the shells and pebbles or between the ascidians, &c., like many of the larger annelids, some of the crabs, and other crustacea, &c.; they may be species that live among or attached to the hydroids, bryozoa, ascidians, and algæ which grow upon the shells and pebbles; such are many of the small crustacea, some annelids, many small gastropod shells, and most of the more delicate bryozoa and hydroids; or they may be larger kinds that creep or swim about over the bottom, in search of food, such as the lobster, the larger crabs, hermit-crabs, large gastropod mollusks, star-fishes, sea-urchins, holothurians, &c. Owing to the great abundance of animal life on bottoms of this character they are the favorite feeding-grounds of many kinds of fishes, such as the tautog, scup, black bass, haddock, and cod, together with many others that are less valuable. Most of the "banks" and "fishing-grounds" resorted to by the line fishermen have either gravelly and shelly or else rocky bottoms, and those banks most frequented by fishes are almost always found to be rich dredging-grounds. The gravelly banks in this region are, in winter and spring, fishing-grounds for cod and haddock, but these fishes retreat to colder waters in the summer.

Among the Crustacea the most abundant and important species are the lobster, *Homarus Americanus*, (p. 395,) the common shrimp, *Crangon vulgaris*, (p. 339, Plate III, fig. 10,) the common rock-crab, *Cancer irroratus*, (p. 312,) *Panopeus Sayi*, (p. 312,) *P. depressus*, (p. 312, Plate I, fig. 3,) the larger hermit-crab, *Eupagurus pollicaris*, (p. 313,) the smaller hermit-crab, *E. longicarpus* (p. 313,) the *Heteromysis formosa*, (p. 396,) *Mysis Americana*, (p. 396,) *Unicola irrorata*, (p. 340, Plate IV fig. 19,) *Amphithoë maculata*, (p. 315, Plate IV. fig. 16,) *Corophium cylindricum*, (p. 370,) which lives among the hydroids, and a species of *Autonoë*, which lives in the crevices among the lobes of the sandy ascidians (*Amarœcium pellucidum*) in large numbers. The barnacle, *Balanus crenatus*, (p. 396,) is very abundant.

One of the most interesting of the Crustacea met with was the *Heterocrypta granulata*, which occurred off Falmouth and near Suconesset light-ship. This is one of the triangular crabs in which the carapax is smooth; the chelipeds are long and triangular. It is a southern species, occurring on the Florida coast, and is new to our fauna.

Another triangular crab, the *Pelia mutica*, also occurs on these bottoms, but this has a rough carapax, and resembles a small specimen of the common spider-crabs, *Libinia*.

Clinging to and creeping over the hydroids and ascidians a singular long-legged Pycnogonid is often met with on shelly bottoms. This is the *Phoxichilidium maxillare*, (Plate VII, fig. 35.) It is most frequently deep purple in color, but gray and brown specimens are often met with.

The larvæ of a fly, *Chironomus halophilus*, was dredged in five fathoms.

The Annelids are quite numerous, and the majority of them are the same as those found on the rocky bottoms, for the same species inhabit the interstices of the massive ascidians, found equally on both kinds of

bottom, and the same tube-dwelling species can attach themselves to stones and shells just as well as to rocks. Most of the additional species are burrowing kinds, and some of them probably inhabited patches of mud or sand. Among the more interesting species are *Nephthys bucera*, (Plate XII, fig. 58;) *Anthostoma acutum* V., a new species; *Scolecolepis cirrata*, new to the American coast; *Scalibregma brevicauda* V., a very interesting new species; *Cirratulus tenuis* V., a new species; *Amphaarete setosa* V., also a new species; *Serpula dianthus* V., (p. 322.) Several rare or undescribed species were also met with that have not yet been fully identified. Among these were a peculiar species of *Nereis*; a large *Anthostoma*; a young *Polydora*; an apparently undescribed species of *Samytha*; a species of *Euchone*, perhaps identical with *E. elegans* V.; the calcareous tubes of a small worm, perhaps a *Vermilia*, which have two carina on the upper side.

Two species of Sipunculoids occurred, one of which is probably undescribed. The other is the *Phascolosoma cœmentarium*, (Plate XVIII, fig. 92,) a species very common on all the northern coasts of New England in deep water. This worm takes possession of a dead shell of some small Gastropod, like the hermit-crabs, but as the aperture is always too large for the passage of its body, it fills up the space around it with a very hard and durable cement, composed of mud and sand united together by a secretion from the animal, leaving only a small, round opening, through which the worm can extend the anterior part of its body to the distance of one or two inches, and into which it can entirely withdraw at will. It thus lives permanently in its borrowed shell, dragging it about wherever it wishes to go, by the powerful contractions of its body, which can be extended in all directions and is very changeable in form. When fully extended the forward or retractile part is long and slender, and furnished close to the end with a circle of small, slender tentacles, which surround the mouth; there is a band of minute spinules just back of the tentacles; the anal orifice is at the base of the retractile part; the region posterior to this has a firmer and more granulous skin, and is furnished toward the posterior end with a broad band of scattered, blackish, acute, recurved spinules, more or less triangular in form, which evidently aid it in retaining its position in the shell. As it grows too large for its habitation, instead of changing it for a larger shell, as the hermit-crabs do, it gradually extends its tube outward beyond the aperture by adding new materials to it. Some of the fishes often suddenly cut short this labor by swallowing the worm, shell and all.

In July the common squids, *Loligo Pealii*, (Plate XX, figs. 102-105,) were taken in considerable numbers by means of the trawl, on gravelly and shelly bottoms off Falmouth, and with them large quantities of the eggs contained in large bunches or groups of long, gelatinous capsules. They were apparently spawning at that time.

Although the Gastropod mollusks are seldom very numerous at any particular spot on these bottoms, yet a pretty large number of species

occur, and they are quite generally diffused. Many of them have already been enumerated as occurring on rocky bottoms. The *Fulgur carica*, (p. 355, Plate XX, fig. 124,) and the *Sycotypus canaliculatus*, (p. 355,) are found chiefly on these bottoms, and are often very abundant. Over a barrel of living specimens were obtained on a single excursion. The *Lunatia heros*, (p. 354, Plate XXIII, figs. 133–136,) though generally found on the sandy bottoms, also occurred in great numbers and of very large size on some of the gravelly bottoms. The pretty little *Natica pusilla* (Plate XXIII, fig. 132) is often common on these bottoms; it is usually delicately painted with brown.

The *Crepidula fornicata* (p. 355, Plate XXIII, figs. 129, 129*a*) was one of the most abundant species, often occurring adhering to each other in great clusters, the lowest ones in the group adhering in turn to dead bivalve shells, pebbles, shells of living *Fulgur* and *Sycotypus*, and still more frequently to these shells when dead and occupied by the larger hermit-crabs, (*Eupagurus pollicaris.*) The dead shells of this *Crepidula* were often found in great accumulations, covering considerable areas of bottom, and with but little admixture, either with other shells or with sand and gravel.

The *Crepidula unguiformis*, (p. 355, Plate XXIII, fig. 127,) though very common, did not occur in such great quantities. *Crucibulum striatum* (p. 399, Plate XXIII, figs. 125, 126) is also common, adhering to various dead shells.

The *Vermetus radicula* (Plate XXIV, fig. 157) is a very curious shell, looking, when full grown, very much like the tube of an Annelid, such as *Serpula* or *Protula*, but the inhabitant is a genuine Gastropod, and has a thin, spiral, horny operculum, for closing the aperture when it withdraws. When young this shell often forms a very regular, closely coiled, spiral shell, looking like that of a *Turritella*, and sometimes does not become irregular until the spire is more than an inch long, but sooner or later it goes off on a tangent and becomes irregular and crooked. Sometimes several of these shells interlock irregularly and thus form large clusters.

The curious and minute *Cœcum pulchellum* (Plate XXIV, fig. 158) is occasionally met with in considerable numbers, though very liable to be overlooked owing to its very small size. *Cœcum costatum* V. is of less frequent occurrence, and easily distinguished by the prominent ridges or ribs that run lengthwise of the shell.

Wherever algæ occur in abundance on these bottoms, the *Bittium nigrum* (p. 305, XXIV, fig. 154) is found in immense numbers, and it is generally associated with *Lacuna vincta* (p. 305, Plate XXIV, fig. 139) and with a few specimens of *Triforis nigrocinctus*, (p. 305, Plate XXIV, fig. 152,) *Cerithiopsis Greenii*, (Plate XXIV, fig. 153,) *Astyris lunata*, (Plate XXI, fig. 110,) *Anachis avara*, (Plate XXI, fig. 109,) &c. On the shelly bottoms *Cerithiopsis terebralis* and *C. Emersonii* ofter occur, but they are not usually common. On similar bottoms, sometimes adhering to

Pecten and other shells, we often met with the various species of *Odostomia*, among which *O. seminuda* (Plate XXIV, fig. 148,) was much the most common; but *O. producta*, (Plate XXIV, fig. 143,) *O. impressa*, (Plate XXIV, fig. 147,) and *O. trifida*, (Plate XXIV, fig. 145,) occurred in shallow water; and also *Turbonilla elegans*, (Plate XXIV, fig. 155,) which is a very handsome, glossy, brown shell; and *T. interrupta*, which is a similar shell, but more slender, with less convex whorls. The *Eulima oleacea* (Plate XXIV, fig. 149) is a very elegant, white, polished, and shining shell, and generally rare, but in two instances we found several of them adhering to the skin of the large Holothurian, *Thyone Briareus*, upon which it seemed to live as a quasi parasite or "commensal."

On shelly and muddy bottoms we occasionally found *Scalaria lineata*, (Plate XXI, fig. 123,) and *S. multistriata*, (Plate XXI, fig. 122,) both of which are rare and elegant shells. The *Pleurotoma bicarinatum* (Plate XXI, fig. 106) occurred rarely.

The bivalve shells are also quite numerous on these bottoms. Among them the *Mactra solidissima* (p. 358, Plate XXVIII, fig. 203) is most conspicuous on account of its great size and frequent occurrence; its dead shells were often very abundantly scattered over the bottom, and were generally incrusted with numerous bryozoa and hydroids. The *Gouldia mactracea* (Plate XXIX, figs. 206, 207) was quite common in many localities in a living state, while the dead shells were generally diffused. Among the other species that are common or abundant are *Scapharca transversa*, (Plate XXX, fig. 228,) *Clidiophora trilineata*, (Plate XXVII, fig. 193,) *Nucula proxima*, (Plate XXX, fig. 230,) *Mytilus edulis*, (Plate XXXI, fig. 234,) *Modiola modiolus*, (Plate XXXI, fig. 237,) *Crenella glandula*, (Plate XXXI, fig. 233,) *Pecten irradians*, (Plate XXXII, fig. 243,) *Anomia glabra*, (Plate XXXII, figs. 241, 242.) The *Modiolaria nigra* (Plate XXXI, fig. 236) occurred only in few localities in the deep water of the middle of the Sound, associated with the common muscle. The *Cumingia tellinoides* (Plate XXX, fig. 221) was found living occasionally, but its dead shells were quite common. The same is true of *Corbula contracta*, (Plate XXVII, fig. 191,) which was perhaps a little more commonly found living than the last. The *Cyclas dentata* (Plate XXIX) fig. 211,) is a handsomely sculptured, pure white shell, which we met with only a few times in the living state, though dead valves often occurred. The same remarks will apply to *Coclodesma Leanum*, (Plate XXVII, fig. 198,) of which the shells were much more common. The *Kellia planulata* (p. 310,) and *Montacuta elevata* also occasionally occur on shelly bottoms, but were seldom obtained alive. The *Cyclocardia borealis* (Plate XXIX, fig. 216) and *C. Novangliæ* (Plate XXIX, fig. 215) were quite common in the deeper waters.

The *Gastranella tumida* V., (Plate XXVII, fig. 190) is a small and rare shell, recently discovered, and has, as yet, been found only on a shelly bottom among hydroids, near New Haven, in 4 or 5 fathoms. The *Angulus modestatus* V. (Plate XXX, fig. 224) is a species recently

described from specimens dredged by us in Vineyard Sound. It is often handsomely banded with light red and pale yellow. It is still a rare species, but has been dredged also near New Haven.

The Ascidians, with the exception of one or two additional species seldom met with, are the same as those of the rocky bottoms, and they often occur in immense quantities, especially the massive sandy ones, *Amarœcium pellucidum*, (p. 401,) and the "sea-pork," *A. stellatum*, (p. 402,) which together often almost entirely cover the bottom over areas many acres in extent. They furnish excellent hiding-places in the openings and crevices between their lobes for numerous Crustacea and Annelids, many of which can be easily secured by putting the masses of these ascidians into buckets of water and leaving them until the water begins to get stale, when they will come out of their retreats in large numbers and seek the surface or edges of the water for oxygen. Or they may be pulled apart directly and the various creatures secured at once.

The *Molgula arenata* (Plate XXXIII, fig. 251) is a nearly globular, but often somewhat flattened species, which covers itself over with closely adherent grains of sand or gravel. It is most common on sandy bottoms but is found also on gravelly ones.

The *Ciona tenella* is an elongated, erect species, attached at base to rocks, dead shells, &c. It is remarkable for the transparency, whiteness, and softness of its integument, and for the bright orange ocelli around its orifices. It is rare in this region, but very common in the Bay of Fundy.

The Bryozoa are very abundant, especially on the shelly bottoms. Some of them grow on algæ, hydroids, ascidians, &c.; and many form incrustations on the dead shells and pebbles. The two most abundant and prominent species are *Bugula turrita* (p. 311, Plate XXXIV, figs. 258, 259) and *Escharella variabilis*, (p. 312, Plate XXXIII, fig. 256.) The former grows attached to the various sea-weeds in great quantities, forming delicate white plumes, often six inches to a foot in length. The latter mostly forms calcareous incrustations over the surfaces of dead shells and pebbles, thin at first, but eventually becoming thickened by the formation of layer over layer, until the crust may become half an inch to an inch in thickness, with a tabulated and vesicular structure in the interior. The masses thus formed often closely resemble genuine corals, especially some of the ancient fossil forms, and they often occur in great quantities. When living the color is dull red, but when recently dried they have a yellowish-green color, which easily bleaches out, however, by exposure to the sun and air. *Vesicularia dichotoma*, (p. 404,) *Alcyonidium ramosum*, (p. 404, Plate XXXIV, fig. 257,) and *Crisia eburnea* (p. 311, Plate XXXIV, figs. 260, 261) are usually abundant. Most of the remaining species have also been mentioned in the previous pages as inhabitants of rocky bottoms, or else among the shore species.

Among the species not previously mentioned are *Cellepora scabra*,

which forms branching, coral-like masses on the slender red algæ; a species of *Lepralia*, found with the last, and also on shells, which is allied to *L. Pallasiana* of Europe; *Mollia hyalina*, which forms circular disks, with irregular, more or less oblique cells; and *Membranipora tenuis*, which is common on the pebbles, often covering their whole surface with a delicate lace-like incrustation, made up of very small, crowded, oval or oblong cells, which have the inner part of the front partly closed over, but with an irregular, mostly three-lobed aperture toward the outer end, which is bordered by small, irregular spinules.

The *Vesicularia fusca* was also found in a few instances, in deep water. It had not been previously known on the American coast. Good specimens of the *Caberea Ellisii* were also dredged in the deeper parts of Vineyard Sound, attached to ascidians.

Of Echinoderms the number of species is not large. The common green star-fish, *Asterias arenicola* (Plate XXXV, fig. 269) is very common; the *Cribrella sanguinolenta*, (p. 407,) is comparatively rare; and the green sea-urchin, *S. Dröbachiensis*, (p. 406,) is quite infrequent. The purple sea-urchin, *Arbacia punctulata*, (p. 326,) is, however, quite common in many localities. The largest and finest specimens were taken off Holmes' Hole, but it was quite abundant, though of moderate size, in Great Harbor and Wood's Hole passage. The *Thyone Briareus* (p. 362) is not uncommon in shallow water, especially among weeds; it has already been mentioned, (p. 418,) as carrying *Eulima oleacea* attached to its skin.

Another Holothurian, the *Pentamera pulchella*, seems to be quite common, judging by the numerous specimens thrown on Nobska beach by the storms, and preserved for us by Mr. Vinal N. Edwards, during the past winter, but it was dredged only in one locality, off Holmes' Hole, by Messrs. T. M. Prudden and T. H. Russell. It is a southern species, not previously known north of the Carolina coasts. It is easily distinguished from the preceding species by its light color, and by having the locomotive-suckers arranged in five broad and very distinct longitudinal bands, with naked spaces between them.

A very delicate little Ophiurian, the *Amphipholis elegans*, was occasionally met with on the shelly bottoms. This is a northern species, much more common in the Bay of Fundy, where it is found from low-water mark to 80 fathoms, and it is found also on the northern coasts of Europe. It has a nearly circular disk, covered with smooth scales, regularly arranged, and each of the scales, on the sides of the slender rays, bears three short, blunt spines. Its color is usually light gray or whitish, frequently more or less marked with dark gray or brown.

The Hydroids are numerous on these bottoms, and mostly of the same species that have been mentioned as occuring on rocky bottoms.

The Polyps are few and essentially the same as those on the rocky bottoms. The only additional species was a small, slender, undescribed

species of *Edwardsia*, *E. lineata* V., living in the interstices among ascidians and the tubes of *Sabella* and *Potamilla*.

Sponges also occur in considerable numbers. Among them the most conspicuous is the *Cliona sulphurea*, a bright sulphur-yellow species, growing into hemispherical or irregular, massive forms, of firm texture, the surface covered with scattered, low, wart-like, soft prominences, about an eighth of an inch in diameter, which contract when the sponge is dried, leaving shallow pits. The sponge commences as a boring species, on various dead shells, and as it grows it penetrates the shells in every direction, forming irregular holes and galleries, which continue to grow larger as more and more of the substance of the shell is absorbed, until the shells are reduced to a completely honey-combed, brittle mass, or a mere skeleton; finally the sponge begins to protrude from the surface, and grows up into mammilliform masses, or small, rounded crusts, which continue to grow and spread in every direction, until finally they may form masses six or eight inches in diameter, with the base spreading over and enveloping various dead shells, pebbles, and the coral, *Astrangia Danæ*, though it often happens that living specimens of the latter grow upon the sponge. Owing to the remarkable boring habits of this and other allied sponges, they are very important in the economy of the sea, for they are the principal agents in the disintegration and decay of the shells that accumulate over the bottoms, thus performing the same function in the sea that fungi and insects perform on the land—the removal of dead organisms that otherwise would accumulate in vast quantities. In this work they are aided, in most regions, either by certain boring Annelids, (*Dodecacerea*, &c.,) or by various boring mollusks, (*Lithodomus*, *Pholas*, *Gastrochæna*, &c.,) but the greater part of this work seems to be effected by the sponges.

Numerous species of Foraminifera were obtained on these and also on the rocky bottoms, but they have not yet been studied. The most common kind occurs attached by one side to dead shells, algæ, &c. It consists of several chambers arranged in a spiral manner, and to the naked eye resembles a minute depressed spiral shell.

List of species inhabiting gravelly and shelly bottoms of the bays and sounds.

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II. 7.—FAUNA OF THE SANDY BOTTOMS OF THE BAYS AND SOUNDS.

The sandy bottoms in Vineyard Sound are chiefly found in shallow water, either along the shores or on the banks and shoals. In Buzzard's Bay they were met with only in few places, near the shore, and have no great extent. To the eastward of Vineyard Sound, throughout the greater part of Nantucket Sound, Muskeget Channel, and the waters south and southeast of Nantucket and Cape Cod, the bottom is generally sandy, sometimes passing into gravelly and shelly.

The true sandy bottoms are not favorable to many kinds of animals, and where the sands are constantly changing, as on most of the shoals in this region, the bottom is sometimes almost barren of life, though certain burrowing species may occur.

The following are some of the special localities where dredgings were made on sandy bottoms: In Buzzard's Bay, at line 11, *d, e, f;* 64, *a, b;* 66, *a, b;* 67, *a, b;* 68, *a, b;* 71, *a, b, d;* 73, *a, b, c, e, f.* In Vineyard Sound, at line 14, *g, h;* 25, *a, b;* 27, *a, b;* 30, *a, b;* 37, *h, i;* 43, *a, b;* 46, *c, d;* 47, *d, e;* 48, *a, b.* A large portion of the species occurring on these bottoms have been mentioned before either as inhabitants of the sandy shores at low water, or as living upon gravelly and shelly bottoms. With the exception of a few species living attached to scattered shells or stones, nearly all the species are such as are adapted to bur-

rowing beneath the surface of the sand, though many of them may also occur creeping on its surface.

The most abundant and characteristic species of Crustacea are the lobster, *Homarus Americanus*, (p. 313,) the common shrimp, *Crangon vulgaris*, (p. 339, Plate III, fig. 10,) the "lady-crab," *Platyonichus ocellatus*, (p. 338, Plate I, fig. 4,) the larger hermit-crab, *Eupagurus pollicaris*, (p. 313,) the smaller hermit-crab, *Eupagurus longicarpus*, (p. 313,) *Anthura brunnea*, *Conilera concharum*, *Unciola irrorata*, (p. 340, Plate IV, fig. 19.)

Of Annelids a considerable number of burrowing species occur, and also a few tube-dwelling species, which attach their tubes to dead shells; among these last are *Sabellaria vulgaris* (p. 321, Plate XVII, figs. 88, 88*a*,) and *Serpula dianthus*, (p. 322.)

The Gastropods are not numerous, and but few are peculiar to sandy bottoms; the majority found have their proper homes on shelly or muddy bottoms and live in much smaller numbers in sandy places; others enumerated in the following list inhabit the patches of eel-grass and algæ that are often scattered over the sandy bottoms in shallow water. A few species, however, have their proper homes on the sandy bottoms. Among the most important of these are *Lunatia heros*, (p. 353, Plate XXIII, figs. 133–136,) *Neverita duplicata*, (p. 354, Plate XXIII, fig. 130,) *Natica pusilla*, (p. 354, Plate XXIII, fig. 132,) *Cylichna oryza*, (Plate XXV, fig. 164,) *Utriculus canaliculatus*, (Plate XXV, fig. 160.)

The bivalve shells are more numerous, and most of them are species that burrow beneath the surface. The most common and characteristic species are *Ensatella Americana*, (p. 356, Plate XXVI, fig. 182, and Plate XXXII, fig. 245,) *Siliqua costata*, (p. 358, Plate XXXII, fig. 244,) *Mactra solidissima*, (p. 358, Plate XXVIII, fig. 202,) *Angulus tener*, (p. 358, Plate XXVI, fig. 180, and Plate XXX, 223, shell;) *Tottenia gemma*, (p. 359, Plate XXX, fig. 220,) *Lyonsia hyalina*, (p. 358, Plate XXVII, fig. 194.) In certain localities, where eel-grass grows, the scollop, *Pecten irradians*, (p. 361, Plate XXXII, fig. 243,) occurs in considerable abundance. The common muscle, *Mytilus edulis*, (Plate XXI, fig. 234,) occasionally occurs in patches or beds. *Lævicardium Mortoni* (p. 358, Plate XXIX, fig. 208) is sometimes abundant in sheltered localities. The *Ceronia arctata* appears to be abundant in some places, as it is sometimes thrown on the sandy beaches in large numbers, but it was seldom dredged. The *Thracia Conradi* lives on sandy bottoms, buried six inches or more beneath the surface, but is seldom obtained alive. The dead shells were occasionally dredged in Vineyard Sound.

Very few Ascidians occur. The most frequent one is *Molgula arenata*, (p. 419, Plate XXXIII, fig. 251,) which lives free in the sand and covers itself with a coating of closely adherent grains of sand. Another species, *M. pellucida*, is occasionally met with; this also lives free in the sand, but does not attach the sand to itself. It has a clean translucent integument, a round body, and two tubes which are large and swollen at their

bases. Where eel-grass or algæ afford opportunities for its attachment, the *M. Manhattensis* (p. 311, Plate XXXIII, fig. 250) generally occurs.

The Bryozoa are not numerous, unless where dead shells are scattered over the sand for their attachment, when many of the same species that inhabit shelly bottoms may occur. The only species that are frequent on the true sandy bottoms are *Bugula turrita*, (Plate XXXIV, figs. 258, 259,) which occurs attached to eel-grass, &c., and *Escharella variabilis*, (p. 311, Plate XXXIII, fig. 256,) which incrusts dead shells or other solid objects; with the last, *Membranipora lineata*, (p. 406,) and several other species may sometimes be found.

Several species of Echinoderms inhabit the sandy bottoms. The most abundant one is the "sand-dollar," *Echinarachnius parma*, (p. 362, Plate XXXV, fig. 267,) which occurs in immense numbers on nearly all sandy bottoms, except on the most exposed shoals. Another related species, *Melitta testudinaria*, was dredged two or three times in Vineyard Sound, but the specimens were dead and broken. It is a very abundant species south of Cape Hatteras, and may be distinguished by having five large oblong perforations near the edge.

At least three species of Holothurians live upon the sandy bottoms. The most common one is the *Thyone Briareus*, (p. 362,) conspicuous on account of its large size and dark purplish-brown color, as well as for the numerous long papillæ that cover its body. It was found on a sandy bottom off Waquoit, with the *Eulima oleacea* (Plate XXIV, fig. 149) adhering to its surface, just as they occurred together on shelly bottoms, (see p. 418.) The *Pentamera pulchella*, (p. 420,) also inhabits sandy bottoms, in shallow water. During the past winter Mr. Vinal N. Edwards collected numerous specimens of this and the preceding species on Nobsca beach, after storms. They doubtless live in the sand, in shallow water, a short distance off the beach. In similar situations the *Caudina arenata*, (p. 362,) occasionally occurs, but it is apparently rare in this region. It has a thick, yellowish white, harsh skin, without suckers, and its body tapers off into a slender caudal portion. The common star-fish, *Asterias arenicola*, (p. 326, Plate XXXV, fig. 269,) is not uncommon on sandy bottoms, though more abundant in rocky and shelly localities. The *Ophiura olivacea* (p. 363) lives among the patches of eel-grass in shallow water on the sandy bottoms, and travels over the surface of the sand quite rapidly by means of its slender, flexible rays.

Of Hydroids very few species ordinarily inhabit sandy bottoms, and the only one that is usually met with is *Hydractinia polyclina*, (p. 328,) which lives on the shells occupied by hermit-crabs. Others occasionally grow on the eel-grass or on dead shells.

The *Cliona sulphurea*, (p. 421,) is the only large sponge that is commonly met with on sandy bottoms, but another bright yellow siliceous sponge, forming smooth, firm, crest-like lobes and plates, occurred on Edgartown beach.

List of species inhabiting the sandy bottoms of the bays and sounds.

ARTICULATA.

Crustacea.

	Page.		Page.
Cancer irroratus	312	Lepidactylis dytiscus	339
Carcinus granulatus	312	Unciola irrorata	426
Platyonichus ocellatus	436	Idotea cæca	340
Hippa talpoida	338	Epelys trilobus	370
Eupagurus pollicaris	426	Conilera concharum	426
E. longicarpus	426	Anthura brunnea	426
Homarus Americanus	426	Limulus Polyphemus	340
Crangon vulgaris	426		

Annelids.

	Page.		Page.
Sthenelais picta	348	A. acutum	416
Nephthys picta	348	Scolecolepis cirrata	416
Eteone, sp	349	Polydora, sp	416
Neresis pelagica	319	Clymenella torquata	343
Lumbriconereis opalina	320	Sabellaria vulgaris	426
Rhynchobolus dibranchiatus	341	Cistenides Gouldii	323
R. Americanus	342	Amphitrite ornata	320
Anthostoma robustum	343	Serpula dianthus	426

Nemerteans.

	Page.		Page.
Meckelia ingens	349	M. rosea	350

Sipunculoids.

	Page.		Page.
Phascolosoma Gouldii	353	P. cæmentarium	416

MOLLUSCA.

Gastropods.

	Page.		Page.
Fulgur carica	355	Odostomia seminuda	417
Sycotypus canaliculatus	355	Turbonilla interrupta	418
Eupleura caudata	371	Bittium nigrum	305
Urosalpinx cinerea	306	Triforis nigrocinctus	305
Tritia trivittata	354	Cerithiopsis Greenii	417
Ilyanassa obsoleta	354	C. terebralis	417
Anachis avara	306	C. Emersonii	417
Astyris lunata	306	Cæcum pulchellum	417

	Page.		Page.
C. costatum	417	Lunatia heros	426
Crepidula fornicata	355	Neverita duplicata	426
C. convexa	355	Cylichna oryza	426
C. unguiformis	355	Utriculus canaliculatus	426
Natica pusilla	426		

Lamellibranchs.

	Page.		Page.
Ensatella Americana	426	Tellina tenta	432
Siliqua costata	426	Angulus modestus	418
Mya arenaria	357	A. tener	426
Corbula contracta	418	Venus mercenaria	359
Clidiophora trilineata	418	Tottenia gemma	426
Lyonsia hyalina	426	Lævicardium Mortoni	426
Thracia Conradi	426	Cyclas dentata	418
Periploma papyracea	435	Solenomya velum	360
Cochlodesma Leanum	418	Gouldia mactracea	418
Mactra solidissima	426	Astarte castanea	432
Mulinia lateralis	373	Myti lus edulis	426
Ceronia arctata	426	Pecten irradians	426
Macoma fusca	359	Anomia glabra	311

Ascidians.

	Page.		Page.
Molgula arenata	426	Molgula pellucida	426
M. Manhattensis	427		

Bryozoa.

	Page.		Page.
Bugula turrita	427	Escharella variabilis	427
Membranipora lineata	427		

RADIATA.

Echinoderms.

	Page.		Page.
Thyone Briareus	427	Melitta testudinaria	427
Pentamera pulchella	427	Asterias arenicola	427
Caudina arenata	427	Ophiura olivacea	427
Echinarachnius parma	427		

Acalephs.

	Page.		Page.
Obelia diaphana	327	Hydractinia polyclina	427

Polyps.

Page.
Paractis rapiformis 363

PROTOZOA.

Sponges.

Page. | Page.
Cliona sulphurea ..... 427 | Massive siliceous sponge 427

Foraminifera.

Page.
Several species 421

II. 8.—FAUNA OF THE MUDDY BOTTOMS OF THE BAYS AND SOUNDS.

The muddy bottoms are inhabited by a considerable number of species, which find their true homes in such localities. Most of these are either burrowing or tube-dwelling kinds. A few creep or swim about over the surface or conceal themselves in the superficial layer of mud and vegetable *débris*.

The character of the mud itself is quite various, and the different kinds are often inhabited by different groups of animals. The mud may be very thick, heavy, and tenacious, consisting chiefly of clay; such mud is usually inhabited by few species of animals. It may consist of finely comminuted sand, mixed with more or less clay; such bottoms are more favorable to animal life. In other places it consists partly of one of the preceding kinds intimately mixed with large quantities of decaying vegetable *débris*, derived chiefly from eel-grass and algæ; such mud, unless too fetid, is often full of animal life. In some cases, especially in well-sheltered localities, where the water is tolerably pure, the mud may contain large quantities of living and dead microscopic organisms, both animal and vegetable, and these may even constitute more than one-half of the bulk of the mud, which, in such cases, is peculiarly soft and flocculent; such mud is extremely favorable to many kinds of animals that feed on the microscopic organisms, especially the bivalve shells, Holothurians, and many Annelids, and the "menhaden" among fishes. The last variety of bottom, when it has a substratum of sand or gravel a few inches below the surface, is the most favorable kind for *oysters*, which grow very rapidly and become very fat in such places.

In Vineyard Sound and Nantucket Sound muddy bottoms are not common, and are mostly of small extent, situated in coves, harbors, or in places where the tides form eddies around projecting points of land, or in the lee of shoals.

In Buzzard's Bay the bottom is muddy over the greater part of its area, except a region of sandy and shelly bottom in the central part.

In Long Island Sound the bottom is generally muddy throughout its

length and breadth, though small areas of rocks, gravel, and sand occur at various places.

The special localities, indicated on the chart, where dredgings were made on muddy bottoms, not including the outside dredgings, are as follows: In Buzzard's Bay, at line 67, *b*; 68, *a*, *b*, *c*: 74, *a*, *b*; 75, *a*, *b*, *c*, *d*, *e*, *f*; in Hadley Harbor, at 10, *a*, *b*, *c*, *d*; in Great Harbor, at 17, *b*, *c*; 19, *b*; in Robinson's Hole, at 78, *a*, *b*, *c*; in Vineyard Sound, at 47, *b*, *c*. Numerous other dredgings were made on muddy bottoms in this region that are not indicated on the chart.

In Long Island Sound numerous dredgings have been made by the writer, with Mr. S. I. Smith and others, during eight years. These extend from a few miles west of the entrance of New Haven Harbor to the Thimble Islands and Faulkner's Island on the east; and from the Connecticut shore nearly across the sound. The greater part of these dredgings were on muddy bottoms, and generally in 3 to 8 fathoms of water.

The following are some of the most common and important of the Crustacea living on these muddy bottoms: the spider-crab, *Libinia canaliculata*, (p. 368,) *L. dubia*, (p. 368,) *Panopeus depressus*, (p. 312, Plate I, fig. 3,) *P. Sayi*, (p. 312,) the "blue-crab," *Callinectes hastatus*, (p. 367,) *Mysis Americana*, (p. 396,) *Ptilocheirus pinguis*, (p. 431,) *Unciola irrorata*, (p. 340, Plate IV, fig. 19,) *Limulus Polyphemus*, (p. 340.) Numerous tube-dwelling Amphipods, including several species of *Ampelisca* and genera belonging to the *Lysianassinæ* occur, some of them in great numbers, and also additional species of crabs and shrimps. All these are of special importance, because they furnish great quantities of food for the fishes frequenting muddy bottoms.

Of Annelids numerous burrowing and tube-dwelling kinds are to be found, some of them in great abundance. One of the most abundant and conspicuous species is *Nephthys ingens*, (Plate XII, figs. 59, 60.) This worm burrows in mud of all kinds, even in that which is so filled with decaying vegetable *débris* as to be very fetid. It grows to the length of more than six inches, with a diameter of a quarter of an inch or more, though most of the specimens are about half this size. The body is whitish, with a red median blood-vessel, but the lateral appendages are dark and the setæ nearly black. It is very active, and wriggles about energetically by undulating its body laterally, to the right and left; this motion enables it to burrow quickly, or to swim quite rapidly. When captured it is very apt to break off the posterior part of its body, but can reproduce it.

The *Diopatra cuprea* (p. 346, Plate XIII, figs. 67, 68) is often abundant where the mud is somewhat firm; the dredge often brings up large quantities of the projecting ends of its large tubes, but the occupant usually escapes by retreating below the surface. The two species of *Rhynchobolus* are also quite common, but *R. dibranchiatus* (p. 341, Plate X, figs. 43, 44) is generally the most abundant. The curious *Travisia carnea* V. is seldom met with, and, like *Brada setosa* V., appears to be rare

in this region. The *Trophonia affinis* (Plate XIV, fig. 75) is more common, though found chiefly in the deeper waters, and more frequently in the cold waters outside, as off Cuttyhunk Island and off Block Island. *Ampharete setosa* V. has been found only in Long Island Sound, near New Haven. The *Melinna cristata* is a northern and European species; it was found in the deeper part of Vineyard Sound, inhabiting flexible tubes covered with fine mud. *Euchone elegans* V. (Plate XVI, fig. 84) was found in the deeper parts of Vineyard Sound, living in small tubes of mud; it was much more abundant in the deeper waters outside. The *Meckelia ingens* (p. 349, Plate XIX, figs. 96, 96*a*) occasionally occurs on muddy bottoms, though more common on sandy ones.

Of Gastropod mollusks a comparatively small number of species occur that are characteristic of these bottoms. There are several species that occur on eel-grass, when it grows on the muddy bottoms, which are not included in the following list. They have been mentioned when speaking of the fauna of muddy and sandy shores.

Among the species of special interest were *Mangilia cerina*, which is a rare and little-known species; *Bela plicata* (p. 383, Plate XXI, fig. 107); *Turbonilla elegans*, (p. 418, Plate XXIV, fig. 155), which was recently described from specimens obtained in Vineyard Sound by us; *T. interrupta*, (p. 418;) two species of *Scalaria*, (p. 418;) *Cylichna oryza*, (Plate XXV, fig. 164;) *Amphisphyra pellucida*, (Plate XXV, fig. 162;) and *Utriculus canaliculatus*, (Plate XXV, fig. 160).

The bivalve shells are much more numerous and are mostly burrowing kinds. Among the most abundant are *Mulinia lateralis*, (p. 373, Plate XXVI, fig. 184 B,) which occurs in immense quantities, especially in soft sticky mud; *Clidiophora trilineata*, (Plate XXVII, fig. 193;) *Tellina tenta* (Plate XXX, fig. 225,) which is often very abundant in soft mud, in sheltered places, as in Hadley Harbor; *Callista convexa*, (Plate XXX, fig. 219;) *Nucula proxima*, (Plate XXX, fig. 230;) *Yoldia limatula*, (Plate XXX, 232;) *Astarte castanea*, (Plate XXIX, fig. 204;) and *Mytilus edulis*, (p. 307.)

The last-named shell, which is the common muscle, occurs in patches, "beds," or "banks," often of great extent. One of these muscle-beds, in which the animals were living, was found extending quite across the mouth of Cuttyhunk Harbor, at line 75, *f*, on the chart; another at Quick's Hole, at line 76, *c*, and 45, *a*, *b*; others at 77, *d*, *e*, *f*; 46, *b*, *c*, *d*. In several instances large beds of dead muscles were found, with few living ones, and in all these cases there were on them large numbers of star-fishes, either *Asterias arenicola*, in case of those in Vineyard Sound; or *Asterias vulgaris* on those in the deeper and colder waters near the entrance of the Sound and off Gay Head; and sometimes both kinds, at intermediate localities. These star-fishes had no doubt devoured the muscles. Among the localities of this kind are, 47, *a*, *b*, *c*, *d*; 53, *b*, *c*; 56, *b*, *c*, *d*; 55, *a*, *b*, *c*; 63, *a*, *b*; 58, *d*; 54, *b*. As this species of muscle grows to full size, under favorable circumstances, in one year, it is probable that these muscle-beds vary greatly in size and position in different

years. They afford habitations for various kinds of animals that belong properly on shelly or stony bottoms, such as *Arbacia punctulata* (p. 326,) *Cribrella sanguinolenta*, (p. 407,) and various shells, ascidians, hydroids, &c. The *Modiolaria nigra* (Plate XXXI, fig. 236) was found in small numbers, but of good size, associated with the common muscle, in the deeper part of Vineyard Sound.

The oyster does not usually occur on true muddy bottoms in this region, unless placed there by human agency, but unless attacked by the star-fishes or other enemies they will flourish well in such localities. Beds of oysters on muddy bottoms always afford lodgment for large numbers of animals that belong properly to the shelly and rocky bottoms; these have mostly been omitted from the following list.

Among the shells of peculiar interest that live in the mud are the species of *Pholas*. The largest and finest species, *P. costata*, has been found living in New Bedford Harbor, according to Dr. Gould. It lived buried in the mud two or three feet below the surface, and the specimens were dug out by the harbor-dredging machines. This is a southern species, found quite commonly on the coasts of South Carolina and Florida, and in the Gulf of Mexico. With the last, *P. truncata* (p. 372, Plate XXVII, fig. 200) was also obtained, but this is quite common in mud and peat-banks, above low-water mark. Of both the preceding species we dredged dead shells at Wood's Hole and in Great Harbor, and with them we found fragments of another, *Zirphœa crispata*, which is a northern and European species. It is seldom that living adult specimens of such deep-burrowing shells can be obtained by the ordinary dredge, and they are rarely thrown up by the waves.

Ascidians are not often found on the muddy bottoms, and most of those that do occur adhere to the shells of oysters, muscles, &c., or to eel-grass. Hydroids and Bryozoa are likewise nearly wanting on true muddy bottoms, though a few may occur on the eel-grass and oysters.

Of Echinoderms there are but few species. The *Thyone Briareus* (p. 362) sometimes occurs where there is growing eel-grass. The common star-fish, *Asterias arenicola*, (p. 326,) has been mentioned above as inhabiting muscle-beds and oyster-beds. The *Amphipholis abdita* V. is a singular Ophiuran, with a small body and very long, slender, flexible, greenish arms, having three spines on each side arm-plate. The arms are sometimes six inches long. The creature buries itself deeply beneath the surface of the soft mud, and projects one or more of the long arms partially above the surface of the mud. On this account it is seldom dredged entire; the projecting arms are usually cut off by the dredge, and the animal escapes; and as it has the power of restoring lost arms, this is only a temporary inconvenience. The same thing probably happens when a voracious fish seizes one of the arms.

List of species inhabiting muddy bottoms of the bays and sounds.

ARTICULATA.

Crustacea.

	Page.		Page.
Pinnotheres ostreum	367	Squilla empusa	369
P. maculatus	459	Lysianassinæ, several species	431
Cancer irroratus	312	Phoxus Kroyeri	
Panopeus depressus	431	Melita nitida	314
P. Sayi	431	Ampelisca, two species	431
Carcinus granulatus	312	Ptilocheirus pinguis	431
Callinectes hastatus	431	Amphithoë compta	370
Libinia canaliculata	431	Corophium cylindricum	415
L. dubia	431	Unciola irrorata	431
Eupagurus pollicaris	313	Epelys trilobus	370
E. longicarpus	313	E. montosus	370
Callianassa Stimpsoni	369	Limulus Polyphemus	431
Crangon vulgaris	339	Numerous Entomostraca	
Mysis Americana	431		

Annelids.

	Page.		Page.
Nephthys ingens	431	Travisia carnea	431
Phyllodoce, sp	349	Trophonia affinis	432
Eulalia, sp	349	Brada setosa	431
Nereis pelagica	319	Cistenides Gouldii	323
Diopatra cuprea	431	Ampharete setosa	432
Marphysa Leidyi	319	Melinna cristata	432
Lumbriconereis opalina	320	Polycirrus eximius	320
Rhynchobolus Americanus	342	Chætobranchus sanguineus	320
R. dibranchiatus	431	Euchone elegans	432

Nemerteans.

	Page.		Page.
Meckelia ingens	432	Cosmocephala ochracea	325
Cerebratulus, sp	324		

Sipunculoids.

	Page.
Phascolosoma cæmentarium	416

Nematodes.

	Page.		Page.
Pontonema marinum	325	P. vacillatum	326