessary to their survival, Dr. Brooks says:

"The most critical time in the life of the American oyster is undoubtedly the time when the egg is discharged into the water to be fertilized, for the chance that each egg which floats out into the ocean to shift for itself will immediately meet with a male cell is very slight, and it is essential that the egg should be fertilized very quickly, for the unfertilized egg is destroyed by the sea-water in a very short time. The next period of great danger is the short time during which the embryos swarm to the surface of the water. They are so perfectly defenseless, and so crowded together close to the surface, that a small fish, swimming along with open mouth, might easily swallow in a few mouthfuls a number equal to the human population of Baltimore. They are also exposed to sudden changes of temperature, and as my experiments have shown that a sudden fall in temperature is fatal to them at this time, the number which are destroyed by cold rains and winds must be very great indeed.

"As soon as they are safely past this stage, and scatter and swim at various depths, their danger from accidents and enemies is greatly diminished, and their chance of reaching maturity increases hundreds, and probably thousands, of times.

"Although the mortality at these early stages is so excessive, the number of young which pass through them safely without help is very great, and if there were no other dangers and uncertainties there would be no need of measures for their protection. As they swim to and fro in the water, they are carried to great distances by the tides and currents and reach all parts of the region of water in which the parent bed is situated. In a favorable year a floating plank or bush, or piece of drift wood, will be found to become covered with small oysters which have fastened to it, although it may not be within miles of any natural oyster-bank. The fact that the young may be collected in this way in any part of the Chesapeake Bay shows that the young oysters must settle down upon the bottom in nearly all parts of the bay, and we should expect the adults to have an equally general distribution. This is far from the case, and nothing could be farther from the truth than the idea that the bottom of the waters of the oyster regions is uniformly covered with oysters, and that it is only necessary to throw a dredge overboard and drag it along the bottom for a short distance in order to bring it up full. Nothing could be a greater mistake, for both in this country and in Europe the oysters are restricted to particular spots, 'beds' or 'banks,' which are as well defined and almost as sharply limited as the tracts of wood-land in a farming country. These beds are so well marked that they can be laid down on a chart or staked out with buoys; and even in the best oyster regions they occupy such an inconsiderable part of the bottom that any one ignorant of their position would have very little chance of finding oysters by promiscuous dredging. Although the young are distributed every year by the tides and currents to all parts of the bottom, the dredge very seldom brings up even a single oyster outside the limits of the beds.

"The restriction of the oysters to certain points does not appear to depend upon the supply of food, or upon the character of the water, but almost entirely upon the nature of the bottom. The full-grown oyster is able to live and flourish in soft mud, as long as it is not buried too deeply for the open edge of the shell to reach above the mud and draw a constant supply of water and food onto the gills. The placing of adult oysters upon such bottoms at convenient points to 'fatten' for the market is a well-known practice. The oyster embryo would be ingulfed and smothered at once if it should settle down on such a bottom, and in order to have the least chance of survival and long life the young oyster must find some solid substance to fasten itself to, in order to preserve it from sinking in the soft mud or from being covered by shifting sand or gravel. As soon as the young oyster finds such a solid body, rough and clean, it fastens one valve of its shell to it by secreting a cement of shelly matter around the growing edge.

"The living and dead shells of the adult oysters furnish the best surfaces for the attachment of the young, and for this reason the points where oyster beds are already established are those where the young have the most favorable surroundings and the best chance for life, and the beds thus tend to remain permanent and of substantially the same size and shape.

"The great mortality of the young, after they have fastened themselves to the shells of the adults, is due in part to want of room, in part to the attacks of enemies, in part to accidents, such as the shifting of the bottom, and in part, no doubt, to lack of food. While the supply of organic matter which is carried to them by the water is very great, it is not unlimited, and the amount which each oyster can obtain at any one time is quite small, and if the oysters covered the bottom in sufficient abundance, some of them might fail to obtain a sufficient supply. I do not believe, however, that this ever occurs, for long before the oysters are sufficiently abundant to exhaust the supply of organic matter, their numbers are limited by other conditions. The growth of an animal does not depend upon the supply of food in general, but upon the supply of the least abundant of the necessary ingredients of the food. It is well known that a field that is very fertile will fail to produce a satisfactory crop of a plant which needs some particular food-ingredient which the soil contains in too small quantity. Although food in general is very abundant, the growth of this particular crop depends upon the amount of this ingredient, and while the seed which has been planted yields an abundant crop of young plants, only a few are able to grow up, and these can grow no faster than they can extract this particular ingredient from the soil.

"In addition to organic food, the oyster needs a supply of carbonate of lime to make its shell, and this is supplied to it, in solution, in sea-water. If the shell is thin, or if it is formed very slowly, the danger from enemies and accidents is greatly increased; and those oysters which are able to construct their shells with the greatest rapidity are the ones which survive and grow up. The amount of dissolved carbonate of lime which the ocean contains is unlimited, but the amount which can reach each oyster is not very great; and if all the oysters which attach themselves were to survive there can be no doubt that they would exhaust the available supply of lime before they failed to obtain enough organic food.

"It is well known that shell-fish of all kinds thrive best when the supply of lime is greatest. The fresh-water mussels which live in streams and ponds where the supply of lime is scanty, grow slowly, and their shells are so thin that they are very subject to accidents, and their numbers are limited; but in limestone regions the shells are large and heavy, and the bottoms of the streams are almost paved with mussels, and it is well known to conchologists that coral reefs and islands are the most favorable regions for the abundant growth of all kinds of shelled molluscs."

The investigations of the United States Coast and Geodetic Survey, in the neighborhood of Crisfield, Maryland, which were coincident with those of Dr. Brooks, led to the conclusion that there is little or no regularity in the recurrence of successful "spatting" seasons, and that all irregularities are due, probably, to variations from the normal temperature and density of the water; the higher the temperature during the spring months the earlier will be the advent of the spawning season, and an increased temperature will also hasten the development of the spat, and of the young oysters after they have become attached. Sudden and extensive changes of density will likewise affect the advent, duration, and success of the spawning, though to a less extent.

Subsequent to the attachment of the animal, changes of the conditions surrounding it are not of so much importance, though naturally such changes will more severely affect the delicate organism of the young oyster than that of the older and more hardened adult.

It is during the first six months of its existence that the oyster is exposed to the greatest danger from its numerous enemies. The thin, delicate shells, from one-sixteenth of an inch to one inch in diameter, are readily bored by the drills, whelks, and other gastropods, or torn off by the crabs, and the immense number of all leaves no room to doubt their destructive effects. As an instance, the inspection of the spat collectors placed in the Big Annemessex River by the United States Coast Survey, shows that during the early months of their existence about 50 per cent. of the young oysters were destroyed.* Naturally, as the animal progresses, it becomes more hardy and better able to resist the attacks of enemies and changes of environment, and on unworked beds, where the oysters are practically in a natural state, the decrease in passing from young growth to mature oysters is about 30 per cent., or about one-third of a given number perish in passing from the first to the fourth year of their existence.

The only essential for securing the attachment of the spat is that the object exposed should be clean. The specimens illustrating attachment show how many and various these objects are; and the formation

* Photographs of this collector are exhibited.

and extension of an oyster-bed are due largely to this ability of the young fry to hold on to anything and everything. The beginning of a bed is probably in most cases accidental. There is an exposure of some object suitable for attachment, to which the drifting embryos cling, and succeeding seasons add to the colony and slowly increase both its population and area; the natural limits are defined by the amount of food and constituents of shell available, the amount of room for development, and the character of surrounding, contiguous bottoms. Oysters cannot live on bottoms not sufficiently consistent to support them; they are unprovided with siphons, or means of locomotion, and if sunk in mud or sand will perish. Neither can they live for long periods out of water unless especially educated for that contingency.

Natural oyster-beds on the American coast are of two classes; worked and unworked beds, each presenting marked features.

The following extracts from the reports of Mr. Winslow to the Superintendent of the United States Coast Survey, describing areas in Chesapeake Bay, indicate the salient features of each class. The beds contrasted are located in Chesapeake Bay and Tangier Sound, an adjacent estuary of the bay.

"Generally speaking, here as in the Sounds, the original beds were formed on the side of the shoals, and wherever there was a sudden change of bottom.

"Whenever the solid beds or 'Rocks' were encountered, they were found to be long and narrow ridges, extending generally in a northerly and southerly direction, except when near Kedge's Strait, where they ran more to the eastward and westward; and we could, in standing across the beds, but rarely obtain more than one or two hauls of the dredge before we were off the 'Rock.' The major axis appears here, as elsewhere, to lie in the direction of the current, and probably all natural extension and growth of any bed are in that direction, the spat being carried backward and forward by the ebb and flow of the tides. The large number of beds near and off Kedge's Strait is probably due to the large number of spat brought out from the Sounds through the Strait.

"The bottom is generally of hard sand covered with sponge and grass. Near Kedge's Strait some mud sloughs were found, and in some cases the substratum of the beds was of clay; but in most of them the stratum of oysters and shells was too thick and hard to be penetrated.

"The beds outside the Sounds have been comparatively free from dredging, and thus present marked differences from those inside.

"They are comparatively longer and narrower, and much more sharply defined. Very few scattered oysters are found near them, and the beds are much more solid, unbroken, and much harder, requiring heavier dredges than those used in the Sounds. The most remarkable difference is, however, in the shape and growth of the oysters.

"On the undredged beds they are long and narrow, with the lower shells very deep and bills very thin and sharp. In no case did we find any single oysters of any class, but all grew in clusters of from three and four to twelve and fifteen. The shells were clean and white, and free from mud and sand. Generally there was found a tuft of red or white sponge attached to the clusters, and the mature first and second class oysters were covered and the interstices between them filled with those of the third and fourth classes; numbers of barnacles were also found, and some *crepidula*, but *tubicola* were present only in small numbers.

"The oysters found upon beds that have been much worked differ materially, being single and broader in comparison to their length, round and with blunt bills. They are usually dark in color, and have a considerable amount of mud and sand on the shells. The sponges do not appear to be as abundant, and the amount of dredging on any bed may always be known by the appearance of the oysters brought up. Upon an overdredged and almost exhausted bed the oysters will be large and single, blunt-billed, with dirty shells, and with an almost entire absence of sponges, barnacles, and *crepidula;* but the shells will be covered with *tubicola* and bored in many places by the *boring pholad*."*

Aside from the effect of the dredge the growth of the oysters on a bed is influenced by many other circumstances. First, the position and character of the object to which the spat fixes itself have a large influence in shaping the form of the shell.

The growth of the "bills" is always toward the surface of the water, and by examining the series of specimens "of peculiar growth, due to attachment of spat," many instances of the curious effect of this effort of the animal will be noticed. During the early stages the shell grows directly out from the beaks; later, the tendency of the lower valve to assume a convex form becomes more marked, and, should the animal be so attached as to be in a horizontal position, this convexity of the lower valve becomes very prominent. If the attachment is such that the lips of the valves are below the beaks, the shell will begin to take a lateral twist, which will sometimes change the direction of shell-growth as much as 90 degrees. Again, should the spat attach in large numbers to any object and become much crowded, having no room for growth or development, except vertically, then each individual shell will become long, thin, narrow, and with very little convexity of the lower valve. Of such description are the oysters growing on natural, undeveloped banks, where they are found in enormous clusters, of from ten to fifty individuals. Such oysters, more common on the Southern coast than the Northern, are called "cat-tongues" and "knife-blades" by the oystermen. The "raccoon" oyster is also of somewhat similar growth and character.

After having developed to some extent in one locality or position, if the oyster be removed to some other point, where the conditions influencing its growth are changed, corresponding changes in the character and growth of the shell may be expected. These changes are il-

* Photographs of specimens are exhibited illustrating these differences.

lustrated by the series showing "peculiarities of growth due to abnormal influences or change of position subsequent to time of attachment." As shown by some of the specimens, owing to change of position, and the effort of the animal to keep the tips of the valves uppermost, the shell has two and three distinct changes in direction of growth, and these changes are sometimes lateral. as though the shell had always fallen on one side or the other; sometimes dorsal and ventral, as though it had always fallen on one edge or the other; and sometimes the irregular growth is a combination of both. This peculiarity is more frequent in oysters from cultivated than in those from natural beds; but it is more marked when it does occur with the natural oysters than with the cultivated ones. As the cultivated beds are more continuously and systematically raked, probably each oyster is turned over once or twice a year, and seldom has an opportunity for any peculiarity of growth to become decided. The natural oyster, however, is rarely handled much before being conveyed to market, and consequently any unusual growth forced upon it is apt to be very remarkable.

The character of the bottom has not only a very decided influence upon the growth of the beds, but also affects the growth of each individual oyster. The shells from impure, muddy waters, are usually dull colored and soft or friable, and when the bottom is very soft, the long flat growth is the only form that has any chance of survival. Types of this form, the "pinched" oyster of the fishermen, are exhibited. A large amount of soft mud, either in the water or on the bottom, likewise affects the interior shell-layers. Particles of the muddy soil get between the valves and under the mantle, and the animal builds a thin layer of shell over them, causing thus the dark blue and black spots about the edges of the shells and over the interior surface, so noticeable in specimens from muddy localities. These peculiarities are shown in the series illustrating the effects of soft bottoms. Shells from hard bottoms and pure waters are much cleaner and harder in character; the shell layers are thinner and less friable, and the *boreal* form more prominent and frequent.

The rate of growth of the American oyster varies with the locality. Generally speaking, it is slower in Long Island Sound than in the Chesapeake, the northern oysters not being considered fit for market until three or more years old, while in Maryland and Virginia waters they attain a marketable size in a year and a half or two years. They are, however, at that age, quite small and are used for steaming or inferior grades of "packed" stock. The size of the animal at different ages also varies with the locality, as does the quality and flavor; but these last two characteristics are by no means constant, even in the same locality. For instance, oysters from the Blue Point district, or Long Island Sound, may be the best in the market during one winter and the worst during the next. Only actual inspection, each season, can decide the comparative merits of the crop from the various localities.

The beds along the entire coast are subject to nearly the same vicissitudes of climate and other natural conditions, influencing the life of the oysters, and as those viscissitudes are not peculiar to the American beds, nor to the molluscan life alone, they do not require special allusion. The number and character of the enemies and the extent of their ravages depends upon the locality. The manner in which the work of such as belong to the mollusca is accomplished, has already been described; but, in addition to the destructive effects of the various *gasteropods* and bivalves, the oysters, in common with several other shell-fish, have to contend with other foes, belonging to other sub-kingdoms. Chief among these are the star-fishes, and the most prominent of that destructive family is the *Asterias forbesii*, or "green" star-fish. They are described and exhibited in the section of economic echinoderms, &c., and specimens of oysters and star-fish, illustrating the method of attack of the latter, are also exhibited in the molluscan collection. The manner in which the oyster is eaten is described by Professor Verrill, as follows:

"After bending their five flexible rays around the shell so as to partly inclose it, they protrude the lobes and folds of their enormous saccular stomach from the distended mouth, and surrounding the oyster shell more or less completely with the everted stomach they proceed to digest the contents at leisure, and when the meal is finished they quietly withdraw the stomach and stow it away in its proper place."

The star-fishes are very destructive in Long Island Sound, but further to the southward, and in Chesapeake Bay, do less damage.

The several varieties of crabs, especially the *Cancer irroratus* and *Carcinus mænas*, destroy many oysters; usually the young are selected, as they are more vulnerable than the mature animals; the damage by crabs, however, is not nearly so great as that done by the star-fish, and though the Chesapeake region suffers more from this enemy than the northern shores, yet on account of the value of the crabs no steps can or will be taken to lessen their numbers. Two species of fishes, the "Sheepshead" (*Archosargus probatocephalus*) and the "Drum" (*Pogonias chromis*) are destructive to oysters, the latter being especially so. Both fishes are provided with teeth with which they crush the young animals, and both usually swallow them, shells and all. The Drum is the chief depredator, but does not often trouble the beds north of New York. On the New Jersey coast, however, it abounds, and moving in schools, will frequently devastate thousands of dollars' worth of property.

The minor enemies may be described as comprising all forms of animal life, such as the sponges, barnacles, annelids, and various shell-fish, that by their presence on a bed deprive the oysters of food or room for development, or, like the mussels, attract other more directly injurious animals.

The boring-sponge (*Cliona sulphurea*), and the red branching sponge (*Microciona prolifera*) are the principal representatives of the *Spongia*.

The former does direct damage occasionally, by its attack on the shells, but usually it rather prepares the way for other enemies than accomplishes anything itself. The latter is not directly harmful, but growing sometimes in great masses, it not only prevents the food supply of the oyster from readily reaching the animal, but interferes with the attachment of the young brood. Hence cultivated beds should be kept clear of this as well as the boring-sponge.

OYSTER INDUSTRY.

The Fishery.

The fishery is regulated by the laws of the various States, the Federal Government exercising no control, and consequently the conditions under which the pursuit is followed are many and various. At the present time the laws relating to the oyster fishery may be said to be based upon one of two general principles. The first, the basis for the regulations of most of the States, considers the oyster beds to be inalienable, common property. Laws based upon this principle are generally of a protective nature, and are in reality regulations of the State, made by it in its capacity of guardian of the common property. The second principle assumes the right of the State to dispose of the area at the bottom of its rivers, harbors, and estuaries, and having disposed of it, to consider the lessee or owner, as alone responsible for the success or failure of his enterprises, and the State in no way called upon to afford him other assistance than protection in legitimate rights. In general terms, under the first principle, the beds are held in common; under the second, in severalty. But one State permits the preemption of an unlimited tract of bottom, and the holding of it in fee: the State of Connecticut. Rhode Island leases her ground for a term of years, at $10 per acre; but the person holding an area has no legal power of disposing of it beyond the limits of the lease. Massachusetts, New York, New Jersey, Maryland, and Virginia, all permit pre-emption of small tracts by individuals for indefinite periods, and on the coast of Long Island the various towns along the shore lease tracts of considerable extent to private cultivators.

Various restrictions are also placed upon the time and manner of conducting the fisheries. Some of the States, noticeably Virginia, prohibit entirely the use of the dredge or scrape; others, noticeably New Jersey, prohibit such use in some localities and permit it in others. All the States, with one exception, prohibit the use of steam vessels or machinery, or fishing by other than their own inhabitants. Connecticut again forms the exception, and quite a large fleet of steam dredging vessels are employed on her beds.

The laws of the various States have several common features. All general fishing is suspended during the summer months. No night fishing is permitted. No steamers are allowed to be used. No proprietary rights to particular areas are given beyond the right to "plant" a limited number of oysters on bottoms adjoining land owned by the planter and peace officers and local authorities are charged with execution of laws relating to the fishery. In a few States or localities, licenses are required to be obtained for each fishing vessel; and in one State, Maryland, a regular police force and fleet of vessels is maintained to support the law. These regulations are easily evaded, except those relating to the steamers and pre-emption of ground. Naturally, no one will put down oysters without being able to protect them; and steamers are too readily detected to make their illegal employment possible. In Connecticut and Rhode Island, the beds being virtually private property, there is no restriction of the fishery, except that it shall not be conducted at night.

The character of the vessel or boat used, depends in a measure upon the means of the fisherman and the constancy of his employment. When the beds are small and worked only at intervals, or where the oysterman is poor, a small boat of any description is used. Dories have the preference on the New England coast, and canoes in the Chesapeake Bay. Sharpies are also used in Long Island Sound. If the beds are extensive, furnishing constant employment, or the oysterman is well-to-do, the size and appointments of the fishing craft are much improved. The character of the oyster ground, its location, and the laws governing the fishing, also influence the type of vessel or boat used. Shoal-water beds, in sheltered localities, where dredging is not permitted, are usually fished from small, open boats; as, for instance, the beds of Rhode Island, south shore of Long Island, sea-coast of New Jersey, and Virginia waters. On the other hand, beds lying in deep water, in exposed positions, and where dredging is allowed, are worked by larger craft of 10 to 40 tons, or steamers; as is the case in Long Island Sound, Delaware and Chesapeake Bays. One of the foregoing conditions also decides the implement to be used; when permitted, it is the dredge—either the enormous one employed by the steamers, the smaller toothed rake-dredge, or smooth-scrape. When dredging is prohibited, the tongs, or nippers, with two handles, sometimes 30 feet long, are used.

The dredges are usually worked by an apparatus termed a "winder." Many forms of "winders" (a winch especially adapted for this purpose) are employed, but the one exhibited is the best and has the latest improvements. It is so designed that if, while reeling in, the dredge should "hang," that is, become immovably fixed by some obstruction on the bottom, the drum is at once automatically thrown out of gearing, and the dredge-rope allowed to run out; the sudden and rapid reverse revolution of the brakes, which has caused many serious accidents and considerable loss of life, is thereby prevented. Small craft use a more simple and less expensive description of winch, and frequently haul in by hand, while the steam dredgers have powerful machinery adapted for this special purpose. The number of men employed varies with the size of the craft;

two, three, and four men are sufficient on board the smaller dredgers, while the larger carry ten and twelve. The average sized "pungy" in the Chesapeake has a crew of seven or eight, and the majority of the "tonging" canoes employ one man and a boy.

In the Chesapeake each haul of the dredge is "culled", that is, the oysters are separated from the shells and refuse, as soon as the dredge is on deck, and everything except the oysters is immediately thrown overboard. In Long Island Sound, however, and on all private beds, the culling does not take place until the end of the day, when all shells, or other matters suitable for "stools" or "cultch," are put on the shell-heaps on shore for subsequent use, and no refuse matter is thrown back on the beds. In each locality the policy is unchanged when the fishing is conducted by means of the tongs, and the difference illustrates the degree of care exercised on private and public beds.

The fishermen, as a rule, are of the lower class and generally very ignorant. The masters of the larger vessels employed in the Delaware and Chesapeake are more intelligent, and the oysterman of the Northern and Eastern States is superior in circumstances and education to those of the Southern States. The "tongers" in both sections are better to do in the world, generally owning their boats or canoes and working for their own profit, than the men engaged on the larger dredging vessels who are not above the ordinary day-laborer in condition.

The packing trade is common to the whole seaboard, but the steaming and canning industries are confined mainly to localities south of the Delaware. A general description of each will give a sufficiently exact idea of the methods employed, there being but little local variation.

While a great many oysters are transported in the shell to markets distant from the seaboard, the largest part of the inland consumption is of "opened" or "shucked" oysters, and nearly every oyster dealer along the coast employs a larger or smaller number of persons to open the oysters and pack and ship the meats. Some of these establishments are small, having as few as half a dozen people engaged; others are large buildings or sheds, and employ hundreds of "shuckers." At some points—for instance, Fair Haven, Conn., and Crisfield, Md.—the shores of the rivers are lined with long whitewashed sheds extending back from the wharves; and it is within these sheds that the "shucking" takes place.

The usual arrangement is as follows: The building is divided off in long alleys; on each side of each alley are numerous stalls, each fitted with a "shucking trough," or box-like receptacle for the oysters in the shell. In the trough are two buckets, one to contain the oysters of ordinary size, the other the large "extras;" a block of wood with a flat piece of iron set in it, with its edge up, on which to break the bills of the oyster; a hammer for the same purpose, and an oyster knife. A workman or woman is supplied to each stall and stands in front of, and facing it, the feet and legs being protected and kept clear of the increasing pile of shells by a wooden shield. Men and women, white and black, are employed, but in well-arranged houses the sexes are assigned different alleys, and in many the same distinction is observed with regard to the races. The buildings are roughly put together and are necessarily dirty, sloppy, and uncomfortable, usually being but imperfectly heated by large stoves. The shucking troughs are supplied with oysters from the lots received during the previous day and night, each shucker informing the foreman when his trough is emptied. The same men and barrows that carry the oysters from the vessels or piles to the shuckers, remove the shells that collect on the floor. In shucking, the workman takes an oyster from the heap in the trough, and holding it in the palm of his left hand, the bills projecting and towards him, and with the knife and hammer in the right hand, he lays the lips on the beveled edge of the iron projecting from the block of wood, and with a blow of the hammer breaks off the bills; the knife is then entered, the valves separated, and the oyster removed and thrown into one of the buckets. In Rhode Island and some parts of New England the hammer and block are not used, but the oyster is "stabbed"; that is, instead of breaking the lips of the valves, the knife is entered at the side and the abductor muscle cut. When his bucket is full the shucker carries it to the end of the alley and pours its contents into a trough leading through a hole in the partition dividing the shuckers from the receivers. The oysters are thus run into a sheet-iron or zinc receptacle called the "skimmer," which is perforated with holes to allow the liquor to run off, and are there cleaned of shell fragments and measured. Each shucker has a number, which he gives as he empties his bucket; at the same time he receives a tally-check and his gallon is scored up to his credit on a huge blackboard. At the end of the day the amount of each score is entered in a book, and the employés are paid at the end of the week. Shuckers make from 75 cents to $1 per day in the Maryland houses, and about 50 cents more in the New England establishments. The men usually make more than the women.

From the "skimmer" the oysters are put into enormous tubs, and from thence are taken, a few gallons at a time, to the "cullender," a sheet iron or zinc basin, perforated with small holes, where they are thoroughly washed. From the cullender they are transferred either to small cans, holding a quart of oysters, or to barrels, kegs, or tubs; when packed in tubs, kegs, or barrels, they go in bulk, with a large piece of ice; when packed in the tin cans, the cans are arranged in two rows inside of a long box, a vacant space being left in the center, between the rows, in which is placed a large block of ice. The cans are carefully soldered up before packing, and together with the ice are laid in sawdust. Oysters packed in this way can, in cool weather, be kept a week or more, and sent across the continent, or to the remote western towns.

The steaming process is that by which the "cove" oysters are prepared. The term "cove" is applied to oysters put up in cans, hermetically sealed, and intended to be preserved an indefinite time. The trade in "coves" is confined principally to the Chesapeake region, and the process of preparing them is as follows: The oysters, usually the smaller sizes, are taken from the vessels and placed in cars of iron framework, 6 or 8 feet long. These cars run on a light iron track, which is laid from the wharf through the "steam-chest" or "steam-box" to the shucking shed. As soon as a car is filled with oysters (in the shell) it is run into the steam-chest, a rectangular oak box, 15 to 20 feet long, lined with sheet iron and fitted with appliances for turning in steam; the doors, which work vertically and shut closely, are then let down, the steam admitted, and the oysters left for ten or fifteen minutes. The chest is then opened and the cars run into the shucking shed, their places in the chest being immediately occupied by other cars. In the shed the cars are surrounded by the shuckers, each provided with a knife and a can arranged so as to hook to upper bar of the iron framework of the car. The steaming having caused the oyster shells to open more or less widely, there is no difficulty in getting out the meats, and the cars are very rapidly emptied. As soon as each shucker fills his can he turns in the contents and receives his tally-check. The oysters, as they are received, are washed in iced water and then transferred to the "fillers'" table, where they lie in great heaps. The "fillers," usually girls, are employed in filling and weighing the round tin cans, which are such familiar objects in every grocery. The cans, having been filled, are removed to another part of the room and packed in a cylindrical, iron crate or basket, which will hold six dozen or more of them. When the crate is full it is lifted by means of a derrick and lowered into a large cylindrical kettle, called the "process kettle" or "tub." The lid of the "process kettle" is then closed and screwed down, and the oysters again steamed. After this second steaming they are placed, crate and all, in the "cooling tub," a rectangular tub containing cold water, and when sufficiently cool to be handled, the cans are taken to the "cappers," or soldering table, and there "capped;" that is, are hermetically closed. From the "cappers" they are transported to another department, labeled and packed in boxes for shipment. The whole steaming process will not occupy an hour from the time the oysters leave the vessel until they are ready for shipment.

The only other branch of the industry not yet alluded to, is "planting," and as this varies with the different States, it is considered in detail. For the capital invested, number of bushels produced, and persons employed, see the "statistical" table at the end of the pages devoted to the oyster.

Maine.—This State is noteworthy on account of her past rather than her present resources. At Damariscotta, and the Sheepscot River, great shell-heaps exist, composed mainly of oyster shells of gigantic size; but there is, at the present day, but one small natural bed, situated some few miles west of Damariscotta. In Portland Harbor, or Casco Bay, a few hundred bushels of oysters, that are brought from the Chesapeake, or Long Island Sound, are laid down on the flats in the summer to fatten. They will not live through the winter, and usually are not allowed an opportunity to attempt the experiment.

New Hampshire.—There was, until lately, a large natural bed in this State, in the Piscataqua River, but over-fishing has caused its practical extinction. Oysters are supplied the market by importation from other localities, either directly, in kegs or tubs, or in the shell by the cargo. In the latter case, the animals are "laid down" for the summer months in the Piscataqua.

Massachusetts.—North of Cape Cod, no natural oyster-beds of any importance occur; though at the mouths of the various rivers and at Wellfleet, on Cape Cod, they have existed in the past. The extinction is supposed to be due to climatic changes and over-fishing. A few oysters from other localities are "bedded" or "laid down" in the spring and summer months, but most of the market supply is derived from direct importations, either in the shell or opened. Quite an important trade in the latter class is carried on between Boston and Norfolk, Va., amounting in 1880 to 250,000 gallons. South of Cape Cod, in Buzzard's Bay, are many natural beds, and quite a flourishing business is carried on in their vicinity; but this is owing in a large degree to the system of cultivation of private beds. The general practice is to take the oysters from the natural banks and deposit them on the private ones, to grow and fatten; shells are also deposited to catch the drifting spat, but the success of the latter method has not been so great as elsewhere. Oysters are also imported from other localities for "bedding" or "laying down," but unless from adjacent States, they do not do well or outlive the winter. The laws regulating oyster planting and farming, permit town and city authorities to grant licenses to work tracts of bottom for twenty years. The extent of tracts is not limited, except that they shall not include any natural bed. Night fishing is not permitted, and infringement of the rights of the person holding the license is punished by a fine of not more than $100 and imprisonment of from thirty days to six months.

Rhode Island.—The natural beds of this State are neither extensive nor exceedingly prolific. They lie principally in the Seekonk River, a branch of the Providence River, and in Cole's and Kickamuit Rivers. The "natural growth" are rarely used in the markets, but are taken in great numbers when young and placed on the private artificial beds, located, for the most part, in the Providence River. The Seekonk furnishes between five and ten thousand bushels of "seed" annually, and two years' growth on an artificial bed makes them marketable. A large number of oysters are also imported from Long Island Sound and the south shore of Long Island for the purpose of "seeding" beds. This process is simply to purchase young oysters, about a year old, and spread the cargo as evenly as possible over the area to be "seeded." This is frequently supplemented by spreading shells of oysters or scallops over and about the area during the early summer months, and with them a number of "mothers," or large oysters about to spawn. Usually 100 bushels of "mothers" to 4,000 bushels of shells are put down. Great success has frequently followed the adoption of this system; but many failures have also occurred, the causes for which are obscure.

The "bedding" or fattening of "Virginias," or Southern oysters, is the most profitable part of the business in this State, and about 500,000 bushels are laid down annually. They do not live through the winter, nor can they stand the voyage north during the summer; consequently, the laying down is done in the spring, and the oysters are sold during the autumn.

The laws governing the private oyster-beds permit the leasing, by any inhabitant of the State, ground below tidewater mark, and outside of harbor lines, for five to ten years, at an annual rent of $10 per acre; prohibit fishing at night, and punish infringements of the rights of leesees by fine and imprisonment. About 1,000 acres are at present under cultivation under the above regulations.

Connecticut.—Like Rhode Island this State has no natural oyster-beds that are of important size or productiveness, when compared with her artificial, private beds. Such as exist are larger and more numerous in the western waters than in the eastern. Like the Rhode Island beds they are fished principally for "seed" for the private areas. The system of cultivation in this State is similar, in all essential points, to that described in Rhode Island, but is much more extensively adopted, the area under cultivation being enormous. More attention is given to "planting" shells and other suitable cultch than in Rhode Island, and the farms differ from those of the other State in lying, generally, in much deeper water. The Rhode Island planters seldom work in water of more than three fathoms depth, while the Connecticut men are throwing shells and oysters over in five and six, and even deeper water. Another feature is the selection by the latter class of hard bottoms in preference to any other. The use of steamers and the constant raking and cleansing of the beds is another distinguishing characteristic of Connecticut oyster growers. Large importations are made from Virginia and other waters, for fattening and bedding, and the business in this particular is entirely similar in methods to that of Rhode Island, and about the same quantity of oysters are imported. The native oyster business, however, greatly exceeds the other, both in value and volume, and its large increase and success are due entirely to the system of cultivation adopted and the laws protecting it. In this region, in planting a new area, about 1,000 bushels of "spawners" (mother oysters) are put down, to 7,000 or 8,000 bushels of shells. The spawners are put over in May, about 40 bushels to an acre, and the shells or "cultch" in July; young seed oysters are sometimes added. The expense is not great, averaging about $40 per acre, and the yield per annum is usually double that amount.

The laws governing oyster planting and farming permit the purchase, at $1 per acre, of unlimited areas, by residents of the State, provided no natural oyster bed is included. The ground is taxed as is also the crop. At the present time some 20,000 acres have been disposed of.

New York.—Throughout the waters of this State are numbers of natural oyster-beds, but all are in a more or less impaired condition and would by no means supply the demand if their efforts were not supplemented by cultivation and importation from New Jersey and Delaware and Chesapeake Bays. These importations are made directly, the oysters coming in the shell, or opened, or are brought in cargoes and "bedded" or "laid down" to fatten. A very prevalent method in this region and to the southward, is to put oysters in fresh or slightly brackish water before selling them. They are thus swollen and appear fatter and plumper. The methods of cultivation are similar to those of Connecticut and Rhode Island, though on the south shore of Long Island not much dependence is placed upon foreign stock, while in the East River there is considerable importation from other localities of "seed" and "spawners." The cultivation of private beds is regulated to a great extent by the authorities of the towns. The State law permits the pre-emption of tracts for an indefinite period, the length depending upon the continuity of the cultivation, and prohibits the use of steam vessels. Along the north shore of Long Island these tracts are held on such uncertain tenure that no very extensive or remunerative business can be done; but on the south shore of the island a better system is in operation, and especially in Great South Bay, (Blue Point district) the oyster farms flourish. The practice there is to lease the ground at a rent of $1 per annum for each acre. Taxes are also laid on the floating property and stock on the beds. The town of Brookhaven, in whose jurisdiction these beds lie, received an income of about $1,500 from the cultivators in 1880, and 371 acres were occupied. No dredging is allowed, and natural beds are common to all residents of the town. These beds are, however, being fast depleted of their stock, and the supply is gradually failing.

The laws of the towns to the westward, on the south shore, generally permit planting, but only by residents; a rent of from $1 to $5 per acre is required, and no dredging permitted.

New Jersey.—This State has many extensive, natural oyster beds, both along the seaboard and in Delaware and Newark Bays; but the natural-bed oysters rarely go directly to market. The usual custom is to transplant them for a season to water and bottom differing from that of their original locality. The Shrewsbury oysters are instances of the good effects of this system. "Natural growth" is exceedingly rare in those waters, and the celebrated stock comes originally from Newark Bay and the south shore of Long Island. There is considerable planting of "Barnegat seed" (small oysters, indigenous to Barnegat Inlet) all along the seacoast; but "shelling" areas in hope of attracting spat is seldom attempted, such areas being regarded as public property. Most of the inhabitants of the shores have, however, areas of more or less extent under cultivation, and the practice of "freshening" the oysters by exposing them to fresh water for a short period is prevalent. The planting of Southern (Chesapeake or Virginia) stock is mostly confined to the Cape May district and Delaware Bay, and most of the plants come from the seacoast, about Chincoteague. The regulations governing the fishery are made by the towns or counties, and generally permit the leasing, for limited periods, of small areas to residents only. The State law prohibits the use of the dredge and pre-emption of natural beds.

In the Delaware Bay the law permits the leasing of larger areas and the use of the dredge. Dredging vessels are licensed at $1 per ton. A "collector" and "special officer", who execute the laws and collect dues and fines, are elected by the persons leasing oyster lots. One-half the money from licenses, property sold, and fines goes to the "oyster fund," which is devoted to paying the expenses of guarding the leased beds. The "seed" for these tracts comes usually from the natural beds, but some is also imported from the Chesapeake and Virginia seacoast.

Delaware.—The natural oyster beds of this State lie on the western side of Delaware Bay, and, though formerly very productive, do not now yield a large crop. Probably 500 acres comprises the total productive area. The State law permits the pre-emption of tracts of 15 acres of "free bottom" for $25. Natural beds are exempted, and citizens of the State alone are permitted to "plant" oysters. An oyster guard-boat is provided, with officers and crew, and regulations governing the close-time, night-fishing, &c., are enforced. The natural beds are worked continuously for "seed," but the major portion of the "planted" oysters come from the Chesapeake. The oysters are culled as dredged, but the "seed" and small oysters are transferred to the "idle-ground," a tract where "seed" is growing, instead of being thrown back on the planted bed. The plantations are located off Little Creek Landing, and no natural beds legally exist, south of a line drawn eastward from Mahon River, except in less than 3 feet of water.

Maryland.—The oyster business of this State is practically confined to dredging the natural beds that exist to an enormous extent in Chesapeake Bay and its tributaries. There is little or no planting or cultivation, the natural areas having in the past supplied all the demands; but of late those areas are becoming much exhausted, and the diminished quantity and quality of the oysters is causing great complaint.

The laws which govern the fishery are, briefly, as follows: Dredging is allowed from October 1 to May 1. Taking of oysters in other ways from September 1 to May 1. Dredging is not allowed in the rivers or creeks, or in their mouths. No steam dredges are allowed. All dredgers and "tongers" must be licensed. Violations of the law are punished by not more than two years imprisonment nor $200 fine. For the enforcement of these regulations there is established a State fishery force, consisting of one steamer and several small sloops. The officers of this fishery force and the sheriffs and constables of the different counties are empowered to make arrests and enforce the law.

"Tonging," that is, taking oysters by tongs, is permitted at any point, and small tracts of bottom, contiguous to the land of the person desiring to plant or cultivate oysters, may be secured for that purpose; very little in that line is, however, attempted.

Virginia.—This State has also extensive natural oyster beds, and, consequently, but little attention is given to planting and cultivation. Dredging is no longer allowed, but the law on that point is frequently disregarded by the lawless dredging vessels of the bay. A certain amount of a rude species of cultivation is carried on, consisting merely in transplanting oysters from one locality to another, but the yield is inconsiderable when compared with that of the natural beds. These, like the Maryland areas, are fast being exhausted by the excessive fishery. No "fishery force" is maintained, and the law is enforced by local peace officers, occasionally assisted by the militia of the State.

None of the remaining Southern States are important oyster centers. The fishery is confined to supplying the local demands, and no packing or canning is attempted. As a general thing the natural beds afford as many oysters, and those of as good a quality, as is desired. In the neighborhood of Charleston, South Carolina, Mobile, Alabama, New Orleans, Louisiana, and Galveston, Texas, a rude system of cultivation, similar to that of Virginia, is carried on to a limited extent.

On the Pacific coast, cultivators have made many attempts to introduce the Eastern oyster or that from Mexican waters, but without material success. The Eastern variety will live and increase in size, but does not breed, and unless the supply is continually augmented by fresh importations from the East the planted beds gradually die out.

The following statistical summary from the United States Census Report shows the volume of the oyster industry of the whole country.

Table showing, by States, the persons employed, capital invested, and value of products in the oyster industry.

States.	Grand total.			Persons employed.		Apparatus and capital.		
	Number of persons employed.	Bushels of oysters produced.	Value of oysters as sold.	Fishermen.	Shoresmen.	Total capital invested in oyster industry.	Number of vessels.	Value of vessels.
Total	52, 805	22, 195, 370	$13, 438, 852	38, 249	14, 556	$10, 583, 295	4, 155	$3, 528, 700
Maine	15		*a* 37, 500	5	10	4, 210	1	3, 000
New Hampshire	9	1, 000	6, 050	6	3	2, 400		
Massachusetts	896	36, 000	405, 550	409	487	303, 175	56	227, 000
Rhode Island	650	163, 200	356, 925	300	350	110, 000		
Connecticut	1, 006	336, 450	672, 875	672	334	361, 200	100	69, 000
New York	2, 724	1, 043, 300	1, 577, 050	1, 958	766	1, 013, 060	426	397, 000
New Jersey	2, 917	1, 975, 000	2, 080, 625	2, 605	312	1, 057, 000	575	530, 000
Pennsylvania			*a* 187, 500					

a This quantity represents only the enhancement, the first cost being included in the Maryland and Virginia statistics

Table showing, by States, the persons employed, capital invested, &c.—Continued.

States.	Grand total.			Persons employed.		Apparatus and capital.		
	Number of persons employed.	Bushels of oysters produced.	Value of oysters as sold.	Fishermen.	Shoremen.	Total capital invested in oyster industry.	Number of vessels.	Value of vessels.
Delaware	1, 065	300, 000	$687, 725	820	*a* 245	$145, 500	65	$50, 000
Maryland	23,402	10, 600, 000	4, 730, 476	13, 748	*b* 9, 654	6, 034, 350	1, 450	1, 750, 000
Virginia	16, 315	6, 837, 320	2, 218, 376	14, 236	*c* 2, 079	1, 351, 100	1, 317	460, 950
North Carolina	1, 020	170, 000	60, 000	1, 000	20	68, 500	90	22, 500
South Carolina	185	50, 000	20, 000	175	10	12, 250	10	2, 500
Georgia	350	70, 000	35, 000	300	50	18, 500	......	......
Florida	166	78, 600	159, 50	140	26	22, 000	......	......
Alabama	300	104, 500	44, 950	250	50	16, 000	20	6, 000
Mississippi	60	25, 000	10, 000	50	10	3, 000	......	......
Louisiana	1, 400	295, 000	200, 000	1, 300	100	36, 750	45	10, 750
Texas	240	95, 000	47, 300	200	40	17, 750	......	......
Washington Ter	85	15, 000	45, 000	75	10	6, 550	......	......

States.	Apparatus and capital.				Products.		Enhancement of value of oysters in process of preparation for market.*d*	
	Number of boats.	Value of boats.	Value of gear and outfit.	Value of shore property.	Bushels of oysters produced.	Value of same to producer.	Number of bushels.	Amount of enhancement.
Total	11, 930	$708, 330	$712, 515	$5, 633, 750	22, 195, 370	$9, 034, 861	13, 047, 922	$4, 368, 991
Maine	3	60	150	1, 000	......	......	75, 000	37, 000
New Hampshire	5	300	100	2, 000	1, 000	800	7, 000	5, 250
Massachusetts	117	9, 485	10, 690	56, 000	36, 000	41, 800	514, 000	363, 750
Rhode Island	100	14, 500	5, 500	90, 000	163, 200	225, 500	274, 300	131, 425
Connecticut	563	33, 165	19, 385	239, 650	336, 450	386, 625	515, 000	286, 250
New York	1, 714	121, 700	42, 460	451, 900	1, 043, 300	1, 043, 300	1, 065, 000	533, 750
New Jersey	1, 400	110, 500	91, 500	325, 000	1, 975, 000	1, 970, 000	237, 500	110, 625
Pennsylvania	......	......	......	......	......	......	*g* 250, 000	137, 500
Delaware	300	12, 000	10, 000	*e* 73, 500	300, 000	325, 000	*h* 834, 500	*i* 362, 725
Maryland	1, 825	130, 520	161, 480	*f* 3, 992, 350	10, 600, 000	2, 650, 000	7, 653, 492	2, 080, 476
Virginia	4, 481	224, 050	329, 250	*j* 336, 850	6, 837, 320	1, 948, 636	1, 622, 130	269, 740
North Carolina	800	16, 000	15, 000	15, 000	170, 000	60, 006	......	......
South Carolina	100	2, 500	2, 250	5, 000	50, 000	20, 000	......	......
Georgia	100	10, 000	3, 500	5, 000	70, 000	35, 000	......	......
Florida	110	8, 000	2, 000	12, 000	78, 600	15, 950	......	......
Alabama	42	4, 000	3, 000	3, 000	104, 500	44, 950	......	......
Mississippi	40	1, 000	500	1, 500	25, 000	10, 000	......	......
Louisiana	120	3, 000	13, 000	10, 000	295, 000	200, 000	......	......
Texas	70	6, 750	2, 000	9, 000	95, 000	47, 300	......	......
Washington Ter	40	800	750	5, 000	15, 000	10, 000	......	......

a Of these, 215 are employed in the canneries at Seaford.
b Of these, 8,864 are employed in the various canneries.
c Of these, 1.578 are employed in the canneries.
d This includes planting, bedding, fattening, and transportation to distant markets in oyster-vessels.
e Of this, $28,500 is invested in the cannery interests at Seaford.
f Of this amount, $2,492,350 represents the cash capital invested in the cannery industry.
g Brought in winter by vessels registered in other States, the men engaged and the value of the vessels being accounted for elsewhere.
h Of these, 184,500 bushels were packed at Seaford, and 650,000 bushels were planted in Delaware Bay.
i Of this, $22,225 represents the enhancement on those canned.
j Of this, $119,350 represents the cash capital in the cannery interests, and $167,500 the value of buildings and fixtures for canning.

Mya arenaria, Linne.

This is the "clam" of the Massachusetts coast. The "long," or "soft clam," of Long Island Sound and the Middle States, and the "Mananose" of the Southern States. Its range is from the Arctic Ocean to South Carolina, but it is rare south of Cape Hatteras. It is particularly large and abundant in Long Island Sound, and is also found on the coasts of Alaska and California. It is fossil in the Post-Pliocene formations of New England and the Southern States, and also in the Miocene of Maryland. This species, though found on sandy shores in the littoral zone, prefers a bottom where there is a mixture of mud or gravel, or both, with the sand. It lives on outer beaches, but not in loose sands, and generally is most abundant in the sheltered bays and estuaries. Its burrows are permanent, and it is usually buried a foot or more below the surface, its long siphons enabling it to reach the necessary food and oxygen at that distance. The specimens of this shell taken from outer sandy beaches are thinner, whiter, and more regular in form than those found in the estuaries; they are also covered with a thin, yellow epidermis. The specimens from the estuaries are rough, mud-colored, and homely, and might easily be mistaken for another species. The spawning season is during the spring or early summer months; the process of reproduction has not yet been studied, and no definite information is available regarding the embryonic or early life of the animal. After they become perceptible, however, they are found anchored to the bottom by a slender byssus, and at a very early stage of growth the foot is developed, and with it the animal's power of burrowing. They usually exist in communities, or beds, on the flats, sinking themselves deep in the sand and mud during the winter, and coming nearer the surface as the warm weather approaches. "The clam" is eaten extensively in the neighborhood of the Bay of Fundy, and the shell-heaps bear evidence that this consumption is not of recent date, but that the *Mya arenaria* furnished the Indians with food centuries ago. Extensive beds occur at intervals along the coast of Maine, and the mouths of all the rivers and estuaries contain this clam to more or less extent. It is indeed the most important shell-fish of the State, and the annual yield is estimated at nearly 316,000 bushels, valued at about $88,472.

The Massachusetts fishery is the one of most consequence, and the whole coast of that State was at one time saturated with clams, the young sometimes being so abundant as to whiten the beaches and flats; of late years, however, this abundance has not been so marked, and the clams are disappearing through overfishing. They are ordinarily taken by digging, but on the flats north of Boston, and in the neighborhood of Plymouth and Duxbury, at one time they were so plentiful that plows were used in turning them up to the surface.

Though the *Mya arenaria* is taken to a small extent in Buzzard's Bay, the next point of importance is Narragansett Bay and the Rhode Island shores. While in Massachusetts Bay the profitable season is during the summer months, in Rhode Island the winter's fishing brings in the largest return; a large number of the inhabitants of the shores being engaged during that season in securing soft clams. The whole coast of Long Island Sound is prolific, and one or two points are especially noted for the abundance, or superior size and quality, of the clams usually found. Guilford, on the Connecticut coast, is especially prominent, the clams from that vicinity sometimes being 6 and 8 inches long, a pound or more in weight, and retailing in New Haven markets for $1.25 per dozen. These clams are, however, only obtained at extremely low tides and are comparatively scarce. About 10,000 of the ordinary size are taken per annum, and are sold at from 40 to 60 cents per dozen. All along the southern shore of the sound are prolific clamming grounds, the principal product of the fishery being shipped to New York. The south shore of the island, especially Rockaway Bay, also sends its quota to supply the New York market. New York and Newark Bays formerly supplied large numbers of soft clams, but of late years those areas have ceased to yield anything of consequence. Along the Jersey coast the annual yield is about 70,000 bushels, valued at about $29,500. Southward of New Jersey the *Mya arenaria* ceases to be of commercial importance, being eaten only by the negroes and a few of the inhabitants of the shores.

During the last few years this mollusk was carried out from the East to San Francisco Bay, apparently by accident, with a cargo of oysters intended for transplanting. Those taken out, however, were sufficient to abundantly stock the bay, and the soft clam is now found there in large numbers.

There is very little in the methods of taking this species that calls for peculiar apparatus or appliances. A spade and bucket are the usual implements at the present day, the use of the plow having been but local, and abandoned when the abundance of the crop decreased. At Bridgeport, Conn., it is still used by Mr. Hawley, but only in cultivating; he having instituted a system of cultivation on a scale of considerable magnitude. His method is, briefly, to plow long furrows in the flats, and lay his clams in them, some 6 or 12 inches apart. Some five years or more are necessary before the crop is realized, but it then pays exceedingly well.

The soft clam is very seldom eaten raw, but is cooked in a variety of ways, usually as soup or chowder, and frequently fried. Some dealers pickle them, and a small number are salted. They are to be bought in the markets of any of the Middle or New England States, raw, and are usually sold in strings of a dozen connected by a cotton cord.

While extensively eaten, the larger portion of the annual crop is utilized as bait by the cod and mackerel fishermen. Unless the prospective fishing voyage is short, the clams used for this purpose are removed from the shell, salted, and packed in barrels; but when only a short trip is undertaken, they are carried fresh in the wells or packed in ice. The saltings are of two kinds: "full salting" and "slack salting," or "covering." In the former method one bushel of salt is allowed to each barrel; in the latter, only from half a peck to half a bushel. About 12 bushels of clams will make a barrel of salted bait, which is valued at $4. The practice of taking mackerel in seines, and the use of the trawls in the cod fishing, which are not baited with clams, is interfering with this branch of the soft clam industry; but it is still of considerable importance.

The following is a summary of the annual product of the fishery, and its value:

Total number of clams (*Mya arenaria*)	164, 195, 200
Total number of bushels	835, 974
Value per bushel (average)	$0. 395
Total value annual product	$330, 523. 24

Mactra solidissima, Chemnitz.

This bivalve is the *Mactra gigantea* of Lamarck, the *Mactra similis* of Say, and the *Spisula solidissima* of Gray and other writers. It is known commonly as the "sea," "surf," or "hen" clam, the various designations being applied indiscriminately. It exists from Florida and the Gulf of Mexico to Labrador, and is abundant along the entire coast. It is found fossil in the Post-Pliocene of Massachusetts, and apparently in the Miocene of the Carolinas. The *Mactra solidissima* properly belongs to sandy shores, and is not often found elsewhere, the only other locality it seems to favor being the gravelly and shelly bottoms of bays and sounds, where it is common and of great size. It exists in sheltered waters and on open beaches, and generally from low-water mark to 5 and 6 fathoms. It is very abundant and large on the outer beaches of New Jersey and south side of Long Island. The shells vary greatly both in size and form; they may be oval, elliptical, triangular, compressed, or swollen, and are sometimes more than 6 inches long and 5 broad. As the siphon-tubes are very short, it does not burrow very deeply, though its large and muscular foot enables it to do so quickly. Large numbers are thrown up on the beaches by every storm, to be utilized as food by the birds, and as manure by man.

The "sea-clam" is not of commercial importance south of New Jersey, and probably is more extensively sought in the Cape Cod region than elsewhere. There they are worth $3 per barrel, but sell in the Boston market, when fresh, at $4; in New York markets they are rare. Their consumption as food is confined to the coasts principally, owing to the ease with which the superior "long clam" and "round clam" can be obtained, and on account of the toughness of the flesh of the large animals. The young of this species are, however, quite equal in flavor and quality to any clam of the coast.

While not holding a high place as an edible mollusk, the sea-clam occupies an important position in the bait-supply of the "Banks" fishermen, and is sought mainly for that purpose. The clams are secured by means of heavy, variously shaped, iron rakes, having from 15 to 25 large teeth, and fitted with wooden poles or handles from 20 to 30 feet long. The fishing is carried on at low water in depths of about 8 feet, and the catch is worth from 25 to 28 cents a bushel. The clams are salted, packed in barrels, and dispatched to the various fishing ports, such as the towns on Cape Cod, Boston, and Gloucester. About three-fourths of the annual crop goes to Boston. In the fall 16 bushels of clams are required to fill one barrel with "meats"; but in the spring only 12 bushels are necessary. The actual cost of a barrel of clams, salted and packed, in Boston, is about $5.75. The shells are also sold at 5 cents a wagon-load, and used for road-making. The capital invested in the business was, in 1880, $10,000, and between 250 and 300 boats were employed.

Cyprina islandica, Lamarck.

This clam is the "sea-clam" or "false quahaug." It is found in deep water, from Block Island to the Arctic. In depth it varies from 6 to 100 fathoms. It has not been found yet as a fossil in North America.

The *Cyprina islandica* is rarely eaten, indeed rarely found, but is available for food or bait. It is easily distinguished from the true quahaug (*Venus mercenaria*) by its brown epidermis.

Ensatella americana, Verrill.

This is one of the species of the genus *Solen*, and has been variously designated as *Solen ensis* and *Solen americanus*, by Gould, DeKay, Adams, Linné, and others. It is the "razor-clam" or "razor-fish" of commerce; and is also called the "razor" and "knife-handle." Its distribution is extensive, the animal being found from Florida to Labrador, and it is common along the whole coast, especially in Long Island Sound, and at Great Egg Harbor, New Jersey. It is fossil in the Post-Pliocene deposits of Maine, Massachusetts, Virginia, and South Carolina, in the Pliocene of South Carolina, and in the Miocene of Maryland, and North and South Carolina.

The *Ensatella americana* is an inhabitant of sand flats and bars, where the water is pure; it is found also, though not so commonly, on the outer sand-beaches of the coast, but generally prefers more sheltered localities. It usually exists at or just below low-water mark, and its large elliptical-shaped burrows, extending 2 or 3 feet into the sand, are easily recognized when the tide is out. If the holes are approached with care at such times, an inch or two of the shell can be seen projecting above the surface; but the slightest jar of the sand is sufficient to send the whole colony to the bottoms of the burrows; and the alarm once given it is useless to attempt to dig them out, for the animals can penetrate the sand much faster than the spade can follow them. Even when partially uncovered they often hold themselves so firmly in the holes by means of their muscular foot, that the body can be entirely withdrawn from the shell before the hold is relaxed. As their siphons are very short, they are obliged to come to or near the surface in order to obtain the necessary supplies of oxygen and food. Therefore, though the animal may be out of sight, yet it is probably only sunk a short distance in the sand, and a sudden thrust of a spade obliquely across the direction of the burrow will frequently unearth the clam. The disadvantages of the short siphons are, however, made up by the great activity of the animal and the wonderful power of its foot, which is its excavating implement and organ of locomotion.

The razor-clam is eaten to some extent along the coasts of Long Island, Long Island Sound, Massachusetts Bay, and coasts of New Jersey. It is to be found in the New York markets, but the trade is not extensive, the sweetish flavor of the flesh being unpalatable to the majority of people. It is used as bait, also, especially about Cape Cod and on the south shore of Long Island, and is devoured by several fishes, such as the skates and tautog, that seem to have the power of rooting it out of the sand. The New Jersey longshoremen also claim that the "winkle" (*Fulgur carica*) has the power of pulling the "razor" from its burrow and devouring it.

Venus mercenaria, Linné.

This is the "quahaug," or "round clam," sometimes known as the "hard clam." It is found from Florida to Massachusetts Bay, and thence northward, though rare and local, to the Gulf of Saint Lawrence. It is very common from Vineyard Sound southward, and is found fossil in the Post-Pliocene formations of Massachusetts, Gardiner's and Nantucket Islands, Virginia and South Carolina, and in the Miocene of Maryland, Virginia, and North and South Carolina. This species lives chiefly on muddy and sandy flats, just below low-water mark; but it is often found above that line, and between tides is frequently left bare. It is more abundant in estuaries than elsewhere. It can burrow but a short distance, having short siphon-tubes, and it is often seen crawling about on the surface by means of the broad, muscular foot with which it excavates its burrow. The shells are variable in color and form, and early writers have made many varieties of this species on that account. Some forms, especially those growing in estuaries, have dull, thick, rough shells, sometimes white, sometimes stained, while shells from outer, sandy beaches are thinner and more delicate, have raised, concentric ridges or ribs, and are marked with streaks of brown or red. Other shells have marked dark blue or purple discolorations outside the pallial line; others are of dead white. All these have been described as distinct species, but there is no structural difference; and intermediate forms are to be found in every locality. As these clams grow old, the valves become rounded, and are then known to the fishermen as "snub-nosed" or "bull-nosed" clams, and are sometimes a pound or more in weight. Their flesh is then a dirty yellow, having lost its clean, white appearance. Little is known, except by analogy, of the embryology of the "quahaug" or of its rate of growth. Ingersoll states that the medium sized sent to market are five years old, while Messrs. Foote & Co., of New Haven, state that the medium-sized clams are but two years old. Their rate of growth no doubt depends upon the locality; where there is an abundant supply of food and lime, and the animal is protected, the growth will be rapid; when otherwise, the growth will be slow. The rate of growth is also said to influence the shape of the shell, the slower the progress the greater being the convexity of the valves. During the winter the "quahaugs" retire into the mud, disappearing from the surface, and in the spring reappear in time for the principal fishery, which begins then and extends throughout the summer, thus alternating with the oyster season.

The "quahaug" fishery is very extensive, this bivalve being, next to the oyster, the most important on the coast; but the implements and methods are simple in the extreme. Many clams are gathered by hand as they crawl on the flats; many more are taken with straight rakes, curved drag-rakes, and dredges. Oyster-tongs are also occasionally used, but not frequently, as the clams do not live in sufficiently close communities to make tonging profitable. The rakes are more generally employed than any other implement, and in form and character they vary with the locality. Some are merely slight modifications of the garden rake; others are more elaborate, having curved teeth or long poles, fitting them for dragging or dredging rather than shallow-water raking. Specimens of the different varieties are exhibited, but, like the other clam fisheries, that of the "quahaug" utilizes many implements designed originally for other purposes, such as the sea-moss rakes, spades, shovels, &c.

"Count" clams, the largest size, bring the best prices, and in the neighborhood of New York sell for $3 per barrel, wholesale. It takes 800 "counts" to make a barrel; and as 3 to 4 barrels, or 2,400 to 3,200 clams, is a good day's catch, some idea of the productiveness of the New Jersey flats and coast is gained from the foregoing. Smaller sizes are sold at 60 cents or $1 per bushel, depending on the size, and some are taken so small that 2,000 are required to fill a barrel; these, when about one inch in diameter, are called "tea-clams." Another name is "Little Neck," derived originally from a neck of land on the north shore of Long Island, known as Little Neck, whose clams had a superior flavor; but the demand for a young, small, and tender clam which has sprung up of late years, and was supplied from the Little Neck stock, has caused dealers generally to apply the term "Little Neck" to all small clams. They are used principally for pickling.

The fishery is not an expensive one, the whole outfit of the "clammer" not requiring an expenditure of over $150, including boat, rake, and baskets, and the pursuit is naturally followed by the poorer class of people—men who are employed by the oyster-dealers in winter and are out of work during the summer. The principal depots are New York and Philadelphia, but a large number of clams are consumed throughout the interior of the New England and Middle States, and every seaboard town sends its quota to supply the demand. To the southward of the Delaware and Chesapeake this consumption diminishes very fast, that of all the Southern States being estimated by Ingersoll at not more than 50,000 bushels, valued at $20,000.

The summary of the annual product and value of the "Quahaug" fishfishery for the whole coast is:

Number of clams taken, 326,245,800.
Number of bushels, 1,087,486.
Value, $657,747.

Mytilus edulis, Linné.

This is the ordinary "black" or "edible" mussel. It is found from the Arctic Ocean south to North Carolina, on the east coast, and south to Monterey on the west coast of the United States. It is very abundant from New Jersey northward and is found fossil in the Post-Pliocene formations of most of the localities north of Rhode Island. It is identical with the common mussel of Europe in all respects.

The *Mytilus edulis* is most abundant in the shallow and brackish waters of bays and estuaries, but flourishes well in any situation where there is a little mud and some solid object to which it can attach itself. The coasts of New Jersey and Long Island are especially adapted to it, and it is found in those regions in immense numbers. It has also increased of late years in Chesapeake Bay and tributaries. It grows very rapidly, reaching maturity, under favorable circumstances, in one season. It is not confined to shallow waters, but exists in the deep as well, having been taken off the coast of Maine in 40 and 50 fathoms. The shells of those living in sheltered localities and on sandy bottoms are, however, much more delicate in texture and brilliant in color than those inhabiting exposed situations. The former are often beautifully marked with alternating bands of different colors or are pale yellow or translucent horn color. The latter are thicker, of a dull brown or bluish-black color, and often much distorted.

The breeding season begins early in the spring, and Verrill states that he has found immense numbers of the size of a pin's head as early as the middle of April. The mussel attaches itself to its support by means of a "byssus" or silk-like thread, spun from the foot, and as it has the power of relinquishing its hold on the ends of the threads at any time, it can change its location at will, and by means of the delicate byssus, can even climb the perpendicular sides of piles and rocks. On the muddy bottoms of bays and sounds these mussels frequently exist in large patches or beds, and such local ities are the favorite resorts of the predatory fishes, mollusks, crustaceans, and radiates. The star-fishes especially frequent these areas and destroy immense numbers of mussels. All the injurious Gasteropods prey upon them more or less, wherever found, and the tautog, drum, and other fishes devour the adults, while the scup and like smaller fish feed upon the young.

Though used as food to a limited extent on both coasts of the United States, there is no organized fishery devoted to the capture of the mussel. In common with many other shell-fish not known in the markets, they are eaten occasionally by the inhabitants of the coast, and of late years some trade is springing up on the coasts of Connecticut and Long Island. Most of the mussels sold for food go to New York and are there disposed of in the natural state, but more frequently are boiled and pickled. Inhabiting the interior of the shell of the mussel is a small messmate—the *Pinnotheres maculatus*, or mussel-crab—which, like the little oyster-crab, is a delicious morsel. While not as yet extensively utilized as food, the mussels, like many other shell-fish, are frequently used for fertilizing the ground, the farmers of Long Island and New Jersey securing them by the wagon-load for that purpose. In time, however, they will probably occupy as prominent a place in the food supply of the American seaboard as they do on the coasts of Europe. The value of the mussel fishery in 1879–'80 is estimated by Ingersoll at $37,000, which represents a yield of 600,000 bushels.

Modiola plicatula, Lamarck.

This species, known as the Ribbed-mussel, is found from Georgia to Casco Bay, Maine, and exists, though more rare and local, further north. It is very abundant from Vineyard Sound to the southward, especially along the coast of New Jersey, and has been reported of late as increasing in Chesapeake Bay. It is more abundant in the neighborhood of estuaries and salt marshes, or on muddy shores, and is usually found about high-water mark, where it is left uncovered for a greater part of the time by the tide. Along the edges of marshes they are sometimes crowded so thickly as to form a stratum 6 inches or more in thickness. Like the *Modiola modiolus*, this species is not of commercial importance. It is very seldom eaten by man, though it is devoured by many fishes, especially the "drums," and by star-fish and the carnivorous Gasteropods. In company with an allied species, the *Modiola hamatus*, and the *Mytilus edulis*, it is used quite extensively on the New Jersey coast for fertilizing ground. The presence, which is by no means infrequent, of this mussel on an oyster-bed, is undesirable, the bunches and masses held together by the byssus, attracting the various enemies, that, though they came for the mussels, remain to devour the more valuable oysters.

Modiola modiolus, Turton.

This, the great "horse-mussel," is found from Greenland southward to New Jersey on the Atlantic, and from the Arctic south to Monterey on the Pacific coast. It is more abundant north of Cape Cod than to the southward, and is found from low-water mark to 80 fathoms. It is fossil in the Post-Pliocene formations of Massachusetts and Canada. The horse-mussel is usually located in crevices between rocks, or bedded in the gravel; and along the coasts is almost entirely confined to rocky bottoms. Its large size and brown, hairy epidermis, sufficiently distinguish it from other species. Though occasionally used for bait, and available for food, it is at present of no commercial importance.

Pecten irradians, Lamarck.

This is the common "scallop" of the eastern coast. It extends from Texas and the Gulf of Mexico to Cape Cod, and is occasionally found north of that point. It is fossil in the Post-Pliocene of North Carolina and Florida, in the Pliocene of South Carolina, and in the Miocene of Maryland.

The "scallop" is found on sandy and shelly bottoms, in sheltered localites, but usually prefers those points where the eel-grass abounds and where there is more or less mud on the bottom. During the summer the young shells may be seen clinging to the eel-grass or sea-weed in large numbers, and in the autumn the mature animals are found in the shallow waters along the shores in great abundance. Also after storms great quantities are thrown upon the beaches. But the scallop is nomadic; no one locality can be sure of its crop, no matter how abundant the animals may have been during the previous seasons. Indeed, some of the harbors of Long Island are visited by scallops in numbers but once in four and five years, and at other points the appearance and disappearance is irregular. Unlike many other bivalve mollusks, the *Pecten irradians* is not fixed immovably to some foreign object; is not anchored by a network of threads or "byssus," nor is it compelled to creep slowly along the surface of the mud or sand by means of a "foot" however muscular and strong. On the contrary, it is a very active swimmer, and by opening and energetically closing its valves, it forces the water from the gill-cavity, the reaction driving the animal backward through the water. It is very watchful, quickly perceiving an enemy, and when alarmed, deserts the matted leaves of eel-grass, its usual habitation, and takes to the bottom. In moving from place to place, the animals make a succession of leaps to the surface, each time advancing some yards on their journey, and great schools of those curions shells are sometimes seen thus darting about in the water. The spawning takes place during the summer, and continues as late as September. The size of the shells at that time is shown in the series illustrating the rate of growth. The growth during the autumn months is quite rapid, but it is claimed that further advancement is stopped as soon as the winter sets in. About the middle of July or first of August following, when the scallops are one year old, the growth begins again, and is very great during the succeeding autumn months. At this age they are marketable. The increase in size after the first year is not very great, and scallops two and three years old are not only difficult to find, but are worthless for market purposes. It is the general impression among the fishermen that the animals see but one spawning season, and die during the succeeding winter. No doubt the excessive fishery has had its influence in producing this opinion, and probably the scarcity of scallops two and three years old, is due, to some extent, to the persistent search for those of a marketable age, or those fifteen and eighteen months old.

The method of conducting the fishery varies somewhat with the locality, but is essentially as follows: The fishing boats, especially in Narragansett and Peconic Bays, which are the principal centers of the industry, are usually cat-boats, small sloops, or sharpies, and are provided with six, eight, ten, and twelve dredges or scrapes of the patterns exhibited. These are put over from the sides and stern of the boat, and towed after her as she sails backward and forward over the dredging-ground. As soon as a dredge is full it is hauled in and emptied on the "culling" board, which extends across the boat, and then put over again. The scallops are then separated from the other matter brought up by the dredge. In calm weather smaller boats or dories are employed, one man pulling and another tending the dredges, and occasionally, in shoal and clear water, a dip-net with a long handle is used. The best grounds for dredging are those where there is only a thin layer of mud over the sand. The only part of the scallop that is used is the great white abductor muscle, known to the fishermen as the "eye" or "heart." This is extracted from the shell, the process being termed "cutting out", by a dextrous motion, or rather combination of three motions of the short knife of the opener. It is wonderful to witness the extraordinary rapidity with which the "cutting out" is done; but though the process appears less fatiguing than oyster-opening, it is not so rapid, the latter process requiring but two motions instead of three. In the early part of the season a bushel of scallops will yield one-half gallon of meats, but in December the animals have increased so much in size, that a full gallon is produced from the same quantity. The "meats" are packed in wooden boxes or tubs, and transported, if possible, without ice, as contact with that article impairs the flavor. The trade is confined principally to to the New England States and New York markets. The meat has a fresh, sweetish, and somewhat insipid flavor, not usually appreciated by the uneducated palate. It is seldom eaten raw, but is usually cooked, being fried or boiled; some also are pickled. In addition to its commercial importance, the *Pecten irradians* furnishes food to many important edible fishes, such as the cod and others; it is also preyed upon by all the carnivorous Gasteropods, and by the star-fish and crabs.

The principal fishing localities on the east coast of the United States are Buzzard's Bay, Massachusetts, Greenwich, Rhode Island, Peconic Bay, Long Island, and Morehead City, North Carolina. On the west coast, Wilmington and San Diego; but there is no regular trade in scallops in those localities.

In 1880 the product and value of the industry was:

Number of gallons, 72,063.

Value, $28,825.20.

Pecten tenuicostatus, Mighels.

This is the "Great" or "Giant" scallop, and is found from New Jersey to Labrador, but is rare and local south of Cape Cod. It is generally found in comparatively deep water, existing in the Bay of Fundy in over 100 fathoms, but may be taken in as little as 2 and 3 fathoms. This species is not abundant nor of commercial importance. It is available for food, however, and is occasionally used as such. It is distinguished from the common scallop by its size, smooth surface, and peculiar, reddish-brown epidermis.

Argina pexata, Gray.

This is the *Arca pexata* of Say and the "Bloody Clam" of the fishermen. It is found from Florida and northern shores of the Gulf of Mexico to Cape Cod, and is local but rare, north of that point. The proper home of this animal is in off-shore shallow bottoms. It is sometimes found in other places, attached by a byssus, but not generally. It is occasionally used for bait, but otherwise is not of importance. The term "bloody," applied to them, and the *Scarpharca transversa*, a similar shell, is due to their discharge of a sanguineous liquor when opened. They are thus, and by their rough, dark, hairy epidermis, readily distinguished.

The various species of star-fishes are supposed to prefer the "bloody" clams to all other food, and the presence of the *Argina pexata* on or about an oyster-bed is therefore a welcome sight to the planter.

Glycimeris generosa, Gould.

This is a Pacific coast species, known as the "Geoduck" or "Giant Clam", having an extensive range, but not existing in very large numbers. It is found in sheltered localities on the coast, from Puget Sound to San Diego; it lives in rather deep water, rarely being found except below extreme low-water mark. Its long siphons permit great depth of the burrows, which usually penetrate the sandy-mud bottoms in which the animal lives, some two or three feet. The northern animals are the largest and most abundant.

The Geoduck is said to be of very fine flavor, but too rich to be used constantly as food. One animal is sufficient for an entire meal. Owing to its scarcity, it is not at present eaten extensively.

Siliqua patula, Dixon.

This species, the "Flat Razor Clam", is found from Alaska to California, and is especially abundant along the northern coast. It grows to a length of four or five inches, and is covered with a glossy, rich brown epidermis. It does not burrow very deep, and is esteemed delicious food, but is not extensively used.

Platyodon cancellatus, Conrad.

This is the "Date Fish", a species closely resembling *Mya arenaria*, found along the coast of California from San Francisco southward. It exists in great abundance in Baulinas Bay and at Santa Barbara. Its habits are essentially those of the "soft clam", and it forms one of the staple food shell-fish of the Pacific coast.

Zirphæa crispata, Mörch.

This mollusk, though widely distributed along the Atlantic coast of the United States, is not of commercial importance, while on the Pacific coast, where it is known as the "Date Fish," it is found in the markets and eaten by numbers of people. The Pacific variety is, however, considerably larger than that ordinarily found on the eastern coast. It is a northern species, not occurring south of Eastern Connecticut, and extending to the Gulf of St. Lawrence, in the Atlantic, and on the west coast being rarely found south of San Francisco. It is fossil in the Post-Pliocene of Maine. All the *Pholadidæ* are borers, and *Z. crispata* is no exception, but it is not very destructive, usually preferring mud and clay to wood.

Macoma nasuta, Conrad.

This species, called the "Tellen", is very common on the Pacific coast, and has a wide range, extending from Kamschatka to Mexico, but is rare south of San Diego. It is abundant in San Francisco Bay, and it was evidently eaten largely by the aborigines, as the shell-mounds in the vicinity of the bay are largely composed of shells of this species. It inhabits muddy flats, burrowing quite deeply, and reaches the water by its two small, red siphons. The usual length is two inches. It is eaten on the Pacific coast by all classes.

Tapes staminea, Conrad.

This species, known as the "Carpet-Shell", "Little-Neck Clam," and "Hard-Shelled Clam", is abundant on the whole Californian coast, and is found in all the markets. Tomales Bay furnishes a large number, as do other points where the animal is to some extent protected, as at Baulinas. It is usually found between tide-marks, buried one or two feet in the bottom, which may be either muddy or stony. This and other species designated as "Little-Neck Clams" occupy a similar place in San Francisco markets to that of the small-sized *Venus mercenaria*, used so extensively in the Eastern States.

Tapes laciniata, Cpr., is a closely allied species, and has about the same distribution as *T. staminea.* No distinction is made in the markets between them, both being sold as "Little-Neck" or "Hard-Shell" clams. They are the most abundant and extensively used of all the clams indigenous to the coast; but of late, since the introduction of the *Mya arenaria*, they have been supplanted in the markets to a great extent extent by that animal.

Chione succincta, Val., and *Chione simillima*, Sby., are also known in the markets as "Little-Neck" clams, but are not so abundant as *Tapes.* They live on sandy beaches on the California coast, and especially in Monterey Bay and other sheltered localities, but are not found in sufficient numbers to be of much importance as a food supply.

Saxidomus aratus, Gould.

This is the "Round Clam" of the Pacific coast. It is found from San Francisco to the southward to San Diego, but is not abundant. Monterey and San Diego produce it in largest numbers. It is probably only a southern variety of the northern shells of this genus.

Teredo.

There are four species of the genus *Teredo* found on the coast of the United States, and also an allied species, the *Xylotrya fimbriata*, of Jeffreys, having similar habits. The *Teredo navalis*, Linné, is the most abundant, and extends from Vineyard Sound to Florida. The *Teredo megotara*, Hanley, is found from Massachusetts Bay to South Carolina. The *Teredo Thomsonii*, Tryon, is indigenous, but its distribution has not yet been thoroughly determined; the *Teredo dilatata*, Stimpson, occurs from Massachusetts to Florida, and the *X. fimbriata* has the same range. These creatures are usually known as ship-worms and inhabit submerged wood-work, floating or stationary, and frequently do great damage. An instance is recorded of the piles of a wharf at Cape Henry having been destroyed in nine days by their ravages. Though they burrow into all submerged wood-work, it is for protection and not for food, and the excavations once made are neatly lined by the animal with shelly material. While at the surface the holes are very small, having been made by the young *Teredos;* as they go deeper, they gradually grow larger, and are sometimes 10 inches in length and one-quarter inch in diameter. The tubes, however they may enter the wood, usually turn, at a short distance from the surface, in a direction parallel with the grain. The burrow of one animal never interferes with, or crosses that of another, and a thin partition of wood is always left between the tubes. The tendency to follow the grain is not due to necessity, for the *Teredo* can bore through the hardest knots; nor is it necessary that the tubes should be straight, for they are often very crooked and tortuous.

The animals grow very rapidly, attaining maturity in one season. The young are produced in May and in the summer months, and during the early stages of development are free-swimming. While embryonic, they have organs both of sight and hearing, and are also provided with a "foot"; but as they develop, their powers of sight and swimming are lost. When they finally locate themselves they are about the size of the head of a pin, but this size rapidly increases. The destructive powers of the "ship-worm" are well known, and probably there is no effective remedy except that in use for protecting the bottom of vessels, viz., copper sheathing. The various poisonous substances applied to timber are of no use, as the animal does not live on the wood, but uses it as a location only. The only remedies likely to succeed are those which will prevent an entrance. The United States Engineer Corps has experimented, at the Delaware Breakwater, for some years, with wood that had been treated with creosote, and the experiments appear to have been successful; but whether the success is accidental or not has not yet been determined.

Martesia cuneiformis, Gray.

This is another species of the genus *Pholas*, and is known as the "Boring Pholad," of the oyster-beds. It is very common and abundant in Chesapeake Bay, and is found in any waters to which Chesapeake oysters have been transported. It lives in small chambers, which it excavates in the shells of oysters or other bivalves, but rarely does any serious damage, the efforts of both oyster and pholad being directed to the prevention of complete penetration of the valve. The pholad appears to flourish best in brackish water, and in Chesapeake Bay was most abundant on oyster-beds that had evidently deteriorated. Their presence, therefore, in large numbers is considered to be one of the indications of deterioration.

CATALOGUE.

MOLLUSCA CEPHALOPODA.

SQUIDS AND CUTTLES.

Ommastrephes illecebrosa, Verrill. Squid, Flying Calamary, Sea-arrow. Northeast coast of North America.

33655. New England coast. United States Fish Commission.
33660. Eastport, Maine. United States Fish Commission.

Loligo pealii, Lesueur. Common Squid. South Carolina to Massachusetts Bay.

33656. New England coast. United States Fish Commission.

Loligo brevis, Blainville. Calamary or Ink-fish. Southern and southeastern coasts of the United States.

33661. Coast of Louisiana. United States Fish Commission.

Architeuthis princeps, Verrill. Giant Squid. Coast of Newfoundland and adjacent waters. Model made by Mr. J. H. Emerton, from measurements and descriptions of a Squid thrown ashore at Catalina, Trinity Bay, Newfoundland, September 24, 1877. Principal dimensions: Length of body, 8 feet; Length of head, 1½ feet; length of tentacles, 30 feet; length of 1st pair of arms, 8½ feet; length of 2d pair of arms, 9½ feet; length of 3d and 4th pair of arms, 11 feet; greatest diameter of body, 2½ feet.

Octopus punctatus, Gabb. Octopus, or Devil Fish. Northwest coast of the United States. Model made by Messrs. J. H. Emerton and Wm. Palmer, from inspection of small specimens, and published measurements and descriptions. Length of longest arms, 16 feet; length of shortest arms, 13 feet; diameter of circle swept by arms, 18 feet.

MOLLUSCA GASTEROPODA.

SEA SNAILS.

Useful for food or bait.

Buccinum undatum, Linné. Whelk. Long Island Sound to Greenland. Not common south of Cape Cod, except in deep water. Very abundant on coast of Maine.

33637. Vineyard Sound. United States Fish Commission.

Fulgur carica, Conrad. Periwinkle, Winkle, and Wrinkle; also Ribbon Whelk.
(See "Injurious Gasteropods.")

Sycotypus canaliculatus, Gill. Periwinkle, Winkle, and Wrinkle; also Hairy Whelk.
(See "Injurious Gasteropods.")

Littorina littorea (Linné), Menké. Pennywinkle, or Sea Snail. Northeastern coast, from Connecticut to Nova Scotia.

33654. Wood's Holl, Mass. United States Fish Commission.

Purpura lapillus, Lamarck. Sea Snail.
(See "Injurious Gasteropods.")

Ilyanassa obsoleta, Stimpson. Sea Snail. Whole southern and eastern coast of the United States, but rare and local north of Cape Cod.

33633. Vineyard Sound. United States Fish Commission.

Lunatia heros, Adams.
(See "Injurious Gasteropods.")

Neverita duplicata, Stimpson.
(See "Injurious Gasteropods.")

Haliotis (several species). See below.

Useful by producing Pearl shell.

Trochiscus norrissii, Sowerby. Turban Shell.

32830. Coast of California. H. Hemphill.

Pomaulax undosum, Chemnitz.

32832. Coast of California. Natural state. H. Hemphill.
32831. Coast of California. Prepared to show pearly layers. H. Hemphill.

Haliotis (various species). Abalones or Sea-Ears. Pacific coast of the United States from San Francisco southward. Coast of Lower California and Mexico. Not common south of Magdalena Bay, Lower California.

Haliotis kamchatkana.

32838. Coast of Alaska. J. G. Swan.

Haliotis corrugata, Gray. Rough Sea-Ear.

32890. Coast of Southern California. W. H. Dall.

Haliotis rufescens, Sowerby. Abalone or Red Sea-Ear.

32900. Monterey, California. H. Hemphill.

Haliotis crachcrodii, Leach. White Abalone.

32823. Coast of California. Paul Schumacher.
32899. Monterey, California. H. Hemphill.

Haliotis splendens, Roe. Splendid Sea-Ear.

32821. Coast of California. Paul Schumacher.
32898. Coast of Southern California. H. Hemphill.

Manufactured state of Haliotis shell.

29302. Furnished by A. B. de Frece & Co., 428 Broadway, New York.
29248. Furnished by Harvey & Ford, Philadelphia, Pa.

Manufactured state of various American Pearl shells derived from Gasteropods.

29301. Variety furnished by A. B. de Frece & Co., 428 Broadway, New York.

Affording dye, as well as ornamental.

Phyllonotus brassica, Lamarck. Purple-shell.

32911. Coast of Lower California. W. H. Dall.

Phyllonotus bicolor, Valenciennes. Purple-shell.

32912. West coast of America. W. H. Dall.

Affording cameo and porcelain stock.

6968. Cameo-shell (*Cassis rufa*), used for cameo cutting. Florida. Dr. Wm. Stimpson.

Injurious, by destroying food-producing mollusks.

Fulgur carica, Conrad. Periwinkle, Winkle, and Ribbon-Whelk. Eastern coast of the United States from Florida to Cape Cod; abundant in Vineyard and Long Island Sounds.

33635. Vineyard Sound. United States Fish Commission.
33458. Oyster Bay, Long Island. H. A. Townsend.
33453. East Greenwich, R I. A. A. Wilson.
33613. Egg capsules. East Greenwich, R. I. A. A. Wilson.

Sycotypus canaliculatus, Gill. Periwinkle, Winkle, Wrinkle, and Hairy Whelk. Whole eastern and southern coasts of the United States as far as Cape Cod; abundant in Vineyard and Long Island Sounds.

33401. Oyster Bay, Long Island. H. A. Townsend.
33454. East Greenwich, R I. A. A. Wilson.
33611. Great South Bay. Blue Point, Long Island. F. C. Dayton.
33636. Vineyard Sound. United States Fish Commission.
33612. Egg capsules. Great South Bay. F. C. Dayton.

Urosalpinx cinerea, Stimpson. Drill or Rough Whelk. Eastern coast of the United States to Massachusetts Bay; local farther north to the Gulf of Saint Lawrence; west coast of Florida; abundant from Virginia to Cape Cod, especially on oyster-beds.

33632. Vineyard Sound. United States Fish Commission.

Purpura lapillus, Lamarck. Drill or Whelk. Long Island Sound to Arctic Ocean; rare and local south of Cape Cod; abundant on northern coasts of New England and Nova Scotia.

33652. Wood's Holl, Mass. United States Fish Commission.

Lunatia heros, Adams. Sea Snail. Georgia to Gulf of Saint Lawrence and Labrador; abundant and large on coasts of New Jersey and Long Island.

33653. Vineyard Sound. United States Fish Commission.

Neverita duplicata, Stimpson. Sea Snail. Massachusetts Bay to Northern Florida; Northwestern Florida to Yucatan; local and uncommon north of Cape Cod; abundant fromNantucket southward.

33455. East Greenwich, R. I. A. A. Wilson.
33610. Great South Bay, Blue Point, Long Island. F. C. Dayton.
33657. Vineyard Sound. United States Fish Commission.

Crepidula plana, Say. Sea Snail or Slipper Shell. Massachusetts Bay to Florida; northern shores of Gulf of Mexico; local northward of Massachusetts to Gulf of Saint Lawrence; common in Vineyard and Long Island Sounds.

33658. Vineyard Sound. United States Fish Commission.

Crepidula fornicata, Lamarck. Sea Snail or Boat Shell. Casco Bay, Maine, to Florida; northern shores of Gulf of Mexico; local north of Massachusetts; abundant from Vineyard Sound southward.

33659. Vineyard Sound. United States Fish Commission.

While the above species of *Crepidula* are neither directly injurious nor beneficial, they are often associated with destructive Gasteropods. In addition, their absence from an oyster-bed is one of the many indications of its deterioration.

MOLLUSCA LAMELLIBRANCHIATA.

BIVALVE SHELL-FISH.

Affording food or bait.

Ostrea virginica, Gmelin. American Oyster.

— Map showing general distribution along the eastern coast of North America.

— Map showing location of oyster-beds along the coast of Prince Edward's Island, Nova Scotia, New Brunswick, and shores of the Gulf of Maine and Massachusetts Bay.

— Series of maps showing the distribution of oysters, and approximate areas and positions of natural and artificial oyster-beds, along the coast of the United States, from Cape Cod to the Rio Grande.

On these maps, red indicates natural oyster-ground; blue, artificial or "planted" beds; purple, interspersed natural and artificial beds; and pink, "scattered" oysters. The strength of the tinting indicates, roughly, the quality, and the variations in color the character, of the several areas.

Catalogue of maps of oyster beds.

Locality.	Scale.	Compiler.
Cape Cod Bay (extinct beds)	1-80,000	Mr. Edward P. Cook.
South coast, Massachusetts, "Nantucket Shoals to Muskeget Channel."	1-80,000	Mr. Vinal N. Edwards.
South coast, Massachusetts, Buzzard's Bay, "Muskeget Channel to Buzzard's Bay."	1-80,000	Do.
Narragansett Bay, "Cuttyhunk to Block Island"	1-80,000	Shell-Fish Commission of Rhode Island and Lieut. Francis Winslow, U. S. N.
Long Island Sound, "Point Judith to Plum Island"	1-80,000	Shell-Fish Commission of Connecticut and Lieut. Francis Winslow, U. S. N.
Long Island Sound, "Plum Island to Welch's Point."	1-80,000	Shell-Fish Commission of Connecticut and Lieut. Francis Winslow, U. S. N.
Long Island Sound, "Welch's Point to New York"	1-80,000	Shell-Fish Commission of Connecticut and Lieut. Francis Winslow, U. S. N.
South coast of Long Island, "Block Island and Montauk Point."	1-80,000	Lieut. Francis Winslow, U. S. N.
South coast of Long Island, "Great South Bay and Fire Island."	1-80,000	Do.
"New York Bay and Harbor"	1-80,000	Do.
Coast of New Jersey, "Sandy Hook to Barnegat Inlet."	1-80,000	Do.
Coast of New Jersey, "Barnegat Inlet to Absecom Inlet."	1-80,000	Midshipman J. B. Blish, U. S. N.
Coast of New Jersey, "Absecom Inlet to Cape May."	1-80,000	Do.
Delaware Bay, "Delaware Entrance"	1-80,000	Do.
Delaware Bay and River	1-80,000	Do.
Sea-coast of Maryland, "Cape May to Isle of Wight"	1-80,000	Lieut. Francis Winslow, U. S. N.
Sea-coast of Maryland, "Isle of Wight to Chincoteague Inlet."	1-80,000	Do.
Sea-coast of Virginia, "Chincoteague Inlet to Hog Island."	1-80,000	Do.
Sea-coast of Virginia, "Hog Island to Cape Henry"	1-80,000	Do.
"Entrance to Chesapeake Bay, Hampton Roads, &c."	1-80,000	Do.
Chesapeake Bay, "York River to Pocomoke Sound"	1-80,000	Do.
Chesapeake Bay, "Pocomoke Sound and Entrance to Potomac River."	1-80,000	Do.
Chesapeake Bay, "Potomac River to Choptank River."	1-80,000	Do.
Chesapeake Bay, "Choptank River to Magothy River."	1-80,000	Do.
Chesapeake Bay "Magothy River to Head of Bay"	1-80,000	Do.
Potomac River, "Entrance to Piney Point"	1-60,000	Do.
Potomac River, "Piney Point to Lower Cedar Point."	1-60,000	Do.
Rappahannock River, "Entrance to Deep Creek"	1-60,000	Do.
Rappahannock River, "Deep Creek to Occupacia Creek."	1-60,000	Do.
York River, "Entrance to King's Creek"	1-60,000	Do.
York River, "King's Creek to West Point"	1-60,000	Do.
James River, "Newport News to Point of Shoals Strait."	1-40,000	Do.
James River, "Point of Shoals Strait to Sloop Point."	1-40,000	Do.
South Carolina, "Winyah Bay"	1-40,000	Mr. G. S. Hobbs.
South Carolina, "Bull's Bay"	1-60,000	Do.
South Carolina, "Long Island to Hunting Island"	1-80,000	Do.
South Carolina and Georgia, "Hunting Island to Ossabaw Island."	1-80,000	Do.
Georgia, "Savannah to Sapelo Island"	1-80,000	Do.
Georgia, Sapelo Island to Amelia Island"	1-80,000	Do.
Georgia and Florida, "Cumberland Sound and St. John's River."	1-80,000	Do.
Florida, "St. Augustine Inlet to Halifax River"	1-80,000	Do.
Florida, "Halifax River to Mosquito Lagoon"	1-80,000	Do.
Florida, "Indian River"	1-80,000	Do.
Florida, "Tampa Bay"	1-80,000	Mr. Silas Stearns.
Florida, "Appalachicola Bay to Cape San Blas"	1-80,000	Do.
Coast of Alabama and Mississippi		Do.
Coast of Mississippi and Louisiana		Do.
Texas, "Galveston Bay to Oyster Bay"	1-80,000	Master C. McR. Winslow, U. S. N.
Texas, "Oyster Bay to Matagorda Bay"	1-80,000	Do.

Ostrea Virginica, Gmelin. American Oyster.

BIOLOGY.

SERIES OF ILLUSTRATIONS OF THE EMBRYOLOGY OF THE AMERICAN OYSTER, PREPARED FOR THE MARYLAND FISH COMMISSION BY DR. W. K. BROOKS, PH. D., OF JOHNS HOPKINS UNIVERSITY, BALTIMORE.

Explanation of the figures.

Unless the contrary is stated, the figures are drawn with a magnifying power of 250 diameters; Zeiss. F. 2, but it was necessary to amplify the sketches considerably in order to reproduce, by the process of photo-engraving, the features which this magnifying power rendered visible, and the figures as they are produced are of about twice the diameter of camera sketches made with the same magnifying power.

The first thirty-two figures show the process of segmentation. Figure 1 is an egg at the end of the first period of rest; Figures 2, 3, 4, 5, 6, and 7, the changes during the first period of activity; Figures 8, 9, 10, 11, 12, and 13, the changes during the second period of rest; Figures 14, 15, and 16. those which take place during the second period of activity; 17, 18, and 19, those which take place during the third period of rest; 20 and 21, during the third period of activity; 22, during the fourth period of activity; 23, during the fifth period of activity, and the remaining figures show more widely separated stages. In all the figures of segmentation, except 29, 30, and 31, the formative pole is above and the nutritive pole below.

Figure 1.—Eggs two hours and seven minutes after fertilization. It is now perfectly spherical, with an external membrane, and the germinative vesicle is not visible.

Figure 2.—The same egg two minutes later. It is now elongated; one end is wider than the other, and a transparent area at the broad end marks the point where the polar globules are about to appear. At the opposite end the external membrane is wrinkled by waves which run from the nutritive towards the formative pole in rapid succession for about fifteen seconds.

Figure 3.—The same egg two minutes later.

Figure 4.—The same egg two minutes later. The yolk has become pear shaped. The polar globule has appeared at the formative pole, in the middle of the broad end of the pear, and the nutritive end of the egg is now less granular than the formative end.

Figure 5.—The same egg two minutes later. Three equidistant furrows have made their appearance, separating it into a single mass at the nutritive pole, and two at the formative pole. At this stage the three masses are about equal in size.

Figure 6.—The same egg two minutes later. The first micromere, *c*, is now perfectly separated, and smaller than the second, *b*, and each is smaller than the macromere, *a*.

Figure 7.—The same egg one minute later. Both micromeres are separated and are spherical, as is also the macromere. This stage ends the first period of activity.

Figure 8.—The same egg forty-five seconds later. The two micromeres have begun to fuse with each other, and the second micromere, *b*, is also partially fused with the macromere, *a*.

Figure 9.—The same egg one minute later. The first micromere, *c*, has also begun to unite with the macromere.

Ostrea Virginica, Gmelin. American Oyster—Continued.

Figure 10.—The same egg one minute later. The line between the second micromere and macromere has disappeared, and the first micromere, *c*, now projects from one end of the elongated mass formed by the union of the spherules *a* and *b*.

Figure 11.—The same egg three minutes later. The fusion of *a* and *b* is now complete, and a large transparent vesicle is now visible in the first micromere, *c*, and another in the compound mass, *ab*.

Figure 12.—The same egg two minutes and thirty seconds later.

Figure 13.—Another egg, about two minutes later. This is the true resting stage, at the end of the second period of rest. The two vesicles have become irregular. The remains of an external membrane adhere to one side of the egg.

Figure 14.—The same egg seven minutes later than Figure 13. The compound mass, *a* and *b*, is elongated, the first micromere, *c*, is well defined, and waves travel from the nutritive towards the formative ends of the two masses. Two segmentation nuclei occupy the positions of the large vesicles of earlier stages. This stage is the beginning of the second period of activity.

Figure 15.—The same egg one minute later. The second micromere, *b*, is now well defined, as well as the first.

Figure 16.—The same egg one minute later. This stage marks the end of the second period of activity. The formative end of the egg is now occupied by four micromeres, two of which seem to be the products of the division of the first micromere, *c*, and two of them the products of the second, *b*.

Figure 17.—The same egg two minutes later, at the commencement of the third period of rest. The second micromere, *b*, has again begun to fuse with the macromere, *a*.

Figure 18.—The same egg three minutes and thirty seconds later. The second micromere is no longer separated from the macromere, and mass, *a* and *b*, formed by their union is nearly spherical.

Figure 19.—The same egg two minutes and a half later, at the end of the third period of rest, viewed at right angles to Figure 18.

Figure 20.—The same egg thirteen minutes later, and in the same position as Figure 18. The spherule, *c*, of figure 19 has divided into two, and the second micromere, *b*, has become prominent, so that there are five micromeres at the formative pole.

Figure 21.—The same egg one minute later, and in the same position as figure 19.

Figure 22.—The same egg in the position of Figure 20, fifteen minutes later than Figure 21, and in the fourth period of activity. There are now seven micromeres at the formative pole, six on one side of the polar globules and one, the second micromere, *b*, on the other.

Figure 23.—The same egg twenty-one minutes later, viewed from the side opposite the second micromere. The cells which have been formed by the division of the micromeres of the stage 19 now form a layer, the ectoderm, which rests, like a cap, on the macromere, *a*.

Figure 24.—The same egg five hours and fifteen minutes later, in the same position as Figure 22, but not quite so much magnified. On one side the polar globule is still separated from the macromere, *a*, by a single spherule—the second micromere, *b*. Opposite this the growing edge, *g*, of the ectoderm is spreading still farther down over the macromere. At the point *g*, and at four other points, are pairs of small cells, which have evidently been formed by the division of the large spherules.

Figure 25.—Another egg at about the same stage.

Ostrea Virginica, Gmelin. American Oyster—Continued.

Figure 26.—The egg shown in Figure 24, fifty-five minutes later. The macromere, *a*, is almost covered by the ectoderm, and the second micromere, *b*, has divided into a number of spherules. At the growing edge, *g*, an ectoderm spherule is seen separating from the macromere.

Figure 27. —A similar view of an egg twenty-seven hours after impregnation. The macromere is almost covered by the ectoderm, *ec*, and is not visible in a side surface view. At *g* is an ectoderm spherule, which is separating from the macromere.

Figure 28.—Optical section of the same egg; *ec*, ectoderm; *en*, macromere, divided into two spherules. No segmentation cavity can be seen in a normal egg at this or any of the preceding stages.

Figure 29.—View of the nutritive pole of an egg a few hours older.

Figure 30.—View of the formative pole of a still older egg.

Figure 31.—Optical vertical section of a somewhat older egg, figured with the polar globule above and the ectoderm to the right. The egg is now flattened from above downwards, and is disk-shaped in a surface view. The macromere has given rise to a layer of larger granular cells, which are pushed in so as to form a large cup-shaped depression. The more transparent ectoderm, *ec*, now carries a few short cilia scattered irregularly, and the two layers are separated from each other by a segmentation cavity. This figure is in Plate III.

Figure 32.—Surface view, and

Figure 33.—Optical section of the embryo at the first swimming stage. The ectoderm has folded upon the endoderm, so as to form a primitive digestive cavity, with an external opening, *g*. The cilia of the velum have now made their appearance around the area occupied by the polar globule. This was not present in the egg from which the figure was drawn, but it was seen in other eggs, and is shown in a later stage of another embryo, Figure 6.

Figure 34 and Figure 35.—Two surface views of the embryo shown in Figure 32.

Figure 36.—An older embryo, in the same position as Figures 32 and 33. The external opening of the primitive digestive tract has closed up, and the two valves of the shell have appeared in the place which it had occupied. The endoderm has no connection with the exterior, and no central cavity could be seen.

Figure 37.—A somewhat older embryo, figured with its dorsal surface above. There is a large, central, ciliated digestive cavity which opens externally by the mouth *m*, which is almost directly opposite the primitive opening, the position of which is shown by the shell, *s*.

Figure 38.—A similar view of a still older embryo. The shell, *s*, has increased in size, and the digestive tract has two openings, the mouth, *m*, and the anus, *an*, which are very near each other on the ventral surface.

Figure 39.—The opposite side of a still older embryo, in which the body wall begins to fold under the shell, to form the mantle *m*.

Figure 40.—Dorsal view of an embryo at about the same stage.

Figure 41.—Dorsal view of an embryo at the stage shown in Figure 38, with its valves extended; *rs*, right valve of shell; *ls*, left valve of shell; *an*, anus; *a*, anal papilla; *ma*, mantle; *v*, velum; *b*, body cavity; *st*, stomach.

Figure 42.—View of left side of a still older embryo; *i*, intestine. Other letters as in Figure 41.

Figure 43.—Dorsal view of an embryo six days old, swimming by the cilia of its velum.

Figure 44.—View of right side of another embryo at the same stage; *mu*, muscles; *l*, liver. Other letters as in Figure 41.

Ostrea Virginica, Gmelin. American Oyster—Continued.

Figure 48.—The seminal fluid of a ripe male oyster, mixed with water, and seen with a power of 80 diameters. Zeiss. a. 2.

Figure 49.—Fluid from the ovary of a ripe female oyster, seen with the same magnifying power.

Figure 50.—Seminal fluid of a ripe male oyster, magnified 500 diameters.

Figure 51.—Egg a few minutes after mixture with the male fluid magnified 500 diameters.

Figure 52.—Egg about thirty minutes after fertilization magnified 500 diameters.

Figure 67.—Section of a portion of the visceral mass of a male oyster magnified 250 diameters. The surface epithelium of the body is shown at the lower end of the figure. Above this is a loose, thick layer of wrinkled cells, which have the appearance of adipose cells from which all the fat has been removed. Above this layer is a large duct, lined with epithelial cells, and filled with ripe spermatozoa, which have been poured into it from two follicles which communicate with it on each side. Above this are sections of a number of the follicles of the testis, in three of which the contents are figured.

Figure 53.—Section of a portion of the visceral mass of a female oyster magnified 250 diameters; *a*. epithelium of the surface of the body; *b*, layer of connective tissue; *c*, layer of wrinkled cells, which are probably fat cells, from which all the fat has been removed; *f*, sections of ten ovarian follicles; *e*, the ovarian eggs.

Figures 54–66.—Abnormal or direct form of segmentation.

SERIES OF PHOTOGRAPHS ILLUSTRATING ATTACHMENT AND GROWTH OF "SPAT" AND OYSTERS. INVESTIGATIONS OF FRANCIS WINSLOW, U. S. N., ASSISTANT U. S. COAST AND GEODETIC SURVEY, 1879.

SERIES OF SPECIMENS ILLUSTRATING ATTACHMENT OF SPAT.

33391. Jamaica Bay, L. I. C. E. Vreeland.
33519. Saunders' Point, Povidence River. Soft bttom. Jason S. Pierce.
32802. Bayou Cook, Louisiana. Alex. Gordon.
32796. Blue Point, Long Island. "Seed" on leather shoe. B. J. M. Carley.
33618. Oyster Bay, Long Island. Growth on stone. H. A. Townsend.
32973. Long Island Sound. Growth on part of stone jug. Hoyt Bros.
32792. Blue Point, Long Island. Growth on *Mactra* shell. B. J. M. Carley.
32958. Long Island Sound. Growth on various "stools." Hoyt Bros.
32958. Long Island Sound. Growth on "King crab." Hoyt Bros.
32958. Long Island Sound. Growth on stone. Hoyt Bros.
33390. Huntington Harbor, Long Island. Growth on stone. Wilson Beardsley.
32793. Blue Point, Long Island. Growth on stone. B. J. M. Carley.
32970. Long Island Sound. Growth on bottle. Hoyt Bros.
32971. Long Island Sound. Growth on stone. Hoyt Bros.
32894. Blue Point, Long Island. Growth on bone. B. J. M. Carley.
3151. Long Island Sound. Growth on stone. Hoyt Bros.
33619. Patchogue, Long Island. Growth on clay pipe. F. C. Dayton.
32932. Blue Point, Long Island. Growth on boot-leg. B. J. M. Carley.
33572. Potomac River oyster transplanted June, 1882, to Delaware Bay. Peculiar growth. Thos. J. Love.
33573. Delaware Bay. "Set" five months old. Thos. J. Love.
33620. Providence River. Growth on crab. Monsell & Dewing.
32794. Blue Point, Long Island. Growth on rubber boot. B. J. M. Carley.

Ostrea Virginica, Gmelin. American Oyster—Continued.

32974. Blue Point, Long Island. Growth on rubber shoe. B. J. M. Carley.
33621. Maurice Cove, Delaware Bay. Growth on twig. Thos. J. Love.
32789. Blue Point, Long Island. Rosette of oysters. B. J. M. Carley.
32895. Blue Point, Long Island. Growth on rubber shoe. B. J. M. Carley.
33102. Presby's Creek, Va. G. W. Harvey.
33622. Maurice Cove, Delaware Bay. Growth on bottle neck. Thos. J. Love.
33459. Delaware Bay. Cluster of young oysters. S. I. Middleton.
32969. Long Island Sound. Growth on crab. Hoyt Bros.
33648. Great South Bay, Long Island. "Set" two months old. Monsell & Dewing.

SERIES OF SPECIMENS ATTACHED TO SLATE COLLECTORS USED BY MR. J. A. RYDER, DURING HIS INVESTIGATIONS AT ST. JEROME'S CREEK, MD., 1880.

33623. Placed August 3, taken in September 16, 1880, 44 days.
33624. Placed July 31, taken in October 21, 1880, 82 days.
33625. Placed August 3, taken in October 21, 1880, 79 days.
33626. Placed August 3, taken in October 21, 1880, 79 days.
33627. Placed August 3, taken in October 21, 1880, 79 days.
33628. Placed September 10, taken in October 21, 1880, 41 days.

SERIES ILLUSTRATING CHARACTERISTICS OF SEVERAL SPECIES OF OYSTERS.

Ostrea edulis Linné. European oyster.

32811. North Sea.

Ostrea borealis, Lamarck. Canadian oyster.

32810. Buzzard's Bay, Mass. Dr. Wm. Stimpson.

Ostrea lurida, Cpr. California oyster.

32879. Crescent City, Cal. W. H. Dall.

Ostrea Virginica, Gmelin. American or Virginia oyster.

33096. Saint Gerome Creek, Md. G. W. Harvey.

SERIES ILLUSTRATING VARIATIONS FROM *O. borealis* to *O. virginica* and *vice versa*.

33098. Tangier Sound, Md. G. W. Harvey.
33381. Oyster Bay, Long Island. Eighteen months old. Planted one year on hard bottom. H. A. Townsend.
32808. Coast of Florida. Raccoon oysters. Lieut. Kossuth Niles, U. S. N.
32961. Long Island Sound. Two to three years old. Hoyt Bros.
33382. Huntington Harbor, Long Island. From hard bottom. Wilson Beardsley.
32960. Long Island Sound. One to two years old. Hoyt Bro's.
32805. Appalachicola Bay, Fla. Lieut. Kossuth Niles, U. S. N.
33387. Huntington Harbor, Long Island. From soft bottom. Wilson Beardsley.
32965. Long Island Sound. Three to four years old. Hoyt Bros.
33102. Presby's Creek, Va. G. W. Harvey.
33407. Oyster Bay, Long Island. From hard bottom. H. A. Townsend.
33379. Oyster Bay, Long Island. From muddy bottom. H. A. Townsend.

Ostrea Virginica, Gmelin. American or Virginia oyster—Continued.

SERIES SHOWING PECULIARITIES OF GROWTH DUE TO ATTACHMENT OF SPAT.

33103. York River, Virginia. G. W. Harvey.
33102. Presby's Creek, Virginia. G. W. Harvey.
33101. Nasawaddox Creek, Virginia. G. W. Harvey.
32974. Long Island Sound. Hoyt Bros.
32797. Blue Point, Long Island. B. J. M. Carley.
33492. Bridgeport, Conn. Point No Point "seed." Wheeler Hawley.
33386. Huntington Harbor, Long Island. From soft bottom. Wilson Beardsley.
33383. Huntington Harbor, Long Island. From hard bottom. Wilson Beardsley.
33588. Indian River, Florida. G. S. Hobbs.
33393. Shrewsbury River, New Jersey. E. G. Blackford.
33390. Huntington Harbor, Long Island. Wilson Beardsley.
33104. Cherrystone Creek, Virginia. G. W. Harvey.
33417. Seaville, New Jersey. J. W. Gandy.
33590. Vicinity of Savannah, Ga. G. S. Hobbs.
33095. Rappahannock River, Virginia. G. W. Harvey.
33565. Poquonock River, Connecticut. J. P. Bogart.
33406. Freeport, Long Island. E. G. Blackford.
33592. Vicinity of Charleston, S. C. G. S. Hobbs.
33569. Maurice River Cove, Delaware Bay. Thos. J. Love.
33100. Little River, Maryland. G. W. Harvey.
33380. Oyster Bay, Long Island. H. A. Townsend.
33396. Bridgeport, Conn. Guilford River "seed." Wheeler Hawley.
33418. East Greenwich, R. I. A. A. Wilson.
33098. Tangier Sound, Chesapeake Bay, Maryland. G. W. Harvey.
33380. Oyster Bay, Long Island. H. A. Townsend.
33598. Corpus Christi, Texas. C. McR. Winslow, U. S. N.
33377. Oyster Bay, Long Island. H. A. Townsend.

SERIES SHOWING PECULIARITIES OF GROWTH DUE TO ABNORMAL INFLUENCES OR CHANGES OF POSITION SUBSEQUENT TO TIME OF ATTACHMENT.

32791. Glenwood, Long Island. B. J. M. Carley.
32795. New York Bay. B. J. M. Carley.
33406. Freeport, Long Island. E. G. Blackford.
33381. Oyster Bay, Long Island. Planted one year on hard bottom. H. A. Townsend.
33382. Huntington Harbor, Long Island. From hard bottom. Wilson Beardsley.
32786. New York Bay. Growth in still water. B. J. M. Carley.
33392. Patchogue, Great South Bay, Long Island. E. G. Blackford.
33569. Maurice River Cove, Delaware Bay. Thos. J. Love.
33427. East Greenwich, R. I. A. A. Wilson.
33403. Bridgeport, Conn. "Planted oysters." Wheeler Hawley.
33394. Great Sound, sea-coast of New Jersey. J. W. Gandy.
33589. Vicinity of Savannah, Ga. G. S. Hobbs.
33393. Shrewsbury River, New Jersey. E. G. Blackford.
33412. Jamaica Bay, Long Island. E. G. Blackford.
33410. Rockaway Inlet, Long Island. E. G. Blackford.
32787. Blue Point, Long Island. From a tide-way. B. J. M. Carley.

Ostrea Virginica, Gmelin. American or Virginia oyster—Continued.

33102. Presby's Creek, Virginia. G. W. Harvey.
33386. Huntington Harbor, Long Island. Wilson Beardsley.
32808. Coast of Florida. Raccoon oyster. Lieut. Kossuth Niles, U. S. N
33599. Blue Point, Long Island. F. C. Dayton.
33651. Cobb's Island, sea-coast of Virginia. Nathan Cobb.
32813. Nova Scotia. From a tide-way. J. R. Willis.

SERIES ILLUSTRATING GROWTH ON SOFT BOTTOM.

33379. Oyster Bay, Long Island. H. A. Townsend.
32959. Long Island Sound. Hoyt Bros.
32920. City Island, Long Island Sound. B. J. M. Carley.
33095. Rappahannock River, Virginia. G. W. Harvey.
33599. Blue Point, Long Island. F. C. Dayton.

SERIES ILLUSTRATING EFFECT OF SOFT MUDDY BOTTOM UPON INTERIOR OF SHELL AND DEPOSIT OF NACRE.

32807. Coast of Florida. Lieut. Kossuth Niles, U. S. N.
33101. Nasawaddox Creek, Virginia. G. W. Harvey.
33102. Presby's Creek, Virginia. G. W. Harvey.
33100. Little River, Maryland. G. W. Harvey.
33590. Vicinity of Savannah, Ga. G. S. Hobbs.
32103. York River, Virginia. G. W. Harvey.
33392. Patchogue, Long Island (Blue Point). E. G. Blackford.
32806. Cat Point, Appalachicola Bay, Florida. Lieut. Kossuth Niles, U. S. N.
33651. Cobb's Island, sea-coast of Virginia. Nathan Cobb.

SERIES ILLUSTRATING VARIATIONS IN COLOR OF EXTERIOR OF SHELL.

33379. Oyster Bay, Long Island. H. A. Townsend.
33571. Potomac River natives, transplanted to Delaware Bay in June, 1882. Thos. J. Love.
33528. New Haven, Conn., natives transplanted to Narragansett Bay in spring of 1882. Jason S. Pierce.
33393. Shrewsbury River, New Jersey. E. G. Blackford.
33588. Indian River, Florida. G. S. Hobbs.
32919. Cow Bay, Long Island. B. J. M. Carley.
32784. Prince Edward's Island (var. *borealis*). Mr. Dawson.
32933. Chesapeake Bay. T. B. Ferguson.
32799. San Diego, Cal. (*Ostrea lurida*). H. Hemphill.
33407. Oyster Bay, Long Island. From hard bottom. H. A. Townsend.
32960. Long Island Sound. Hoyt Bros.
32814. Rhode Island. Col. Totten.
33408. Oyster Bay, Long Island. From hard bottom. H. A. Townsend.
33406. Freeport, Long Island. E. G. Blackford.
32782. New York Bay. B. J. M. Carley.
33380. Oyster Bay, Long Island. H. A. Townsend.
33640. Coast of California (*Ostrea lurida*). R. E. C. Stearns.

SERIES ILLUSTRATING GEOGRAPHICAL VARIETIES.

COASTS OF NEW BRUNSWICK, MAINE, MASSACHUSETTS, AND RHODE ISLAND.

32783. Miramichi River, New Brunswick. W. H. Dall.
32785. Shediak, New Brunswick. W. H. Dall.

Ostrea Virginica, Gmelin. American or Virginia oyster—Continued.

33092. Shediak, New Brunswick. G. F. Mathew.
33093. Buctouche, New Brunswick. G. F. Mathew.
32978. Sheepscot River, Maine. From extinct beds. R. Dixon.
33555. Sheepscot River, Maine. From extinct beds. Dr. C. A. White.
32810. Buzzard's Bay, Massachusetts (var. *borealis*). Dr. Wm. Stimpson.
33448. East Greenwich, R. I. A. A. Wilson.

Providence River, Rhode Island.

33518. Natives, transplanted in 1881 to soft bottoms. Jason S. Pierce.
33523. Natives, three years old, transplanted when two years old to soft bottoms. Jason S. Pierce.
33524. Natives; old. Jason S. Pierce.
33530. Natives from Jolly Banks bed, hard bottom. Jason S. Pierce.

COAST OF CONNECTICUT AND NORTH SHORE OF LONG ISLAND.

32790. Greenwich, Conn. B. J. M. Carley.
33528. New Haven, Conn., three years old, transplanted to Providence River in spring of 1882. Jason S. Pierce.

Bridgeport, Conn.

33492. Point No Point. "Seed." Wheeler Hawley.
33488. Housatonic River. "Seed." Wheeler Hawley.
33496. Point No Point. "Seed." Wheeler Hawley.
33396. Guilford River. "Seed." Wheeler Hawley.
33403. Cultivated oyster twelve to fifteen years old. Wheeler Hawley.
33391. Two years old; transplanted to Jamacia Bay, Long Island, when six months old. Cornelius Vreeland.

South Norwalk, Conn.

32957. One year old. Hoyt Bros.
32962. Three years after transplanting. Hoyt Bros.
32966. Five to twenty years old. Hoyt Bros.
32972. Hoyt Bros.

NORTH COAST OF LONG ISLAND.

Huntington Harbor.

33382. From hard bottom. Wilson Beardsley.
33386. From soft bottom. Wilson Beardsley.
33390. Natural growth. Wilson Beardsley.

Oyster Bay.

33377. Planted on hard bottom. H. A. Townsend.
33376. Planted on hard bottom. H. A. Townsend.
33381. Planted on hard bottom one year. Eighteen months old. H. A. Townsend.
33408. Natural growth on hard bottom. One year old. H. A. Townsend.
33407. Natural growth on hard bottom. H. A. Townsend.
33378. Planted on soft bottom. H. A. Townsend.
33379. Natural growth on soft bottom. H. A. Townsend.

Ostrea Virginica, Gmelin. American or Virginia oyster—Continued.

Cow Bay.

32781. B. J. M. Carley.
32812. "Cove." B. J. M. Carley.
32919. "Mill pond." B. J. M. Carley.
32779. Loyd's Harbor. B. J. M. Carley.
32791. Glenwood. B. J. M. Carley.

SOUTH COAST OF LONG ISLAND.

Great South Bay, Patchogue and Blue Point Districts.

32914. "Seed." B. J. M. Carley.
32777. B. J. M. Carley.
33392. E. G. Blackford.

Oakdale.

33411. E. G. Blackford.

Freeport.

33406. E. G. Blackford.

Jamaica Bay and Rockaway Inlet.

33410. "Rockaway." E. G. Blackford.
33412. "Jamaica Bay." E. G. Blackford.

VICINITY OF NEW YORK AND COAST OF NEW JERSEY.

New York Bay.

32782. B. J. M. Carley.
32780. B. J. M. Carley.

Shrewsbury River.

32778. B. J. M. Carley.
33393. E. G. Blackford.

Barnegat Inlet.

33558. Illustrating growth of spat and barnacles. Allan Neill.
33559. Very old. Allan Neill.

Seaville.

33417. J. W. Gandy.
33465. Natives, three years after transplanting. Peter Watkins.
33467. Natives, one, two, three, five and six years after transplanting. Peter Watkins.

Somers' Point.

33480. Natives, one, two, and three years old. H. H. Vansant.

Lake's Bay.

33499. Five years old. Alex. Fish.

Ocean View.

33471. One to three years old. J. C. Sharp.

Ostrea Virginica, Gmelin. American or Virginia oyster—Continued.

Cape May.

33452. Cape May seed. J. W. Gandy.

DELAWARE BAY.

Maurice River Cove.

32915. Three years old. B. J. M. Carley.
32568. "Extras," five years old. Thomas J. Love.
33569. Peculiar growth. Thomas J. Love.

Arnold's Point.

33577. After transplantation for six months to Maurice River Cove. Thomas J. Love.
33575. "Culls," after transplantation for six months to Maurice River Cove. Thomas J. Love.

CHESAPEAKE BAY AND SEACOASTS OF MARYLAND AND VIRGINIA.

Chesapeake Bay.

32933. State of Maryland.
32954. Herring Bay, Maryland. E. G. Blackford.
33100. Little River, Maryland. G. W. Harvey.
33096. Saint Gerome Creek, Maryland. G. W. Harvey.
33099. Point Lookout Creek, Maryland. G. W. Harvey.
33097. Deep Creek, Virginia. G. W. Harvey.
33095. Rappahannock River, Virginia. G. W. Harvey.
33102. Presby's Creek, Virginia. G. W. Harvey.
33104. Cherrystone Creek, Virginia. G. W. Harvey.
33101. Nasawaddox Creek, Virginia. G. W. Harvey.
33103. York River, Virginia. G. W. Harvey.
33506. Chesapeake oysters, four years old, transplanted in 1881 to Lake's Bay, New Jersey. Alex. Fish.
33481. Chesapeake oysters, transplanted for one and two years to Somers' Point, New Jersey. H. H. Vansandt.
33561. Chesapeake oysters, transplanted to Barnegat, New Jersey. Allan Neill.

Potomac River.

33516. Transplanted to hard bottom, Providence River, Rhode Island, in the spring of 1882; will not live through the winter. Jason S. Pierce.
33571. Transplanted in June, 1882, to Delaware Bay. Thomas J. Love.

Tangier and Pocomoke Sounds.

32976. Pocomoke Sound. E. G. Blackford.
32788. Tangier Sound. E. G. Blackford.
33098. Tangier Sound. G. W. Harvey.
33512. Transplanted to hard bottom, Providence River, Rhode Island, in the spring of 1882. Will not live through the winter. Jason S. Pierce.

Ostrea Virginica, Gmelin. American or Virginia oyster—Continued.

Sea Coast.

33505. Hog Island oysters, four years old, transplanted in 1881 to Lake's Bay, New Jersey. Alex. Fish.
33470. Hog Island oysters, three years after planting. Peter Watkins.

COAST OF SOUTH CAROLINA, GEORGIA, AND FLORIDA.

Vicinity of Charleston, S. C.

33591. Bored by *Cliona*. Two and a half years old. C. C. Leslie.
33592. Two and a half years old. C. C. Leslie.
33593. From Wadmelaw River. Cultivated. Four years old. C. C. Leslie.
33594. From Togodo River. C. C. Leslie.

Vicinity of Savannah, Ga.

33589. Two and a half years old. G. S. Hobbs.
33590. Four years old. G. S. Hobbs.

East coast of Florida.

33588. Indian River. Natives. G. S. Hobbs.

West coast of Florida.

32806. Cat Point. Lieut. Kossuth Niles, U. S. N.
32807. Lieut. Kossuth Niles, U. S. N.
32805. Appalachicola Bay. Lieut. Kossuth Niles, U. S. N.
32808. Raccoon oysters. Lieut. Kossuth Niles, U. S. N.

COAST OF LOUISIANA AND TEXAS.

32800. Timbalier Bay, Louisiana. W. Alex. Gordon.
32801. Southwest Pass, Louisiana. W. Alex. Gordon.
32802. Bayou Cook, Louisiana. W. Alex. Gordon.
32803. Four Bayous, Louisiana. W. Alex. Gordon.
32804. Grand Lake, Louisiana. W. Alex. Gordon.
33597. Galveston Harbor, Texas. Master C. McR. Winslow, U. S N.
33598. Corpus Christi, Tex. Master C. McR. Winslow, U. S. N.

PACIFIC COAST OF THE UNITED STATES.

Ostrea lurida, Cpr.

32879. Crescent City, Cal. W. H. Dall.
32809. Shoalwater Bay, Washington Territory. H. Hemphill.
32799. San Diego, Cal. H. Hemphill.
33640. R. E. C. Stearns.

Ostrea Virginica, Gmelin.

32798. San Francisco Bay, transplanted from Newark Bay, New Jersey. H. Hemphill.

SERIES ILLUSTRATING TRADE CLASSIFICATIONS.

"Cullers."

32916. Cow Bay, Long Island. Three years old. B. J. M. Carley.
32965. Long Island Sound. Three to four years old. Hoyt Bros.

Ostrea Virginica. Gmelin—Continued.

"Box."

32917. Cow Bay, Long Island. Three years old. B. J. M. Carley.
32964. Long Island Sound. Four to six years old. Hoyt Bros.

Single extra.

32918. Cow Bay, Long Island. Four years old. B. J. M. Carley.

Double extra.

32776. Cow Bay, Long Island. B. J. M. Carley,

Extra.

33568. Maurice River Cove. Five years old. Thos. J. Love.

SERIES ILLUSTRATING RAVAGES OF ENEMIES.

32956. Long Island Sound. Killed by star-fish (*Asterias forbesii*). Jas. Richardson.
32929. Long Island Sound. Killed by "hairy-whelk" (*Sycotypus canaliculatus*). Jas. Richardson.
32927. Long Island Sound. Destroyed by a whelk (*Fulgur carica* or *Sycotypus canaliculatus*). Jas. Richardson.
3151. Long Island Sound. Illustrates method of destruction by star-fish (*Asterias forbesii.*)
32928. Long Island Sound. Destroyed by "drill" (*Urosalpinx cinerea*). Jas. Richardson.
32788. Crisfield, Md. Shell covered with worm tubes. E. G. Blackford.
33566. Vicinity of New York. Shell covered with worm tubes and polyzoa. E. G. Blackford.

Ravages of boring sponge. (*Cliona sulphurea*, Verrill.)

33591. Vicinity of South Carolina. C. C. Leslie.
33377. Oyster Bay, Long Island. H. A. Townsend.
33403. Bridgeport, Conn. Wheeler Hawley.
32820. New York Bay. B. J. M. Carley.
32966. Long Island Sound. Hoyt Bros.

Ravages of boring pholad. (*Martesia cuneiformis*, Gray.)

32917. Cow Bay, Long Island. B. J. M. Carley.
33095. Rappahannock River, Virginia. G. W. Harvey.
33556. Tangier Sound. Split shells. T. W. B. Clark.
33579. Tangier Sound. Split shells in alcohol, showing pholad *in situ*. T. W. B. Clark.
33581. Tangier Sound. Split shells showing pholad *in situ*. T. W. B. Clark.
33582. Tangier Sound. Exterior of shells showing borings. T. W. B. Clark.

MODEL OF AN OYSTER-BED.

Illustrating the manner in which a natural oyster-bed is formed, the change in its condition after a period of extensive fishing, and the methods of attack of the various enemies, inhabitants of shelly areas. The vertical scale is necessarily exaggerated. Prepared by Lieut. Francis Winslow and J. Palmer.

USEFUL BIVALVES OTHER THAN OYSTERS.

Mya arenaria, Linné. Long Clam, Soft-shelled Clam, or Mananose. East coast of North America from South Carolina to Arctic Ocean. Abundant from New Jersey northward; scarce south of Cape Hatteras; abundant in San Francisco Bay, California.

32829. Canarsie Bay, Long Island. E. G. Blackford.
32955. Cape Cod, Massachusetts. E. G. Blackford.
33094. Bay of Fundy. G. F. Mathew.
33464. Ocean View, N. J. T. C. Sharp.
33474. Guilford, Conn. A. A. Foote.
*32833 (*Mya Hemphillii*), San Francisco Bay, California. H. Hemphill.

Mactra solidissima, Chemnitz. Hen Clam, Surf Clam, or Sea Clam. Florida and Gulf of Mexico to Labrador. Abundant from Delaware Bay to Cape Cod; in Casco Bay and Bay of Fundy. Low-water mark to 10 fathoms.

32869. Massachusetts Bay. W. H. Dall.

Callista gigantea, Chemnitz. Painted Clam. Southern coast of the United States.

32867. South Carolina. Dr. Wm. Stimpson.

Macoma (*sp.*) Salmon Tellen.

32874. Coast of Florida. Mr. Conrad.

Cyprina islandica, Lamarck. Sea Clam. Long Island to Arctic Ocean, in soft sand or mud, at from 10 to 100 fathoms.

33607. Vicinity of Long Island. E. G. Blackford.

Gnathodon cuneatus, Gray. Cuneate Clam. Gulf coast, vicinity of New Orleans.

32839. Lake Pontchartrain, Louisiana. Gustav Kohn.

Ensatella Americana, Verrill. Razor Fish or Razor Clam. Florida to Labrador. Common from New Jersey to Gulf of Saint Lawrence, from low-water mark to 20 fathoms.

33585. Long Island Sound. A. A. Foote.

Venus mercenaria, Linné. Quahaug or Round Clam. Abundant from Florida to Massachusetts Bay. Rare and local further north on coast of Maine, Nova Scotia, and southern shore of Gulf of Saint Lawrence. Not found on coast of Maine east of Kennebec River, nor in Bay of Fundy. The shells of *Venus mercenaria* vary so much in color and character that a number of distinct species have been described. The variations, however, are, like those of the oyster, by no means constant, and are due, principally, to the character of bottom and water. In the following series, four varieties are shown, with the intermediate types connecting them.

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* Transplanted from the east by accident, with young oysters.

Purple-shelled variety: Exterior of shell smooth and discolored; interior more or less purple tinted about margin.

32817. Rockaway, Long Island. B. J. M. Carley.
32862. Dr. Wm. Stimpson.
32877. Dr. Wm. Stimpson.
33404. Oyster Bay, Long Island. Soft bottom. H. A. Townsend.
33419. Narragansett Bay, Rhode Island. A. A. Wilson.
33428. Ocean View, N. J. Two to three years old. T. C. Sharp.
33509. Lake's Bay, N. J. Muddy bottom. Five years old. Alex. Fish.
33560. Barnegat, N. J. Allan Neill.

White-shelled variety: Exterior, rough, with high, thin concentric ribs; interior, white.

32862. Dr. Wm. Stimpson.
32838. Barataria Bay, Louisiana. Gustav Kohn.
33404. Oyster Bay, Long Island. Soft bottom. H. A. Townsend.
33405. Seaville, N. Y. J. W. Gandy.
32818. New York. B. J. M. Carley.
33446. East Greenwich, R. I. A. A. Wilson.
33478. Somers Point, N. J. H. H. Vansant.
33560. Barnegat, N. J. Allan Neill.

Intermediate: Exterior, rough; interior, purple tinted.

32862. Dr. Wm. Stimpson.
33478. Somers' Point, N. J. H. H. Vansant.
32877. Dr. Wm. Stimpson.
33428. Ocean View, N. J. Two to three years old. T. C. Sharp.
33472. New Rochelle, N. Y. A. A. Foote.
33404. Oyster Bay, Long Island. Soft bottom,
33560. Barnegat, N. J. Allan Neill.

Intermediate: Exterior, smooth; interior, white.

33472. New Rochelle, N. Y. One to four years old. A. A. Foote.
32877. Dr. Wm. Stimpson.
33560. Barnegat, N. J. Allan Neill.
33478. Somers Point N. J. H. H. Vansant.
33404. Oyster Bay, Long Island. Soft bottom. H. A. Townsend.
33421. East Greenwich, R. I. A. A. Wilson.
33446. East Greenwich, R. I. A. A. Wilson.

Elongated variety:

33405. Seaville, N. J. J. W. Gandy.
32817. Rockaway, N. J. B. J. M. Carley.

Snub-nosed variety:

32862. Dr. Wm. Stimpson.
33419. Narragansett Bay. A. A. Wilson.
32819. Fire Island, Long Island. B. J. M. Carley.

Mytilus edulis, Linné. Edible mussel. Arctic Ocean south to North Carolina on the eastern coast, and to Monterey on the Pacific coast of the United States. Abundant from New Jersey northward.

33349. East Greenwich, R. I. A. A. Wilson.
33583. Stony Creek, Long Island Sound. A. A. Foote.
33629. Vineyard Sound. U. S. Fish Commission.

Modiola plicatula, Lamarck. Grooved mussel. Georgia to Casco Bay, Maine; more rare and local further north. Abundant from New Jersey to Massachusetts.

33596. Coast of New Jersey. U. S. Fish Commission.
33486. Ocean View, N. J. T. C. Sharp.
33457. East Greenwich, R. I. A. A. Wilson.

Modiola modiolus, Turton. Horse Mussel. Greenland south to New Jersey on the eastern coast and south to Monterey on the Pacific coast of the United States. Abundant north of Cape Cod, and about Long Island and Staten Island.

33662. Georges Bank. R. H. Hurlburt.
33608. Vicinity of New York. E. G. Blackford.
34643. Stones, shells, &c., attached by byssus. E. G. Blackford.

Pecten irradians, Lamarck. Scallop. Florida and northern shores of the Gulf of Mexico to Cape Cod. Rare and local further north. Abundant from Long Island Sound southward.

33608. Great South Bay, Long Island. F. C. Dayton.

East Greenwich, R. I.

33567. Series illustrating color variations. A. A. Wilson.

SERIES ILLUSTRATING GROWTH.

33431. Size during first week in September.
33432. Size during second week in September.
33433. Size during third week in September.
33434. Size during fourth week in September.
33435. Size during first week in October.
33436. Size during second week in October.
33437. Size during third week in October.
33438. Size during fourth week in October.
33439. Size during first week in November.
33440. Size during second week in November.
33441. Size during third week in November.
33442. Size during fourth week in November.
33443. Size when about one year old—marketable.
33444. Size when fifteen months old.
33445. Size when twenty-seven months old (very rare).

Pecten tenuicostatus, Mighels. Great or Giant Scallop. New Jersey to Labrador. Rare and local south of Cape Cod. Abundant in Frenchman's Bay, Mount Desert. Common in Massachusetts and Casco Bays and Bay of Fundy.

33631. Cape Cod, Massachusetts. U. S. Fish Commission.
32979. Castine, Me. Showing ravages of boring sponge (*Cliona sulphurea*). A. R. Crittenden.
32980. Castine, Me. Showing ravages of boring sponge (*Cliona sulphurea*). L. J. Heath.

Argina pexata, Gray. Bloody Clam. Florida and northern shores of the Gulf of Mexico to Cape Cod. Rare and local further north. Abundant from New Jersey to Massachusetts.

33570. Maurice River Cove, Delaware Bay. Thos. J. Love.
33460. East Greenwich, R. I. A. A. Wilson.

Glycimeris generosa, Gould. Geoduck or Giant Clam. Pacific coast, in rivers and estuaries, from Puget Sound to San Diego. Not common as southern limit is approached, nor very abundant at any point.

33614. California coast. R. E. C. Stearns.
33615. California coast. R. E. C. Stearns.

Siliqua patula, Dixon. Razor Clam. From Vancouver's Island to San Diego. Coast of California. Abundant in Oregon and Washington Territory and adjacent islands.

32881. W. H. Dall.

Semele decisa, Cpr. Flat Clam. San Diego and California coast.

32847. San Diego, Cal. H. Hemphill.

Platyodon cancellatus, Conrad. Date Fish. San Diego, Santa Barbara, and San Francisco, Cal. Coast of California.

32850. Baulinas Bay. H. Hemphill.

Zirphœa crispata, Mörch. Date Fish. Northwest coast of America to California, Puget Sound, Vancouver Island, San Diego, and San Pedro.

32856. Baulinas Bay. H. Hemphill.
33641. R. E. C. Stearns.

Macoma nasuta, Conrad. Tellen. Kamschatka to San Diego, Cal. Littoral, 3 feet in mud.

32848. San Francisco market. H. Hemphill.

Saxidomus aratus, Gould. Round Clam. San Francisco Bay and San Diego, Cal.

32843. San Diego, Cal. H. Hemphill.

Chione succincta, Valenciennes. Little Neck Clam. Coast of California.

32841. San Diego, Cal. H. Hemphill.

Chione simillima, Sowerby. Little Neck Clam. San Francisco to San Diego, Cal.

32842. San Diego, Cal. H. Hemphill.

Tapes staminea, Conrad. Little Neck Clam. Coast of California. Littoral, 2 feet in mud.

32854. Baulinas Bay, California. H. Hemphill.
32844. Tomales Bay, California. H. Hemphill.

Tapes laciniata, Cpr. Little Neck Clam. Monterey and San Diego, Cal.

32846. San Diego, Cal. H. Hemphill.

USE OF ORNAMENTAL BIVALVES OTHER THAN THOSE AFFORDING FOOD.

Pearl-producing.

Unionidæ.

Unio (various sp.). River Mussels. Fresh water streams of the United States. Abundant in the rivers of the Western States.

25986 to 26010. Series having both valves polished. From Dr. C. A. Miller, Cincinnati, Ohio. Comprises the following species:

Unio metanevrus, Rafinesque.
alatus, Say.
ornatus, Lea.
verrucosus, Barnes.
gibbosus, Barnes.
rectus, Lam.
cylindricus, Say.
pyramidatus, Lea.
tuberculatus, Barnes.
luteolus, Lamarck.
circulus, Lea.
anodontoides, Lea.
pustulosus, Lea.
crassidens, Lamarck, &c.

26092*a*. River mussel affording pearl-shell, illustrating application of raw material. Cincinnati, Ohio. D. Shaffer.

26092. Carvings, from pearl-shell afforded by river mussels, for use as studs, buttons, pins, brooches, &c. Cincinnati, Ohio. D. H. Shaffer.

26092*b*. Pearls derived from river mussels. Cincinnati, Ohio. D. H. Shaffer.

Aviculidæ.

Margaritiphora fimbriata, Dkr. Pearl Oyster. Head of Gulf of California to Panama. Common in the region of La Paz, Lower California, and in vicinity of Panama.

13507. Colonel Jewett.

3624. Illustrating formation of pearls. Panama. Colonel Jewett.

32836. Gulf of California. J. Xantus.

——. Polished shell. Chicopee, Mass. Jas. T. Ames.

32921. Made into artificial fish-bait. Boston, Mass. Bradford & Anthony

32922. Made into artificial minnow. Boston, Mass. Bradford & Anthony

——. Series of buttons, studs, stopper-caps, &c. Manufactured from, and showing application of, American pearl-oyster shell. Furnished by A. B. De Frece & Co., 428 Broadway, New York.

Otherwise useful and ornamental.

Composition shell-work for box-covers and frames, made by gluing shells in mosaic.

29527. Basket. Made from Florida shells. E. F. Gilbert, Jacksonville Fla.

22210. Basket. Made from Florida shells. Mrs. Mott, Jacksonville, Fla

22209. Frame. Made from Florida sea-shells. Mrs. C. E. Mott, Jacksonville, Fla.

22211. Easter Cross. Made from Florida shells. Mrs. Mott, Jacksonville.

29526. Shell flowers. Made from Florida shells. E. F. Gilbert, Jacksonville, Fla.
32869. "Hen Clam" (*Mactra solidissima* Chem). Painted inside and used for catch-alls.
32840. Cuneate clam (*Gnathodon cuneatus*). Semi-fossil (in shell heaps); used for macadamizing roads. Lake Salvador, Louisiana. Gustav Kohn.

Injurious bivalves.

Teredo. SHIP-WORM.

T. navalis, Linné. Florida to Vineyard Sound. *T. megotara*, Hanley. Massachusetts to South Carolina. *T. Thomsonii*, Tryon. Massachusetts and Buzzard's Bay. *T. dilatata*, Tryon. Massachusetts to South Carolina. *Xylotrya fimbriata*, Jeffreys. Long Island to Florida.

Specimens of wood showing ravages.

32982. Bangor, Me. (Brig H. B. Emory.) C. H. Parker.
32908. In lignum-vitæ wood. Gloucester, Mass. Samuel Elwell, jr.
33106. (*Teredo chlorotica*, Gld.) Wood's Holl, Mass. Vinal N. Edwards.
33105. (*Xylotrya fimbriata*, Jeffr.) Wood's Holl, Mass. Vinal N. Edwards.
32984. (*Teredo navalis?* L.) New Haven, Conn. A. E. Verrill.
32902. (*Teredo* sp.) Showing damage effected in white-pine wood in one year. Pier 44, North River, N. Y. W. T. Pelton.
32901. Showing damage to hard-pine wood effected in one year. Charleston, S. C. W. T. Pelton.
32983. Schooner Carrie Melvin; done in six weeks. Charleston, S. C. A. G. Hunt.
32815. (*Teredo* sp.). Gulf coast. Dewey.
32816. Showing lining of tubes. Texas. Dr. Schott.
19405. (*Xylotrya* sp.) Coast of Oregon. J. G. Swan.
33616. (*Teredo* sp.) Showing ravages in six weeks. Indian River, Fla. G. S. Hobbs.
33617. (*Teredo* sp.) Showing ravages in three months. Indian River, Fla. G. S. Hobbs.
33638. (*Teredo* sp.) Wood showing ravages. U. S. Fish Commission.
33630. *Teredo megotara*. Hanley. Off Martha's Vineyard. (Specimens in alcohol.) U. S. Fish Commission.

Martesia cuneiformis, Gray. Boring pholad. Southern coast of the United States to New Jersey. Rare and local further north, and in Long Island Sound. Abundant on oyster-beds of Chesapeake Bay.

33580. Tangier Sound, Maryland. T. W. B. Clark.
(For illustration of ravages, see oyster section, "Ravages of enemies.")

Enemies other than mollusca, inhabiting oyster-beds and destructive to shell-fish.

Panopeus Sayi, Smith. Mud Crab.

3628. Off Martha's Vineyard. U. S. Fish Commission.
(See Section, *Crustacea, Echinoderms, &c.*)

Cancer irroratus, Say. Rock Crab.

3630. Vineyard Sound. U. S. Fish Commission.
(See Section, *Crustacea, Echinoderms, &c.*)

Carcinas Mœnas, Gould. (*Carcinus granulatus*, Say.) Green Crab.

3627. Vineyard Sound. U. S. Fish Commission.
(See Section, *Crustacea, Echinoderms, &c.*)

For other crabs see Section, *Crustacea, echinoderms, &c.*

Asterias Forbesii, Verrill. (*Asterias arenicola*, Stimpson.) Green Star-fish.

5559. Vineyard Sound. U. S. Fish Commission.
(See Section, *Crustacea, Echinoderms, &c.*)

Microciona prolifera, Verrill. Red, Branching Sponge.

531. Wood's Holl, Mass. U. S. Fish Commission. (Not directly injurious.)
(See Section, *Crustacea, Echinoderms, &c.*)

Cliona sulphurea, Verrill. Boring Sponge.

1010. Vineyard Sound. U. S. Fish Commission.
(See Section, *Crustacea, Echinoderms, &c.* For ravages, see oyster section, "Ravages of enemies.")

Archosargus probatocephalus (Walb.) Gill. Sheepshead.
See "Fishes." Family *Sparidæ.*

Pogonias chromis, Lacep. Drum.
See "Fishes." Family *Sciænidæ.*

COMMENSAL.

Pinnotheres ostreum, Say. Oyster Crab. Commensal with southern oysters and with northern in rivers where southern oysters have been long planted.

4991. New York market. E. G. Blackford.

Pinnotheres maculatus, Say. Commensal with edible mussel (*Mytilus edulis*) and Great Scallop (*Pecten tenuicostatus*).
For specimen see Section, *Crustacea, Echinoderms, &c.*

SHELL-FISH FISHERY.

VESSELS AND BOATS.

55804. Model of an oyster schooner. Chesapeake and Delaware Bay type. Used in dredging oysters. U. S. Fish Commission.
26536. Model of an oyster schooner. (Scale, 1 inch to the foot.) Chesapeake and Delaware Bay type. Used in dredging oysters. T. B. Ferguson.
25002. Model of a Chesapeake canoe-pungy. (Scale, 1 inch to the foot.) Used in dredging oysters. T. B. Ferguson.
55807. Model of an oyster pinkie. U. S. Fish Commission.
42758. Model of a Chesapeake oyster-pungy. T. B. Ferguson.

25003. Model of a Chesapeake oyster-canoe. (Scale, 1 inch to a foot.) Made from two logs and used in "tonging" oysters in Chesapeake Bay. T. B. Ferguson.

22217. Model of a fishing boat used by Chinese fishermen on the Pacific coast in shell-fishery. Livingstone Stone.

22213. Model of a fishing boat used on the Pacific coast in the shell-fishery. Livingstone Stone.

25657. Model of a Nantucket dory. (Scale, 1 inch to the foot.) Used in gathering clams for bait. W. H. Chase.

12678. Model of a New England dory. (Scale, 1 inch to the foot.) Used in gathering and transplanting clams. Starling & Stevens, Ferryville, Me.

24752. Model of a Connecticut sharpie. (Scale, 1 inch to the foot.) Used in the oyster and scallop fisheries of Long Island and Long Island Sound. H. C. Chester.

29537. Model of Providence River cat-boat. Used in scallop fishery. J. M. K. Southwick.

—— Crayon showing clamming dories on the beach. U. S. Fish Commission.

—— Crayon showing Connecticut steam oyster-dredger "W. H. Lockwood," at work off New Haven. U. S. Fish Commission.

The types, such as cat-boats, dories, sloops, and small schooners, used along the New England coast in the seine and line fishing, are also employed indiscriminately in the shell-fish fisheries, especially those of the oyster and scallop. In Long Island Sound, of late years, these craft have been superseded, however, to a great extent, by the steam dredging vessels. For other models see Industrial Exhibit.

IMPLEMENTS.

57570. Oyster dredge used by Connecticut steam oyster dredgers. When of this size but two are used, one on each side of the vessel. With smaller sizes, four are operated at the same time. C. D. Hall.

57089. Oyster dredge with teeth. Style in general use in Chesapeake and Delaware Bays. U. S. Fish Commission.

57090. Oyster scrape without teeth. Style in general use in Chesapeake and Delaware Bays, in shallow water and on soft bottom. U. S. Fish Commission.

31792. Model of an oyster dredge, and patent "winder." Showing method of operating the dredging apparatus. C. S. Belbin.

57092. Improved "winder" or windlass for hauling in oyster dredges. U. S. Fish Commission.

57693. Oyster tongs, 10-foot handles and 10 teeth. Galvanized iron frame. U. S. Fish Commission.

57694. Oyster tongs, 10-foot handles and 10 teeth. Galvanized iron frame. U. S. Fish Commission.

26110. Oyster tongs, 8-foot handles and 12 teeth. Head of wood, frame of small brass rods. S. Salisbury.

26109. Oyster-tongs. 8-foot handle and 8 teeth. Head of wood, frame of small brass rods. S. Salisbury.

25205. Oyster-tongs. 8-foot handle and 10 teeth. Frame, head, and teeth of galvanized iron. Wilcox & Crittenden.

29111. Oyster-nippers. 8-foot handle and 3 teeth, 2½ inches long. S. Salisbury.

57806. Model of oyster-tongs. W. P. Haywood.

57557. Scallop-dredge, Narragansett Bay. For use on hard bottoms. A. A. Wilson.

57558. Scallop-dredge, Narragansett Bay. "Slider" style; for use on grassy bottoms. A. A. Wilson.

57559. Scallop-dredge, Narragansett Bay. "Kettle-bail" style; for use on muddy bottoms. A. A. Wilson.

57087. Scallop-dredge, New Bedford. Old style with twine net. J. T. Brown.

57088. Scallop-dredge, New Bedford. New style, with iron-mesh net. J. T. Brown.

57091. Clam rake. Provincetown, Mass., style. Used in taking sea-clams. (*Mactra solidissima.*) J. T. Brown.

57695. Clam rake. Nantucket style. 13-foot pole, 23 teeth, twine net. Used in taking sea-clams. (*Mactra solidissima.*) U. S. Fish Commission.

29466. Clam hoe. Provincetown, Mass. Wm. H. Hesbolt.

29437. Hand-claw. Used for gathering "hen" clams and scallops. Wellfleet, Cape Cod, and coast of Maine. M. W. Grant.

36043. Clam rake. 23-foot pole, 16 teeth 6 inches long. Used in taking "quahaugs" (*Venus mercenaria*) and "hen" clams. (*Mactra solidissima.*) U. S. Fish Commission.

36040. Clam rake. 18-foot pole, 16 teeth 6 inches long. Used in taking "quahaugs" (*Venus mercenaria*) and "hen" clams. (*Mactra solidissima.*) U. S. Fish Commission,

36045. Clam rake. Wellfleet style. U. S. Fish Commission.

36046. Clam rake. Wellfleet style. 5-foot handle, 13 teeth, 5 inches long. Used in taking "quahaugs" (*Venus mercenaria.*) U. S. Fish Commission.

36047. Clam rake. Wellfleet style. 5 foot handle, 17 teeth 6 inches long. Used in taking "quahaugs" (*Venus mercenaria.*) U. S. Fish Commission.

—— Clam rake (model) used in collecting sea-clams. (See model of Nantucket dory.)

—— Oyster shovel (model). (See model of Chesapeake oyster canoe.)

The moss rakes, large and small, and various agricultural implements such as spades, shovels, hoes, &c., are used in taking clams and other shell-fish; but they are not exhibited in this section.

OYSTER CULTIVATION.

Tracing of the official map of the Shell-Fish Commissioners of the State of Rhode Island, showing location of oyster-farms in the Providence River and Narragansett Bay, and illustrating the methods employed in assigning portions of the bottom for oyster-cultivation, and in maintaining the buoys and marks in proper position. Scale $\frac{1}{10000}$. Index plan of the above. Scale $\frac{1}{80000}$.

Copy of the official map of the Shell-Fish Commissioners of the State of Connecticut, showing the natural beds, the area under cultivation, and the area designated or applied for but not yet improved; and illustrating the system adopted by the State of Connecticut for the purpose of en couraging the oyster industry.

Copy of the the triangulation sheet of the Connecticut commission. Contributed by the shell-fish commission of the State of Connecticut.

Copy of the map of the town commissioners of Patchogue, Long Island, showing the oyster-farms and areas belonging to the various oyster companies and oyster associations of Great South Bay, Long Island.

For laws and regulations governing oyster-farming in the foregoing localities, see "Introduction" and reports of commissioners in the collection of publications.

METHODS OF PRESERVING AND TRANSPORTING SHELL-FISH.

Models of the apparatus used in "steaming" oysters, including the following articles:

Tram-car of iron, on iron wheels, for holding oysters while in steam-chest, and transporting them thence to the opening room.

Steam-chest of oak, lined with iron and fitted with appliances for admitting steam when doors are closed. Doors movable vertically and close fitting.

Iron tracks for car.

Turn-table for car.

Tin pot fitted to hook to side of car and into which the oysters are put as soon as opened.

Sieve in which the oysters are put for washing after reception from openers.

Table upon which the oysters are placed after washing and where the cans are filled and weighed.

Crate or basket, circular in form and of iron, into which the cans are piled, regularly, after being filled. Models of cans shown in position.

Dray for transporting cans.

Derrick for raising crates in transporting them from process-kettle to cooling-tub.

Process-kettle, circular, of iron, lid closing hermetically, and fitted with steam-pipes and thermometer. In the course of preparation the crates containing the cans of oysters are placed in the kettle, the lid closed, and the steam turned on.

Cooling-tub, of wood, containing cold water. The crates with contents are transferred to this tub, after steaming, in order to cool them.

Capping-table. The cans are transferred to this table, from the cooling-tub, and there have the caps soldered on.

Capping-iron (natural size). This is an arrangement of an ordinary soldering iron, so as to facilitate the soldering of the cans.

Models of the apparatus used in opening and packing oysters.

Shucking trough, with stand for workman, hammer, knife, block, two buckets; one to receive small oysters, the other for "selects."
Skimmer and gallon pot for receiving oysters from the shuckers.
Three tubs, one to receive small oysters, one for "selects," and one holding water.
Cullender in which the oysters are washed.
Shake-bucket for transferring oysters to and from tubs.
Table holding the cans to be filled.
Dipper for holding water.
Cup for holding oysters.
Cup for holding water.
Funnel for filling cans.
Case in which cans are packed for shipment.

Implements used—natural size.

Set of measuring cups.
"Dipper."
Set of funnels.
Shake-bucket.
Gallon pot.
Hammer.
Knife.
Shucker's buckets.
Block.
Case containing cans. A. Booth & Co., Baltimore, Maryland.
Oyster tubs and buckets used in transporting shell-fish. W. S. Robinson & Co., New Haven, Connecticut.
Oyster-tubs used in the Western States in transporting oysters. Mann Bros., Chicago, Illinois.