The Ascidians are generally uncommon on muddy shores, but wherever the eel-grass flourishes, and especially in sheltered situations, the *Molgula Manhattensis* (p. 311, Plate XXXIII, fig. 250) is usually to be found adhering to it. The *Botryllus Gouldii* (Plate XXXIII, figs. 252, 253) is also frequently found growing upon the eel-grass in such situations, as well as upon the piles of wharves, bottoms of boats, &c. This species was found in great profusion upon the eel-grass in Little Harbor, at Wood's Hole, and in Waquoit Pond. In both these localities the water is nearly pure and but slightly, if at all, brackish. But it has also been found by Professor D. C. Eaton on the piles at Brooklyn, New York, where the water is more brackish. This species when young forms thin, soft, circular or oval incrustations covered with stellate clusters of the minute animals, (fig. 253,) which are imbedded in it; each of these has a small circular orifice toward the outer end, opening into the gill cavity, and another orifice opening into a larger cavity in the center of the cluster, which is common to all those in the cluster; and it has a central external orifice, through which the waste water from the gills, the fæces, and the eggs are discharged. These young colonies begin to appear in June and grow very rapidly, new individuals being formed by buds that originate from the first ones in rapid succession, so that in two or three weeks the small colonies will increase from a quarter of an inch in breadth up to three or four inches, if they be situated on a flat surface and have room to spread. If upon the stem or leaf of the eel-grass they will extend entirely around it, and perhaps several inches along its length, if not opposed by other colonies. At the same time the crusts increase very much in thickness. Thus by the end of the summer, the eel-grass, algæ, stems of hydroids, &c., often become completely covered up by the luxuriant growth of this curious compound animal. The colors of this species are extremely variable and often very elegant, and it is seldom that two colonies can be found with precisely the same pattern of color. Growing upon the same leaf of eel-grass, many different colonies may often be found, each showing a different arrangement of the colors.

In one of the most common varieties the general color of the common tissue between the stellate clusters is dull olive-green, thickly specked with small flake-white spots, which are formed by the enlarged terminal portion of stolon-like processes, which bud out from the perfect individuals composing the clusters, and are arranged somewhat in circles around the clusters; the lower portion of these stolons is usually yellow or orange, and the outer part deep purple, tipped with flake-white. The individual animals, or zoöids, composing the stellate clusters, are deep purple, with the branchial orifice yellowish white, surrounded by a circle of orange; a short flake-white longitudinal line runs along the middle of the upper side, interrupted by the branchial opening, but this line is often represented only by two white spots; other flake-white spots are usually irregularly scattered over the outer end.

In another variety the deep purple zoöids have a circle of flake-white around the branchial orifice, a short white bar or spot beyond it on the outer end, a white spot on the middle between the orifices, and another white spot on the inner end near the anal orifice; the stolons colored as in the preceding.

In another common variety (var. *bicolor*) the colors are similar except that the outer half of each zoöid is almost entirely covered with flake-white, sometimes tinged with orange, while the proximal half is deep purple. Another has the purple zoöids spotted and blotched with flake-white over the whole surface; sometimes the specks are so fine and numerous as to give a uniform silvery or frosted appearance, (var. *farinacea.*)

One peculiar variety (*annulata*) has a small circle of white around the the branchial opening, surrounded by another large circle of flake-white, which incloses nearly the outer half of the zoöid. The variety *atrox* has the zoöids covered to a considerable extent with flake-white, so arranged on each as to present the appearance of a skull; the two eyes being formed by deep purple spots.

The variety *variegata* is pale yellowish olive or orange-brown; the zoöids have a white ring around the branchial orifice, inclosed by a brown ring, which is often interrupted; and the latter is surrounded more or less completely by flake-white, there is usually also a median bar of flake-white; the inner portion is deep purple, more or less mottled with white, and there is a white spot at the inner end. In the variety *albida* nearly the whole upper surface of the zoöids is flake-white.

In another very beautiful and distinct variety (var. *stella*) the common tissue is translucent, pale olive, with white-tipped stolons; the zoöids are brown or purple, marked on the upper side with two parallel longitudinal bars of flake-white, which are separated by a narrow dark line, all of which radiate from the center of the cluster, thus producing the appearance of a many-rayed star, with the rays alternately white and dark; the white bars are sometimes interrupted near the inner ends, and small specks of flake-white are sometimes scattered over the outer end. In this form there are often ten to fifteen zoöids in each cluster, and they appear longer and less swollen than in the other varieties, owing, perhaps, to the optical effect of the radiating lines. This is the most distinctly marked variety that was observed, and was at first thought to be a distinct species.

The Radiates are not abundant on muddy shores. The *Thyone Briareus* (p. 362) is sometimes found on such shores, in sheltered situations, among eel-grass. The common star-fish, *Asterias arenicola,* (p. 326, Plate XXXV, fig. 269,) is often altogether too abundant on muddy shores, on the oyster-beds, where it commits great havoc.

The *Hydractinia polyclina* (p. 328) is often found on the shells occupied by "hermit-crabs." Several species of *Obelia* grow upon the eel-grass, where the water is sufficiently clear. The *Halecium gracile* V. (p. 328,) is frequently found attached to the shells of oysters, and to other solid objects.

List of species commonly found on the muddy shores of the bays and sounds.

ARTICULATA.

Crustacea.

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Gelasimus pugnax	367
Sesarma reticulata	367
Pinnixa cylindrica	367
Pinnotheres ostreum	367
Cancer irroratus	367
Panopeus depressus	367
P. Sayi	367
Callinectes hastatus	367
Carcinus granulatus	367
Libinia canaliculata	368
L. dubia	368
Eupagurus longicarpus	368
E. pollicaris	368
Callianassa Stimpsoni	369
Gebia affinis	368
Virbius zostericola	369
Crangon vulgaris	369
Palæmonetes vulgaris	369
Mysis stenolepis	370
M. Americana	370
Squilla empusa	369
Gammarus mucronatus	370
Amphithoë valida	370
A. compta	370
A. longimana	370
Unciola irrorata	370
Corophium cylindricum	370
Idotea irrorata	370
Erichsonia attenuata	370
Epelys trilobus	370
E. montosus	370
Limnoria lignorum	370
Limulus Polyphemus	370
Numerous small Entomostraca, of many genera.	

Annelids, (*Chœtopods.*)

	Page.
Nereis virens	371
N. limbata	371
Diopatra cuprea	371
Lumbriconereis opalina	371
L. tenuis	371
Maldane elongata	371
Notomastus luridus	371
N. filiformis	371
Cistenides Gouldii	371
Amphitrite ornata	320
Rhynchobolus Americanus	371
R. dibranchiatus	371
Cirratulus grandis	371
Polycirrus eximius	371
Chætobranchus sanguineus	371

MOLLUSCA.

Gastropods.

	Page.
Ilyanassa obsoleta	371
Nassa vibex	371
Eupleura caudata	371
Urosalpinx cinerea	372
Astyris lunata	372
Crepidula convexa	371
Littorina irrorata	372
Lacuna vincta	372
Bittium nigrum	372
Triforis nigrocinctus	372
Bulla solitaria	371

Lamellibranchs.

	Page.		Page.
Pholas truncata	372	Venus mercenaria	372
Tagelus gibbus	373	Kellia planulata	374
Mya arenaria	372	Argina pexata	372
Mulinia lateralis	373	Mytilus edulis	372
Macoma fusca	372	Modiola plicatula	374
Cumingia tellinoides	374	M. hamatus	374
Angulus tener	372	Pecten irradians	374
Petricola pholadiformis	372	Ostræa Virginiana	374

Ascidians.

	Page.		Page.
Molgula Manhattensis	375	Botryllus Gouldii	375

RADIATA.

Echinoderms.

	Page.		Page.
Thyone Briareus	376	Asterias arenicola	376

Acalephs.

	Page.		Page.
Hydractinia polyclina	376	Halecium gracile	376

II. 4.—ANIMALS INHABITING THE PILES AND TIMBERS OF WHARVES AND BRIDGES, BOTTOMS OF VESSELS, BUOYS, AND OTHER SUBMERGED WOOD-WORK.

In these situations a large number of species may be found, but the majority of them are not peculiar to such stations. There are, however, quite a number of species that are nearly always found under these circumstances, and others are directly dependent for their very existence upon submerged wood. Some of these, like the *Teredo*, for example, are of so great importance, owing to the injuries which they do to valuable property, that it seems desirable to make a special division for the animals ordinarily found in connection with wood-work of various kinds, whether injurious or not.

On the piles of wharves and bridges various kinds of sea-weeds often grow in abundance, each species having a particular zone to which it is limited; but as these plants require light, they are found almost exclusively upon the outer rows of piles and timber, and are most abundant on the outer side of the piles and on the southern exposures, where they get the most sunlight. These algæ afford congenial homes to a considerable number of animals, most of which occur also among algæ on the rocky shores and in tide-pools. Beneath the wharves, where the piles are constantly shaded, very few algæ, and those only of the smallest and simplest kinds, such as Ocillatoriæ and Diatoms, are to be found. But in these shaded situations many animals, such as Tubularians and other Hydroids, some Ascidians, Bryozoa, &c., delight to dwell. Many of these adherent animals also live in abundance on the outermost piles of the wharves, at or just below low-water mark, where they are more or less exposed to the sunlight.

The animals that are found among or attached to the seaweeds growing on the piles are, for the most part, identical with those that are to be found in similar situations among the algæ on rocks and in rocky tide-pools.

Among those that are nearly or quite peculiar to submerged wood-work are several species of "ship-worms," (*Teredo* of several species, and the *Xylotrya fimbriata*,) which are bivalve mollusks; the wood-eating *Limnoria;* several species of barnacles, which belong to the Crustacea; some of the tubularians, and other hydroids, &c.

Of the salt-water Insects two species have been observed on the piles of wharves. One of these is a small, slender, green larva, with a dark, firm head, and sharp jaws. It is the larva of a small, two-winged fly, probably identical with the *Chironomus oceanicus* of Packard.

On the piles of a wharf at Menemsha, Dr. Edward Palmer found, in October, a very interesting insect-larva. It lived in a stout tube composed of grains of sand firmly cemented together, and attached by its whole length to the piles; the single specimen is broken at both ends. The tube is flattened, and consists of a central, subcylindrical, tapering portion, or proper tube, which is covered on all sides with a single layer of small grains of sand, neatly arranged; along each side of this, and partly covering its upper surface, and to fill the angle between it and the surface to which it was attached, larger grains of sand are cemented. The preserved portion of the tube is about three-quarters of an inch long and nearly one-quarter wide, at the larger end, but not more than half as wide at the small end. The larva is about a third of an inch long, rather stout, and has a pair of long, sharp, curved jaws, and three pairs of rather long, hairy legs. It belongs to the Phryganidæ, among the Neuroptera, and somewhat resembles some of the well-known larvæ of the caddis-flies, common in fresh water, which make tubes or cases of various kinds. Dr. Hagen, who has examined this specimen, refers it to the genus *Molanna*, of which three North American species are known, but only in the adult state. All the larvæ of this genus, known in Europe, live in fresh water, and no other species of the Phryganidæ has been observed in sea-water, although some live in water that is slightly brackish.

Of Crustacea the most important species is the *Limnoria lignorum*, (p. 370, Plate VI, fig. 25.) This little creature is grayish in color, and covered with minute hairs. It has the habit of eating burrows for itself into solid wood to the depth of about half an inch. These burrows are nearly round, and of all sizes up to about a sixteenth of an inch in diameter, and they go into the wood at all angles and are usually more or less crooked. They are often so numerous as to reduce the wood to mere series of thin partitions between the holes. In this state the wood rapidly decays, or is washed away by the waves, and every new surface exposed is immediately attacked, so that layer after layer is rapidly removed, and the timber thus wastes away and is entirely destroyed in a few years. It destroys soft woods more rapidly than hard ones, but all kinds are attacked except teak. It works chiefly in the softer parts of the wood, between the hard, annual layers, and avoids the knots and lines of hard fiber connected with them, as well as rusted portions around nails that have been driven in, and, consequently, as the timbers waste away under its attacks, these harder portions stand out in bold relief. Where abundant it will destroy soft timber at the rate of half an inch or more every year, thus diminishing the effective diameter of piles about an inch annually. Generally, however, the amount is probably not more than half this, but even at that rate, the largest timbers will soon be destroyed, especially when, as often happens, the *Teredos* are aiding in this work of destruction. It lives in a pretty narrow zone, extending a short distance above and below low-water mark. It occurs all along our shores, from Long Island Sound to Nova Scotia. In the Bay of Fundy it often does great damage to the timbers and other wood-work used in constructing the brush fish-weirs, as well as to the wharves, &c. At Wood's Hole it was formerly found to be very destructive to the piles of the wharves. The piles of the new Government wharves have been protected by broad bands of tin-plate, covering the zone which it chiefly affects. North of Cape Cod, where the tides are much greater, this zone is broader, and this remedy is not so easily applied. It does great damage, also, to ship-timber floating in the docks, and great losses are sometimes caused in this way. Complaints of such ravages in the navy-yard at Portsmouth, New Hampshire, have been made, and they also occur at the Charlestown navy-yard, and in the piles of the wharves at Boston. Probably the wharves and other submerged wood-work in all our sea-ports, from New York northward, are more or less injured by this creature, and, if it could be accurately estimated, the damage would be found surprisingly great.

Unlike the *Teredo*, this creature is a vegetarian, and eats the wood which it excavates, so that its boring operations provide it with both food and shelter. The burrows are made by means of its stout mandibles or jaws. It is capable of swimming quite rapidly, and can leap backward suddenly by means of its tail. It can creep both forward and backward. Its legs are short and better adapted for moving up and down in its burrow than elsewhere, and its body is rounded, with parallel sides, and well adapted to its mode of life. When disturbed it will roll itself into a ball. The female carries seven to nine eggs or young in the incubatory pouch at one time.

The destructive habits of this species were first brought prominently to notice, in 1811, by the celebrated Robert Stephenson, who found it rapidly destroying the wood-work at the Bell Rock light-house, erected by him on the coast of Scotland. Since that time it has been investigated and its ravages have been described by numerous European writers. It is very destructive on the coasts of Great Britain, where it is known as the "gribble."

The remedies used to check its ravages are chiefly copper or other metallic sheathing; driving broad-headed iron nails, close together, into the part of the piles subject to their attacks; and applying coal-tar, creosote, or verdigris-paint, once a year or oftener.

Another singular crustacean, common on the piles at Wood's Hole, is the *Tanais filum*. This is a very slender, whitish species, almost thread-like in form, but has the first pair of legs much thickened, with very peculiar, stout claws, ovate in form; the rest of the anterior legs are very slender. The antennæ are short and thick, the inner ones directed forward; the outer ones more slender, and curved outward and backward. This species lives among the adhering ascidians and hydroids on the piles, and has also been found in deeper water, in the Bay of Fundy. Its habits are little known, but some of the allied species have been accused of boring in wood.

Two species of barnacles are very common on the piles of the wharves. The common barnacle of the rocky shores, *Balanus balanoides*, (p. 305,) is also common on the piles of wharves and bridges, between tides, and also on the bottoms of vessels, &c. It never grows very large, although it may become so crowded together as to form a continuous crust. It is easily distinguished from the other species by its membranous base, which never forms a solid plate, like that of the other species. The "ivory-barnacle," *Balanus eburneus*, is also common on all kinds of submerged wood-work, whether fixed or floating. It is usually abundant on the piles and timbers of wharves, buoys, oyster-stakes, bottoms of vessels, &c. It is chiefly found below low-water mark if on fixed objects, and is even more common in the brackish waters of estuaries than in the purer waters outside, and it is capable of living even in pure fresh water, for Professor Jeffreys Wyman has sent me specimens collected, by himself, about sixty-five miles up the Saint John's River, in Florida, where the water is not at all brackish. This species is sometimes found adhering to the carapax of crabs, the shell of *Limulus*, and various mollusks. It is easily distinguished from most species on account of its low, broad form and its smooth white exterior. It has a shelly base. The *B. crenatus*, common on shells and stones in deep water, also occurs on vessels. Other species are often found on the bottoms of vessels that have come from warmer latitudes. Some of them are of large size. One of the most frequent of these is *Balanus tintinabulum*.

Several species of "goose-barnacles," *Lepas*, are frequently found alive on the bottoms of vessels, and especially such as have recently arrived from the West Indies and other foreign countries. These resemble, in general appearance, *L. fascicularis*, (Plate VII, fig. 33,) which is a common indigenous species, usually found adhering to floating sea-weeds and other small objects in early summer, in large numbers. It is doubtful whether any of those found on the bottoms of vessels can be regarded as true natives of this region. The most common of them is *L. anatifera;* the valves of its shell are bordered with orange. The other common species are *L. anserifera* and *L. pectinata.* Species of the curious genus, *Conchoderma*, also occur on the bottoms of vessels.

Among the Crustacea that commonly occur among the ascidians, hydroids, and algæ on the piles of wharves, are *Panopeus Sayi*, (p. 312,) *P. depressus*, (p. 312, Plate I, fig. 3,) *Gammarus ornatus*, (p. 314, Plate IV, fig. 15,) *Amphithoë compta* S., (p. 370,) *Corophium cylindricum*, (p. 370,) *Melita nitida*, (p. 314,) *Caprella*, sp., (p. 316,) and various small Entomostraca. *Jæra copiosa* (p. 315) often occurs abundantly near high-water mark, on old piles and timber, living in the crevices and cracks, or under loosened bark.

Of Annelids very few if any species occur that are peculiar to these situations. The *Potamilla oculifera* (p. 322, Plate XVII, fig. 86) is quite common on the piles of wharves where the water is pure. *P. microphthalma* V. (p. 323) also occurs under the same circumstances, and also on the piles in harbors, where the water is brackish.

The *Lepræa rubra* V. was found living in tubes among the ascidians on the piles of the wharves. This is a Terebelloid worm, somewhat resembling the *Amphitrite ornata*, (Plate XVI, fig. 82,) but is much smaller, and there are fascicles of setæ on all the segments. There are three pairs of arborescently divided branchiæ, which are pedunculated, the last pair being quite small. The body is bright red, the tentacles pale flesh-color.

The *Nicolea simplex* V. (p. 321,) was also found with the last in large numbers, but mostly of small size. Both males and females of *Nereis limbata* (p. 318, Plate XI, fig. 51, male) were often found among the barnacles and ascidians on the piles of the wharves at Wood's Hole, but the males were the most abundant, while the reverse was the case with those dug out of the sand and gravel on the shores.

Numerous other Annelids were occasionally met with among the ascidians and algæ. Among these were *Polycirrus eximius*, (p. 320, Plate XVI, fig. 85;) *Podarke obscura* V., (p. 319, Plate XII, fig. 61;) a *Phyllodoce*, &c. Two Nemerteans were also common; one of these was an olive-green species, with a light dorsal stripe, belonging probably to the genus *Cerebratulus*, but it was not carefully studied; the second was *Polinia glutinosa*, (p. 324, Plate XIX, fig 97.)

Of Gastropod mollusks quite a number of species occur on the piles of wharves, and some of them in great abundance, especially the smaller kinds which live among the hydroids and confervæ. The most abundant species is generally the *Astyris lunata*, (p. 306, Plate XXI, fig. 110,) which generally occurs among the small algæ and especially on the Tubularians, in countless numbers; *Anachis avara* (p. 306, Plate XXI, fig. 109) is often found in considerable number; *Bittium nigrum* (p. 305, Plate XXIV, fig. 154) and *Triforis nigrocinctus* (p. 305, Plate XXIV, fig, 152) are usually common and the former often is very abundant; *Cerithiopsis Greenii* (Plate XXIV, fig. 153) sometimes occurs, but is rare; *Ilyanassa obsoleta* (p. 354, Plate XXI, fig. 113) and *Tritia trivittata* (p. 354, Plate XXI, fig. 112) are common, especially the former; *Urosalpinx cinerea* (p. 306, Plate XXI, fig. 116) is generally to be found at or below low-water mark on the piles and buoys; *Bela plicata* (Plate XXI, fig. 107) is sometimes met with, but is not common; *Odostomia bisuturalis* (p. 307, Plate XXIV, fig. 146) and other species of the genus are often found near low-water mark on the piles, especially where they are somewhat decayed. *Littorina palliata* (p. 305, Plate XXIV, fig. 138) and *L. rudis* (p. 305, Plate XXIV, fig. 137) nearly always occur near high-water mark, on the piles, where there are algæ. In the harbors, where the water is brackish, and less frequently in the purer waters, the *Alexia myosotis* (Plate XXV, fig. 168) may be found on timbers and piles near high-water mark, and sometimes, also, *Skenea planorbis*, (Plate XXIV, fig. 142,) *Littorinella minuta*, (Plate XXIV, fig. 140,) and *Rissoa aculeus*, (p. 306, Plate XXIV, fig. 141.) Among and feeding upon the Tubularians growing on the piles at and just below low-water mark, the beautiful *Æolidia pilata* (Plate XXV, fig. 174) may often be found, especially in the harbors where the water is more or less brackish.

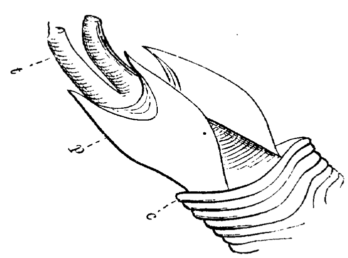
Another related species, apparently the *Cavolina gymnota*, was found by Professor Todd, on an old wreck in the Wood's Hole passage, but it differs in several points from any form that has been described. The branchiæ were arranged in six transverse simple rows, on each side, those of the second and third longest; in the anterior rows there were four to six branchiæ, the lower ones much shorter than the upper ones. In life the branchiæ were dark green or blackish.

Several other Gastropods are occasionally met with in these situations, but the species above named are about all that ordinarily occur.

Among the Lamellibranchs, or "bivalve-shells," we find the *Teredo* tribe, nearly all of which are peculiar to submerged wood-work, either fixed or floating, and most of them are capable of doing great damage, both to ships and to the timber and piles of wharves and bridges, or other similar structures. Although popularly known as the "ship-worm," these creatures are not at all related to the worms, but are true mollusks, quite nearly allied, in many respects, to the common "long-clam" (*Mya*) and to the *Pholas*. Like those shells the *Teredo* excavates its holes or burrows merely for its own protection, and not for food; but the *Teredo* selects wood in which to form its holes, and when these have been excavated it lines them with a tube of shelly material. The holes are very small at the surface of the wood, where they were formed by the young *Teredos* but they gradually grow larger as they go deeper and deeper into the wood, until they sometimes become ten inches or more in length and a quarter of an inch in diameter, but the size is generally not more than half these dimensions. The holes penetrate the wood at first perpendicularly or obliquely, but if they enter the side of the timbers or planks across the grain, the burrows generally turn horizontally in the direction of the grain a short distance beneath the surface, unless prevented by some obstruction, or by the presence of other *Teredo* tubes, for they never cross the tubes of their companions or interfere with each other in any way, and there is always a thin layer or partition of wood left between the adjacent tubes. It is, however, not necessary that they should follow the grain of the wood, for they can and do penetrate it in every direction, and sometimes not more than half the tubes run in the direction of the grain, and they are often very crooked or even tortuous. They rapidly form their burrows in all kinds of our native woods, from the softest pine to the hardest oak, and although they usually turn aside and go around hard knots, they are also able to penetrate through even the hardest knots in oak and other hard woods. The Teredos grow very rapidly, apparently attaining maturity in one season, and therefore, when abundant, they may greatly damage or completely destroy small timber in the course of four or five months, and even the largest piles may be destroyed by them in the course of two or three years.

The most abundant species in this region is the *Teredo navalis* (cuts 1 and 2; Plate XXVI, fig. 183, animal; Plate XXVII, fig. 186, shell.)

1.



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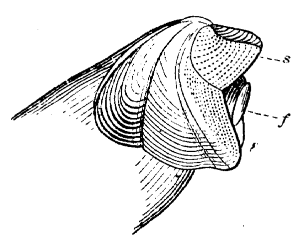

EXPLANATION OF THE CUTS.

Fig. 1. Posterior or outer end of a living *Teredo navalis*, removed from its burrow; *c*, the muscular collar by which it adheres to the shelly lining of its burrow; *p*, the shelly "pallets" which close the aperture when the animal withdraws; *t*, the two retractile siphon-tubes which project from the hole when the animal is active.

Fig. 2. Anterior end and shell of the same; *s*, the front part of the shell; *f*, the foot or boring organ.

This is the same species that has attracted so much attention in Europe, during nearly two centuries, on account of the great damage that it has done, especially on the coast of Holland. Nevertheless no full description of the animal of this species has yet been published, nor any satisfactory figures of the soft parts.

When removed from its tube (see Plate XXVI, fig. 183) the animal is found to have a very long, slender, smooth, soft, whitish body, tapering somewhat toward the outer or posterior end, (fig. 1,) which has a muscular, circularly wrinkled collar, (*c*,) by which the animal is, when living, attached to the inside of the shelly lining of its tube. To the inside of this collar two shelly plates, known as the "pallets," (*p*,) are attached by their slender basal prolongations; their outer portions are broad and flat, and more or less emarginate or two-horned at the end. These are so connected with the muscles that when the animal withdraws its tubes into its hole the free ends of these pallets are made to fold together and close the opening, thus serving as an operculum to protect the soft tubes against enemies of all kinds. Between the bases of the pallets arise the siphonal tubes, (*t*,) which are soft and retractile, united together for half their length or more, but separate and divergent beyond; they are nearly equal, but the ventral or branchial tube is perhaps a little larger than the other, and is fringed with a few small papillæ at the end; the tubes are white or yellowish, sometimes specked with reddish-brown. At the anterior end of the body and farthest from the external opening of the hole, is seen the small, but elegantly sculptured, white bivalve shell, (cut 2, *s*; and Plate XXVI, fig. 183, *s*.) The shell covers the mouth and palpi, liver, foot, and other important organs. The foot (*f*) is a short, stout, muscular organ, broadly truncate or rounded at the end, and appears to be the organ by means of which the excavation of the burrow is effected. The shell is covered by a delicate epidermis, and probably does not assist in rasping off the wood, as many have supposed. The gills are long and narrow, inclosed mostly in the naked part of the body, and are reddish brown in color. The *Teredos* obtain their microscopic food in the same manner as other bivalve mollusks, viz., by means of a current of water constantly drawn into the branchial tube by the action of vibrating cilia within; the infusoria and other minute organisms are thus carried along to the mouth at the other end, while the gills are supplied with oxygen by the same current; the return current passing out of the dorsal tube removes the waste water from the gills, together with the fæces and excretions of the animal, and also the particles of wood which have been removed by the excavating process. As the animal grows larger the burrows are deepened, the lining of shelly matter increases in length and thickness, the shell itself and the pallets increase in size, and the terminal tubes grow longer. But as the orifices of the terminal tubes must necessarily be kept at the external opening of the burrow, the muscular collar at the base of the tubes constantly recedes from the entrance, and with it the pallets; at the same time imbricated layers of shelly matter are usually deposited in the upper end of the shelly tube, which are supposed to aid the pallets in closing the aperture when the tubes are withdrawn. When the animal has completed its growth, or when it has encountered the tubes of its companions and cannot pass them, or when it approaches the exterior of a thin piece of wood and cannot turn aside, it forms a rounded or cup-shaped layer of shelly matter, continuous with the lining of the tubes, and closing up the burrow in front of its shell; sometimes it retreats and forms a second partition of the same kind.

This species produces its young in May and probably through the greater part or all of the summer. The eggs are exceedingly numerous, probably amounting to millions, and they are retained in the gill-cavity, where they are fertilized and undergo the first stages of their development. The embryos pass through several curious phases during their growth. In one of the early stages they are covered with fine vibrating cilia, by means of which they can swim like ciliated infusoria; later they lose these cilia and develop a rudimentary bivalve shell, which is at first heart-shaped, and the mantle begins to appear and larger retractile cilia develop upon its edge, which serve as organs for swimming; but at this period the shell is large enough to cover the whole body when contracted. In this stage they swim actively about in the water; later the cilia become larger, a long, narrow, ligulate foot is developed, by means of which they can creep about and attach themselves temporarily to solid objects; the shells become rounder, a pair of eyes and organs of hearing are developed; after this the little animal begins to elongate, the locomotive cilia are lost, the eyes disappear, and the mature form is gradually assumed. These young *Teredos*, when they finally locate upon the surface of wood-work and begin to make their burrows, are not larger than the head of a pin, and consequently their holes are at first very minute, but owing to their rapid growth the holes quickly become larger and deeper.

This species is very abundant along the southern coast of New England, from New York to Cape Cod, wherever submerged wood-work, sunken wrecks, timber buoys, or floating pieces of drift-wood occur. It also infests the bottoms of vessels not protected by sheathing. It is not confined to pure sea-water, but occurs in the piles and timbers of our wharves in harbors that are quite brackish. I have found it abundant in the piles of Long Wharf in New Haven Harbor, where the water is not only quite brackish, but also muddy and contaminated with sewerage and other impurities. At Wood's Hole it was found to be very abundant in the cedar buoys that had been taken up from various localities and placed on the wharves to dry and be cleaned. Captain B. J. Edwards informed me that formerly, when the buoys were not taken up, they would not usually last more than two years, owing chiefly to the attacks of this *Teredo*, but under the present system there are two sets of buoys, which are alternately taken up and put down every six months. After a set has been taken up and allowed to dry thoroughly they are scraped to remove the barnacles, &c., and then receive a thorough coat of verdigris paint, each time, before they are put down. With this treatment they will last ten or twelve years, but they are more or less perforated and injured every year, until finally they become worthless. Inasmuch as the *Teredos* produce their young all through the summer, and they develop to a very large size in one season, it is evident that the best time to take up the buoys would be in midsummer, before the early crop of young have grown large, and leaving too little time for the later crop to become large, in the buoys thus put down, before winter, when most of them would probably be killed by the cold weather. In this way the damage might be materially diminished, if not inconsistent with the other duties of the officers of the vessels employed in this service. There are, as yet, no means of estimating the extent of the damage done to our wharves, shipping, &c., by this and the various other species of *Teredo* found on our coast, but judging from their abundance along the whole coast, it is much greater than is generally supposed.

The *Teredo navalis* is also abundant on the coast of Europe, from the Mediterranean and Black Seas to Christiania, and the coasts of Great Britain. Its habits have been quite thoroughly investigated by several Dutch naturalists, owing to the great damage that it has done on their coast, at times even threatening a general inundation of the country by destroying the wood-work of the dikes. This *Teredo* occupies a zone of considerable breadth, for it often lives considerably above low-water mark and extends several feet below it, even to the depth of fourteen feet, according to some writers.

The best remedies in common use to resist or prevent its attacks are copper-sheathing, used chiefly on vessels; broad-headed nails, closely driven, used for piles and timbers; creosote and coal-tar, frequently applied. The various poisonous substances that have been applied to timber for this purpose, however useful they may be in other respects, have little or no effect on the *Teredo*, for it does not depend upon the wood for its food, and even protects its body externally with a layer of shell, lining its holes. The only remedies that are likely to succeed are those calculated to prevent the lodgment and entrance of the young ones beneath the surface. Even creosote, thoroughly applied under pressure at the rate of 10 pounds per square foot, has been found insufficient to prevent their attacks, for piles thus treated at Christiania were found by Mr. Jeffreys to be filled with the *Teredo* within two years after they were put down.

Several other species of *Teredo* also occur on this coast. The *Teredo megotara* (Plate XXVII, fig. 188) has been found in floating pine wood at Newport, Rhode Island, and in cedar buoys, &c., at New Bedford, Massachusetts; as well as in Massachusetts Bay, at Provincetown and other places; it is also found as far south as South Carolina at least. This species sometimes grows to a large size, forming tubes at least eighteen inches long. It sometimes occurs, also, in the piles of wharves in this region. The *Teredo Thomsoni* (Plate XXVII, fig. 187) has been found in great numbers in the marine railway and also in cedar buoys at New Bedford. It has also been found at Provincetown in a whaling-ship that had cruised in the West Indies.

The *Xylotrya fimbriata* (Plate XXVII, fig. 189) is very similar to the common *Teredo*, except that it has long, oar-shaped pallets, with slender stalks; the blade is flattened on the inside and convex externally, and consists of ten to twelve, or more, funnel-shaped segments which set one into another; their margins project at the sides, making the edges of the blade appear serrated. This species appears to be indigenous on this coast. It has been found living in a sunken wreck in Long Island Sound, near New Haven, and I have also taken it from the oak timbers of a vessel, the Peterhoff, employed in the blockading service, during the late war, on the coast of the Southern States. It grows to a rather large size, often forming holes a foot or more in length and a quarter of an inch in diameter, though usually smaller. The pallets are sometimes half an inch long.

Among the kinds of bivalve shells that do not bore in wood, there are but few species that commonly inhabit piles of wharves. The most frequent of these is the common muscle, *Mytilus edulis*, (p. 307, Plate XXXI, fig. 234,) which sometimes adheres in large clusters. The common oyster, *Ostræa Virginiana*, (p. 310,) often attaches itself to the piles, but in such situations seldom survives the winter.

Ascidians often occur in large quantities attached to the piles, at and just below low-water mark, and also on the under side of floating timber. They often completely cover large surfaces and spread over the barnacles, hydroids, and algæ, which have previously located. They grow very rapidly, attaining their full size during a few weeks in midsummer.

The most abundant species are usually *Molgula Manhattensis* (p. 311, Plate XXXIII, fig. 250) and *Cynthia partita*, (p. 311, Plate XXXIII, fig. 246.) At Wood's Hole, on the piles of the Government wharf, in August and September, the *Perophora viridis* V. was exceedingly abundant, creeping over and covering up the other ascidians as well as the barnacles, hydroids, and algæ. This is a compound or "social" Ascidian, in which stolon-like tubular processes come out from the basal portion of the first individuals and run in every direction over the surfaces of objects to which they are attached, producing buds at intervals, which rapidly develop into little Ascidians like the old ones, and give out other stolons in their turn; thus they will very soon cover large surfaces, though each individual Ascidian is quite small. The body is compressed, broad oval, or more or less rounded in outline, with a terminal branchial, and lateral anal orifice, both slightly raised on short and broad tubes. The body is attached to the stolons by a short narrow pedicle, and is usually not more than an eighth of an inch high. The color is bright green or yellowish green, and the integument is soft and translucent.

On the piles of the same wharf, and associated with the last, was another compound Ascidian, *Amarœcium constellatum;* this forms solid gelatinous masses, with a smooth, convex surface, usually less than an inch in diameter and about half an inch high, but often larger. The zoöids, or individual animals, are quite small, long, and slender, and entirely imbedded in the gelatinous mass that unites them together. They are arranged in circular, oval, or stellate groups, with a common cloacal orifice in the center of each cluster. The masses are usually pale orange-red, varying to yellowish and pale flesh-color. The stomach of each individual is bright orange-red; the branchial sac is flesh-color, pale yellow, or orange; the tubes and upper part of the mantle bright orange or lemon-yellow.

The *Botryllus Gouldii* (p. 375, Plate XXXIII, figs. 252, 253) also frequently occurs on the piles of the wharves, creeping over the stems of Tubularians, the surfaces of other ascidians, fronds of algæ, or on the surface of the wood itself. It also frequently forms broad, soft incrustations on the bottoms of boats, floating timber, &c.

The Bryozoa are also usually quite abundant on the piles and timbers of wharves, &c.

The *Bugula turrita* (p. 311, Plate XXXIV, figs. 258, 259) is one of the most common as well as one of the most elegant of these. It occurs attached to the adhering sea-weeds, &c., forming delicate white plumes.

The *Escharella variabilis* (p. 311, Plate XXXIII, fig. 256) usually forms firm, coral-like incrustations, but when attached to hydroids and sea-weeds it spreads out into foliaceous or lichen-like, rigid, calcareous fronds, which are dull red while living.

On the piles at Wood's Hole the *Bugula flabellata* was also very abundant. This forms elegant circular or fan-shaped fronds, consisting of numerous repeatedly forked, flat, and rather narrow branches, on which the cells are arranged in about three longitudinal rows. This species, like others of the genus, bears very singular structures, known as avicularia, which, under the microscope, have the form and appearance of the stout, hooked beaks of certain birds, such as the hawk, owl, parrot, &c. These beaks are attached by flexible stems, and are provided internally with powerful muscles by means of which they are constantly opened and closed, and can bite with considerable force. In this species these are attached to the sides of the cells, along the edges of the branches. Their office seems to be to defend the colony against small parasites, and dirt of all kinds, which, unless thus removed, would soon cover up the cells and destroy the animals. In addition to these, various less conspicuous species often occur in abundance, especially *Vesicularia gracilis; V. dichotoma* V.*;* and *V. cuscuta.*

Of Radiata there are but few species in such localities, with the exception of the Hydroids, which are usually very abundant.

The green star-fish, *Asterias arenicola*, (p. 326, Plate XXXV, fig. 269,) may occasionally occur adhering to the piles just below low-water mark, but it does not have this habit to such an extent as does the *A. vulgaris*, north of Cape Cod, for the latter is almost always to be seen in abundance on the piles of the wharves of the northern seaports, as at Portland, Eastport, &c., and less abundantly at Boston.

One of the most beautiful, as well as one of the most abundant, of the Hydroids that occur on the piles of wharves, and on the under side of floating timber, is the *Parypha crocea*, (Plate XXXVI, fig. 274.) This species grows in great luxuriance upon the piles, especially in those harbors where the water is somewhat brackish. It forms large clusters of branching stems, often six inches or more in height, each of which is surmounted by a beautiful, flower-like, drooping head of a pink or bright red color. These heads are often broken off, or even voluntarily cast off, when the animals are unhealthy, but new ones are soon reproduced, and, therefore, this does not seem to be a very serious accident, though certainly a very inconvenient one, for the mouth, stomach, tentacles, and most other organs are all lost when these "heads" drop off. This species does not produce free-swimming medusæ, but the buds, corresponding to those that develop into free medusæ in many other cases, in this remain attached to the heads in drooping clusters, looking like loose clusters of light red grapes, in miniature.

The buds produced by the hydroid-heads of one colony are either all males or females, and, while attached to the hydroid-heads, eggs or spermules are developed within them; the eggs are fertilized and develop into young hydroids, which, when finally expelled, are provided with a circle of slender tentacles, and need only to attach themselves to some solid substance by the basal end of the body to become fixed, tubularian hydroids, similar to the old ones in many respects, though still very small and simple in structure. These young tubularians swim and crawl about for a time, and after attaching themselves they rapidly grow larger and produce stolons from the base, from which buds arise that develop into forms like the first one; other buds are produced from the sides of the stems, which also become like the others, and in this way the large clusters of tubularians are rapidly formed.

Several species of Campanularians are also to be found attached to the piles and timbers of wharves and bridges. At Wood's Hole the most abundant species was *Obelia pyriformis*, which grew in great profusion on the piles just below low-water mark. It is a delicate and much branched species, with elongated, pear-shaped, reproductive capsules, and is beautifully phosphorescent. On the hull of an old wreck in Wood's Hole passage, where the tide flows with great force, the *Obelia flabellata* was found in abundance, though it does not appear to have been noticed on this side of the Atlantic before. It has very elongated, slender, simple, but crooked stems, with numerous, alternate, short, forking, fan-shaped branches; these generally fork close to their origin, the divisions diverging in opposite directions. The hydroid calicles (hydrothecæ) are small, cup-shaped, or broad bell-shaped, with a smooth rim, and they are borne on slender pedicles that are of various lengths, but mostly short and composed of only four to six rings. The reproductive capsules (gonothecæ) are urn-shaped, with a short, narrow neck; they are borne on short pedicles, of few rings, arising from the axils of the branches. Some of the specimens were eight or ten inches long.

On the piles of Long Wharf, at New Haven, the *Obelia gelatinosa* of Europe was found growing in great luxuriance in September. The water at this locality was quite brackish, but it will probably be found, also, in pure sea-water, for on the coast of Europe it is common both in brackish and pure ocean-water. It is probable that this species has not been observed before on our coast, for although the name occurs in several local lists, these refer, according to Mr. A. Agassiz, to other species, and he does not include the present species in his Catalogue of North American Acalephæ. It is a large species, growing to the length of ten or twelve inches, and branches widely and very profusely. It differs from most of our other species in having a thick, compound stem, composed of many united tubes. The smaller branches are, however, profusely divided, and the branchlets are simple, very slender, white, and translucent, their delicacy contrasting strongly with the stout, dark-colored stems. The larger branches mostly arise in pairs, close together, but immediately diverge; the small branches and branchlets are alternate. The hydrothecæ are very small, deeply bell-shaped, the rim divided into ten or twelve teeth, which are squarish in form, and slightly emarginate at the end; their pedicles vary in length, and are often rather long and slender, especially the terminal ones. The gonothecæ are elongated, urn-shaped, with a narrow, short, tubular neck. I also found this species in April, growing on oysters, at Great Egg Harbor, New Jersey.

Several other species of *Obelia* occur in similar situations, together with various related genera.

The *Sertularia pumila*, (p. 327, Plate XXXVII, fig. 279) often occurs attached to the *Fucus* and other sea-weeds growing on the piles.

The *Halecium gracile* V., (p. 328,) often grows on the piles in great abundance, especially where the water is somewhat brackish, and it sometimes also occurs in great profusion on floating drift-wood.

Of Actinians the most frequent species is the *Sagartia leucolena*, (p. 329, Plate XXXVIII, fig. 284,) which can almost always be found among the adhering barnacles and ascidians; not unfrequently it attaches itself within a dead barnacle, and, in fact, seems quite partial to such a location.

The *Metridium marginatum* (p. 329) also frequently occurs on the piles, but is much less frequent, and generally of smaller size than it is farther north, as about Boston and on the coast of Maine.

Several sponges occur frequently on the piles of the wharves, but they have not been well determined. Among them the *Grantia ciliata*, or a closely allied species, is very common, and also another of the same group, which is tubular and branched, (*Leucosolenia botryoides* ?).

The common, red branching sponge (p. 330) is frequent, and also a slender branching species of *Chalina*, near *C. oculata*. Two or more species of *Tedania*, forming irregular, massive, pale-yellow sponges of a brittle texture, are common.

List of species commonly found on piles and timbers of wharves and bridges on buoys, bottoms of vessels, and other submerged wood-work.

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II. 5.—ANIMALS INHABITING THE ROCKY BOTTOMS OF THE BAYS AND SOUNDS.

In this region the proportion of rocky bottom is relatively quite small, and mostly to be found only in quite shallow water. Therefore the animal life is very similar to that of the rocky shores and tide-pools, near low-water mark.

In Vineyard Sound and vicinity the rocky bottoms examined were chiefly at the following localities, as indicated on the accompanying chart, viz.: 1st. An area south of Parker's Point and occupying a part of the bottom of the passage between Parker's Point and Nonamesset Island, on both sides of the channel, and extending somewhat south of a line drawn from Nobska Point to the southeastern end of Nonamesset Island. The dredgings made in this area are, 9, *a*, *b*, *c*, *d*; 2, *a*, *b*; 3, *a*, *b*, *c*; 4, *a*, *b*; 5, *c*, *d*, *e*; 8, *a*, *b*; 18, *a*, *b*. 2d. An area south and southwest of Nobska Point; dredgings, 21, *b*, *e*; 22, *a*; and others not recorded were made on this patch. 3d. In the Wood's Hole passage, between the north end of Nonamesset Island and the opposite shores, there are numerous rocky patches, and the tides flow with great force; dredgings, 14, *a*, *b*, *c*, *d*, *e*, *f*, *g*; 16, *a*, *b*; 17, *c*, *d*, *e*; 15, *a*, *b*; and many others were made on this bottom. 4th. A small area between Uncatena Island and Long Neck; dredgings, 11, *e*, *f*, and 71, *c*, were on this patch. 5th. A small area, south of the Wepecket Islands, where the dredging, 73, *d*, was made. 6th. A region of rocks and sand off West Chop, north of Martha's Vineyard; in the dredgings made here, 37, *c*, *d*, *e*, some very fine hydroids and ascidians were obtained. 7th. In Quick's Hole, the passage between Nashawena and Pasque Islands, a rocky bottom, with abundant ascidians, hydroids, and sponges, was found, where dredgings 77, *a* and *c*, were made.

In addition to these localities numerous dredgings were made on rocky bottoms off Gay Head and Devil's Bridge, and also between Martha's Vineyard and No Man's Land, but these properly belong to the cold outer region.

In the vicinity of New Haven, rocky bottoms, generally of small extent, are found off the light-house, and off South End and Branford Point, also among the Thimble Islands. All these localities have been examined by me in numerous dredging excursions made during the past eight years. Nevertheless the fauna of the rocky bottoms of