species, found in the same situations, is the *Mœra levis* SMITH; this is whitish in color, with black eyes.

Two species of the genus *Amphithoë* also live under rocks at low water, but these, like the other species of this genus, construct tubes in which they dwell. The *Amphithoë maculata* (Plate IV, fig. 16) is much the larger, and constructs large, coarse tubes of gravel, bits of sea-weed, &c., and attaches them in clusters to the under sides of stones. They often leave their tubes, however, and may be found free among the weed or under stones. The color is generally dark green, though sometimes reddish, and there is often a series of light spots along the back, and the whole surface is covered with minute blackish specks; the eyes are red. The second species, *Amphithoë valida* SMITH, is much smaller, being generally less than half an inch long. It is usually bright green in color, and has black eyes. It often lives among the bright green fronds of *Ulva latissima*, and its color is nearly that of the *Ulva*.

Another amphipod, resembling a small *Gammarus*, about half an inch long, and light olive-brown or yellowish brown in color, is sometimes found in large numbers swimming actively about in the larger tidal pools, and occasionally darting into the growing sea-weeds for rest or concealment. This is the *Calliopius læviusculus*. It also often occurs in vast numbers swimming at the surface, far from land, not only in the sounds and bays, but out at sea, as for instance in the vicinity of St. George's Bank and in the Gulf of St. Lawrence, where it is equally abundant. It is devoured in large quantities by numerous fishes. The *Hyale littoralis* occurs near high-water, among algæ, and in pools.

The Isopods are also well represented on the rocky shores. One of the most common is the *Sphæroma quadridentata*, (Plate V, fig. 21,) which bears some resemblance, both in form and habits, to the "pill-bugs," which live upon the land. This species is found in abundance under stones and rocks, or creeping slowly about among the branches and roots of sea-weeds, on their sides and upper surfaces, from low-water mark nearly up to high-water mark. In color it is exceedingly variable, for no two can be found that are alike; but the colors, consisting of irregular blotches and dashes of dark gray, light gray, slate, greenish, and white, are so blended as to imitate very closely the colors of the barnacles and gray surfaces of the rocks where they live, and no doubt they derive considerable protection from their enemies by these imitative colors. When disturbed they curl themselves up in a ball and fall to the bottom.

Another smaller and much more active species, which has a more slender form, is found in vast numbers creeping actively about over the rocks and barnacles, and especially beneath rocks and drift-wood. This is the *Jæra copiosa*. It is also excessively variable in color, but shades of green, gray, and brown predominate, and cause it to imitate very effectively the surfaces of the rocks covered with small green algæ, where

it loves to dwell. It is found nearly up to high-water mark, and has a wide range both northward and southward along the coast.

Another very common and much larger isopod is the *Idotea irrorata*, (Plate V, fig. 23,) which grows to be nearly an inch long. Its colors are extremely varied. Often the general color is dark gray, light gray, dull green, or brownish, thickly specked and blotched with darker, but the colors are often brighter and the markings more definite; not unfrequently a band of white, or yellowish, or greenish, runs along the middle of the back, with perhaps another along each lateral border. This species occurs creeping among the "rock-weeds" and other algæ at low water, in the pools, creeping on the under sides of stones, adhering to eel-grass, and also among floating sea-weeds, away from the shore, and in many other situations. Its colors are generally well adapted for its concealment, by imitating, more or less perfectly, the rocks and weeds among which it lives. Even those with bright green markings are thus protected when living on eel-grass or *Ulva*; the dark, obscurely marked ones when on dead eel-grass or dark *Fucus*; the grays and browns when on stones and among barnacles, &c. This protection is not perfect, however, for they often fall victims to hungry fishes of many kinds.

The *Idotea phosphorea* HARGER, is a closely allied species, which grows even larger. It can easily be distinguished by the tail-piece, which is acute in this, but tridentate in the last, and by its rougher surface and more incised lateral borders. Its colors are similar and equally variable, though they are frequently in larger and more definite spots and blotches, and the light spots are often bright yellow. It is, as its name indicates, decidedly phosphorescent. It lives under the same circumstances as the preceding species, but is much less common in this region, though it is abundant in the Bay of Fundy. It often occurs among the crowded stems of *Corallina officinalis* in the larger tide-pools.

Another related species, the *Erichsonia filiformis* HARGER, (Plate VI, fig. 26,) also occurs among the *Corallina* and other algæ in the tide-pools. This is a smaller species than the two preceding, but is somewhat similar in its colors, which are equally variable and equally adapted for its concealment; in this the colors are more commonly various tints of brown, or dull reddish, or light red, which are well adapted to blend with the colors of the *Corallines*. Quite a different looking creature is the *Epelys montosus*, which is occasionally found concealed beneath stones where there is more or less mud. This species also frequents muddy bottoms, and is pretty effectually concealed by its rough-looking back and the coating of mud and dirt that always adheres to it.

Clinging to the hydroids and delicate algæ on the under sides of stones, and in tide-pools, curious slender-bodied crustacea belonging to the genus *Caprella* (similar to fig. 20, Plate V) may often be found in considerable numbers, but they are still more abundant on rocky bottoms off shore. They have the habit of holding on firmly by the pos-

terior legs, and extending the body out at an angle, with the long, rough front legs stretched out in various directions. While in these attitudes and at rest they often closely resemble the branches of the hydroids and algæ among which they live, especially as they also imitate them in colors, for all these species are variable in color, being generally gray, with darker specks, when living among hydroids, but often bright red when living among red algæ. This habit of holding themselves stiffly in such peculiar positions recalls the similar habits of many insects, especially some of the Orthoptera and the larvæ of the geometrid moths, and they also recall the larvæ, just named, by their singular mode of climbing actively about among the branches of the hydroids and algæ, for they bend the slender body into a loop, bring the hind legs up to the front ones, and taking hold with them stretch the body forward again, just like those larvæ, though their legs are long and slender and differ widely in structure. These little creatures are very pugnacious and are always ready to fight each other when they meet, or to repel any intruder similar in size to themselves. Their large claws are well adapted for such purposes.

The marine worms or Annelids are very numerous under the rocks between tides, and concealed beneath the surface of the gravel and mud that accumulates between and beneath the stones and in crevices. Many kinds also live in the pools, lurking among the roots of the algæ, burrowing in the bottom, or building tubes of their own in more exposed situations. Many of these annelids are very beautiful in form and brilliant in color when living, while most of them have curious habits and marvelous structures. Several species are of large size, growing to the length of one or two feet. Some are carnivorous, devouring other worms and any other small creatures that they can kill by their powerful weapons; others are vegetarians; but many are mud-eaters, swallowing the mud and fine sand in great quantities, for the sake of the animal and vegetable organisms that always exist in it, as is the case with clams and most of the bivalve shells, and many other kinds of marine animals.

All these Annelids are greedily devoured by most kinds of marine fishes, whenever they can get at them, and, since many of the annelids leave their burrows in the night to swim at the surface, or do this constantly at the breeding season, they make an important element in the diet of many fishes besides those that constantly root for them in the mud and gravel, like the tautog, scup, haddock, &c. The young of nearly all the annelids also swim free in the water for a considerable time, and in this state are doubtless devoured in immense numbers by all sorts of young and small fishes.

One of the largest and most common Annelids found under rocks, burrowing in the sand and gravel, is the *Nereis virens*, (Plate XI, figs. 47–50.) It lives both at low-water mark and at a considerable distance farther up. It grows to the length of eighteen inches or more, and is

also quite stout in its proportions. The color is dull greenish, or bluish green, more or less tinged with red, and the surface reflects bright iridescent hues; the large lamellæ or gills (fig. 50) along the sides are greenish anteriorly, but farther back often become bright red, owing to the numerous blood-vessels that they contain. It is a very active and voracious worm, and has a large, retractile proboscis, armed with two strong, black, hook-like jaws at the end, and many smaller teeth on the sides, (figs. 48, 49.) It feeds on other worms and various kinds of marine animals. It captures its prey by suddenly thrusting out its proboscis and seizing hold with the two terminal jaws; then withdrawing the proboscis, the food is torn and masticated at leisure, the proboscis, when withdrawn, acting somewhat like a gizzard. These large worms are dug out of their burrows and devoured eagerly by the tautog, scup, and other fishes. But at certain times, especially at night, they leave their own burrows and, coming to the surface, swim about like eels or snakes, in vast numbers, and at such times fall an easy prey to many kinds of fishes. This habit appears to be connected with the season of reproduction. They were observed thus swimming at the surface in the daytime, near Newport, in April, 1872, by Messrs. T. M. Prudden and T. H. Russell, and I have often observed them in the evening, later in the season. At Watch Hill, Rhode Island, April 12, I found great numbers of the *males* swimming in the pools among the rocks at low-water, and discharging their milt. This worm also occurs in many other situations, and is abundant in most places along the sandy and muddy shores, both of the sounds and estuaries, burrowing near low-water mark. It occurs all along the coast from New York to the Arctic Ocean, and is also common on the northern coasts of Europe.

With the last, in this region and southward, another similar species, but of smaller size, is usually met with in large numbers. This is the *Nereis limbata*, (Plate XI, fig. 51, male.) It grows to the length of five or six inches, and can easily be distinguished by its slender, sharp, light amber-colored jaws, and by the lateral lamellæ, which are small anteriorly and narrow or ligulate posteriorly. Its color, when full grown, is usually dull brown, or smoky brown or bronze-color anteriorly, with oblique light lines on the sides, and often with a whitish border to each ring, which form narrow, pale bands at the articulations; posteriorly the body and lateral appendages are pale red, and the longitudinal dorsal blood-vessel is conspicuous. The male, of which the anterior part is represented in fig. 51, differs greatly from the female in the structure of the middle region of the body, which is brighter red in color, and has the side appendages more complicated and better adapted for swimming. The females agree with the males very well in the form and structure of the head and anterior part of the body, but the middle region does not become different from the anterior, as in the male. Both sexes are often dug out of their burrows, under stones or in the sand, but in such places there are few males in proportion to the fe-

males. The males, however, sometimes occur swimming free at the surface in vast numbers. They swim with an undulating motion, and are quite conspicuous on account of the bright red color of the middle region of their bodies. Mr. S. I. Smith observed them swimming in this way, in the daytime, in August, at Fire Island, on the southern side of Long Island, where they occurred in incredible numbers and were eagerly pursued by the blue-fish, which at such times would not take bait. We often caught them in Vineyard Sound, in the evening, at the surface, with towing-nets. These worms must, therefore, contribute largely to the food of many fishes. It is very common on our sandy shores as far south as South Carolina. A third species, *Nereis pelagica*, (Plate XI, figs. 52–55,) is abundant under stones farther north, but in this region is chiefly found on shelly bottoms, in the deeper waters of the sounds. These three species of *Nereis* are called "clam-worms" by the fishermen. Two large species of worms belonging to the genus *Rhynchobolus* (formerly *Glycera*) are often met with in burrows, in the mud beneath stones. These are pale reddish, deep flesh-colored, or dull purplish red, and rather smooth-looking worms, thickest in the middle, and tapering to both ends. They have a large proboscis, armed at the ends with four black, hook-like jaws, and are remarkable for their rapid spiral gyrations. They belong more properly to the muddy and sandy shores, and will, therefore, be mentioned more particularly in another place. They are represented on Plate X, figs. 43–46. *Ophelia simplex* occurs under stones at half-tide, and below.

The *Marphysa Leidyi* (Plate XII, fig. 64) is a large and handsome worm, occasionally met with under stones at low-water mark, but is more common on shelly bottoms in shallow water off shore. It grows to the length of six inches or more, and its body is flattened, except toward the head, where it becomes much narrowed and nearly cylindrical. It is yellowish or brownish red, and brilliantly iridescent. The branchiæ are bright red, and commence at about the sixteenth segment; the first ones have only one or two branches, but farther back they become beautifully pectinated. There are six unequal caudal cirri, the lower lateral ones longest. It is furnished with powerful jaws, and is carnivorous in its habits.

A small but very active worm, *Podarke obscura* V., (Plate XII, fig. 61,) is often found in large numbers beneath stones. These are dark brown or blackish in color, sometimes with lighter bands. They come out at night and swim at the surface in vast numbers. They are also often met with at the surface among eel-grass, in the daytime, in large numbers. A large and very singular worm, which burrows and constructs tubes in the mud and gravel beneath stones, is the *Cirratulus grandis* V., (Plate XV, figs. 80, 81.) This is usually yellowish brown, dull orange, or ocher-colored, and is remarkable for the numerous long, flexible, reddish or orange cirri that arise all along the sides. Another very large and interesting worm, often associated with the last, both among and under

rocks, and on muddy shores, is the *Amphitrite ornata*, (Plate XVI, fig. 82.) This worm constructs rather firm tubes out of the consolidated mud and sand in which it resides, casting cylinders of mud out of the orifice. It grows to be twelve to fifteen inches in length. Its color is flesh-color, reddish, and orange-brown to dark brown, and it has three pairs of large plumose or arborescent gills, which are blood-red. The tentacles are flesh-colored, very numerous, and capable of great extension, even to the length of eight or ten inches, and are kept in constant motion in gathering up the materials with which it constructs its tube. Two species of worms, remarkable for their soft bodies filled with bright red blood, which is not contained in special blood-vessels, are also found under stones where there is mud in which they can burrow. The smaller of these is *Polycirrus eximius*, (Plate XVI, fig. 85.) Its tentacles are very numerous, and are extended in every direction by forcing the blood into them, which can be seen flowing along in the form of irregular drops, distending the tubular tentacles as it passes along. The second species is a much larger and undescribed species, remarkable for its very elongated body and for having very singular branching gills on the sides along the middle region; the first and last of these gills are simple or merely forked, but those in the middle are divided into numerous branches; and in either case each branch is tipped by a cluster of setæ. In allusion to this remarkable feature I have called it *Chætobranchus sanguineus*. Its tentacles are like those of the last species, but longer and more numerous; in full-grown specimens they can be extended twelve to fifteen inches or more. Its color is blood-red anteriorly, but more or less yellowish at the slender posterior part. It is very fragile and it is seldom that a large specimen can be obtained entire. It grows to be twelve to fifteen inches long. This, like the three species last mentioned, feeds upon the minute organisms contained in the mud, which it swallows in large quantities. Two species of *Lumbriconereis* are, also, frequently found burrowing in the mud and sand beneath stones, but they belong more properly to the muddy shores. They are long, slender, reddish, and brilliantly iridescent worms, readily distinguished by having a smooth, blunt-conical head, without tentacles. They are carnivorous and have complicated jaws. The head and anterior part of the body of the larger species (*L. opalina* V.) is represented in Plate XIII, figs. 69, 70. The other (*L.tenuis* V.) is very slender, thread-like, nearly a foot long, and has no eyes.

There are several kinds of highly organized annelids which may be found adhering to the under side of stones or concealing themselves in crevices. Among these are three species, which have the back covered with two rows of large scales. One of these, having twelve pairs of nearly smooth scales, is the *Lepidonotus sublevis* V., (Plate X, fig. 42;) the color is variable, but usually brown or grayish, with darker specks, thus imitating the color of the stones. Another more common species is the *Lepidonotus squamatus*, (Plate X, figs. 40, 41,) which also has

twelve pairs of scales, but they are rough, and covered with small rounded or hemispherical tubercles; this is usually dark brown. The third species has sixteen pairs of smooth scales, and belongs to another genus. This is *Harmothoë imbricata;* it varies exceedingly in color, but is usually grayish or brownish, more or less specked, blotched, or striped with blackish; sometimes there is a black stripe along the middle of the back; sometimes the general color is dark reddish. These three species of scaly worms all have a large proboscis with four powerful jaws at the end, and a circle of papillæ, as in figs. 40 and 41; they are carnivorous in their habits and rather sluggish in their movements. When disturbed they curl themselves up into a ball. They are very complicated in their appendages, and the spines and setæ of these appendages are very curious in structure, when examined with a microscope. Notwithstanding their numerous sharp spines they are often devoured by fishes, and they frequently also fall victims to their more powerful companions belonging to the Nereis tribe, and are sometimes destroyed even by the apparently inoffensive Nemerteans. Adhering to the under sides of the rocks and stones there are several kinds of tubes constructed by annelids. One of the most common and abundant kinds of these tube-dwelling worms is the *Sabellaria vulgaris* V., (Plate XVII, figs. 88, 88*a*.) This worm constructs firm and hard tubes out of fine sand and a cement secreted by special glands. These tubes are bent and twisted in various directions and are generally united together into masses or colonies, sometimes forming aggregations of considerable thickness and perhaps several inches or a foot across. The tubes of this worm are also common on the shells of oysters. Another very curious and beautiful worm, the *Scionopsis palmata* V., constructs much larger and coarser tubes out of bits of sea-weeds and shells, sand, small pebbles, and other similar materials; these tubes are long and crooked and attached for their whole length to the under side of rocks. The worm that constructs them has some general resemblance to the *Amphitrite ornata*, but is seldom more than three or four inches long and is usually darker colored, the color being generally reddish brown or dark brown, more or less speckled with white. There are only seventeen fascicles of setæ on each side. The gills are only three in number, viz: an odd median one, much larger than the others, placed just behind the tentacles; and a pair of smaller ones, but similar in form and just back of the first; all three gills have a stalk or peduncle, and branch toward the end in a palmate or digitate manner, each of the divisions again subdividing. The gills can be retracted beneath a sort of collar which arises just behind them; their color is greenish, specked with white. The gills of this worm are very elegant in form, and quite unlike those of any other known species, both in position and form. Therefore it is necessary to establish a new genus for this species. It has been found from Vineyard Sound to New Jersey; both among eel-grass in shallow water, and under stones. The *Nicolea simplex* is a related species, with similar habits.

The crooked, round, calcareous tubes made by *Serpula dianthus* V., are often to be found adhering to the under surfaces and sides of stones near low-water mark, and also in the pools in more exposed situations; sometimes they are even aggregated together into masses. When disturbed the worm suddenly withdraws its beautiful wreath of gills into its tube and closes the aperture closely by means of a curious plug or operculum. This is placed at the end of a rather long pedicle, and is funnel-shaped, the outside longitudinally striated and the edge bordered by about thirty sharp denticles; from the middle of the upper side another smaller, short, funnel-shaped process arises, the edge of which is divided into twelve or thirteen, long, rather slender, rigid processes, which are usually a little curved inward at the top, but may be spread apart in a stellate form. A small, rudimentary, club-shaped operculum exists on the other side. When these tubes are placed in sea-water and left undisturbed for a short time, the occupant will cautiously push out its operculum and display its elegant wreath of branchiæ, which varies much in color in different specimens, but often recalls the varied hues and forms of different kinds of pinks, (*Dianthus.*) The name which I have given to it alludes to this resemblance. Fine specimens of this *Serpula* may often be found, also, in the pools near low-water mark, attached to the upper surfaces or sides of rocks, and in such situation they display their charms to great advantage. The wreath of branchiæ is nearly circular, consisting of two symmetrical parts, each of which is made up of about eighteen pectinate branchiæ; these are covered on their inner surfaces with slender filaments which extend nearly to the ends, but leave the tips naked. Young specimens have fewer branchiæ. In the more common varieties these branchiæ are purple at base, with narrow bands of light red or pale yellowish green; above this they are transversely banded or annulated with purplish brown, alternating with yellowish green, or with purple and white; the pinnæ usually correspond in color to the part from which they arise, but are sometimes all purple. In other specimens the branchiæ are yellowish white, or greenish white, banded with brown. In one variety (*citrina*) they are bright lemon-yellow, or orange-colored, throughout. The operculum, in all the varieties, is usually brownish green above, with the sides purplish brown, lined with whitish near the edge, and with a greenish white band at the base; the pedicle is usually purplish, with two or more bands of white. The body is usually deep greenish yellow, with the back lemon-yellow; the collar is broad with an undulated border, and is pale green, veined with darker green blood-vessels. This species is also often met with in dredging on shelly bottoms.

The *Potamilla oculifera* (Plate XVII, fig. 86) is another beautiful annelid, related somewhat to the *Serpula*, but its tubes are tough and flexible; they are constructed out of fine sand and other foreign matters, glued firmly together with the special secretions of the animal. These tubes are often found attached to the under sides of stones, but, passing

around to the sides, open upward by a free extremity; they also frequently occur in sheltered nooks in the tide-pools. The worm, when undisturbed, puts out a beautiful wreath of branchiæ somewhat resembling that of the *Serpula*, but there is no operculum. The branchiæ are always beautifully colored, though the colors are quite variable. In one of the commonest styles of coloration, the branchiæ are surrounded at base with reddish brown; above this with a ring of white; next by a band of reddish brown; then for the terminal half the color is yellowish gray, with indistinct blotches of brown; on the outer sides of the branchiæ there are one to three dark red eyes. There are ten or more branchiæ in each half of the wreath, and they are longer on one side than on the other.

Another related species, the *Sabella microphthalma* V., also occasionally occurs in the pools and on the under sides of stones, constructing tubes very much like those of the last species. This is a much shorter and stouter worm, with the branchial wreath relatively much larger and nearly half as long as the body. The branchiæ are pale yellowish, greenish, or flesh-color, with numerous transverse bands of darker green extending to the pinnæ; on the outer side of the branchiæ there are numerous minute eye-like spots of dark brown, arranged in two rows on each. The body is usually dull olive-green. The *Fabricia Leidyi* V., is another member of this group of worms, but is of very minute size. It constructs delicate, flexible tubes, free toward the end, which usually stands upright. Its tubes may be found in the pools and on the under side of stones. The worm itself is very small, slender, and when undisturbed protrudes a wreath, composed of six branchiæ, to a considerable distance above the mouth of the tube. The branchiæ have five to seven pinnæ on each side, the lowest much the longest, so that when expanded they all reach nearly to one level. At the base of the branchiæ there are two pulsating vesicles, alternating in their beats; and just back of these there are two minute brown eye-specks; two similar eyes exist at the posterior end. Eleven segments of the body bear fascicles of setæ. Color yellowish white, the blood-vessels red.

Two or more species of the minute but beautiful worms belonging to the genus *Spirorbis* are found attached to the fronds of sea-weeds, to shells, stones, &c., especially in the pools. These are related to the *Serpula*, and like it form solid calcareous tubes, but these are always coiled up in a close spiral, and the coil is attached by one side. The little worms put out an elegant wreath of branchiæ, and are furnished with an operculum. Another very interesting and beautifully colored worm, sometimes found under and among the stones, where there is mud, is the *Cistenides Gouldii* V., (Plate XVII, figs. 87, 87*a*.) This constructs very remarkable, conical, free tubes, of grains of sand arranged in a single layer, like miniature masonry, and bound together by a water-proof cement. This worm belongs more properly to the muddy and sandy shores and will be mentioned again.

Under stones and decaying sea-weeds, near high-water mark, two or more kinds of small slender worms are usually found in great numbers; these differ widely from all those before mentioned, and are more nearly related to the common earth-worms of the garden. One of these is white, slender, and about an inch long, tapering to both ends. This is *Halodillus littoralis* V., apparently forming a new genus allied to *Enchytræus*. Another is of about the same size, but rather longer and more slender, and light red in color. It has a moniliform intestine, with a red blood-vessel attached to it above and below. It belongs apparently to the genus *Clitellio*, (*C. irroratus* V.)

In addition to all these setigerous *Annelids* which have been enumerated, there are quite a number of worms to be found on the rocky shores which are destitute of all these external appendages, and have the surface of the body smooth and ciliated. There are two tribes of such worms: in one of them the body is much elongated, and either roundish, or flattened, and usually very changeable in form and capable of great extension and contraction. These are known as *Nemerteans*; most of them have a proboscis which they can dart out to a great length. In the other group, known as *Planarians*, the body is broad, short, and depressed, and often quite flat, and their internal structure is quite different.

One of the largest of the Nemerteans, the *Meckelia ingens*, (Plate XIX, figs. 96, 96*a*,) is met with under stones where there is sand, but it belongs properly to the sandy shores. It is an enormous, smooth, flat worm, yellowish, flesh-colored, or whitish, and sometimes grows to be ten or twelve feet long and over an inch wide. The *Meckelia rosea* also occurs occasionally in similar places. This is similar in form, but is smaller, less flattened, and decidedly red in color. It is often covered by adhering sand. Another species, belonging to the Nemerteans, is often found in great abundance under stones from mid-tide to near high-water mark. Many of them are often found coiled together in large clusters. This is the *Nemertes socialis*; it is very slender or filiform, and often five or six inches long when extended. Its color is dark ash-brown or blackish, a little lighter beneath, and it has three or four eyes in a longitudinal group on each side of the head. Another larger species, apparently belonging to the genus *Cerebratulus*, but not sufficiently studied while living, is also abundant under stones. It is much stouter and is usually dark olive-green, brownish-green, or greenish-black in color, but a little lighter below and at the borders of the head. Several other small Nemerteans occur under similar circumstances. In the pools, creeping over and among the algæ and hydroids, a yellowish or light orange-colored species, one or two inches long, is often met with. This species secretes an unusual amount of mucus, which is, perhaps, connected with its climbing habits, and I have on this account named it *Polinia glutinosa* V., (Plate XIX, fig. 97.) It varies in the number of its eyes, according to its age, but they are always grouped in oblique clusters as in the figure.

The color is sometimess bright orange anteriorly, but lighter posteriorly, with a faint dusky or greenish line along the middle.

Another species, closely resembling the last in form, color, and size, is quite common under stones; and especially in dead tubes of *Serpula*, near low-water mark. This is the *Cosmocephala ochracea* V., (Plate XIX, figs. 95, 95*a*;) it has numerous eyes on the sides of the head, three or four on each side forming an anterior row parallel with the margin; the others forming two parallel oblique groups, usually with two or three eyes in each, farther back. On the lower side of the head there is, on each side, an obliquely transverse groove. The color is usually dull yellowish-white or grayish; the anterior part is often tinged with orange and the posterior with ash-gray; there is generally a distinct paler median line, most distinct anteriorly. It grows to be two or three inches long, when extended.

Of the Planarians several species are also found creeping over the under side of stones and in the tide-pools. One of the most abundant is *Procerodes frequens*, which is a very small but lively species, found creeping on the under side of stones near high-water. It is usually about an eighth of an inch long, dark brown or blackish above and gray below, and it has two reniform eyes. The *Monocelis agilis* is still smaller, elliptical, with only one median eye; its color is dark brown or blackish. By some writers this genus is placed among the Nemerteans. Two larger species of this group are also occasionally found on the under side of stones. One of these, the *Planocera nebulosa*, (Plate XIX, fig. 100,) is usually about half an inch wide and three-fourths long, but may become nearly circular, or may extend into a long elliptical form. It is flat and thin, with flexuous edges. Its color is olive-green above, with a lighter median stripe behind, and yellowish green below. The tentacles on the back are whitish and retractile.

The *Stylochopsis littoralis* V., (Plate XIX, fig. 99,) is also frequently found on the under side of stones. It is remakable for having a cluster of eyes on each tentacle, other clusters in front of them, and two or more rows of eye-spots around the margin, especially in front. Its color is variable, but usually greenish, greenish yellow, or brownish yellow, often reticulated with flesh-color; there is generally a pale median streak posteriorly. The eggs were laid July 12th in large clusters, composed of many small white eggs closely crowded together, side by side, and attached to the surface of the glass jar in which they were kept.

There are also representatives of the "round worms," or Nematodes, to be found beneath the stones and among the roots of algæ, hydroids, &c. The commonest of these is, perhaps, the *Pontonema marinum* (Plate XVIII, fig. 94.) This is a small, very slender, smooth, white, round worm, tapering to both ends, and very active in its movements, constantly coiling itself into a spiral and again uncoiling itself. Its head is furnished with about six minute cirri; in the male the tail is short, narrow, nearly straight, but one-sided, rapidly tapering, and subacute; in the female

the body is much longer, and the tail is long, slightly tapered, straight, and obtuse. The *Pontonema vacillatum* also occurs in similar places in abundance. In this species the male has a short, obtuse, incurved tail; the female a straight, tapering, narrow, obtuse one. Both species are oviparous, and the female genital orifice is near the middle of the body. These worms are from a quarter to half an inch or more in length. Their complete history is not known; they are closely allied to many of the parasitic worms, and it is possible that in some stages of their development these are also parasites.

Of the Radiates there are also numerous species to be found on these rocky shores.

Although the purple "sea-urchin," *Arbacia punctulata*, and the green "sea-urchin," *Strongylocentrotus Dröbachiensis*, (Plate XXXV, fig. 268,) are sometimes met with, their occurrence is irregular and uncertain at low-water in this region. The former occurs in abundance on rocky and shelly bottoms in the sounds; while the latter occurs chiefly on similar bottoms in the cold area, and at low-water on the outer rocky shores, and still more abundantly farther north.

The green star-fish, *Asterias arenicola*, (Plate XXXV, fig. 269,) is found in large numbers at low-water among the rocks at certain times, but at other times is seldom met with, though a few young specimens can almost always be found by careful search beneath the stones. The adults were very abundant on the shore at Parker's Point, in the latter part of June; but by the middle of July very few could be found there. Their habit of coming up to the shore may be connected with their reproductive season. They are always abundant on shelly bottoms in the bays and sounds, especially where there are beds of muscles or oysters, upon which they feed. They often prove exceedingly destructive of oysters planted in waters that are not too brackish for their comfort. They manage to eat oysters that are far too large for them to swallow whole, by grasping the shell with their numerous adhesive feet, and then, after bending their five flexible rays around the shell so as partly to inclose it, they protrude the lobes and folds of their enormous saccular stomach from the distended mouth, and surrounding the oyster-shell more or less completely with the everted stomach they proceed to digest the contents at leisure, and when the meal is finished they quietly withdraw the stomach and stow it away in its proper place. In this way a large "school" of star-fishes will, in a short time, destroy all the oysters on beds many acres in extent, unless their operation be interfered with by the watchful owners. In one instance, within a few years, at Westport, Connecticut, they thus destroyed about 2,000 bushels of oysters, occupying beds about 20 acres in extent, in a few weeks, during the absence of the proprietor.

In order to stop their operations it is necessary to dredge over the oyster-grounds and destroy all the star-fishes thus brought up, by leaving them on shore above high-water mark; for if simply torn in pieces

and thrown overboard, as is sometimes done, each ray has the power of reproducing all the lost parts, so that each fragment may, after a time, become a perfect star-fish.

The color of this species is generally dark green or brownish green, with the madreporic plate bright orange; the males are more inclined to brown, and sometimes have a reddish tint. It is found all along the coast from Massachusetts Bay to Florida.

The eggs of this species, like those of most other star-fishes, produce peculiar larvæ, entirely unlike the parents, and provided with vibrating cilia by means of which they swim about in the water, or at the surface, for a considerable time. The young star-fish develops within the larva and gradually absorbs the substance of the larva into its own organization.

The development of this and our other common species has been very fully described and illustrated by Mr. A. Agassiz.

Of the Hydroids many species occur in the pools, or attached to the lower sides of overhanging rocks, or of stones that have an open space beneath them, or growing upon the *Fucus* and other sea-weeds at low-water mark. The most abundant of all is the *Sertularia pumila*, (Plate XXXVII, fig. 279,) which grows in small tufts of delicate branches on the stems and fronds of all the larger sea-weeds, and on the sides and lower surfaces of stones. Another beautiful species, the *Obelia commissuralis*, (Plate XXXVII, fig. 281,) occurs at low-water mark and in tide-pools, attached to stones and sea-weeds. It is very delicate and much branched, and sometimes grows five or six inches high, though usually smaller. At certain times it produces small medusæ in its urn-shaped reproductive capsules; these are discharged and swim free for some time, having sixteen tentacles when they become free. Several other species of this genus also occur attached to the sea-weeds at low-water. The most common of these is *O. diaphana*, which grows about an inch high, attached to the stems of *Fucus*. The *Campanularia flexuosa* is another similar hydroid, remarkable for its large reproductive capsules, in which medusæ are developed that never become free. This species occurs in the pools at low-water, on weeds and stones, and also on the lower sides of overhanging rocks or the timbers of wharves. It is much more abundant farther north, as at Eastport, Maine, where it grows in profusion on the timbers of the wharves, hanging down from their lower sides, collapsed and dripping, while the tide is low. The *Pennaria tiarella* (Plate XXXVII, figs. 277, 278) is a very conspicuous and beautiful species on account of its much-divided black branches and numerous bright red flower-like hydroids. It occurs occasionally in the pools, and just below low-water mark, attached to stones, corallines, &c., but is more common in somewhat deeper water on rocky and shelly bottoms. The "file-fish" feeds on this species, and probably on other allied hydroids, for its stomach was found full of the stems and branches, cut up in fine pieces. Its broad, sharp-edged jaws are admirably

adapted for browsing on hydroids, but yet this may not be its principal food, for our observations were very few on this fish, owing to its rarity. One of the most interesting of the hydroids, found in the rocky pools at low-water, or in other shaded places, is the *Hybocodon prolifer*, (Plate XXXVIII, fig. 282.) This is one of the largest and most beautiful of the tubularians, and is very conspicuous on account of its deep orange-red color. It is by no means common, and grows only in those pools where the water is pure and cool, or under the shade of overhanging rocks. It usually grows singly or in groups of two or three clustered together. The delicate hydrarium of *Bougainvillia superciliaris* (Plate XXXVII, fig. 276) is also occasionally met with in the larger tide-pools near low-water mark, and the small, free medusæ, which are produced by budding from the hydrarium, are frequently found swimming in the waters in spring. The *Clava leptostyla* is a beautiful and apparently soft and tender species, but it grows in clusters on the fronds of *Fucus* at low-water mark, on the most exposed shores, and withstands the most powerful surf, unharmed. The colonies are bright light red in color and consist of numerous hydroids arising from creeping stolon-like tubes, which interlace to form the base of the colony. Each of the hydroids consists of a cylindrical stem, slender at base and about a quarter of an inch high, at the end of which there is a thicker, club-shaped or fusiform "head," covered with about fifteen to thirty, long, slender tentacles, but the form both of the heads and tentacles is constantly changing, owing to their contractions. The small medusa-buds are grouped in clusters below the tentacles and do not become free. This species is also to be found in the pools and on the under sides of large stones close to low-water mark.

The *Hydractinia polyclina* is often met with covering the dead shells inhabited by the hermit-crabs, whether in the pools or in deeper water off shore, with a soft, velvet-like, reddish coating, which is made up of hundreds of hydroids united together by their bases into a rather firm, continuous layer, covered with conical points. This basal layer sometimes not only entirely covers the shell, but extends out considerably beyond the borders of the aperture, so as to increase the capacity of the interior. This is no doubt a great gain to the crab, because he will not be so soon compelled to exchange his shell for a larger one. Each colony of these hydroids is either male or female; the sexes differ in depth of color, the male colonies being palest. But in each colony there are also many sterile individuals, who have to do the eating and digesting for the whole community, while the sexual individuals attend to the reproduction of the race. Farther north, as at Nahant, Massachusetts, this species often incrusts broad surfaces of the rocks in the pools, but I have not observed it growing in this way south of Cape Cod; yet in one instance we dredged it growing on a rock.

The *Halecium gracile* V. is frequently found growing in profusion on the under side of stones, in tide-pools, and attached to oysters, dead

shells, &c., in shallow waters, both of the sounds and estuaries. It forms rather dense, pale, flexible tufts, three or four inches high, with very numerous slender branches.

Of Polyps there are several species belonging to the actinians, or "sea-anemones," and one species of genuine coral, (*Astrangia*,) but the latter is seldom found at low-water, though common in shallow water, on rocky bottoms. The most common of the actinians is the "fringed sea-anemone," *Metridium marginatum*. This may almost always be found on the under sides of large stones that have sufficient space beneath, in sheltered crevices near low-water mark, and adhering to the rocks along the borders of the larger tide-pools, where they are shaded and protected by the overhanging sea-weeds. In full expansion this species has a very graceful form. From the expanded base the body rises in the form of a tall, smooth column, sometimes cylindrical, sometimes tapering slightly to the middle, and then enlarging to the summit. Toward the top the column is surrounded by a circular thickened fold, above which the character of the surface suddenly changes, the skin becoming thinner and translucent, so that the internal radiating partitions are visible through it. This part expands upward and outward to the margin, which is folded into numerous deep undulations or frills, and everywhere covered with very numerous, fine, short, crowded tentacles. The tentacles also cover the upper side of the disk, half way to the mouth, but are larger and less crowded in proportion to the distance from the margin. The mouth is oval and the lips divided into numerous folds. The largest specimens are sometimes five or six inches high and three or four inches across the disk. The colors are extremely variable. Most frequently the sides of the body are yellowish brown or orange-brown, but it may be of any shade from white, flesh-color, pink, salmon, chestnut, orange, yellow, light brown, to dark umber-brown; or it may be mottled and streaked with two or more of these colors. The upper part of the body and tentacles are translucent, and have lighter colors, generally either white, pink, flesh-color, or pale salmon; the tentacles are also frequently banded with flake-white, and often have dark tips. This species, when much irritated, throws out from minute loop-holes along the sides large numbers of long, slender, white threads, which are covered with microscopic stinging-organs, powerful enough to defend them from the attacks of fishes and other enemies; but they do not penetrate the human skin.

Another species, the "white-armed anemone," *Sagartia leucolena*, (Plate XXXVIII, fig. 284,) is also common at low-water, especially on the under side of large stones, and sometimes nearly buried in sand and gravel. This is more elongated and slender than the last, and has a smaller, simple and plain disk, with the tentacles much longer and more slender, and crowded together near the margin; the surface of the body is smooth and uniform, without any thickened fold. The color is usually pale salmon or flesh-color, and the skin is translucent,

so as to show the internal lamellæ; the tentacles are paler and more translucent, and usually whitish, but sometimes pale salmon. The tentacles, in full expansion, are over an inch long. A second elongated species of *Sagartia* (*S. modesta*) occurs buried up to its tentacles in the gravel and sand among rocks. This species is quite rare, and has a much thicker and firmer skin, which is nearly opaque and dull yellowish in color; the tentacles are shorter, with dark greenish markings at the base.

The *Halocampa producta* (Plate XXXVIII, fig. 285) also occurs under the same circumstances with the last, though it may also be found on sandy shores, slightly attached to a shell or pebble, perhaps a foot beneath the surface, but in expansion it stretches its body so as to expand its tentacles at the surface, above its burrow, into which it quickly withdraws when disturbed. This species is remarkable for the great length and slenderness of its body in full extension; for having only twenty tentacles, with swollen tips; and for the rows of suckers along the sides, to which it fastens grains of sand, &c. It has no distinct disk at the base, which is bulbous and adapted for burrowing Its color is whitish, flesh-color, or pale salmon, with the suckers whitish. The tentacles usually have darker brown tips, but sometimes the tips are flake-white. In full expansion the length of large specimens is about a foot, and the diameter about a third of an inch, but in contraction the body becomes much shorter and more swollen.

The *Astrangia Danæ*, which is the only true coral yet discovered on the coast of New England, is occasionally found on the under side of overhanging rocks, or in pools where it is seldom or never left dry. The coral forms incrusting patches, usually two or three inches across, and less than half an inch thick, composed of numerous crowded corallets, having stellate cells about an eighth of an inch in diameter. The living animals are white, and in expansion rise high above the cells and expand a circle of long, slender, minutely warted tentacles, which have enlarged tips. These coral-polyps, when expanded, resemble clusters of small, white sea-anemones, and like them they will seize their prey with their tentacles and transfer it to their mouths. They feed readily, in confinement, upon fragments of mollusca or crustacea.

Several species of sponges also occur in the rocky pools and on the under sides of stones. The most conspicuous one is a bright red species, which forms irregular crusts, and rises up in the middle into many small, irregular, lobe-like branches. Another species forms broad, thin incrustations, of a sulphur-yellow color, on the under side of stones. These species have not been identified. A small, urn-shaped or oval species, with a large aperture at the summit, surrounded by a circle of slender, projecting spicula, occurs in the pools, and is probably the same as the *Grantia ciliata* of Europe.

In addition to the numerous species already enumerated, most of which belong to groups that are essentially marine animals, there are

a few species of marine insects that are frequently met with under stones, or among the small green algæ. Among these a small lead-colored insect belonging to the family of "spring-tails," *Anurida maritima*, is the most abundant. With it a spider, *Bdella*, and several species of mites (*Trombidium*) are often found. Several specimens of a "false scorpion," *Chernes oblongus*, were also found by Mr. Smith near low-water mark under stones. In the pools and on the rocks, among the green confervæ and other sea-weeds, the active green larvæ of a two-winged fly, *Chironomus oceanicus*, is often found in abundance. This larva we have detected in the stomach of the "tom-cod," mixed with small crustacea.

List of species inhabiting the rocky shores of the sounds and bays.

In the following list the species living in these situations are brought together systematically, whether mentioned in the preceding pages or not. The lists are not to be regarded as complete, but include most of the species ordinarily met with. The references are to the pages of this report, where remarks upon the species may be found:

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MOLLUSCA.

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Acalephs.

Polyps.

PROTOZOA.

Sponges.

II.—2. FAUNA OF THE SANDY SHORES OF THE BAYS AND SOUNDS.

These sandy shores vary considerably in character according to their situations and composition. In the more exposed positions the beaches of fine loose sand differ but little in character from those that prevail so extensively on the ocean shores, from Cape Cod to North Florida. In more sheltered situations there is generally more or less mud mixed with the sand, which often forms shores with a very gentle slope, running down to broad flats, bare at low-water; such flats of sandy mud are the favorite homes of large numbers of burrowing creatures; but even on the exposed beaches of loose siliceous sand, which are completely torn up and remodeled by every storm, there are still to be found many kinds of animals perfectly adapted to such conditions, finding there their proper homes. In other cases there is more or less gravel and pebbles mixed with the sand, which, under some conditions of exposure, produce a firm and compact deposit, admirably adapted to the tastes and habits of certain tube-dwelling and burrowing creatures. In other places, especially in sandy coves or other sheltered situations, the sandy flats are partly covered by tufts and patches of eel-grass, and