

CHAPTER XIII.



The Marine Aquarium, Inmates, and Maintenance

MARINE AQUARIA

Freshwater aquaria are familiar household objects, but the Marine aquarium is known to the general public only through the exhibitions at World's fairs or those in some of the larger cities, as in Castle Garden, Battery Park, New York; the Vivarium of the University of Pennsylvania, at Philadelphia; and the Grotto of the Fish Commission Building, at Washington, D. C.

It is a general opinion that the marine aquarium is difficult to establish in the household, though it is really easier to maintain, when properly installed, than those of freshwater, as ventilation, good light and sunshine are not as important; they are even to some extent objectionable, as strong light is likely to produce an excessive growth of algæ, and oscillatoria, which may cause turbidity in the water, and the marine fauna is more comfortable without much light, as in the ocean they obtain comparatively little.

AERATION. The necessary aeration is not produced by the growth of plants, as is the case in the freshwater aquarium. The marine flora cannot be kept in fine growing condition under any circumstances, and may be largely dispensed with, its purpose being more to enhance the beauty and add to the natural appearance of the aquarium than to serve as oxygenators. The all-important necessity is an efficient artificial aeration, and some little experimentation is necessary that the introduced air is evenly distributed at all times, and in sufficient quantity to satisfy the requirements of the animals without excess and overstimulation. The correct amount under varying conditions is soon learned. The air should be admitted along the rear of the aquarium as a heavy fog, not in small bubbles to burst on the surface. More air must be introduced when the water is warm than when it is cold, as at higher temperatures less is absorbed by the water, while the animal requirements are greater, they being then the most active.

The simplest and most efficient aerating device is the cylinder and pump described on page 178; and which should be kept in constant operation, though care should be taken not to over-aerate the water.

Another simpler aerating device consists of a flowerpot or jardinaire, having the bottom hole plugged with a piece of sponge and suspended over or supported on the frame of the aquarium. Into this some of the water is filled and in percolating through the sponge is both cleared and aerated. It fully answers the purpose for shallow smaller tanks.

FORMS OF MARINE AQUARIA. Any large glass receptacle may be used, but the best forms have glass fronts and sides, slate backs and bottoms, and are constructed so that no metal or cement comes into contact with the salt water. The cement should be covered with strips of glass and the frames arranged outside the glass so that the glass cover-plate rests on the upper edges of the glass and slate, and protects the frame from the action of the salt water, to prevent its rusting and to exclude iron rust from the water. The purpose of the cover is to check a too rapid evaporation and to avoid the trifling splashing caused by the escape of the air through the water.

ARRANGING THE AQUARIUM. In the arrangement of the aquarium the bottom should be covered with sand and small pebbles, upon which either a central or two side mounds of stones, preferably granite, may be erected, interspersed with sea shells, corals and other marine objects, to form grottos and caves, but kept away from the glass, as they may topple and break it. Then the bottom should be covered with a thick layer of fine beach sand, the purpose being to produce a realistic effect, simulating a small section of the quiet bottom of the sea. The slate back may also be covered with pieces of rock, pumice and corals, to form a background, having shelves and projections at different elevations to which the sea anemones and other polyps may attach themselves, or on and behind which deep pockets may be formed and filled with sand, into which the other animals may burrow and hide. Very picturesque marine effects in the decorations and embellishments are possible, different in character from those employed for the freshwater aquarium or the terrarium. The animals will also burrow into the sand on the bottom as it offers the best medium for the continuance of their natural habits.

SEAWATER. Admirers of the marine aquarium in seaboard towns have ready access to seawater and others may have it shipped to them. It should not be taken near the outlet of a freshwater stream, or where contaminated by sewage, but at some distance from the shore; and should be permitted to stand several days before use, that it may purify itself. Care is also necessary that the vessel in which it is transported is clean, odorless and tasteless.

The simplest and best method, however, is to produce seawater artificially, as when the constituents are in proper proportions, it is preferable to the natural water, and is cleaner, clearer, and less likely to contain algæ in excess; those present being introduced with the plants and animals and are required by some of the inmates. Marine plants and animals have been found to thrive as well and better in the artificial than in the natural seawater.

MARINE AQUARIA

Analyses have shown that seawater contains mineral salts of the following proportion, in 1000 parts:

Sodium chloride.....	26.9 parts.
Magnesium chloride.....	3.2 “
Magnesium sulphate... ..	2.2 “
Calcium sulphate... ..	1.4 “
Potassium chloride... ..	.6 “
Sodium bromide.. ..	.06 “
Potassium sulphate... ..	.04 “
Water.....	965.6 “
	1000.

ARTIFICIAL SEAWATER. Experienced marine aquarists prepare artificial seawater with the following salts, the proportions given being for a volume of ten gallons, and the weights in Apothecaries' weight, as this is the most convenient source from which they may be obtained.

Sodium chloride (Tablesalt)....	2 lb. 8ʒ. 2ʒ.	18 gr.
Magnesium chloride.. ..	3ʒ. 5ʒ.	13 gr.
Magnesium sulphate.	2ʒ. 3ʒ. 1ʒ	8 gr.
Potassium sulphate.....	5ʒ. 2ʒ	10 gr.

and sufficient wellwater to bring the whole to ten gallons.

These proportions of salts, expressed in the Metric system, would be:

Sodium chloride.....	.663 grams.
Magnesium chloride.....	.75 “
Magnesium sulphate.50 “
Potassium sulphate.....	.15 “

Added to 25 litres of wellwater.

The salts should be fresh and be kept in glass-stoppered bottles. The magnesium chloride deteriorates when exposed to the atmosphere, and the tablesalt should not be very moist.

Each of the salts must be dissolved in a glass or porcelain vessel by stirring in a little water and then separately added to the wellwater, until the whole quantity is exactly ten gallons, or any desired part or multiple thereof, in the same proportions. The prepared seawater should be kept in a clean glass or stoneware vessel in a cool place and lightly covered for two or three weeks, and occasionally stirred to insure a complete solution and uniform mixture; after which it is ready for use.

A solution of Turk's Island salt of the proper gravity has been successfully used by the Fish Commission, at Washington, for small aquaria, but it is best to prepare the saltwater as above given.

When the aquarium has been filled, it should be left undisturbed for a day or two, after which the water will be found to be clear and limpid.

More water than is required to fill the aquarium should be prepared so that a part may be kept in reserve, which, in a cool place, will not deteriorate but improve in quality and in fitness for use in case of necessity, which may happen to the novice.

HYDROMETER. A hydrometer or specific gravity bulb is not absolutely necessary but is useful. Seawater has a specific gravity of 1.023 to 1.031, which means that a volume equal to one cubic centimeter is approximately .027 grams heavier than the same volume of freshwater of the same temperature, customarily taken at 10°C. or 50°F. Should the hydrometer sink below this point, then the water is not sufficiently saline, or should it rise above, it is too concentrated. Having established the degree of salinity of the water when the aquarium has been filled, its maintenance is simple; evaporation to produce concentration is only the wellwater, which may be filled in, or should changes occur to affect the degree of salinity, a part of the water may be siphoned and some of the reserve water added, to again establish the correct balance. This very rarely or never occurs.

Before the living inmates are introduced, the aeration should be operated for some time, that the water will be charged with air, to revive the animals after their exhausting journey or from other disturbances which may affect their survival.

TEMPERATURE. With proper aeration the temperature of the water does not seriously affect the inmates. Those of the household, of 70°F. to 80°F. in the summer, are not injurious, if the air supply is sufficient; for which reason the aeration should be more considerable in warm than in cool weather. The activity of the animals also increases with the temperature, whereby they liberate more carbonic acid gas and require a corresponding increase of oxygen for their comfort.

MARINE AQUARIUM PLANTS. The growth of plants in the marine aquarium for other than ornamental purposes has never been satisfactorily accomplished. No dependence can be placed on them to serve as oxygenators; for, though they are of most exquisite and delicate forms and beautiful colors, they are all of the lower order of cryptogamous plants which rank as very indifferent generators of oxygen.

MARINE FLORA. These marine cryptogams or algals are all non-flowering, cellular plants, which may be classed by their colors, as this very nearly corresponds with the botanist's classification based on their methods of reproduction. The lowest and simplest forms, Chlorospermeæ, are bright or grass-green in color, the next higher, Melanospermeæ, olive-colored, and the highest forms, Rhodospermeæ, are red in color. All have a wide range of distribution in America and Europe, and consist of arctic,

temperate and tropical genera. Those of the Atlantic and Pacific oceans are similar, but for the purpose of this volume the Middle Atlantic coast species only will be described.

Cape Cod is accepted as the dividing line, as north and south of it a markedly different marine flora exists, because the great arctic and equatorial currents maintain different temperatures of the water; and though the more common seaweeds may be found in both sections, those to the north are essentially arctic and those to the south temperate zone species. About a third of the species of each section do not extend very far into the other. The common forms here mentioned occur from New England to the Carolinas and some still further south.

GREEN MARINE ALGÆ. Chlorospermæ have the widest range, and those tide-mark forms which flourish in full light and where freshwater reaches them at some stages of the tide, or which survive when laid bare by the receding tides, are the hardiest and will thrive best in the marine aquarium. Of these Green Algæ the most generally distributed species are:

Ulva lactuca, (Linn.) or Sea Lettuce, Oyster Green, has pale yellowish-green 6 to 8 inches long and 4 inches wide, thin, membranous fronds with crisped edges, which consist of a single layer of cellules. Quite generally distributed on the Atlantic coast between tide-marks and in deeper water, usually attached to all kinds of objects in the water.

Ulva latissima (Linn.) or Green Laver, Heavy Sea Lettuce, has dark bluish-green very much broader variable fronds, which may attain a length of 24 to 36 inches and a width of 12 to 20 inches. The fronds are thin, soft and glossy, of irregular outline with waved and ragged edges. It grows attached below low-tide marks and is common everywhere.

Purpyra vulgaris (Ag.) or Purple Laver, Purple Weed, is variable in color and may have blackish-green, purple or brown, with thin, satiny, ribbon-like fronds, elegantly waved, crisped and puckered on the edges. The fronds are also variable in form, sometimes two inches broad in the centre and tapering to both ends, or a broad membrane ten inches across. Common in shallower water everywhere, but grows to largest size in California.

Enteromorpha intestinalis (Link.) or Gut Weed, has simple unbranched fronds 6 to 10 inches high and $\frac{1}{2}$ inch wide, slender at the bottom but of the same width above. It is often inflated with air bubbles and then assumes the intestinal appearance indicated by the name. The color is light green, often yellow or white at the top. Grows in tide-pools and shallow water along the Middle Atlantic coast.

Enteromorpha compressa (Grev.) or Band Weed, has two layers of cellules in the compressed or flattened fronds, slender at the base but gradually expanding above, with a blunt, straight-cut top. This alga grows to 8 and 10 inches in length and is of a dark-green color. It may be found along the entire Atlantic coast and is one of the few which may survive in the aquarium.

Cladophora rupestris (Linn.) or Rock Branchweed, has dark, dull-green, stiff and rigid fronds with secondary acutely divided branches and closely clustered branchlets. The plant forms a tuft 3 to 6 inches high. May be found near low-water marks in tide pools or attached to the sides of rocks and wreckage. Most plentiful along the New England shore, but extends south to Florida.

Cladophora arcta (Dillw.) or Arched Branchweed, has very thickly clustered branches and straight branchlets, giving the tuft a graceful arched appearance. The color is a glossy yellowish-green. It is frequently met with below tide-marks from Cape Cod south to Virginia and near Santa Cruz in California.

Bryopsis pulmosa (Lam.) or Sea Feather, has beautiful bright-green tufted 2 to 6 inches long branches, with spreading slender filamentous pinnate fronds, which are shorter at the ends of the branches and placed to give the plant a feathery appearance. May be found in tide-pools growing on the rocks and on wreckage, and is very widely distributed on the Atlantic and Pacific coasts.

Chaetomorpha melagonium (Web.) or Flowing Hair, has stiff wirey 4 to 12 inches long, articulated, bristly fronds tapering at the base, with blunt tips, rising from a disclike holdfast. It is of clear dark-green color and common on northern rocky shores; very rarely in sandy localities.

Chaetomorpha tortuosa (Dillw.) or Sea Wool, forms green mats composed of very thin filaments on rocks and shells, a densely felted and interwoven mass of wooley, confervalike growth. Common from Delaware northward.

Vaucheria marina (Dillw.) or Marine Vaucheria is a small brilliantly green tufted plant growing quite generally on the mud banks and rocks between tide-marks. Another form, *V. submarina*, occurs in deeper water.

OLIVE-COLORED MARINE ALGÆ. Melanospermeæ are mostly of strong growth and leathery consistency, and will not thrive in the aquarium. They are a very numerous family of which but a few species of the more widely distributed genera are here given.

Alaria esculenta (Grev.) or Edible Bladderlock, belongs to the group of Algæ popularly known as "Kelps," and has a quilllike midrib which constitutes the stem, winged at each side with ribless leaflets, often divided

to somewhat resemble a frond of the "Boston fern." It usually grows to 5 to 6 feet with instances of over 20 feet in length, and is of olive-green color. The young plants soon grow to 6 to 8 inches and are of delicate green and yellowish color. Rarely occurs south of Cape Cod, in both shallow and deep water, but sometimes found in the Gulf Stream drift.

Fucus vesiculosus (Linn.) or Rock Weed, is common on submerged woodwork and rocks and is variable both in the size of the plant and of the fronds; but occurs to two feet in length. It is of leathery texture with flat fronds having numerous small air bladders on each frond and is fastened by disclike holdfasts. The color is olive-green in the younger plants and greenish-brown in the older growth. Occurs generally as far south as the Carolinas.

Fucus nodosus (Linn.) or Knotted Sea Whistle, derives its name from the "knots" in the fronds produced by the larger air bladders. It is a stringy plant of rich olive-green color. The fronds are generally small and pinnate. Usually found associated with the foregoing. Other common Fuca are *F. furcatus*, Forked Rock Weed; and the California Rock Weed, *F. fastigatus*.

Sargassum vulgare (Ag.) or Gulf Weed, Sea Lentel, occurs principally in the drift of the sea on the coast. It has a disclike holdfast with a central stem and branching fronds, with the midrib distinct and crisped and toothed edges. The globular air vessels are set between the leaves on short stems. The plant grows below low-tide marks and is common along the Atlantic coast.

Laminaria saccharina (Lam.) or Oar Weed, Sugar Sea Belt, has an eight inch long stem and a flat base consisting of rootlike prongs. The stem expands into a wide, dark olive-green, leathery, thick and smooth frond, ruffled at the edges, 4 to 8 feet long and 6 to 12 inches wide. There are also a number of smaller varieties. Found in deep pools and below tide-marks south to Virginia.

Laminaria flexicaulis (Le Jolis) or Sea Tangle, is somewhat similar to the above, but the frond is broader and divided into long segments; which together with *L. longicuris*, are popularly known as Finger Tangles. They usually grow in deeper water than the first named and may reach a length of ten feet. Sometimes found in the Gulf Stream drift.

Stilophora rhizodes (Ag.) or Needle Weed, is a bristlelike filiform seaweed with widely spreading irregularly forked branches and cylindrical fronds, with wartlike clusters of spores which resemble chaplets of beads. It is of olive-green color and occurs below tide-marks from Cape Cod southward.

Punctaria latifolia (Grey) or Broad-leaved Dotted Weed, is a variable plant which has a cylindrical stem enlarged into a flat tender frond 3 inches wide and 12 inches long, of pale olive-green color, crisped on the edges and dotted with minute spore masses. Very common between tide-marks along the whole Middle Atlantic coast.

Chorda filum (Stack.) or Mermaid's Fish-line, consists of thread-like tough and elastic cords rising from a disclike holdfast, which reach a length of 10 to 30 feet, dependent upon the depth of water. It affords an anchorage to many of the smaller Algæ, which attach themselves to it. Quite common along the Middle Atlantic coast.

Chordaria divaricata (Ag.) or String Weed, is a bushy tough and elastic dark olive-green plant with threadlike sticky cylindrical branches fastened by a small disc to shells, stones and other algæ. It is a deep-water plant usually not over 15 inches high, distributed along the entire Middle Atlantic coast. *C. flagelliformis* (Ag.) or Whiplash, is a very dark-brown, threadlike plant greatly resembling the foregoing.

There are quite a number of other Olive-colored Algæ, but as none of them should find a place in the marine aquarium, they need not be mentioned.

RED MARINE ALGÆ. Rhodospermeæ are mostly of fragile texture and grow in sheltered rock pools, protected from light and the chafing of the waves, or in deep water. Exposed to strong light they lose much of their red color and become greenish, yellowish and white, and soon decay. This group also comprehends some of orange, brown and purple colors, but most of them are a deep red. It is the largest order, and only a few of the most generally distributed forms will be described.

Corallina officinalis (Linn.) or Coral Weed, is a variable alga both in size and general appearance, which may vary in color from reddish-purple to greenish-red. It is usually from 1 to 4 inches in height, the frond composed of slightly flattened filaments with the stem and principal branches diverging from the edges; the plant being composed of small wedge-shaped joints. It grows in great abundance upon rocks, wreckage, and in tidewater pools along the Middle Atlantic coast and in California.

Delesseria sinuosa (Lam.) or Oak Leaf Weed, is a delicate, often parasitical, 3 to 8 inch high alga, of which the stem is flattened to form the midrib and veins of the fronds, greatly resembling an oakleaf. It is met with in the drift on the beach, and is a deepwater species of fine pink to deep lake-red color. Another form is *D. alata* (Lam.), having the margins of the lobes entire and the fronds narrower. Both found north of Cape Cod and on the California coast.

Polysiphonia violacea (Grev.) or Many-tubed Violet Weed, is a very common form in tide-pools and below tidewater; very variable in appearance. The stem is thick and twiglike, the primary branches widely spread, the secondary branches short and much divided, with feathery tufts at their ends. The color is violet and brownish-red and the plant grows to a height of 12 to 16 inches. May be found from Cape Cod south to Florida.

Polysephonia urceolata (Grev.) or Pitcher Weed, has very fine silky filaments which grow in a 4 to 10 inch tuft of fine carmine-red color. The thin stems are many-branched and the fronds assume a bushy appearance composed of many slender filaments. Its name is derived from the form of the seed vessels. Common on both the Atlantic and Pacific coasts.

Polysephonia fastigiata (Grev.) or Black Tassel Weed, consists of a dense tuft of many times divided filaments all of about the same length so as to form a cockadelike tuft. It is parasitic on some of the Fuca. The color is dark-brown or black. Common along the entire Middle Atlantic coast.

Polysephonia elongata (Grev.) or Lobster-horn Weed, consists of a cluster of straight stalks about the thickness of heavy twine, joined at the upper ends, with the branches irregularly forked. The winter form is almost denuded of branches and from it the name is derived. The color is light-brown, pink and red. Common on the Middle Atlantic coast and grows in deeper water.

Chondrus crispus (Lyn.) or Irish Moss, has 3 to 6 inch high tough, leathery, curled and fan-shaped fronds on a flattened stem. From it a tasteless gelatine is made. Grows on a rocky bottom on the entire Atlantic coast, and is a deep brown or purple color in deep water and yellowish-green in shallow water.

Phyllophora membranifolia (Ag.) or Red Leafweed, consists of a bunch of 12 to 20 irregular branched stems bearing wedge-shaped, fanlike $\frac{1}{2}$ to 1 inch long fronds, having forked and divided edges. The plant reaches a height of 3 to 6 inches and grows on rocks and solid bottom in deep water in the warmer section of the Atlantic coast. It is clear red in color, sometimes violet in the older growths.

Calithamnion americanum (Harv.) or Sea Shrub, is a dainty and beautiful crimson or rose-red shrublike alga, of which the fronds are almost as fine as a cobweb and the plant composed of innumerable delicate branches from a central stalk attached by a disclike holdfast. Generally distributed on the Atlantic coast south of Cape Cod. One of the handsomest common forms. Another frequent form of these fine algæ is *C. versicolor* (Ag.) the Many-colored Sea Shrub, distinguishable from the ten other

forms by the diversity of its colors; which shade in different parts of the same plant from rosy-red and bright-green to violet, brown, dark-green, olive and yellow. It grows to about 3 to 5 inches in height. All of the genus are beautiful plants, common to the Middle Atlantic coast.

Grinnellia americana (Harv.) or Flame Weed, is a very beautiful alga, having a delicate red membranous frond 12 to 24 inches long and about 3 inches across the centre; with crisped and sinuous margins, and tapering to a fine point at both ends. It usually grows in 5 to 8 fathoms of water and is so beautiful that it is to be regretted that it will not usually survive in the aquarium.

There are many other common genera of Red Algæ, but space will not permit of a further mention.

ALGÆ FOR MARINE AQUARIA. The following are the best Algæ for the marine aquarium:—Green Algæ. *Ulva lactuca* and *U. latissima*; *Cladophora rupestris*, *Bryopsis plumosa* and *Vaucheria marina*. Red Algæ. *Corallina officinalis*, *Delesseria sinuosa*, *Polysiphonia violacea*, *P. urceolata* and *P. fastigiata*; *Phyllophora membranifolia*, *Callithamnion americanum* and *C. versicolor*.

The Olive-colored Algæ should not be introduced or only small plants under careful supervision. Some of the above may survive for a longer or shorter period, but very rarely become fully acclimated. For the aquarium to which considerable light has access, the Green Algæ will best serve, as they are the most likely to adopt themselves to these conditions; while those which are in subdued light or protected by green tissue paper on the front next to the light will serve for some of the Red Algæ and still allow sufficient light to pass for the Green. The arrangement should be by planting the green nearest the window or source of light, and the red farthest away or screened by rockwork.

For the aquarium in which marine fauna are kept a few tufts of *Ulva* and *Enteromorpha*, and one or more each of *Polysiphonia* and *Phyllophora* will be all that it is advisable to introduce.

It is best to speedily transfer the plants from their native sites to the aquarium, and to clean them with saltwater before placing them into it. Any clean vessel will serve for their conveyance, and they should be transmitted unhurt by friction or exposure to the atmosphere. Packed between thick layers of moist seaweed they may be carried considerable distances, this being better than in seawater which may rise considerably in temperature and so injure the plants. Trials should be made, and experience will be the best guide for their care and treatment.

MARINE ANIMALS. Even a list of the marine fauna of the Middle Atlantic coast would be so long, diverse and complicated that it could not

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find a place in this book. Only the most common *littoral* forms, those living on or near the shore, are mentioned and those of greatest interest to the collector are described. The Marine fauna may be roughly classed as:—

I. Porifera.	Sponges.
II. Cœlenterata.	{ Polyps, etc., Seaweedlike Zoöphytes and small Jellyfishes, some of the Corallines, and Hydrozoa generally. { Larger Jellyfishes and Scyphozoa generally. { Sea-anemones, Actinoid corals and Actinozoa generally. { Comb-jellies and Ctenophora generally.
III. Vermes.	Worms and Leeches.
IV. Molluscoida.	Sea-mats or Polyzoa, and Corallines or Brachiopods.
V. Echinodermata.	{ Starfishes, Brittle-stars, Sea-urchins, Sea-cucumbers, Feather- stars, Sea-lilies and Radiates generally.
VI. Arthropoda.	{ Crustaceans, Entomostraca, Barnacles, Lobsters, Shrimps, etc., King Crabs, Sea Spiders, Squilla, and the Amphipods and Iso- pods in general.
VII. Mollusca.	{ Limpets, Tops, Whelks, Periwinkles and other Gasteropods; { Mussels, Clams, Scallops and Pelecypods generally. { Cuttles and other Cephalopods.
VIII. Chordata.	Sea Squirts and allied forms.
IX. Pisces.	Fishes.

PORIFERA OR SPONGES. These constitute one of the lowest forms of animal life, propagating by gemmation or budding. The sponge of commerce is the skeleton or framework, the organic portion being a soft and jellylike substance of which the external layer is composed of flat cells with numerous pores and larger openings for inhaling and straining the water; the middle layer of cells having various functions, as the formation of the framework, digestion and reproduction; and the internal layer of cylindrical cells leading to sacs, each having a flagellate hair to create a current. These take in the food, digest it and eject the excrement. Almost every seaweed, rock, mollusc and crab has some member of this family attached to it, which vary in size from tiny specks to large and substantial masses of varying forms and colors. Sponges are roughly divided into two classes, Calcarea and Non-Calcarea.

The genera most usually met with are the following, of which a brief description will suffice, as they do not survive in the marine aquarium.

DUSEIDEIA, having an imperfectly cellular body composed of a gelatinous membrane covered with amorphous particles of sand.

GRANTIA, having a firm, elastic body with calcareous spicula compacted in a gelatinous base.

HALISARCA, having a gelatinous or fleshy substance forming an irregular crust on the object to which it adheres.

HALICHONDRIA, having an elastic body permeated by canals opening to the surface and siliceous spicula in the fibre distributed throughout its homologous body.

SPONGIA, having a very porous body composed of net-fibres traversed by canals opening to the surface, the fibres without spicula. Very irregular and variable in form, and parasitical or incrustated on and under stones and other objects.

Sponges should not be introduced into smaller aquaria and should be carefully scraped from stones and other objects, as they soon decay and may pollute the water.

CÆLEENTERATA OR POLYPS. These are somewhat higher forms of animals. The **Hydrozoa** are zoöphytes resembling seaweeds, which live in colonies, small compound jellyfishes composed of many individuals; and the **Millepores** live in colonies and secrete a stony instead of horny skeleton. Of these no further mention need be made. The **Scyphozoa** are larger jellyfishes of various forms of development, but also do not require mention. The **Actinozoa** include anemones, actinia and actinoid corals, of which the first are of particular interest, but other forms of Corals, Corallines, Sea-pens, Sea-whips and Sea-fans, and the **Ctenophora**, including the Comb-jellies, require but brief mention, as none of them will survive in the Marine aquarium.

SEA ANEMONES and ACTINIA. These polyps belong to the order **Actinaria**. They mostly inhabit crevices, dark holes and under stones, but some hardy species may be taken in exposed positions, or piles, submerged woodwork and other firm objects. There are both deep and shallow-water forms. They generally consist of an undivided column or stalk with a pedal disc or holdfast at the under side, and an oral disc with central mouth surrounded by circles of tentacles at the upper. They are capricious in the forms which they assume and when fully expanded are often of considerable size, but are sensitive and when disturbed collapse and shrink into inconspicuous dusky buttons, as they are soft and very contractile. The most of the **Actinaria** are developed from eggs which form on the edges of the inner walls of the column. These, when mature, are ejected from the mouth, small ciliated spheres which swim about until they find a suitable location to which to attach themselves. Some forms reproduce by budding, either on the disc or from the sides of the column. As a means of defense they emit long slender threads or acontia, having minute stinging cells. Nearly all are carnivorous and feed on small animal organisms, crustaceans and molluscs.

The most common and generally distributed Middle Atlantic coast forms are:

Metridium marginatum, (Les.), having a smooth, cylindrical, light-brownish column with deeply folded and fringed margin, and numerous short, fringelike tentacles, of which the central are the longest. The color is variable, the disc usually a light flesh-color and the tentacles greyish with brighter colored tips. When expanded it is sometimes ten inches across the disc, and when contracted appears as a broad flat cone. This is the most conspicuous and abundant form, found from low-water marks to 90 fathoms, on piles, bridges, submerged woodwork, etc., and in rock crevices and under stones, from Cape Hatteras northward.

Eloactis producta, (Stimp.), has rows of suckers the entire length of the column. It can expand to a length of 12 inches, but is usually shorter and thicker. There are twenty tentacles about the margin of the thick disc. The colors are variable but usually in dusky tones with brighter shades and mottlings. Found from Cape Cod to the Carolinas, on sandy beaches and under rocks at low-water marks; or buried under the sand with the mouth and tentacles only above the surface. One other form, *Ilyanthus levis*, (Stimp.), is found south of the Carolinas to Florida. These are nearly related to the numerous genus *Halocampa* of Europe, of which there are two American species, both north of Cape Cod.

Aulactinia capitata, (Ver.), has a 6-inch long dark-grey or bluish column, $1\frac{3}{8}$ inches in greatest diameter when extended, and 96 tentacles in four rows about a rose-colored disc. Found at low-water marks from Cape Cod to Florida. There are other deep-water species of this genus.

Cerianthus americanus, (Ver.), a very long and slender form, has an 18 to 20 inches long column tapering from the disc to the base, which can be contracted to 8 inches. The 124 marginal tentacles are $1\frac{1}{2}$ inches in diameter across the disc, when expanded. Found in shallow water from Cape Cod to Cape Hatteras.

Tælia crassicornis, (Gosse), has a short and thick $1\frac{1}{2}$ to 2 inches high column when extended, and short, thick tentacles. The colors of the disc are brilliant in varying shades of bluish-green mottled with crimson, often bright cherry-red. The tentacles are somewhat lighter in color, usually grey and flesh-colored. It is voracious and will entrap small fishes, crabs, etc., that come into contact with the disc and tentacles. Found in shallow water from Massachusetts northward on ledges and in tide-pools.

Edwardsia sipunculoides, (Stimp.), has a slender, brownish, truncated 1 to $1\frac{1}{4}$ inch long column, and 24 to 30 short tentacles about a narrow disc, usually of a dull grey or pinkish color. Another form, *E. lineata*,

(Ver.), is similar to the above. This genus has one other Middle Atlantic coast parasitic form and four species north of Cape Cod.

Ammophilactis rapiformis, (Ver.), has a 3-inches long column surmounted with a $1\frac{1}{4}$ inches diameter disc, with 144 tentacles in a crowded circle. The colors are variable, but incline to pinkish and bluish tones. Found in tide-pools from Cape Cod to Cape Hatteras.

Cylista leucolena, (Ver.), has the $2\frac{1}{2}$ to 3 inches long cylindrical, translucent column usually rose-colored and covered with scattered wartlets. The disc is simple and thin and the 96 slender, crowded tentacles are placed in five rows on the margin of the $\frac{1}{2}$ inch diameter disc. The tentacles are pinkish- and whitish-grey, darkest in color at the disc; and in size are twice as long as the diameter of the extended column. Common from Cape Cod to North Carolina on submerged woodwork and under stones.

Sagartia luciae, (Ver.), is a small $\frac{1}{4}$ to $\frac{3}{8}$ inch high and $\frac{1}{4}$ inch diameter polyp, having 84 tentacles in four rows, of which the central are the longest. The colors are bright but variable. Found from Cape Hatteras north. Another form, *S. pustulata*, (McMur.), has the $\frac{3}{8}$ inch column broken by longitudinal and transverse furrows. The $\frac{1}{4}$ inch diameter disc has 64 long tentacles arranged in four rows. Found in the same localities, often associated with the above. Other shallow- and low-water forms are *S. gracillima*, having a 1-inch column and 48 tentacles, and *S. modesta*, very similar in form to *C. leucolena*, but smaller and having a few hairy excrescences on the column.

PARASITIC ANEMONES. This interesting group contains a number of species which attach themselves to the shells of hermit crabs, whelks and other animals, probably on account of the change of location they afford, and they in their turn aid as a disguise to the animals with which they are associated. There are a number of American forms which have this habit, among them some of those already described, which are the more generally distributed forms.

GORGONACEA, the family of the Sea-fans, Sea-whips and Sea-feathers; and Pennatulacea, the Sea-pens, are colonies of polyps closely united about a horny axis, which resemble miniature trees and branches covered with a coating of animal matter. None of these survive in the aquarium.

MADROPORES, the family of the Branch and Reef Corals, also cannot be kept alive in smaller aquaria and further mention of them is omitted. For purposes of ornament some of the calcareous structures of American Corals are desirable, especially those of the Florida reefs. These are *Gorgonia flabellum*, the Sea Fan; *G. cervicornis*, the Stag-horn Coral; *Meandrina labyrinthiformis*, the Brain Coral; *Orbicella annularis*, the Star

Coral; *Agaricia agaricites*, the Fungus Coral; and *Millepora alcicornis*, the Finger Coral or Sea Ginger. These corals cleared of the polyps may be obtained adhering to the rocks upon which they grew, or may be fastened with hydraulic cement in desired localities in the aquarium.

VERMES OR WORMS AND LEECHES. The marine forms occur in mud and sand, under stones and in rock crevices, crawling over the weeds and the bottom; or, either free or attached, in tubular cases, or sometimes attached to other animals. The Platyhelminths are principally flat worms, the Nemertinea thread-worms, the Nemathelminths round-worms, and the Polychæta many-bristled-worms; the Annulata ringed worms, and the Sedentaria tubicolous or pipe-worms. With but few of these we are concerned. Elsewhere the Trematoda, internal and external parasitic, and the Cestoda, strictly internal parasitic worms are mentioned.

NEMERTINA. These long and slender marine worms are generally distributed between tide-marks and are from $\frac{1}{2}$ inch to many feet in length and exceedingly contractile. Some will survive in confinement. The most generally species are:

Nemertes socialis, color black or brown, slender slightly flattened, 5 to 6 inches long when extended, with four eyes on each side of the head; and *N. viridis*, color olive-green or brown, rather thick, slightly flattened, 6 to 8 inches long when extended; eyes black in two rows. Both common under stones, etc., in shallow water.

Tetrastemma arenicola, color dark-pink or purple, slender, cylindrical, 4 to 5 inches long when extended, head changeable in form, neck slightly constricted. Common in sand and mud at low water marks.

Cosmocephala ochracea, color grey or yellowish-white and mottled, 2 to 3 inches long when extended, rather stout and cylindrical. Common on low-water-marks, usually in empty shells.

Polina glutinosa, color orange or light-yellow, eyes numerous in oblique lines on head, 2 to 3 inches long when extended, usually on algæ and woodwork.

This group of worms will not long survive in aquaria together with other animals.

SEDENTARIA. These tubicolous marine worms make interesting aquarium studies as they construct tubes of grains of sand, seaweeds and particles of shell by mucus secretions; other secrete calcareous matter which forms hard cases. All have the anterior portion more developed than the posterior end of the body. The most general and interesting are:

Amphitrite ornata, color red or brown, 8 to 12 inches long, with three pairs of plumelike gills and many flesh colored tentacles at the head, which are constantly in motion. The tubes are $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter,

composed of sand and mud. Found in sand and gravel and under or attached to fixed objects; from Cape Cod to Maryland.

Cistenides gouldii, color light red, body short and slightly curved, head obliquely flat, with two broad groups of golden bristles on each side of head, $\frac{1}{2}$ to 2 inches long. Constructs conical horn-shaped tubes of a single layer of sand. Found on sandy beaches from New Jersey northward.

Clymenella torquata, color pale red with bright bands, 4 inches long; body segmented and bristled, head funnel-shaped. Constructs nearly straight tubes of sand. Ranges from New Jersey northward close to low-water marks.

Serpular dianthus, color variable, dull olive and reddish, with plume-like gills which form a wreath about the head. The white calcareous tube is 3 inches long and $\frac{1}{8}$ inch in diameter, and has the end coiled and contorted. The free end has a circular opening with an operculum. Found in tide-pools attached to shells and rocks, from Cape Cod to Florida.

These are a few of the most characteristic forms.

MOLLUSCOIDA. Of the Polyzoa there are hundreds of named species, mostly consisting of colonies of small polyplike organisms, depositing calcareous matter and attached to plants, stones and other fixed objects. The Branchiopods are somewhat similar to the lamellibranch molluscs, but the two valves of the shell are always dissimilar. They are usually fastened to some marine object by a fleshy peduncle extending between or through the valve; and the body cavity is lined with cilia. In the order Inarticulata the hinge of the shell is wanting and the thin plates may be moved in every direction. In the order Articulata the valves are articulated by a hinge formed by teeth on the lower and sockets on the upper valve. They are much lower forms than the Mollusca and need not be here further described.

ECHINODERMATA. These Radiates of the higher type have an exterior skeleton and most of them have the spines from which the name is derived. They include the Asteroidea or Starfishes, Ophiuroidea or Brittle-stars, Desmosticha or Sea-urchins, Holothuroidea or Sea-cucumbers, and the Crinoidea or Feather-stars and Stone-lilies. Brief mention of these will be made, description being confined to the most common species of the Middle Atlantic coast.

STAR FISHES or RAYS. These animals derive their name from their asteroid or starshaped forms, the different species having from 5 to 22 rays. The external skeleton is complex, and consists of calcareous plates and spines either firmly united to form a solid shield or separate and imbedded in the integument. The mouth is in the centre of the ventral

side, a furrow extending along each arm in which are the ambulacra or tube-suckers by which the animal moves and seizes its prey. The folded stomach is connected to the mouth and occupies the greater part of the central space. The four species of the Middle Atlantic coast are:

Asterias forbesii, (Stimp.), the most common Atlantic coast ray, has a comparatively small body with five rather broad arms swollen at the base and tapering to a blunt point. The upper surface is rough and covered with short spines which are larger at the edges of the rays. The colors are variable, but usually red or reddish-brown, with bright-orange plates in the younger and yellowish-red, brown and purple in the older individuals. It grows from 10 to 16 inches in diameter and is common from Massachusetts to Florida. Another form, *A. vulgaris*, has a very similar body, but the five rays are not as swollen, a little more slender, and taper to sharper points. It may also usually be distinguished by the difference in color, as it is darker and the yellowish-red tones are absent. Common and often associated with the above from Cape Cod to New Jersey. Both are very destructive to oysters.

Luidia clathrata, (Stimp.), is a slender five-rayed 4 to 5 inches in diameter light colored ray, with the long arms tapering to a point and fringed on the edges with distinct spines, but rather smooth on the surface. The body is small and there are two rows of ambulacra. It has the habit of breaking into pieces when taken from the water and can rarely be transported entire to the aquarium. Common from New York to the Carolinas. There are two other Florida forms of the genus.

Echinaster sentus, (Ver.), is heavier than the above with five broader arms and a relatively larger body, and has the surface rough with spines. It is purplish-red in color, 4 to 4½ inches in diameter, and has two rows of ambulacra. Found near the shore from New Jersey to Florida.

Only the five-rayed forms are common on our coast, those of ten and more rays are deep-sea forms. Starfishes are voracious and only very small ones should be introduced into the aquarium with other weaker animals or with molluscs. If kept by themselves any of the described forms often survive for a long time, especially in large aquaria.

BRITTLE-STARS. The Ophiurans or Brittle-stars have the long distinct and serpentine cylindrical arms attaches like appendages to a small, round body. They have no tube-suckers, locomotion being by movements of the arms. Three species are common on the Middle Atlantic coast, but most of them are found in warmer southern and western waters.

Ophiopholis aculeata, (Ver.), has the upper surface of the body covered with variously arranged plates surmounted by small, short spines. The five arms are long, slender and tapering, having transverse oval plates

with flat granules, and fringed with thick obtuse spines. The under side is covered with regular rows of quadrangular plates. The color is variable, usually variegated and spotted with purple. It is a large species, about 18 inches in diameter, and may be found in shallow water along the entire Northern Atlantic coast.

Ophiothrix angulata, (Ver.), is a small Florida species, sometimes found farther north. The body is covered with short rough spines, and the five arms are narrow, tapering and beset with long spines serrated on the edges and ends. The color may be pinkish-yellow or light-brown, according to the bottom upon which it lives.

Amphiura squamata, (Ver.), is a small 2 to 4 inch diameter animal. The body is less than $\frac{1}{2}$ diameter, and the five arms threadlike and almost smooth on their surface. This is a delicate species found from New Jersey northward below low-water marks.

SEA URCHINS. These animals are closely related to the Starfishes, the shell-like covering showing the lines of union of the rays. They are mostly deep-water forms, the two shallow-water species on the Middle Atlantic States coast are:

Arbacia punctulata, (Ver.), having a one inch in diameter shell with $\frac{1}{2}$ to $\frac{3}{4}$ inch long spines. The color varies from straw-yellow and whiteish-grey to brown, with the spines tipped with brown. A small species found in shallow water from Massachusetts to Florida.

Strongylocentrotus drobachiensis, (Grey,) the Common Sea-egg, has a 2 inch in diameter shell, greatly resembling a large chestnut-burr, usually of greenish-purple color. The body is circular and sometimes depressed, and the tube-feet slender. It moves slowly and feeds on small algæ, oscillatoria, and decaying animal matter. Common in shallow water along both the Atlantic and Pacific coasts, most abundant on the coast of Maine.

Both these forms are harmless and useful aquarium inmates.

SAND DOLLARS OR SHIELD URCHINS. This urchin, of which the circular disc forming the skeleton, is a common object on some beaches, belongs to the genus *Echinarachnius*, of which one species occurs in Middle Atlantic coast waters.

Echinarachnius parma, (Stimp.) has a skeleton consisting of a flat disc composed of calcareous matter and sand, often 4 to 5 inches in diameter, which in life is covered by short silky spines. The animal is somewhat like a jellyfish in general form, occurs in deeper water, and is very rarely taken near the shore.

SEA CUCUMBERS. These higher forms of Echinoderms are native to warm waters, and but one species occurs on the Middle Atlantic coast.

Pentacta frondosa, (Jaeg.), or Brown-Sea-cucumber is the largest common Atlantic species which measures from a few inches to a foot in length when extended. *Holothuria princeps* and *H. floridana*, the Florida Sea-cucumbers, are large species which have been collected and dried for export to China.

FEATHER STARS AND STONE LILIES. This class of Crinoidea inhabit deep water where they form branching featherlike and flowerlike beds. Some are permanently attached, others become detached and float about by movements of the raylike arms. They are rarely found on the shore and fail to survive in aquaria.

CRUSTACEANS. The larger Marine crustaceans are divided into a number of groups, the Branchyura or true Crabs, the Anomoura or Hermit Crabs, etc., the Macroura or Lobsters and Shrimps, the Xiphosura or King Crabs, the Squillidæ or Mantis Shrimp, the Cirripedia or Barnacles and Tops; and the smaller Marine Entomostraca or Water Fleas.

These will be mentioned in this order.

Callinectes hastatus, (Ord.), or Common Edible Crab, Blue Crab, Sea Crab, has the shell or carapace about twice as broad as long, and armed with a distinct projecting spine and eight short acute teeth on each side, gradually increasing in size towards the eyes. There are four unequal-sided teeth between the eyes and a median spine beneath. The front limbs, bearing the claws, are similar to each other in form, and the three succeeding pairs of legs are slender, terminating in sharp points, and the posterior pair end in expanded oval joints for swimming. The carapace grows to a length of 3 inches and a breadth of $5\frac{1}{2}$ to 6 inches, and is covered with minute granulations and margined with fine hairs. The upper surface is of dark-green or bluish color, the lower dusky-white, the feet and claws blue, tipped with yellowish-red. The period of spawning and shedding extends over several months. It is very active, crawling and swimming rapidly, and may be taken on muddy and sandy bottoms in both salt and blackish water, from Cade Cod to Florida. It is predaceous and feeds upon all living and dead animals. This species may be distinguished by the sharp spine on each side of the carapace. There are four other species of this genus in more southern waters.

Carcinus menus, (Say), or Green Crab, has a bright green color varied with spots and blotches of dull yellow and brown, and has the carapace and limbs more or less granulated. It has heavy claws and legs shorter than the foregoing and shorter spines at the sides of the narrower carapace, with four unevenly ciliated teeth at each side and three between the eyes. The last pair of legs also nearly resemble the other three pairs and lack the broad swimming blades of the foregoing species. Abundant between tide-

marks and in tidal pools, but also resorts to the peaty banks on the shore and in ditches and streams of salt and brackish waters. In some parts of New England it is known as the "Joe Rocker." Abounds from Cape Cod to New Jersey and further south.

Cancer irroratus, (Say), or Common Rock Crab, may be distinguished by the nine blunt teeth on each side of the front margin of the nearly smooth carapace, which is evenly sub-oval in outline, two-thirds as long as broad. The claws are short and stout and the four posterior legs long and rather slender, with pointed tips. The carapace and upper surface of the legs are yellowish in color with purplish-brown dots and mottlings at the sides and rear. Between tides it burrows in the sand and gravel or is concealed among rocks and weeds. Its range is from Labrador to South Carolina but occurs most generally above Virginia.

Cancer borealis, (Stimp.), or Jonah Crab, is closely related to the foregoing, and may be distinguished by the rougher carapace and claws, the shorter and thicker legs and the bright-red color above and yellowish color beneath the carapace, claws and legs. The carapace reaches $3\frac{1}{2}$ inches in length and $5\frac{3}{4}$ inches in breadth. Its habitat is similar to the above, but does not occur below the New England States. It lives a more exposed existence and is rarely concealed among the rocks.

Panopeus herbstii, (Edw.), the most common and largest of the Mud Crabs, is dark-olive above and yellowish-white below the carapace, and has the large claws black, tipped with lighter color. The largest measure 2 inches across the carapace and range from Massachusetts to Brazil. Other smaller Mud Crabs are *P. depressus*, *P. sayi* and *P. harrisii*, all ranging along the Middle Atlantic coast as far south as Florida.

Platyonichus ocellatus, (Lat.), or Lady Crab, Sand Crab, has a $2\frac{1}{2}$ to 3 inches carapace, nearly as long as broad, the form roughly suggesting a six-sided figure. The lateral margins bear five spines or teeth and the front limbs and claws are long and somewhat slender. The color is dingy-white and the back is covered with red and purple spots. It frequents the sand of low-water marks and exposed beaches buried to the eyes, and feeds on smaller living and dead animals. It is a common feature of the sea beach. Found from northern New England to Florida, from low-water marks to ten fathoms.

Ocypoda arenaria, (Rath.), or Sand Crab, Ghost Crab, is a small shore crab about 1 inch long, $1\frac{1}{2}$ inch broad and 1 inch thick. The carapace folds down between the eyes, which are prominent on the long peduncles. It burrows in the sand in holes often three feet deep and is very quick in its movements when disturbed. It has the habit of raising itself on its feet and moving the eyes in its desire to see approaching enemies and prey. The

colors are almost exactly those of the sand and the coarsely granulated carapace appears like a little mound of wet sand. Common from Long Island to Brazil, and subsists largely on Beach fleas, upon which it springs by a sudden movement of the legs.

Menippe mercenaria, (Say), the Stone Crab, is a frequently occurring Southern form not present on more northern shores.

Libinia emarginata, (Leach), or Common Spider Crab, or Sea Spider, has the whole surface of the body covered with hairs, matted with mud and algæ. The carapace is nearly round and the limbs have a thick granulated covering. The legs are long and slender and the claws short and weak. The males are larger than the females and often have a spread of 12 inches. It hides in the mud and decaying weeds and is sluggish in movement. Common from Maine to Florida. A second species, *L. dubia*, closely resembles the above, but its range is more to the north.

Lambrus Pourtalesii, (Say), or Long-armed Spider Crab, has a thick roughly spined, almost pear-shaped $1\frac{1}{2}$ inches broad carapace, very long, heavy, roughly granular and spined $\cdot 3$ inches long forelimbs with very short claws. Lives among rocks, which it closely resembles, and ranges from Cape Cod to Florida.

Hyas coarctatus, (Say), or Toad Crab, inhabits both shallow and deep water, its name being derived from the repulsive appearance of the carapace and the size of the body, which resembles a toad. The legs are slender and the claws short and weak. Common along the Atlantic coast.

Eupagurus pollicaris, (Stimp.), or Hermit Crab, Soldier Crab, lives in shallow water and protects its soft hinder portion in empty Gasteropod shells, which it carries with it by holding fast with the hooklike end of the body. Found from Massachusetts to Florida. Three other Middle Atlantic coast species are *E. pubescens*, *E. bernhardus* and *E. longicarpus*, all of similar form and habits. These crabs make interesting aquarium inmates and thrive best when they can come on rocks above the surface.

Gelasimus minax, (*Uca minax*), (Le Côté), or Common Fiddler Crab, abounds in almost every salt water and brackish marsh and estuary. The males are provided with unequal claws, the larger of which is likened to a fiddle and the smaller to the bow. The claws of the female are of equal size. They congregate in numbers and excavate holes in mud banks above the reach of the tides, to which they scamper when disturbed. Two other very similar species, *G. pugnax* and *G. pugilator*, also occur from New England to Florida. Of these the one described is the larger. Associated with the Fiddler another crab, *Sesarma reticulata*, the Brown Shore Crab, will often be found. It is reddish-brown in color and has

stout claws of nearly equal size. In form it very nearly resembles the Fiddler.

Pinnotheres ostreum, (Say), or Oyster Crab, of which the female lives parasitically in the gill cavity of the oyster and the smaller male leads a free existence on or near oyster beds, are very unlike in appearance; the male having a firm carapace, dark-brown above with a central dorsal stripe and two white spots, and white below, with white legs and yellowish claws; and the thin-shelled female has a transparent whitish color tinged with pink; the carapace of the adult female being about $\frac{1}{2}$ inch broad and a little less in length. Occurs from Massachusetts to South Carolina.

Pinnotheres maculatum, (Say), or Scallop Crab, occurs in the shells of some Sea Mussels and Scallops and attains somewhat larger size than the foregoing. The female only is parasitic, the smaller male usually lives among seaweeds and on the mud bottoms. Occurs most generally along the New England coast.

Hippa talpoida, (Say), or Sand Bug, has an oval body about half as long as broad, the sides forming a nearly regular curve, giving to the animal a buglike appearance. The tail is carried under the body and the eyes are placed on long peduncles. The color is translucent yellowish-white, overlaid with a purplish tinge on the back, sometimes mottled. Ranges from Cape Cod to Florida, and is known to fishermen as the Bait-bug.

Limulus polyphemus, (Lat.), or King Crab, Horseshoe Crab, though not a true crab and belonging to the order Xiphosura, should be here described, as some naturalists regard it as a low type of Crustacean, while others place it among the Arachnida. It has a very large carapace terminating in a spine at the posterior angle on both sides, a small abdomen with a long, tapering spine at its end. The basal portion of the legs serve as masticating organs. It is slothful in its habits and is usually buried in the mud and sand in the shallow water of estuaries and along the shore, feeding upon various smaller animals. Its range is from Maine to Florida, and is abundant along the shores of the Delaware Bay. Very small specimens have survived for long periods in aquaria.

CRABS AS SCAVENGERS. Crabs are voracious feeders and will attack their own species and most of the other living inmates of the aquarium. Only small specimens should be introduced, which serve as excellent scavengers.

Homarus americanus, (M-E.), the American Lobster, is one of the most important food invertebrates, and has the body made up of two sections. The anterior portion, consisting of the head and thorax, is covered with a carapace, and the posterior portion or abdomen is covered with six

segments and a terminal flap or telson. Below the carapace there are five segments corresponding to the pairs of legs, of which the anterior pair bear the claws. Each segment of the abdomen has a pair of appendages on the lower side, the swimmerets, and the telson has two larger ones terminating in two broad plates. The eyes are on two short movable peduncles and there are two long and two short antennæ or feelers. The American Lobster is variable in color, usually darker green and bluish on the carapace with the under side and the limbs of a lighter color; that of the adult is usually a greenish black, but the color depends upon the character of the bottom which it inhabits. Its range is from Labrador to Delaware and Virginia, but it occurs most numerous from Massachusetts northward, as it prefers a rocky and gravelly bottom covered with a growth of the larger seaweeds. Of the Atlantic species there are but two varieties, known to fishermen as the School Lobster and the Rock Lobster. One other species, *Panulirus interruptus*, (Rand.), also classified as *Senex interruptus*, the California Spring Lobster, is a smaller form, ranging southward from California, and is similar to the European *P. vulgaris*.

SHRIMPS and PRAWNS. These animals have compressed bodies and soft carapaces with the abdomen large in comparison with the combined head and thorax. The difference between the Shrimps and Prawns is not well defined, as they are nearly related forms. In France they are known as Crevettes and in Germany as Garnellen.

Crangon vulgaris, (Fabr.), or Common Sand Shrimp, reaches a length of two inches, and varies in color with the character of its habitat, from pale translucent grey, to resemble the surface upon which it lives, to darker colors and mottlings on a muddy bottom. It secretes itself so that only the eyes and antennæ are visible, and buries itself when disturbed. Abounds from Labrador to North Carolina between tide-marks, principally on weedy bottoms. *B. franciscorum* is the California species.

Penæus setiferus, (M-E.), the largest Southern Shrimp of the markets, ranges from Charleston, S. C., south. *P. brasiliensis* is another form from the same locality.

Squilla empusa, (Say.), or Mantis Shrimp, is a larger deepwater species belonging to the Squillidæ, and is similar to the *Squilla* of Europe. It somewhat resembles the lobster and is 6 to 10 inches in length. Its range is from Cape Cod to Florida, and is rarely found near the shore.

Palæmonetes vulgaris, (Stimp.), or Common American Prawn, is usually one inch long, but reaches a length of 1½ inches, and occurs abundantly along the Middle Atlantic coast. The body is almost colorless and transparent, marked by irregular spots and blotches of grey and brown. It is the "bait" shrimp of the angler, and inhabits both salt and

brackish water, preferably on a muddy bottom; and is abundant in calm weather in pools and ditches among vegetation, and about piles and other submerged woodwork. It is a very good aquarium scavenger; also serving as food for the fishes and other inmates.

Pandalus borealis, (Kroyer), or Deep Water Prawn, is a 6 to 7 inch long species which never approaches the shore. Two other forms, *P. montagni* and *P. prepinquus*, also inhabit deep water having abundant vegetation.

CIRRIPEDIA. These Crustaceans include the Barnacles and similar forms everywhere plentiful in salt and brackish water. A few of the larger forms attached to a plant or stone may be introduced into the aquarium, but should be under careful observation, as they do not usually survive. The most common are *Balanus eburneus*, or Black Barnacle, Sea-acorn; *B. balanoides*, or Ivory Barnacle, common on the Atlantic coast on most submerged woodwork, either fixed or floating, and *B. crenatus*, a parasitic form attached to crabshells, stones, etc. The larger *B. tintinabulum*, and *Lepas fascicularis*, or Goose Barnacle, are found attached to the bottoms of vessels that have come from warmer latitudes.

MARINE ENTOMOSTRACA. The order Crustacea also includes those of minute size, Water-fleas which are both free-swimming and parasitic. They form a considerable part of the food of fishes and other marine animals and need no further mention here.

AMPHIPODA. These forms are numerous on all beaches; the most generally distributed are:

Orchestia agilis, (Smith), or Beach Flea, Sand Hopper, which occurs in countless numbers on every beach. When disturbed it hops by means of the three pairs of abdominal legs and buries itself in the sand. In color it resembles the sandy shore, and is $\frac{5}{8}$ inch and less in length. Another form *Talorchestia lingiconis*, is similar to the above.

Gammarus locusta, (Lat.), also resembles the above but is larger and lives in the water under stones and among the weeds. The colors are uncertain and variable.

Caprella geometrica, (Lat.), or Skeleton Shrimp, is a small and curious amphipod, so slender as to appear like a skeleton adhering to the seaweeds. It is about $\frac{5}{8}$ inch long and moves like a measuring-worm. Will survive in the aquarium.

There are a number of Boring Amphipods which do not require mention here.

ISOPODA. This numerous class is widely distributed and is frequently found on marine plants. The most general form is:

Cirolena concharum, (Lat.), having a rounded segmental body and seven pairs of short legs. It is found swimming in shallow water among plants from Cape Cod to South Carolina, and is rarely over $\frac{1}{2}$ inch long. Four other smaller and larger Isopods need no further mention. All are of similar form and habits.

MOLLUSCA. Of the Marine Mollusca it is proposed to mention only a few of the shallow-water Middle Atlantic coast species most likely to be found by the collector, as there are so many hundreds of genera and thousands of species that space will permit of their being only superficially treated.

UNIVALVES. The most common Limpets, Periwinkles and Whelks, are:

Acnæa testudinalis, (Müll.), or Smooth Limpet, which has a thin, elevated, oblong-oval, saucer-shaped shell, with the apex turned forward. The surface is checked with minute radiating lines and the color is generally a greenish-white, with darker brown stripes. It is about $\frac{4}{5}$ inch long, $\frac{1}{2}$ inch broad, and $\frac{1}{4}$ inch high. The most common limpet, found along almost the entire Northeastern Atlantic coast.

Crepidula fornicata, (Lam.), or Slipper Limpet, Quarter Deck, has a basin-shaped obliquely-oval shell, one side more oblique than the other, with a thin, shelf-like projection at the apical end, and the apex turned to one side. The surface is wrinkled with lines of growth, the aperture obliquely sub-oval, the edge entire and sharply defined with dark spots and blotches. Length $1\frac{1}{2}$ inches, breadth $1\frac{1}{5}$ inches, color light-brown. Found adhering to each other and to shells on the Atlantic coast generally.

Littorina irrorata, (Say), or Common Periwinkle, has a thick variegated greenish shell of six whorls, a shallow suture, pointed apex and sub-oval aperture. Found in estuaries of the Middle and Southern States coast.

Natica duplicata, (Say), or Coned Natica, has a large, dark and solid $1\frac{1}{2}$ to 2 inches shell, the upper whorls compressed to give a pyramidal form. The surface is marked with faint revolving lines, and the color is chestnut-brown or black. Found on sandy and muddy shores and beaches along the Northern Atlantic coast to Massachusetts.

Columbella lunata, (Sowb.), or Dove Shell, has a small, ovate-conic, six-whorled, reddish-brown shell with flat whorls, a shallow suture and smooth surface. Crescent-shaped yellowish-white spots mark the surface, and the interior is a soft dove-color. Length $\frac{8}{16}$ inch. Abundant from Cape Cod to Florida.

Nassa obsoleta, (Say), or Small Whelk, has an ovular dark reddish-brown or olivate, six-whorled, polished 1 inch long shell with some-

what rounded whorls, a moderately elevated spire and blunt apex. Found on muddy shores not exposed to the surf, from Maine to Florida.

Nassa trivittata, (Say), a smaller form, has an ovate-conic $\frac{7}{8}$ inch greenish-white, seven-whorled shell, with the surface marked with lines and granulations. The whorls are rounded, suture depressed and apex acute. Found at low-water marks along the Atlantic coast generally.

Buccinum undatum, (Linn.), or Common Whelk, has a heavy ovate-conic six-whorled greyish 3 inches shell, marked with coarse revolving lines and waved transverse wrinkles. Found from Canada to the Carolinas and further south.

Urosalpinx cinereum, (Say), or Oyster Drill, has a long-oval coarse and solid five- or six-whorled, ash-colored or reddish-brown, one inch long shell with a number of rib-like undulations and revolving lines on the convex whorls. The suture is depressed and the beak slightly curved. Common along the Middle Atlantic coast and larger in southern waters.

Fulgur canaliculata, (Say), or Turret Conch, has a 6 to 9 inches long pear-shaped, rather thin, pale faun-colored shell, with about six turreted whorls and a deeply impressed channeled suture. It is one of the common Conchs of the Atlantic coast, found from Cape Cod to Georgia.

Fulgur carica, (Linn.), or Spined Conch, has a solid ash-colored six-whorled shell, with a series of compressed spines or nodules about the larger three whorls. The upper whorls are somewhat depressed and the suture shallow and not channeled as in the foregoing. It is less abundant but is distributed in the same localities.

BIVALVES. The most common Bivalves of the Middle Atlantic States coast are:

Ensis directus, (Conr.), or Common Razor Clam, has yellowish-green scabbard-shaped valves about 5 to 6 inches long and 1 inch broad, with rounded, nearly parallel ends. It lives on sandy beaches near low-water marks along almost the entire Atlantic coast.

Mya truncata, (Linn.), or Common Soft-shell Clam, or Gaper, has oblong-ovate inequilateral strong, deeply concave 3 inches long valves with distinctly marked umbones. The valves are rounded anteriorly and truncated posteriorly, dingy white in color with yellowish and brown wrinkled epidermis. Generally distributed along the Atlantic coast south to South Carolina, and most abundant along the New England coast.

Macra solidissima, (Dillw.), or Trough Clam, another soft-shelled form, has very large, massive, transversely ovate, sometimes triangular $4\frac{1}{4}$ inches long valves, with the epidermis usually worn or eroded. The umbones are usually distinct and the surface slightly folded at the lines of growth. This clam is also known as the Beach- or Dipper-clam, and is

found on the sandy beaches on the Atlantic coast from Labrador to Cape Hatteras.

Petricola pholadiformis, (Lam.), or Boring Clam, has elongated, acutely rounded, chalky, $1\frac{1}{2}$ inches long valves, the anterior part short and the posterior long and neatly rounded. The animal has two long siphon tubes united at the base, with the inhaling tube the longer. Found in varying localities along the Atlantic coast at low-water marks.

Acra transversa, (Say), or Common Cockle, has rhomboidal, oblong $1\frac{1}{2}$ inches long valves, with 32 to 35 ridges or ribs placed in radiating lines from the umbones to the margins. This is the common radiate-shelled clam of the Atlantic coast.

Venus mercinaria, (Linn.), or Common Hard-shell Clam, Quahog, has thick and solid, obliquely ovate or heart-shaped grey and chalky valves with the anterior ends very short, the posterior ends terminating in a blunt truncated point, and the curved and elevated umbones placed far forward to project nearly to the front of the shell. This clam is brought into the market under different names, the younger as the Cherry Stone and Little-neck, the older as the Hardshell, and the very large ones, which reach a length of $3\frac{1}{2}$ to 4 inches, as the Chowder Clam. Those having shells 6 inches long or larger are known as Horse or Sea Clams. Common along the entire Eastern and Middle States Coast.

Mytilus edulis (Linn.), or Edible Mussel, has thin, polished, triangular-ovate, dark-bluish, $2\frac{1}{2}$ inches long valves, with a pointed beak and plainly defined lines of growth. The umbones are immediately at the beak. Very common between tide-marks on the Atlantic coast, from the Arctics to North Carolina.

Modiolus plicatulus, (Lam.), or Horse Mussel, has oblong-ovate much elongated greenish-brown and horn-colored 2 to 3 inches long valves; with the posterior end traversed by numerous radiating ribs. The umbones are placed above the beak. Common on muddy banks of estuaries and shores, crowded in vast numbers, exposed at low tide; from Nova Scotia to Georgia.

Pecten gibbus, var. *irradians*, (Lam.), or Common Scallop, has nearly round, rather strong, dusky or blackish $2\frac{1}{2}$ inches long valves, having about 20 elevated, rounded ribs, wrinkled concentrically by fine lines of growth, and an ear-like hinge about two-thirds as broad as the shell. Common along almost the entire Atlantic coast from Nova Scotia to Tampa, Fla.

Ostrea virginica, (Gmel.), or Chesapeake Bay Oyster, has now become a widely distributed native species, found along the entire Atlantic coast. Owing to its sedentary life, it has become very irregular in both

form and size, and specimens from different localities would scarcely be recognized as of one and the same species.

Anomia simplex (Orb.), or Jingle Shell, or Jingle, has rounded, scaly, variously wrinkled and undulated, $\frac{3}{4}$ inch in diameter valves. The shells are a common feature on the seashore, their fine pearly lustre and flattened form distinguishing them from other oysters and clams. It is a hardy species found abundantly on oyster beds and adhering to fixed objects along the Atlantic coast.

MARINE MOLLUSCS AS SCAVENGERS. Marine Univalves feed upon plants and animals, more particularly the lower forms, algæ, oscillaria, protozoans and hydroids. In the aquarium they perform useful purposes, keeping the glass clean and devouring food particles which might contaminate the water. They are not quite as good scavengers as some of the freshwater species. Bivalves also render good service in keeping the water clear, but only a few should be introduced, as they require considerable water for respiration and to obtain sufficient of the minute vegetable and animal life upon which they feed.

SQUIDS. Two of the Squids may be mentioned, as they are common along almost the entire Atlantic coast. These are *Ommastrephes sagittatus* (Lam.), and *Loligo pealii*, (Les.), both from 6 to 12 inches long. All the family are ferocious creatures, the tyrants of the lower orders; solid fleshy animals having powerful arms furnished with rows of cup-like suckers, strong jaws and membranous tongues, armed with recurved prickles. They discharge an inky fluid through a siphon. The beak or pen is the cuttle-fish bone of commerce and forms the skeleton of the animal.

CHORDATA. These animals are common on marine plants, submerged woodwork and other fixed objects. Their characteristic of ejecting jets of water secured for them their popular name of Sea-squirts. They are usually of dull colors except in southern waters, and are either individual or compound animals. The common species are:

Molgula manhattensis, (Say), a very general form, has an olive-green globular body with slightly rough surface, about $\frac{3}{4}$ inch diameter. Two siphon tubes extend above the upper end. Found on seaweed, etc., either singly or in clusters.

Cynthia partita, (Say), another common form, has an oblong body, one inch in diameter, of rusty brown color, marked with red and purple. Usually found on piles or flattened under stones.

Botyllus gouldii, (Stimp.), is a generally distributed compound form which appear as thick incrustations and bands on plants and piles. There are many other common forms. Individual Sea-squirts will survive in smaller aquaria, but it is not advisable to introduce the compound forms.

PISCES. Of the Marine fishes only those forms will be mentioned which are readily obtainable, the native Eastern and Middle States coast species, and strays of the Gulf Stream, which may survive in the marine aquarium. These are:

Herrings or Clupeidæ. These fishes are distributed throughout the whole of the North Atlantic, and the young make interesting aquaria inmates. They may be obtained in abundance along the shore in summer. Of these the Common Herring, *Clupea harengus*, the Sardine, *Sardinella*, and the Menhaden, *Brevoortia tyrannus*, are the most numerous forms.

Toothed Minnows or Pæciliidæ occur in brackish water near the mouths of rivers and along the coast. They are all small fishes varying in the adult from 2 to 6 inches. The most common forms are Popsy Minnow, *Cyprinodon variegatus*; the Killifish, *Fundulus heteroclitus*; the May Fish, *F. majalis*; and the Rainwater Fish, *Lucania parva*. All are very hardy and will survive in the aquarium.

Sea-horses or Hippocampidæ. The strange shape and interesting habits of these fishes make them very desirable aquarium inmates which survive for long periods. The abundant form on the Atlantic coast is *Hippocampus hudsonius*, very similar in appearance to *H. hippocampus* of Europe.

Pipe-Fishes or Syngnathidæ. These fishes are closely related to the Sea-horses and are found everywhere on the Atlantic coast. The head is small and the body elongated, somewhat resembling the eel. The common form is *Siphostoma fuscum*, a most interesting aquarium fish.

Sticklebacks or Gasterosteidæ. These interesting nest-builders have three salt and brackish water species which thrive in the aquarium. These are the four-spined Stickleback, *Apeltes quadracus*; the ten-spined Stickleback, *Pygosteus pungitius*, which also inhabits fresh water, and the Two-spined Stickleback, *Gasterosteus bispinosus*. Schools of them may sometimes be encountered in midsummer in bays and brackish water estuaries. Their habits are described on page 72.

Silver-Sides or Atherinidæ. These small carnivorous fishes are found in numbers near the shore in brackish water and at the mouths of rivers. They resemble the smelt. Two species occur on the Middle Atlantic coast, *Menidia cerea* and *M. notata*, known as the Sand Smelt and the White Bait.

Mulletts or Mugilidæ. The young of this genus will survive in the aquarium. The adults reach a size of 2 feet and over. The most numerous marine forms are the Grey Mulletts, *Mugil cephalus* and *M. curema*, both numerous in salt and brackish water during the summer.

Crevallés or Carangidæ. The young of three species of these fish are abundant during the summer months along almost the entire Middle

Atlantic coast. These are the Goggler, *Trachurops crumenophthalmus*; the Thread-fish, *Alectis crinitus*; the Common Moon-fish, *Vomer setapinis*; and the Silver Moon-fish, *Selene vomer*.

Sea-Basses or Serranidæ. More than 20 species of these fishes occur on the Atlantic coast and the young of other tropical forms are carried up in the Gulf Stream. They are popularly known at the seaside as Blackfish and Rock Blackfish. The most common species is *Centropristes striatus*, small specimens of which are very interesting aquarium inmates.

Snappers or Lutianidæ. The young of these fine food fishes will survive in the aquarium. They are widely distributed, those frequenting the Gulf Stream and straying to the Middle Atlantic coast being the Grey Snapper, *Neomænis griseus*; the Dog Snapper, *N. jocu*; the Schoolmaster, *N. apodus*; the Mutton-fish, *N. analis* and others.

Grunts or Hæmulidæ. The young of these beautiful sub-tropical fishes also stray to more northern waters. Among these are the Common Grunt, *Hæmulon plumieri*; the Grey Grunt, *H. macrostomum*, and the Yellow Grunt, *H. sciurus*.

Croakers or Scienidæ. This family contains about 30 genera and 150 species, including the Weakfish, *Cynoscion*; Kingfish, *Menticirrhus*; Croaker, *Micropogon*; Drum, *Pogonias*; Cape May Goodie, *Leiostomus*; Mademoiselle, *Bairdiella*, and others, the young of which will thrive fairly well in the aquarium. Most of these make peculiar noises from which they derive their common name. Some of them reach a large size and occur in shallow water on sandy shores along the Atlantic coast.

Wrasses or Labridæ. Of these fishes there are 8 or 10 species on the Atlantic coast, the most common being the Tautog or Blackfish, *Tautoga onitis*, and the Cunner, *Ctenolobrus adspersus*. These are large fishes of which the young may be kept in the aquarium.

Harvest Fishes or Stromateidæ. Three species of these fishes occur on the Middle Atlantic coast. These are the Harvest-fish, *Peprilus paru*; the Butter-fish, *Poronotus triacanthus*, also known as the Pumpkin-seed; and the Black Rudder-fish, *Palinurichthys perciformis*.

Butterfly Fishes or Chætodontidæ. The young of these fishes frequent the Gulf Stream and are sometimes taken in northern latitudes. They are most beautiful marked and of singular appearance. There are 8 to 10 genera and nearly 200 species; carnivorous fishes of tropical seas, very hardy, which will survive in the aquarium. They are also known as Angel Fishes.

File-Fishes or Monacanthidæ. These small shore fishes of warmer waters are closely related to the Balistidæ of the tropical seas, and may be taken in shallow water in summer. They are beautiful in form and

colors. The common form is *Stephanolepis hispidus* of the Eastern and Middle States coast.

Swell Fishes or Tetrodontidæ. These curious fishes, also known as Puffers, Globe-and Porcupine-fishes, are summer visitors from warmer seas. Two species are taken on the Middle Atlantic coast, the common Swell-fish, *Spheroides maculatus*, very abundant, and the Rabbit-fish, *Lagocephalus lævigatus*, an occasional straggler.

Sculpins or Cottidæ. These fishes are most abundant in the waters of the northern seas, several forms straying below Cape Cod. The common Miller's Thumb or Blob, *Uranidea gracilis*, may also be found in clear, cold freshwater streams; and the common Marine Sculpin, or Grubby, *Acanthocottus æneus*, near the coast, from Maine to Cape Hatteras.

Toad Fishes or Batrachidæ. These fishes resemble the Sculpins, and are the most repulsive looking fishes of the coast. They frequent oyster beds, and the common form, *Opsanus tau*, is abundant along the coast, the young, when cleaned of the adhering mud, making hardy and odd aquarium inmates.

Blennies or Blenniidæ. Two species of these small fishes inhabit the shallower waters on the Atlantic coast, living principally in the Kelp and other weeds. The common form is *Pholis gunnellus*, the well-known Butter-fish.

Gobies or Gobiidæ. Several species of small size, the Scaleless Goby, *Gobiosoma bosci*; and the Chubby Goby, *Gobius soporator*, are sometimes seen in aquaria. The former ranges from Cape Cod to Texas, the latter along the Gulf States and farther north. They are hardy and will survive in the aquarium for long periods.

Gurnards or Triglidæ. Several species of Sea Robbins are represented on the Atlantic coast. The young of the Web-fingered Sea-robbin, *Prinotus Palmipes*, and the Wing-fish, *P. evolans*, make interesting aquarium inmates, as they have the habit of crawling over the bottom on their pectoral appendages.

Flying Gurnards or Cephalacanthidæ. These fishes, known as Sea-bats, occur on the Atlantic coast and the young are frequently taken for the aquarium. The one common species is *Cephalacanthus volitans*.

Star Gazers or Uranoscopidæ. Of these fishes there is but one species along the Middle Atlantic coast, *Astroscopus anoplus*, which reaches a length of 12 inches. The young are sometimes seen in aquaria in which they may survive for long periods.

Cusk Eels or Ophidiidæ. But one species occur on the New Jersey coast, *Rissola marginata*, about 7 inches in length, found in the surf and

shallow water. It differs from the Eel in being scaleless and having the ventral fins on the throat as long and forked barbels.

Cods or Gadiidæ. The Tom-cods are small fishes of which the Frost-fish, *Microgadus tom-cod*, is found from Cape Sable north. The young make interesting aquarium fishes.

Flat Fishes, Soleidæ and Pleuronectidæ. A number of species of Flat-fishes occur on the Atlantic coast of which the young are frequent seen in aquaria. They have the habit of secreting themselves to the eyes in the sand, and their peculiar movements in swimming and odd appearance are interesting. There is but one common species of Sole on the Middle Atlantic coast, the Hog Choker *Achirus fasciatus*, which will live in freshwater. Of the Flounders there are a number of common forms, the common Flat-fish or Winter Flounder, *Pseudopleuronectes americanus*; the Summer Flounder, *Paralichthys dentatus*; the Southern Flounder, *P. lethostigmus*; the Four-spotted Flounder *P. oblongus*; the Window-pane, *Lophopsetta maculata*; and the Rusty Dab, *Limanda ferruginea*.

Skates or Rajidæ. The common skate, *Raja erinecea*, is frequently taken on the coast from Virginia northward. It reaches a length of 18 inches. Sometimes the larger *R. radiata* strays south of Cape Cod but it is a northern form. Another very large species is the Barndoor skate, *R. lævis*, which reaches a length of four feet. The first named is very hardy and easily kept, and is a common feature of all larger Marine aquaria.

Sting-rays or Dasyatidæ. Of this family the young of one species the Common Sting-ray or Stingaree, *Dasyatis centrurus*, is frequently taken near the shore and in salt bays and inlets. It is common from Cape Cod south. The adults reach a length of 12 feet. The long spine on the slender tail can inflict dangerous wounds.

Frog Fishes or Antennariidæ. In the floating seaweed from the Gulf Stream a bright colored little fish, the Mousefish or Sargassum-fish, *Pterophryne histrio*, is often found, which will survive in the aquarium. It is of bright orange color mottled with various shades of red and brown.

Fishing Frogs or Lophiidæ. The common form is known as the Angler or Goose-fish, *Lophius piscatorius*, which occurs in the shoals and flats, and is singular on account of its repulsive ugliness and voracity. It grows to a large size but the young are interesting aquarium inmates.

Salt-water Eels or Leptocephalidæ. The common form is the Conger-eel, *Leptocephalus conger*; but occasionally some rare straggling tropical eel is found by the collector, borne to northern waters in the Gulf Stream.

CARE OF THE MARINE AQUARIUM. The maintenance of the marine aquarium, when properly understood, is as simple as that of freshwater.

Less humus will form, the glass need but seldom be cleaned, the evaporation is inconsiderable, and the conditions of the water and its temperature, when the aquarium is properly established and aerated, require but little attention. The inmates, however, should have close supervision until they have become accustomed to their changed environments. Occasionally, even with the most careful attention, water contamination may occur or a cloudiness of the water manifest itself. This may be due to an excessive growth of algæ in the water, the death of an inmate, the decay of a plant, or mistakes on the part of the attendant. A more rapid aeration may often relieve this condition, when some such happening has been the cause and corrections have been made; but should this prove ineffectual, or after several days not improve the appearance and remove the turbidity, then some of the water should be siphoned and replaced by the reserve water. The turbid water, if the contamination was not a dangerous one, may be filtered and when clear and in normal condition, may be again used or reserved. Mishaps of this kind should not occur more frequently than in the freshwater aquarium.

FILTERS. A charcoal filter or any other mechanical, not chemical, household filter will answer the requirements; but one easily constructed can be made of two glass funnels or of two flower pots, one a trifle smaller than the other. When constructed of the pots, pieces of pipe are cemented into the bottom holes and cotton gauze laid over these openings. The smaller pot is filled halfway with coarse sand, then to the top with fine sand and covered with a piece of gauze, brought over the edge and secured about the outside of the pot. The larger pot is filled about one-fourth with fine sand. Upon this is placed a layer of powdered charcoal to nearly fill it, and the opening of the smaller pot then tightly inserted into the opening of the larger pot and firmly secured. A siphoning tube is placed into the aquarium, suction applied with the lips, the tube then put over the inlet tube in the smaller pot, the filter secured that the water of the aquarium will flow through it, and by a hose placed over the outlet of the larger pot led into a receptacle. From this it may then be returned to the aquarium. By siphoning from the bottom, sometimes drawing but a part of the water through the filter will correct the difficulties; more often, however, the aquarium must be almost or entirely drained. Experience will teach when this is necessary, and should not be needlessly done, as the disturbance caused thereby is always detrimental to the animal life.

FEEDING MARINE ANIMALS. Some of the inmates cannot be fed and must take their nutriment from the water in the form of algæ, oscillatoria, diatoms and infusoria. Fanciers often arrange a number of smaller all-glass battery jars on a shelf below the larger aquarium, sometimes con-

nected with the aerating device, for the breeding of these low forms, and containing a marine plant or two; from which they are dipped with water, but this is not imperatively necessary. Other and larger animals should be furnished with more substantial food, the preferable dietary being finely scraped lean beef and mutton, minced angle worms, and small particles of oysters, fish and crab-meat. Tweezers or feeding rods are required to place the food in, on or near the molluscs, anemones and other polyps, which should be fed once a week; but the small crabs, starfishes, other higher forms, and the fishes, should have the same food, given them at intervals of two or three days. Great care must be exercised that all the food is consumed, as its rapid decomposition will cause water contaminations. If any remains uneaten, it should be at once removed with the dipping-tube. The partly digested or rejected food fragments, given off by the lower animals and the skins of the polyps, should also be removed. Careful sanitation is as necessary with the marine as with the freshwater aquarium; even more so, as the scavengers of the sea are not as efficient as those of freshwater.

Anemones should be sufficiently fed or they will become dissatisfied with their positions and move about to find a more desirable situation. The food should be placed on the end of the feeding stick and the tentacles lightly touched with it, several very small pieces being offered to the same individual. If they are rejected the anemone is not hungry, as it has the power of making its tentacles adhesive, or not, at will. Some forms kill their prey by acontia, small threads and spicules with stinging cells, which they give off at will. These should have the food brought directly into the centre of the disc, for if the tentacles are touched they will immediately collapse. When hungry, they will at once engorge the food, if not, it will be rejected and should be removed. The water in the vicinity of anemones should also be stirred occasionally.

It should be noted that the food requirements of marine animals in the aquarium are less than in natural surroundings, which should be considered in feeding, and that they take more food when the water is warm than when it is cold.

STOCKING THE AQUARIUM. Overcrowding is as objectionable in the marine as in the freshwater aquarium. Not more than one inmate of any kind to the quart of water should be introduced, or less according to the existing conditions and the kind and size of the animals. Overstocking is one of the most frequent causes of discouragement and failure to the novice. It should be remembered that marine aquaria are to be admired as much for the artistic arrangement of the inanimate objects they contain as for the wonderful and varied forms of marine life; and a few healthy and

comfortable animals and plants are preferable to a larger number in sickly or dying condition.

In handling the animals, to place them into the aquarium, the anemones and similar fauna should be introduced together with the shells and stones to which they may adhere. All the other low forms should be handled in a spoon; while fishes, crabs, etc., should be transferred with a shallow net. None should be forcibly removed from any object to which they are attached, as it is always injurious, very often fatal to them. After they have been put into the aquarium, they should not be touched, and if it is necessary to assure oneself that they are alive, a very small glass tube will serve as a blowpipe and a breath of air will cause sufficient movement to determine the question.

A very little experience and observation will enable the fancier to distinguish between a sick or dead inmate and a healthy and living one. If the shape and position of the anemones have not changed, a clouded appearance forms about the sponges, the bristles of the pipe worms remain unchanged and motionless, the snails on one spot and enclosed in their shells, the mussels, clams and oxygen in the same position with constantly gaping valves and no appearance of water currents over them, the crabs without movement of the eyes or antennæ, and the fishes torpid and motionless; these are all suspicious signs requiring investigation.

MARINE SCAVENGERS. The scavengers of the marine aquarium are gasteropods, shrimps and crabs, which are effectual when the amount of food is properly regulated.

ACCLIMITIZATION IN THE MARINE AQUARIUM. Deaths are most likely to occur when the animals are first introduced, as the changed conditions during their transportation affect them even more than existence in a properly arranged, well aerated aquarium; but after they have become acclimated to their new surroundings, the deaths are not more numerous than with the fauna of the freshwater aquarium. Trials with the marine aquarium are earnestly advocated; they have a novelty and beauty all their own, may be set up anywhere and maintained at no greater expense than the keeping of the finely bred goldfishes.

COLLECTING FOR THE MARINE AQUARIUM. In making collections the periods of lowest water twice a month, at the new and full moon, give the most satisfactory results, but especially at full moon in the months of September and October and in March and April. A sandy beach may not yield many specimens, but back-bays and thoroughfares, their borders and outlets, are favorable localities. Cliffs, rocks and boulder-strewn beaches, or where tide-pools and depressions have formed, overflow at high tide and above low-water when the tide recedes, are the best; and

often many forms of plants and animals may be found in a limited space. It is necessary to have some experience in collecting, as localities passed over by the novice as devoid of specimens may yield an abundance to the experienced collector. A thorough examination of the whole area should be made, the seaweeds lifted, submerged woodwork examined, stones overturned, and every rock, depression and cavity explored with both the net and the fingers.

A light basket with shoulder-straps, containing a number of large-mouthed bottles and jars, a shrimp net, a pole with a strong iron point at one end and a detachable garden rake for the other, a coldchisel and



FIG. 236. Dredge net.

hammer, hip boots and felt gloves to protect from the sharp edges of mussels and the slippery footing and concealed crevices, will be desirable; and for use in a boat, a dragnet, constructed of an iron frame 24 by 8 inches, with hoop-iron scrapers on the longer sides will be useful. This dredge, Fig. 236, will collect sponges, worms, anemones, corals, molluscs, shrimps, crabs, fishes and often the rarer deepwater plants. Anemones and coral-

lines should be taken with the smaller objects to which they adhere or a piece of it removed with the chissel, but when this cannot be done they should be carefully removed with a paper knife or with the finger nails, so as not to injure their bases.

Fishes may be taken in a net, the simplest being an iron hoop and netting attached by a rope to a long pole and baited with a broken clam, or the wire netting lobster trap. The flat fishes lie under the sand and are usually taken in the dragnet.

A constant observation of the tide should be kept, as its unobserved advance is often dangerous to the collector.

TRANSPORTING MARINE CATCHES. The best forms of jars are wide-mouthed and of glass or stoneware, with tightly fitted corks through which a glass tube has been passed to extend two inches above and below, to prevent spilling. These receptacles should be not over three-fourths full of water, so that the motion in transportation will change the air. Many of the animals may be shipped in moist, not wet, seaweed. A thick layer should be placed in the bottom of a can or box, and upon this the plants intended for the aquarium, then a second layer of weeds, and upon this the animals. These should

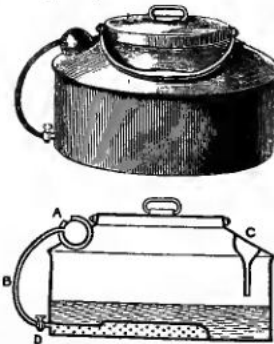


FIG. 237. Buckland Collecting can.

then be covered with a considerable quantity of moist weeds. Some of the fishes and other forms will survive for hours, if carefully packed as suggested. The illustration, Fig. 237, is the Buckland collecting can, which has a perforated false bottom connected by a pipe, pet-cock and hose, D. and B., with the air bulb, A. The funnel C. aids in aerating and siphoning the water. This may be set under the car seat and the bulb operated with the foot. Modifications of this device are easily made, and are in general use.

RECEIVING CONSIGNMENTS. Upon arrival, a number of shallow receptacles filled with seawater should be at hand, to separate the animals and to quarantine them until assured that they are in healthy condition. The marine plants also should be cleaned with saltwater and quarantined a day or two before introduction into the established aquarium. The anemones may not at once adhere in the desired positions, may attach themselves to the glass or roll on the bottom; or they may, by expanding their discs on the surface, float about for days in reversed position. Pouring water into the hollow depression of the disc will cause them to sink, as they then lose their buoyancy. It will be found that most of them will expand more freely on bright days, though some forms, which prefer darkness, will seek these localities, when offered. When considerably fed they will not open for some days, but if it is desired to have them do this, a very small particle of food given an hour before will excite the appetite and cause them to open very widely in expectation of a further meal.

AQUARIUM TOOLS. These should consist of straight and bent dipping tubes, a siphoning tube and hose, a shallow net with a straight front, a sponge or piece of felt on a stick to clean the glass, a glass syringe for aeration and feeding the mussels and other low forms; a filter, as already described, long scissors, tweezers and feeding sticks. Pieces of charcoal behind and under the rockwork will serve as antiseptics and aid in keeping the water clear. With larger aquaria some efficient method of aeration is imperatively necessary.