

CHAPTER X.

**The Molluscs, Vermes and Hydrozoa
of Freshwater**

FRESHWATER MOLLUSCS

The molluscs of interest to the aquarist belong so two classes. They may be described as animals devoid of bony structure and joints, with soft, thick and tough tunics or mantles, fleshy bodies and calcareous shells of one or two valves; the Gasteropods or Univalves and the Lamelli-branchia or Bivalves. The first of these comprise the snails, limpets and slugs, and the second the mussels and oysters. They have simple digestive systems consisting of a mouth, a canal, digestive glands and anus; a contractile heart of several cavities with but few blood vessels, the blood being forced directly into the organs and through the spaces between them. The breathing structures are either comb-gills or simple air breathing chambers serving as lungs. The nervous system consist of special sense organs and ganglia of nerve substance located at different parts of the organism.

UNIVALVES. Most of the univalves have a single shell, but with some this is rudimentary, in others reduced to a few calcareous grandules beneath the mantle, though these latter are mostly land and marine forms. The shells of freshwater snails vary in form and may be flat-coiled, spiral, oval-oblong, elongate or earshaped, varying also from a length of two inches and over to microscopic sizes. Some have a horny or calcareous lid or operculum attached to the foot, whereby the aperture is closed when the snail has retired into it. Fig. 140. This is usually marked with curved striations about a central nucleus, the original operculum of the young snail. A mass of muscular tissue forms the foot, constituting the organ of motion, and movement consist of its contraction and expansion from the rear to the front. A part of the foot and the digestive system are enclosed in the shell. The head is distinct and usually has two, sometimes four, tentacles serving as organs of touch and possibly of hearing. The eyes are distinct and may be developed at the ends of a second pair of tentacles or upon longer or shorter pedicels, between, to the side of, or under the tentacles.

In the aquatic species respiration is by gills in the water breathers, or by an air-chamber or rudimentary lung in the air breathers, the entrance to the breathing organs being near the mantle.

The shell is formed by an excretion of carbonate of lime and some

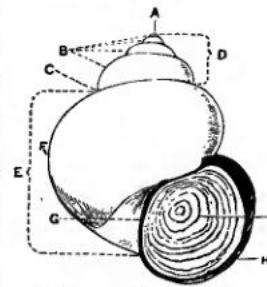


FIG. 140. Outline of a Freshwater snail.

- A. Apex.
- B. Whorls.
- C. Suture.
- D. Spire.
- E. Body whorl.
- F. Periphery.
- G. Inner lip.
- H. Outer lip.
- I. Operculum.

animal matter; the whorls turning about a central columella or pillar, with the outer or body whorl always the larger. The apex is the first growth of the shell and subsequent development is marked by lines of growth indicating a former position of the aperture. When the suture or depression between the whorl, from the apex to the aperture, forms a right hand spiral, the shell is right-handed or dextral, and when turned to the left is left-handed or sinistral. The shell grows by the addition of new layers on the lip or outer edge, but the inner portion of the mantle also forms calcareous matter to increase the thickness of the shell with age. The outer coating is the harder, but the action of the acids in the water often erodes it, whereby the shell may lose some of the whorls. When the erosion has penetrated the interior lining or nacre and the acidulated water comes into contact with the animal, death results.

Reproduction is by eggs, and some of the genera are oviparous, depositing the spawn to hatch, while others are ovoviviparous and hatch the young in the oviduct of the female. The oviparous snails deposit translucent gelatinous masses in which the yolks of the eggs are visible, which enlarge and gradually assume the form of tiny snails with transparent shells and escape from their gelatinous covers to the plant. The ovoviviparous snails bury themselves in the mud and silt and bring forth a number of perfect young, which, though very small, exactly resemble their parents. Some species carry the young with them, inside the shell, until they have grown to considerable size.

BIVALVES. Most of the Bivalves have double-hinged valves or shells, a tonguelike foot, sometimes provided with a byssus or tuft of threads with which to attach themselves. The body of the animal consists of a mantle of two lobes, leaflike gills, one or more siphons or orifices, a heart, stomach, liver, intestines, reproductive organs and muscles, Fig. 141. The valves increase in size by the addition of concentric rings to the outer edges and in thickness by deposits of nacre on the inner side; the umbone or nucleus being the original shell of the young mussel. The valves are united by a hinge which varies in structure with the different species, and are kept closed by adductor muscles connecting them at each end. The interlocking projections of the hinge are known as teeth, and according to their location are cardinal when placed under the beak, anterior and posterior lateral when placed before or behind the umbones.

A set of muscles constitute the anterior and posterior retractors and protractors which control the foot. Mussels have no distinct head, the mantle covering the entire animal and is attached to the valves by a membrane. Under it, on the posterior end, are the gill plates, partly separated by the foot and the viscera, and forming a large cavity. In front of the gills

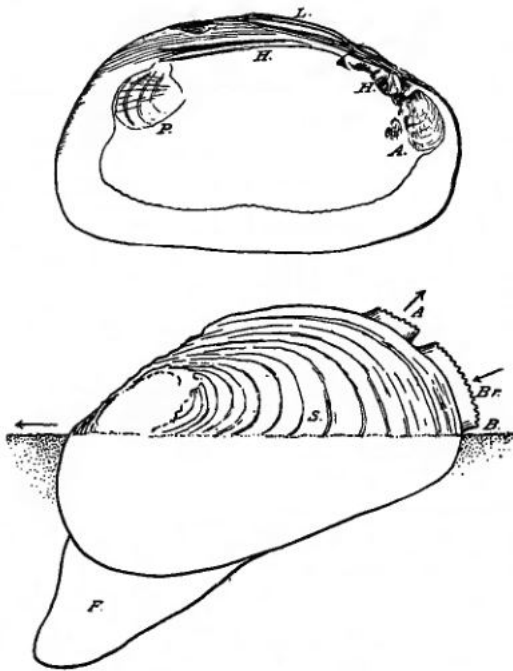


FIG. 141. Diagrams of a Freshwater Mussel.

- B. Beak.
- L. Ligament.
- H.H. Hinge.
- A. Adductor scars.
- S. Shell.
- F. Foot.
- Br. Branchial openings.
- A. Anal opening.

The Arrows indicate direction of the animal and the currents.

are the labial palps, two pairs of triangular flaps and between the gills and the hinge is the pericardium containing a three-chambered heart, and below this the organ which serves as the kidneys. The liver is a compound digestive gland over the posterior portion of the gills and under this is the stomach, connected with the mouth by the oesophagus. The digestive canal consists of an irregular coiled tube which passes through the pericardium to the posterior end of the body. The simple nervous system consists of ganglia at the mouth, foot and adductor muscles.

Respiration consist in taking the water through the inhaling siphon, passing it over and between the gills and out of the body by the exhaling siphon.

These water currents reach the other organs, aerate the blood, convey food to the stomach and carry off the waste materials of the system.

Reproduction varies with the genera, but with most of the freshwater species is the following. The eggs are developed in the ovaries, pass to the gills, where they lodge and hatch. The minute valves are connected by an elastic hinge, the foot only partly developed, as from it extends a number of slender filaments, the byssus. When ejected by the parent, they swim by opening and closing the valves until they come into contact with a fish to which they attach themselves and there undergo a metamorphosis. The byssus disappears, the foot is fully developed, the interior organs undergo material changes and the valves assume the shape of the adult. Then the mussel quits its host and falling to the bottom takes up the habits of its kind.

The hereafter described molluscs are those of fair size which will be of interest to the aquariist, the breeder of aquarium fishes, and the student of natural history in the home aquarium. The nomenclature is that now

adopted by Conchologists and differs materially from that in use prior to the past decade. The classification is in part that of Lang's Textbook of Comparative Anatomy and that of the Academy of Natural Sciences of Philadelphia. Some of the mentioned genera are undesirable in the aquarium and should only find a place in the terrarium or in special aquaria adapted to their study.

CLASSIFICATION OF THE UNIVALVES. Freshwater univalves are of two Orders, the Prosabanchia, gilled or water-breathing snails, including the families of the Neritidæ, Viviparidæ, Valvatidæ, Ampularidæ, Hydrobidæ and Melanidæ in the first Order; and in the second Order the Pulmonata or lung-breathing snails, including most of the land snails and slugs, together with the semi-aquatic family of the Succinea, the aquatic family of the Lymnæidæ, comprising the Lymnæa, Planorbis, Segmentina and Ancylus, and the family of the Physidæ, comprising the Physa and Aplexa.

The following classification will briefly describe these orders, families genera and species, and serve as a key to the subsequent descriptions, which are necessarily confined to Eastern and Middle States snails, though the most of them are also common to other sections of the United States.

ORDER PROSABRANCHEA—Shell spiral, aperture closed with an operculum, gills internal, water-breathing.

Family Neritidæ—Shell semiglobular, aperture closed with an operculum, breathing by gills.

Genus Neritina—*N. reclinata*, *N. showalteri*.

Family Viviparidæ—Shell concoidal or discoidal, aperture closed with an operculum, gills internal.

Genus Viviparus—*V. viviparus*, *V. georgianus*.

Genus Campeloma—*C. decisum*, *C. ponderosus*.

Genus Lioplax—*L. subcarinata*.

Family Valvatidæ—Shell depressed, aperture rounded, closed with an operculum, gills protrusile and plumelike.

Genus Valvata—*V. tricarinata*, *V. bicarinata*, *V. sincera*.

Family Ampullariidæ—Shell globular, depressed at apex, aperture closed with an operculum.

Genus Ampullaria—*A. depressa*, *A. miamiensis*.

Family Hydrobiidæ—Shell globose or subglobose, apex well defined, operculum wingshaped or oval.

Genus Somatogyrus—*S. altilis*, *S. subglobosus*.

Genus Amnicola—*A. limosa*, *A. granum*.

Genus Bithynia—*B. tentaculata*.

Family Melaniidæ—Shell elongated or conical or fusiform with pointed aperture usually subrhomboidal, closed with an operculum.

Genus Goniobasis—*G. virginica*, *G. mulineata*.

Genus Anculosa—*A. carinatus*.

MOLLUSCS, VERMES AND HYDROZOA

ORDER PULMONATA.—Shell either spiral, conical, merely a calcareous plate, or altogether rudimentary; no operculum in freshwater species, breathing by a simple pulmonary sac; coming to the surface to breathe.

Family Succineadæ—Shell imperforate, thin, ovate or oblong; aperture large, no operculum, breathing by lungs.

Genus Succinea—*S. obliqua*, *S. retusa*.

Family Lymnæidæ—Shell thin, spiral or conical, no operculum, eyes sessile, breathing by lungs.

Genus Lymnæa—*L. stagnalis*, *L. palustris*, *L. columella*, *L. decidiosa*, *L. catascopium*.

Genus Planorbis—*P. bicarinatus*, *P. campanulatus*, *P. trivolvis*.

Genus Segmentina—*S. armigerus*, *S. wheatleyi*.

Genus Ancyclus—*A. rivularis*, *A. parallelus*.

Family Physidæ—Shell sinistral, oblong, thin, spire acute, aperture narrow oval, no operculum, breathing by lungs.

Genus Physa—*P. heterostropa*.

Genus Aplexa—*A. hypnorum*.

NERITINA. These snails are not generally distributed and are seldom met with. They have semi-globular shells consisting of an abrupt, flat spiral with crescent-shaped aperture and are rarely over a half inch in length.

N. recliwata, Fig. 142, the larger native species, has a thick, strong globose-oval shell of greenish-olive color undiluted with faint green lines, polished on the under side, three-quarters inch long, consisting of three whorls, of which the body whorl takes up almost the entire shell and the spire very short and almost always eroded by the action of acids in the water.

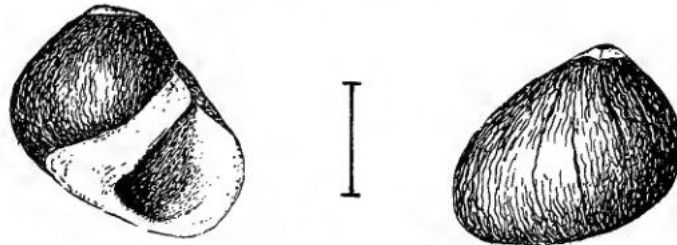


FIG. 142. *Neritina recliwata*. Enlarged.*

The aperture is about four-fifths the length of the shell. The body is pale grey clouded with black, the head dusky, the tentacles long and rodlike, the eye prominent and placed on pedicels at the outer base of the tentacles, which are marked by darker or black lines. The wingshaped operculum has the fanlike striations spread from a nucleus at the upper margin. The snail is native to Florida. Its movements are slow and it does not survive in the aquarium. It is oviparous, laying from 18 to 36 eggs on plants and stones which hatch in 14 to 16 days.

N. showalteri, Fig. 143, is a very rare smaller snail native to Alabama. Its $\frac{1}{4}$ to $\frac{3}{8}$ inch long rather thick shell is smooth, round, semi-translucent,

*The bar, in all cases, indicates the true size.

and of a greenish-yellow horn color. The three whorls are convex, the



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FIG. 143. *Neritina shorvalderi*. Enlarged.

spire very much depressed and the suture spightly impressed. The body whorl takes up almost the entire length of the shell. The incurved aperture

and the operculum are crescent-shaped, the body of a dusky grey color, the tentacles long and the eyes prominent.

The *Neritina* are widely distributed in Europe and tropical countries but only these two are native to the United States.

VIVIPARUS. These snails inhabit marshy places, still water, rivers and streams. They have the whorl of the shell very convex, an angulated aperture and a horny operculum showing concentric lines of growth. The larger species of the Eastern and Middle States attain a length of shell of $1\frac{1}{2}$ inches. The females of most of the genera have evenly developed, sharply pointed tentacles, while the males have the right thicker and more bluntly pointed. These snails live exclusively on dead animal matter, algæ and confervæ and are harmless to aquarium plants, though not as active as the *Planorbis*. They were formerly classed as the *Paludina*.

V. Viviparus, Fig. 144, the most common species, inhabits ponds and still water. It has a thick, well-rounded oblong olive-green or brownish shell of four or five inflated, sharply defined whorls; a blunt apex and deeply impressed suture. The



FIG. 144. Potomac Snail, *Viviparus viviparus*.

body whorl is marked by three well-defined reddish-brown bands which diminish towards the smaller whorls. The thick snout and long, curved, flexible

tentacles and the body are bluish-grey with faint orange and yellow spots. The projecting eyes are placed upon short pedicels under the tentacles, and the foot is bluntly ovate and broad. The operculum is ovate and shows concentric rings. This snail is ovoviviparous, the eggs hatching at different periods in the oviduct, at which time the snail secretes itself in the mud or pebbles. It is common to America and Europe, and is popularly known as the "Potomac snail." Abundant at Washington, D. C.

V. georgianus, Fig. 145, is found in canals, lakes and slow streams, sometimes in ponds and ditches. The shell is brownish-green in color

with usually five yellow bands, more distinctly marked on the body whorl. It has four to five convex whorls, the first a mere dot and the body whorl very wide and exceeding half the shell in length. All are rounded and sharply



FIG. 145. Georgia Snail, *Viviparus georgianus*.

defined, with impressed suture. The operculum is bluntly pearshaped and thick, with well defined lines. The body is dark brown, spotted with yellow, the snout broad and the tentacles long and divergent. The eyes are placed on the outer bases of the tentacles. It is ovoviviparus and harmless to aquatic plants when sufficiently fed, and bears a close resemblance to the foregoing. Quite generally distributed throughout the Middle and Southern States; first found at Hopetown, Georgia. Known as the Georgian Snail. Also note the Japanese Snail, *V. malleatus* hereafter described.

CAMPELOMA. These snails inhabit still water and slow-flowing streams. The shells are thick, heavy and about as long, but narrower than the foregoing, and the whorls flatter and not as rounded. The larger Eastern and Middle States species rarely exceed $1\frac{1}{2}$ inches in length and most of the species less than $\frac{3}{4}$ inch.

C. decisum, Fig. 146, is common in ponds and nearly all freshwater in the Eastern section of North America, from Nova Scotia to the Rio Grande. The $\frac{3}{4}$ to 1 inch long shell is elongate-ovate, rather thick and heavy

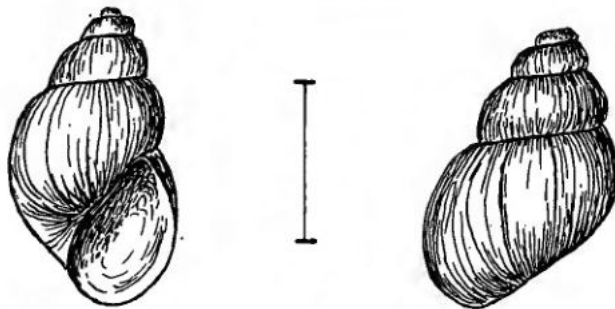


FIG. 146. *Campeloma decisum*.

with a smooth surface not very considerably marked by lines of growth. Its color is greenish with irregularly disposed brown lines of growth and is usually eroded at the apex so that of the five whorls sometimes but two or three remain. The body whorl

is about two-thirds the length of the shell, the aperture oval-oblique more than half the length of the body whorl, and the operculum is elongate-ovate with a thin transparent margin. It is ovoviviparous and harmless in the aquarium, though a considerable feeder and should be furnished with food in addition to the algæ and confervæ. It is found in streams in New

Jersey, the Delaware, Schuylkill and the Susquehanna. Common throughout New England.

C. ponderosus, Fig. 147, is the largest Eastern and Middle States species but not as common as the foregoing. The $1\frac{3}{4}$ inch long polished shell is globosely-ovate, very thick and heavy, with a roughened surface showing very heavy striations of growth;

of a greenish horn-color with irregularly disposed brown and black streaks. It has five or six whorls, of which the body whorl is equal to about four-fifths

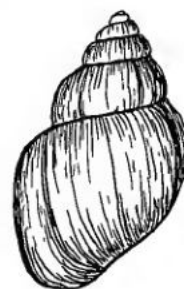


FIG. 147. *Campeloma ponderosus*.

of the length of the shell, a short spire and a perfect apex, usually eroded. The aperture is oval, narrowed above, slightly oblique, and about half the length of the shell. The operculum is elongate-ovate with a thin margin. The body is a dull brown, the tentacles thick and the eyes prominent and black in color. It is ovoviviparous and is found in New York, the Lake regions, Ohio, Indiana, Illinois, Michigan, Tennessee and Alabama. No experiments with it in the aquarium have been reported.

LIOPLAX. These snails are similar to the foregoing but have parallel sides, the front truncated and the posterior extremely obtusely rounded. The shells are concoidal, elongated and thin, the apex pointed, and the operculum with concentric rings.

L. subcarinata, Fig. 148, is found in Pennsylvania, New Jersey, Ohio, Kentucky and some other of the Middle Western States. The elongated shell is $\frac{3}{4}$ inch long, of a bright brownish-green color with brown transverse lines of growth.



FIG. 148. *Lioplax subcarinata*.

Of the five whorls, the body whorl takes up three-fourths of the shell; the suture is distinct, the apex pointed but often eroded, and the aperture pear-shaped. The lines of the operculum are concentric, and the body a dark grey dotted with orange. It is ovoviviparous. Fine specimens have been taken from the Delaware and Schuylkill rivers and their tributaries. This is the only species of the

Eastern and Middle States and there is but one in the Southern States, *L. pilsbryi* of the Chipola River, Florida, a very rare species.

VALVATA. These small snails never exceed $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter and are principally prized on account of their odd appearance and the curious formation of their water-breathing organs or branchia. Most of the species are almost exclusively vegetable feeding and destructive to plants, and but few should be introduced into the aquarium, though they are comparatively harmless, due to their small size.

V. tricarinata. Fig. 149, has a slightly depressed turbinate, translucent yellowish-and greenish-brown shell $\frac{1}{4}$ inch in diameter, of three to four smooth whorls with faint lines of growth and flattened spire. The body is slightly translucent, the plume-like branchial filaments long, the eyes black, the posterior of the foot extending nearly to the circumference of the shell, and the thin operculum near the extremity of the foot. It is oviparous and vegetable feeding and inhabits the Eastern and



FIG. 149. *Valvata tricarinata.* Enlarged.

Middle States generally, with a kindred slightly larger variety, *V. bicarinata*, Fig. 150, native in the Schuylkill river and its tributaries. It is about $\frac{3}{8}$ inch in diameter.

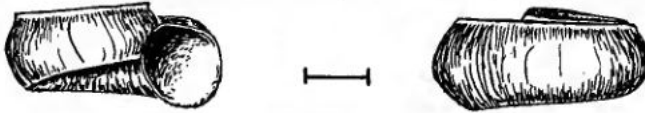


FIG. 150. *Valvata bicarinata.* Enlarged.

V. sincera, Fig. 151, has a globose-discoidal faintly striated brownish-green shell, consisting of three and a half accurately rounded whorls which enlarge rapidly from the apex. The suture is deeply impressed, the spire flattened and the apex obtuse. This snail is seldom over $\frac{8}{16}$ to $\frac{1}{4}$ inch in diameter and occurs in Vermont and the Northwestern States. There are other species of the Valvata but they do not occur in the Eastern or Middle States.

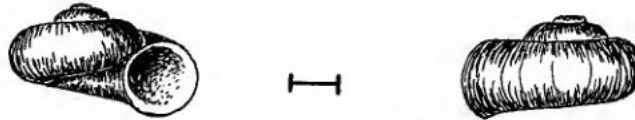


FIG. 151. *Valvata sincera.* Enlarged.

AMPULLARIA. This family has no members inhabiting waters of the Eastern and Middle States. All the species are large and handsome; but as their size would lead to the inference that they would be destructive to aquarium plants, experiment would be advisable before introducing them, as their food is vegetable and those kept in confinement eagerly devour lettuce. They are nocturnal in habits and seldom appear out of the shell during the day. They are interesting inmates for the Terra-aquarium.

A. depressa, Fig. 152, has a greenish-olive two inches long shell, with a series of ten to fifteen olive bands and yellow margins on the five smooth and polished whorls, which are more or less distinctly marked by lines of growth, a well defined suture and a depressed spire. The operculum is auriculate with the nucleus at the inner margin. The body is grey,

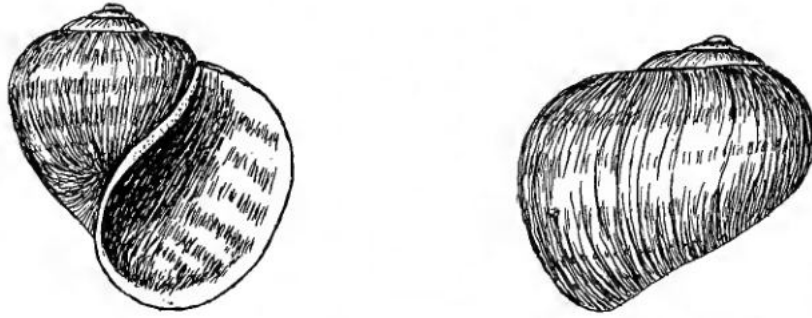


FIG. 152. *Ampullaria depressa*.

striated and dotted with black, the tentacles of the males yellowish-brown and of the females reddish or orange. It inhabits canals and ditches of soft muddy bottom and sluggish current in the middle Southern States, is oviparous and lays 30 to 70 eggs on plants above the water level, which are soft when deposited but acquire a hard shell from exposure to the atmosphere. They hatch in about 12 days and are the size of a large pea.

A. miamiensis, Fig. 153, has a globose, yellowish-brown 2½ inches long heavy shell with moderately impressed suture, a depressed spire and large body whorl. The aperture occupies about one-half the length of

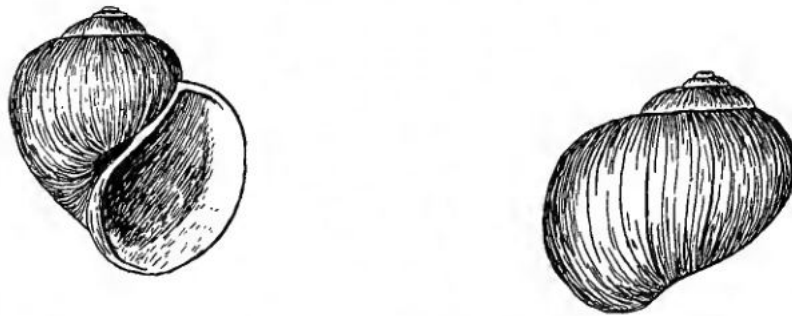


FIG. 153. *Ampullaria miamiensis*.

the shell, the operculum is calcareous and striated, with the nucleus at the upper side. This handsome snail occurs only in Southern freshwater, principally in Florida. Probably the largest native North American species is *A. pinei*, from the same locality, which reaches a length of 3 to 3½ inches.

SOMATOGYRUS. These small snails are quite generally distributed, and on account of their size harmless and inconspicuous in the aquarium. They are slothful in their habits and hibernate in cold water. The shells are pretty and of fine form.

S. altilis, Fig. 154, has a $\frac{3}{8}$ to $\frac{2}{18}$ inch long, smooth, thick, subglobose pale light-green or horn-colored shell of four whorls, with a sharp suture, short spire, nearly rounded aperture and regularly ovate operculum. The body is brownish-grey, the tentacles long and somewhat slender, and the eyes a bright bluish-black.

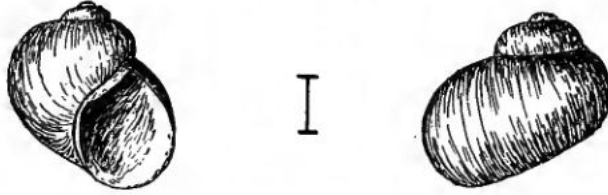


FIG. 154. *Somatogyrus altilis*. Enlarged.

It is quite generally distributed in the eastern section of the United States and has been found in the Potomac at Washington, and in both the Delaware and Schuylkill rivers. Also occurs in cold water ponds in the Middle States generally.

S. subglobosus, Fig. 155, has a $\frac{1}{4}$ to $\frac{3}{8}$ inch long obliquely transverse subglobose solid polished yellowish-green shell of four whorls, an impressed suture, a short spire and an oblique white aperture. The body is yellowish-brown or grey and the tentacles brown.



FIG. 155. *Somatogyrus subglobosus*. Enlarged.

It is not common to the Eastern and Middle but occurs in the Southern States, principally in South Carolina, but is occasionally met with in

Virginia and Maryland and at Washington, D. C.

AMNICOLA. These tiny snails are principally mentioned as they constitute a numerous genus, the Hydrobidæ. They have thin ovate conical shells with acute spires, small oblique, rounded ovate apertures and horny operculæ; are widely distributed and occur abundantly in many localities.

A. limosa, Fig. 156, has a conical very convex yellowish-brown slightly wrinkled $\frac{1}{4}$ inch long shell tinted with grey, of five or six whorls, with deeply impressed suture. The body whorl takes up about one-half the length of the shell. The body is brown and the tentacles of a lighter color. It



FIG. 156. *Amnicula limosa*. Enlarged.

occurs from Maine to Pennsylvania and Ohio, and is very numerous on the muddy shores of the Delaware and Schuylkill rivers.

A. granum is a very small species, not much larger than a pin's head, found in ponds near Philadelphia. It has a slender, conic-ovate yellowish-brown shell, having four or five convex whorls, deeply impressed suture and orbicular aperture. It ranges from Lake Superior to Virginia. Gould mentions another species, *A. pallida*, which has not been described as occurring in the Middle States.

BITHYNIA. These small whorled snails are usually found in ponds, ditches, canals and slow streams of not too cold water. They are oviparous and water-breathing, differing principally from some of the smaller Physa in having the whorl of the shell dextral. They thrive fairly well in the aquarium but are vegetable feeding and indifferent scavengers.

B. tentaculata, Fig. 157, has a glossy grey or horn-colored conical $\frac{3}{8}$ to $\frac{1}{2}$ inch long shell of six rounded whorls, with a distinct suture and pointed



FIG. 157. *Bithynia tentaculata*. Enlarged.

apex. The body whorl takes up more than half the length of the shell. The body is almost black, spotted with yellow and the divergent filiform tentacles are long and slender. The eyes are black and set at the

base of the tentacles and the obovate operculum calcareous and brittle. It is a harmless oviparous snail, feeding principally on decaying vegetation. Found quite generally in the Eastern and Middle States.

MELANIIDÆ. It should be noted of this family that it contains many genera and hundreds of species. Almost every river drainage system of the world has either distinct or closely allied forms; those of the United States being the Strepomatidæ, of which there are many local genera, the most common of the Eastern and Middle States being the Goniobases and Anculosa of the Hudson, Susquehanna, Delaware and Potomac basins. For brevity these only are described, the others are closely related similar forms.

GONIOBASIS. This genus has most beautiful conical or fusiform shells, showing faint lines of growth and often series of longitudinal ridges on the seven to ten whorls. Occurs quite generally in flowing waters.

G. virginica, Fig. 158, is a very common species of the middle Atlantic coast States. It has a truncated turreted yellowish-brown $\frac{7}{8}$ to 1 inch long shell, usually eroded at the spire. The eight to ten whorls are marked with a dull reddish line near the base of the whorls, with a second line

near the middle of the body whorl, but one or both are sometimes absent. The slender body is pale orange above and bluish white below, banded by irregular interrupted black lines. It occurs in the above mentioned localities and is very abundant in the Delaware and Schuylkill rivers.

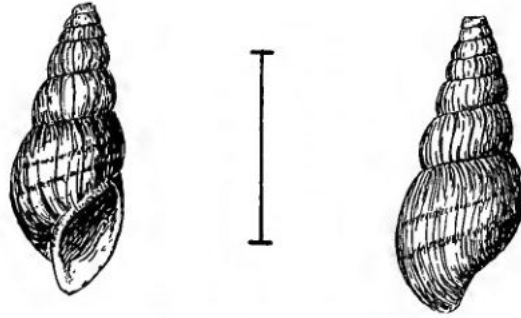


FIG. 158. *Goniobasis virginica*.

G. multilineata, Fig. 159, is also common in the tributaries of the Delaware river and in the Middle States.



FIG. 159. *Goniobasis multilineata*.

It has a gradually tapering very slightly convex $\frac{5}{8}$ to $\frac{3}{4}$ inch long conical yellowish-brown shell of seven whorls marked by a number of reddish or brown bands, a pointed oblong aperture and a usually eroded apex. It is also common to Eastern and Middle States river systems.

ANCULOSA. Many species occur in all the Middle-Western and Southern States but only one species is generally distributed in the Middle States.

A. carinata, Fig. 160, has a conical dark horn-colored or blackish $\frac{3}{4}$ inch long shell, very variable in appearance, with three or four whorls, all more or less keeled on the middle of the whorls. The suture is but slightly indented, the apex often truncated but usually eroded, and the aperture oval and one-third as

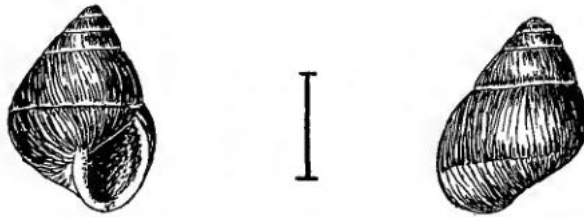


FIG. 160. *Anculosa carinatus*.

long as the shell. Varieties of this species are very generally found in streams and rivulets throughout the Middle and some of the New England States.

SUCCINEA. This genus contains the most generally distributed semi-aquatic snails which are only a part of their existence in freshwater, making their homes in marshes and the mudbanks of ditches, ponds and streams and are found in swampy places or on plants along the banks. They are to be distinguished from the aquatic snails by the presence of four cylindrical tentacles, the longer bearing the eyes. They are not desirable in the aquarium, but are frequently introduced with aquatic plants.

S. obliqua, Fig. 161, has a $\frac{7}{8}$ to $1\frac{1}{4}$ inch long, ovate, thin and fragile pale-green or amber shell, which is faintly striated and roseate in color at the apex.



FIG. 161. *Succinea obliqua*.

It has three whorls of which the body whorl is large and much expanded, and about $\frac{7}{8}$ the length of the shell. The spire is very small, the aperture oval and is two-thirds the length of the shell.

The body has a yellowish-brown color which shows through the semi-transparent shell. This snail is quite generally distributed in New York, Pennsylvania, New Jersey and Georgia. It is destructive to aquarium plants.

S. retusa, Fig. 162, has a $\frac{1}{2}$ to $\frac{7}{8}$ inch long somewhat conical ovate-oblong very thin pellucid yellowish-white minutely striated shell of three whorls, of which the body whorl constitutes nine-tenths of the entire shell and tapers gradually to the apex.



FIG. 162. *Succinea retusa*. Enlarged.

The spire is short, the suture indistinct, and the aperture four-fifths the length of the shell. The body is a little longer than the shell, of a translucent greyish color marked with black spots.

This snail is found quite generally in the Eastern and Middle States.

LYMNÆA. This numerously represented genus is found in stagnant and sluggish water, ponds and streams; feeding upon waste matter and aquatic plants, as all the genus are herbivorous and a few species also carnivorous. They are active, prolific and thrive in the aquarium, but are destructive and constant feeders, preferring the healthy growing plants to algæ and decaying vegetation; though they are also effective scavengers and devour animal substances and food offal, and sometimes their own spawn. When bred in the aquarium they considerably loose their destructive habits and become feeders on algæ. All are air breathers and will leave the water to rest upon aquatic plants, but only at long intervals. The shells of this family are all dextral.

L. stagnalis, Fig. 163, is the largest representative of this group, the shell reaching a length of $1\frac{1}{2}$ to 2 inches. It is usually of a greenish-white or yellowish-grey color; of six or eight whorls; of which the body whorl is larger, fuller and rounder than the others, which are drawn to a long, graceful dextral spiral, terminating in a finely pointed apex. The suture is

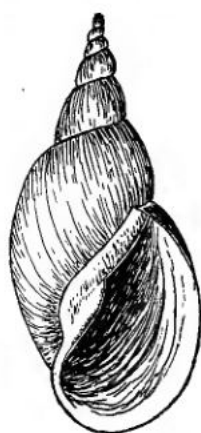


FIG. 163. Niagara Snail, *Lymnaea stagnalis*.

deep and the aperture oval. The body is yellowish-grey with a greenish tinge, spotted with brown and the tentacles flat, triangular and have a backward trend. It is oviparous and the 70 to 150 eggs, deposited at in-

tervals in cylindrical capsules, hatch in 15 to 20 days. This is one of the most handsome snails, of which a pair or two may be kept in the aquarium without damage to the plants. Its range is over the entire northern latitudes, and in the United States is found from Vermont through the Northern tier of States to the Pacific Ocean. It is popularly known as the "Niagara Snail."

L. palustris, Fig. 164, is a destructive though interesting common snail found in nearly all ditches, ponds and streams in the Eastern Atlantic slope and in Europe. The conical shell is $\frac{3}{4}$ to $1\frac{1}{4}$ inches long, of a light horn-color on the body whorl and usually a dark horn-color, brown or black above. It has five or six whorls separated by white lines, with the body whorl half as long as the shell.



FIG. 164. *Lymnaea palustris*.

The ovate aperture is nearly as long as the body whorl and the suture is deeply depressed. The body is dark gray or nearly black, with a violet tint, faintly spotted with yellow and black, and the tentacles flat and conical. It ranges from New England through Pennsylvania and south. Its habit of coming above the water serves as an identification in the aquarium, into which it is sometimes introduced with aquatic plants. The 60 to 80 eggs are deposited in a cylindrical capsule and hatch in 12 to 20 days.

L. columella, Fig. 165, has an ovate thin and fragile $\frac{5}{8}$ to $\frac{3}{4}$ inch long shell of four whorls crossed by minute lines of growth. The suture is deeply impressed and conspicuous, the spire narrow and the aperture larger than half the length of the shell. The body whorl is large and expanded, and the

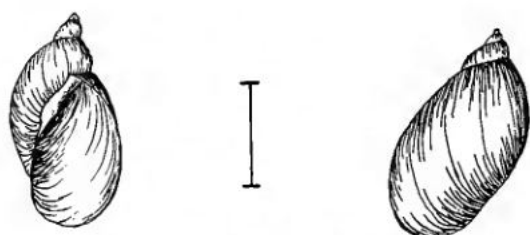


FIG. 165. *Lymnaea columella*. Enlarged.

body partly translucent with the central portion light brown. The tentacles are short and mottled with black. It inhabits the Eastern coast States from Maine to South Carolina, and west to Ohio and the Northwestern States. The

spawn is deposited in irregular patches of 50 to 100 and hatch in about 20 days. This species is similar to *Succinea*, but may be distinguished by the spiral line on the shell and the fold on the columella.

L. decidiosa, Fig. 166, has a somewhat inflated thin translucent light-ochre or brownish $\frac{3}{4}$ inch long shell, showing faint lines of growth. The spire is rapidly attenuated to an acute point, and the five whorls are separated by a deep suture, the aperture being one-half the length of the shell. The body is light yellowish-grey, minutely dotted with white; and the tentacles short, broad and translucent.

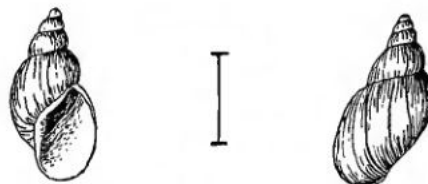


FIG. 166. *Lymnaea decidiosa*. Enlarged.

Its range is from New England to the Mississippi and it inhabits rivulets and small lakes.

L. catascopium, Fig. 167, is very similar to *L. putris* of Europe and has a smooth and polished $\frac{3}{4}$ inch long greyish or yellowish-brown shell with lightly marked lines of growth, and is darker at the apex, with

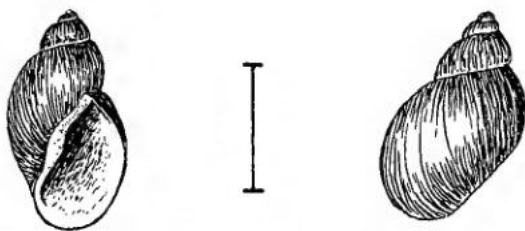


FIG. 167. *Lymnaea catascopium*.

four or five convex whorls of which the body whorl is large, the suture well defined, the spire tapering to an acute point and the aperture one-half the length of the shell. The body is yellowish-brown sprinkled with light-yellow spots; the

tentacles are short and the translucent foot as long as the aperture. It inhabits the rivers and streams of Massachusetts and New York near Niagara Falls, and the Delaware and Schuylkill rivers; and is one of the most frequently met with species. It is often introduced into the aquarium with plants. The 20 to 40 eggs are deposited in a transparent yellowish capsule which hatch in about 16 days.

All the native *Lymnaea* should be only sparingly introduced into the aquarium as they make havoc with the plants. Some species sever the

leaves by clean cuts across the blades, others by devouring the edges. If the aquarium is not covered they leave the water and crawling on the glass and over the edges dry out and die. One was found twenty feet from the nearest aquarium.

PLANORBIS. This numerously represented genus has the spiral shell flattened so that the view from above, below and on each side is different. The species vary in size, the largest being one and a half inch in diameter and the smallest less than $\frac{8}{82}$ inch. It is the best native easily procured snail for the aquarium, preferring algæ to any other food, and if not overstocked is harmless to aquatic plants and is a good scavenger.

P. bicarinatus, Fig. 168, has a brownish-grey shell never over $\frac{1}{2}$ inch in diameter, showing pale grey lines in the suture, with more than three complete whorls, angulated on each side with a slightly keeled periphery. The spire is on the left side and is depressed as deeply as on the other side. The body is a dusky or blackish-brown and the tentacles a yellowish-brown, generally of varying lengths. It inhabits quiet waters from New England to Georgia and westward to Tennessee, and will hibernate in cold water. The eggs are deposited from March to July in small irregular yellow masses and hatch in 15 to 25 days, dependent upon the temperature.

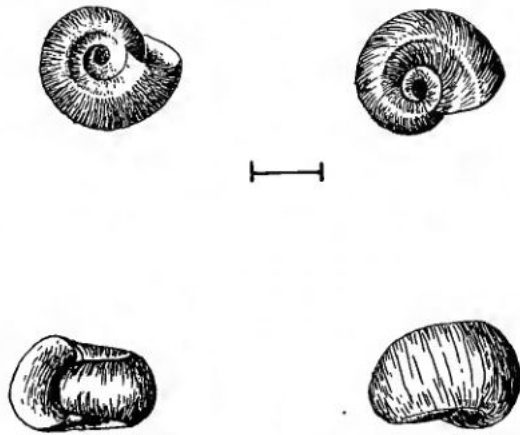


FIG. 168. *Planorbis bicarinatus*, four views. Enlarged.

P. campanulatus, Fig 169, has a yellowish $\frac{3}{4}$ inch in diameter compact shell, consisting of four slowly enlarging flattened whorls, distinctly marked

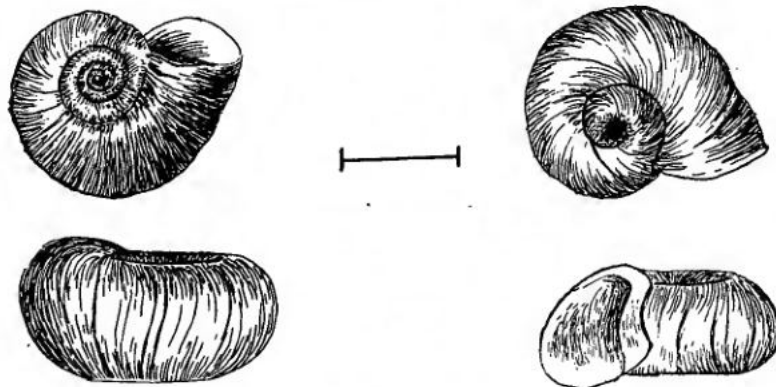


FIG. 169. *Planorbis campanulatus*, four views. Enlarged.

with lines of growth, with the body whorl slightly depressed. The suture is distinct, the apex compressed and the aperture dilated and deflected to the left; the other side showing the whorls nearly as well defined. The body is a dusky brown or russet, and the filiform tentacles are long and marked with dark brown lines. It inhabits streams of colder water in New England, New York, Northern Pennsylvania, Ohio and Illinois, and has been occasionally met with in the vicinity of Philadelphia.

P. trivolvis, Fig. 170, is a very generally distributed species having a laterally flattened $\frac{3}{4}$ to $\frac{7}{8}$ inch in diameter yellowish-green or brown shell, which consists of four and a half cylindrical whorls with finely marked lines of growth, and is slightly keeled towards the left side. The aperture is also deflected to the left. The spire is slightly impressed, nearly level on the right side, but the left side is considerably depressed and the whorls

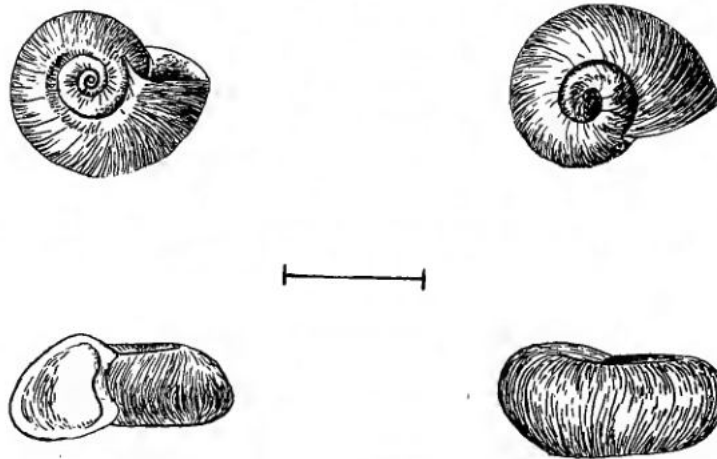


FIG. 170. *Planorbis trivolvis*, four views. Slightly enlarged.

disappear in a depression about two and a half whorls from the apex. The body is dark brown dotted with ochre and the tentacles long and slender. This snail occurs very generally in the Eastern and Middle States and is found in the Delaware and Schuylkill rivers. Its eggs are laid in a yellowish vermiform mass and hatch in 12 to 20 days.

P. magnificus, Fig. 171, is the largest recently known American species, having the flattened sinistral shell very large and heavy, about $1\frac{1}{2}$ inch in diameter and 1 inch high. The upper or spire half of the shell is pale-brown and the lower half dark-brown. The surface is glossy and marked by fine lines of growth. The spire is narrow, the suture depressed, and the summit of the nearly five complete whorls acutely angular and the umbilicus deeply funnel-shaped. The base of the whorls is so narrowly rounded as to appear almost angular. The last whorl is very large, rounded at the periphery, and the irregularly ovate aperture but slightly oblique.

Found at Lower Cape Fear river in the vicinity of Wilmington, N. C.
No other locality has been reported.

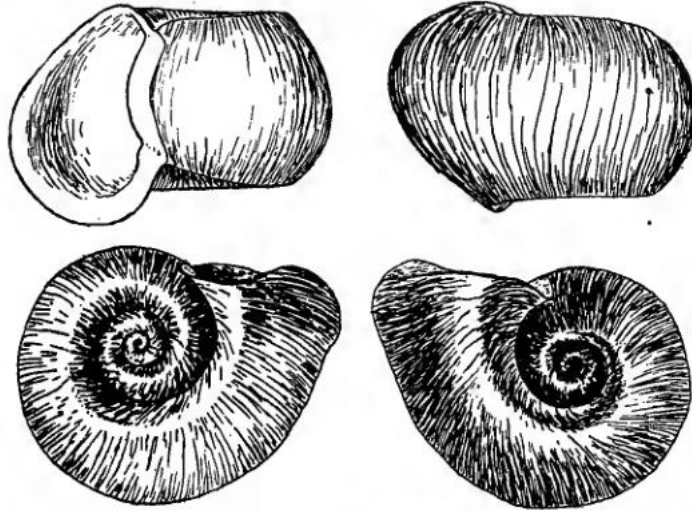


FIG. 171. Cape Fear river Snail, *Planorbis magnificus*. Four views.

There are many other smaller species of *Planorbis* but their size would preclude their use in the aquarium, though they are nearly all hardy and will survive, except the very cold water species.

SEGMENTINA. These snails differ from the *Planorbis* in having projections or teeth within the aperture of the shell, which is discoidal with but few of the whorls visible on both sides.

S. armigerus, Fig. 172, has a light-brown polished shell $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter, with the lip much darker. The four sub-cylindrical whorls are slightly keeled upon the left side and show faint lines of growth. The right side is nearly planed with a slightly depressed centre.

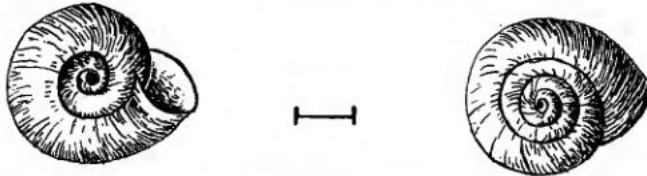


FIG. 172. *Segmentina armigerus*. Enlarged.

The body is a dull grey. It is a tiny insignificant snail to but little purpose in the aquarium. Quite generally met with in the Eastern and Middle States.

S. wheatleyi, Fig 173, is a still smaller species, rarely over $\frac{1}{8}$ inch in diameter, having a slightly keeled shell with the two and a half whorls distinctly outlined on the right side and lost in the depression of the left side. The aperture is at an angle pointing to the left.



FIG. 173. *Segmentina wheatleyi*. Enlarged.

Inhabits rivers and lakes of the Eastern and Middle States.

ANCYLUS. These small snails are popularly known as "Freshwater Limpets" and though belonging to the family of the Lymnæidæ greatly differ from them in appearance. They are sluggish and do not swim or float in the water but adhere to plants or move slowly over the bottom. Their food is principally algæ and aquatic fungi.

A. rivularis, Fig. 174, inhabits slow-flowing streams and may be found on aquatic plants, stones and on the bottom near the margins. The $\frac{1}{4}$ inch long dishlike shell terminates in a broad oval base which entirely covers the snail so that only the tentacles and a part of the snout protrude when the snail is active. It is of pale transparent horn-color, with the body greyish-brown marked with white, having a central yellowish longitudinal line upon the head. About 10 to 16 eggs are enclosed in a round capsule, which hatch in 20 to 36 days. It inhabits the Delaware and Susquehanna rivers and tributaries, and is met with generally in the Eastern and Middle States to Upper Missouri.

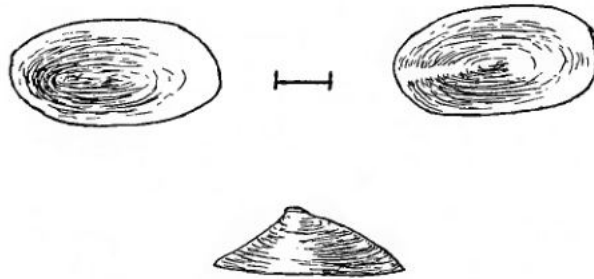


FIG. 174. *Ancylus rivularis*. Enlarged.

A. parallelus, Fig. 175, greatly resembles *A. lacustris* of Europe, but may be distinguished in having the apex of the shell directed to the right, in opposite direction to the European species. It may be found in still

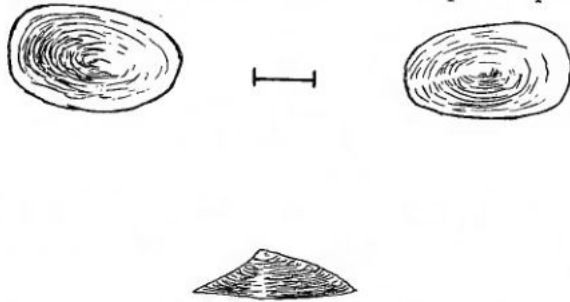


FIG. 175. *Ancylus parallelus*. Enlarged.

water and sluggish streams on the under sides of floating plants, and has a very thin yellowish mottled shell with a sharp apex and oval aperture. It grows to a length of $\frac{5}{16}$ inch. The body is yellowish grey with the tentacles of a lighter color. The 6 to 20 eggs are enclosed in a globular capsule and hatch in 16 to 30 days.

Neither of these species of *Ancylus* long survive in the aquarium as they fall victims to the fishes.

PHYSA. This genus may be distinguished by the left-hand or sinistral turn of the whorls of the spindle-shaped shell. It has no operculum but an extended mantle and two long and slender tentacles. It is not a numerous genus though widely distributed. A sub-genus is *Aplexa*.

P. heterostropha, Fig. 176, reaches a length of shell $\frac{3}{4}$ inch and is to be found on the water plants of ponds and streams quite generally in the Eastern and Middle States. The elongated translucent polished spindle-shaped shell is ovate, of yellowish-brown color terminating rather abruptly in an acute apex, and the large aperture is oval, about three-fourths the length of the shell. Of the four or five slightly convex whorls the body whorl is inflated and more than half the length of the shell. The suture is well marked, the apex pointed and the aperture narrow and longer than the spire. The body is yellowish-grey or darker, dotted with whitish-yellow; and the long and slender tentacles are pointed.



FIG. 176. *Physa heterostropha*. Enlarged.

It is an active snail but of objectionable vegetable feeding habit. It deposits 6 to 20 eggs in a capsule, which hatch in 15 to 20 days. Found generally throughout the Eastern and Middle States and in the Delaware and Schuylkill rivers. It is frequently introduced into the aquarium with aquatic plants, and is one of the most common freshwater snails.

Aplexa hypnorum, Fig. 177, has a slender translucent highly polished yellowish-brown or ochre shell, of five or six oblique revolving flattened whorls with convex apex and narrow aperture. The body is black, which tends to give the thin shell also a black color. It inhabits stagnant pools and is found in slow-flowing streams of Vermont, Massachusetts, New York, Pennsylvania and the Western States.

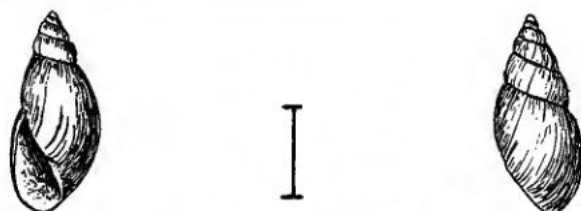


FIG. 177. *Aplexa hypnorum*. Enlarged.

There are many other species of *Physa* and *Aplexa*, but not native to the Eastern and Middle States. As they are largely herbivorous and therefore objectionable in the aquarium they need not be described.

GENERAL REMARKS. Descriptions of the colors of the shells of snails can only be done approximately as they are variable and depend upon the character of the water which the snails inhabit. The presence of iron, for instance, stain them to darker colors or black, while slight acidities bleach them to paler colors. If the empty shells are laid in oxalic acid their true colors will soon appear. Those given are based on the observations of the author, either of living snails in his aquaria or of those in his cabinet collection.

BEST AQUARIUM SNAILS. Experienced aquarists avail themselves of but four species as aquarium scavengers. These are the Planorbes, usually *P. trivolvis*, the larger common species, popularly known in the author's section of the country as the "Ram's horn" or "flat Schuylkill snail;" *Viviparus viviparus* or "Potomac snail;" *Lymnæa auricularia* or "Transparent African snail;" and *Viviparus malleatus* or "Japanese snail." The first two have been already described, the latter two will now be mentioned.

L. auricularia, Fig. 178, is native to the water systems of the Mediterranean and some other parts of Europe. It is a beautiful snail having a peculiar ear-shaped shell with a broad body whorl and the others flattened and rapidly diminishing, and a depressed spire. The shell is of a nearly transparent light horn-color, through which the darker color and the brown and black spots of the body plainly show. It has broad

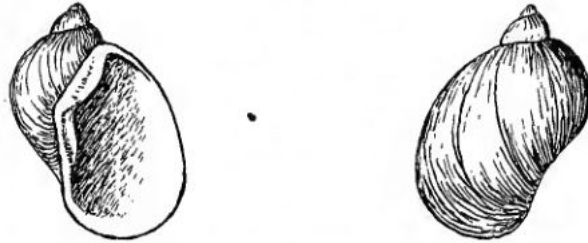


FIG. 178. Transparent African snail, *Lymnæa auricularia*.

and flat conical tentacles, small dark eyes and a broad foot, paler on the under side. It feeds entirely on algæ, decaying vegetation and offal, never attacking growing plants. It is active in habit, never comes entirely above the surface of the water, thrives in the aquarium and is one of its most interesting inmates. It is not as tenacious of life as the first two named, but is prolific and reaches a maximum length of $1\frac{1}{2}$ inches. Its eggs are deposited in long vermiform gelatinous masses on the stems and under the floating leaves of plants and on the glass of aquaria; which hatch in 12 to 20 days, the tiny snails being almost invisible in their transparent shells. This snail is exotic but is extensively bred in the Eastern and Middle States; may sometimes be had of dealers, but is usually obtained by exchange or purchase among aquarium fanciers.



FIG. 179. Japanese snail. *Viviparus malleatus*.
Nearly adult and younger shell, showing keel.

V. malleatus, the Japanese snail, Fig. 179, has now become naturalized at San José, California, in a little valley at the foot of Mount Hamilton. It is an edible snail, known to the Chinese as "Tsen law," which was either planted or accidentally introduced by the Chinese and Japanese of the neighborhood.

They are for sale in the Oriental quarters of some of the Pacific cities, and are collected in the rice fields near Yokahama and there sold for a few cents a quart. They are ovoviviparous, very hardy, most tenacious of life, and when not buried under the pebbles, the most indefatigable "workers" of any of the snails bred as aquarium scavengers. In the author's vicinity they may be had of several breeders who have given them preference to the other three desirable species. The shell is similar to *V. viviparus* but darker in color, lacking the bright color bands, and has a distinct keel in the centre of the body whorl, extending part-way on the next following. They grow to a diameter of 2 inches and over, and their almost entirely black color makes them conspicuous inhabitants of the aquarium. They are harmless to the plants, ravenous feeders on algæ and offal, never at rest and constantly moving over the glass of the aquarium, or feeding on the parasitic algæ on the water plants and on the humus under the pebbles. The young, when they leave the female, are $\frac{3}{8}$ inch in diameter, having a horn-colored, very markedly keeled shell. The Chinese species of the same genus is *V. stelmaphora*, for which the above has been mistaken; but this snail has not been introduced into the United States. The Japanese snail will cross with the Potomac snail, the mixed breed more resembling the latter, as it does not have the keeled shell of the Japanese snail.

For the aquarium intended and equipped for fishes, these four species are particularly recommended. Nearly all the others mentioned are not desirable and should be introduced only when the approved species cannot be obtained. More than one species is also advisable, as they all vary somewhat in their preference of diet.

SNAIL BREEDING. A "snail farm" in which the desirable aquarium snails may be bred is best arranged in a large jar in which there is a luxuriant growth of aquatic plants rooted in clean soil and covered with a thin layer of sand. No fishes or insects should be introduced, as they prey upon the young snails when first liberated from the gelatinous capsules of the oviparous species and the newly born young of the ovoviviparous genera. Feeding with any of the starchy fish foods should be occasionally done, as the young snails thrive better than when entirely dependent upon algæ and decaying vegetation; but this should not be done in excess that the snails may not feed too considerably upon this supply and thereafter become less effectual scavengers. Excessive feeding would also contaminate the water and cause the death of the snails.

When many snails are kept in an aquarium, it is advisable to place a few pieces of gypsum or of plaster of paris, about the size of a large pea, in the tank three or four times a year. These gradually dissolve and

furnishes lime for the shells of the snails without depriving other animal or plant life in the aquarium thereof. All water under natural conditions contain mineral salts, but those of the aquarium may become exhausted, and it is requisite that they should be replaced.

CLASSIFICATION OF THE BIVALVES. Freshwater mussels belong to the order of the Lamellibranchiata and are divided into two families, the Cycladidæ and the Unionidæ. The following classification will briefly describe the order, families, genera and species, and serve as a key to the subsequent descriptions, which are confined to Eastern and Middle States mussels, though many are common to other sections of the United States.

ORDER LAMELLIBRANCHIATA.

Family Cycladidæ—Valves small, suborbicular, hinge with cardinal and lateral teeth, animal with open simple mantle, siphon more or less united, two unequal gills each side, foot large and tongue-shaped.

Genus Sphærium—*S. simile*, *S. striatinum*.

Genus Pisidium—*P. compressum*, *P. abditum*.

Family Unionidæ—Valve large inequipartite oval or elongated, hinge with a simple or divided cardinal tooth in each valve and an elongated lateral tooth, gills free from the abdominal sac with dorsal attached to mantle, upper siphonal opening somewhat fringed.

Genus Unio—*U. complanatus*.

Genus Lampsilis—*L. radiosus*, *L. ochraceus*, *L. cariosus*.

Genus Anodonta—*A. cataracta*, *A. implicata*.

Genus Margaritana—*M. margaritifera*, *M. marginata*.

SPHÆRIUM. These small mussels are generally distributed and have thin, ovate-globose shells, and the hinge has two minute cardinal teeth in each valve, sometimes but one, and compressed marginal teeth. They are seldom over $\frac{3}{4}$ inch long.

S. simile, Fig. 180, is the larger species of the Eastern Section and has sub-oval dark chestnut-brown very convex valves, varying considerably in outline. In the adult the extremities are broader and nearly equally rounded, the posterior part somewhat longer and more pointed and the umbones nearly central; while with the young the light-yellow valves are thin, compressed and the hinge margins nearly a straight line. The surface of the adult shell is concentrically wrinkled with distinct lines of growth, and the hinge has oblique minute cardinal teeth, and those of the margin are distinct, strong and white. The valves are $\frac{3}{4}$ inch long, $\frac{1}{2}$ inch broad and $\frac{2}{5}$ inch thick. The animal is of a light salmon-pink color and

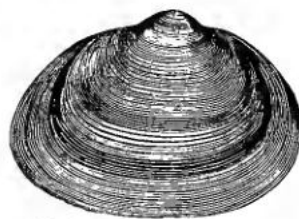


FIG. 180. *Sphærium simile*.
Enlarged.

slothful in movement. It is found in larger ponds and in rivers of the Eastern and Middle States and along the Lakes. This mussel is nearly related to *S. rivicola* of Europe, both in size and in the appearance of the valves.

S. striatinum, Fig. 181, has thin rounded-oval, pellucid, somewhat inflated valves with the umbones central and inwardly inclined. In the adult, they are of light-greenish horn-color and in the young a very light yellowish color, and are $\frac{1}{2}$ inch long, $\frac{2}{8}$ inch broad and $\frac{1}{8}$ inch thick. The animal is of light pink color and its movements are rapid. Found everywhere in the mud of freshwater ditches and streams among the roots of water plants. This mussel is nearly related to *S. cornea* of Europe resembling it in size, shape and generally in color.



FIG. 181. *Sphaerium striatinum*.
Enlarged.

Other locally distributed Sphaeriums are *S. rhomboidium*, *S. tenue* and *S. truncatum*. Both the described species survive in the aquarium.

PISIDIUM. These tiny mussels differ from the foregoing in having but one siphon and are more inclined to inequilateral forms; are not generally quite so thick and are of a lighter color. They vary from $\frac{1}{8}$ to $\frac{1}{4}$ inch in length, are never active, thrive well in the aquarium and often bury themselves for a long period.

P. compressum, Fig 182, has solid, very oblique triangular inflated subequalateral yellow or grey valves with light-blue interior, a thick hinge having small cardinal and distinct lateral teeth. The umbones are prominent and placed a little posteriorly and the valves have a slight beak, the posterior being evenly rounded. The lines of growth are concentric and finely marked. The valves are about $\frac{1}{8}$ inch long, $\frac{1}{7}$ inch broad and $\frac{1}{10}$ inch thick. Found quite generally in the United States and is common to New England, New York, Pennsylvania and Ohio. This mussel considerably resembles *P. conicum* of Europe.



FIG. 182. *Pisidium compressum*.
Enlarged.

Other Eastern States species are *P. abditum*, Fig. 183, *P. equilaterale*, *P. ferrugineum* and *P. ventricosum*, all still smaller than the foregoing and so tiny as to be of no considerable value to the aquarist.



FIG. 183. *Pisidium abditum*.
Enlarged.

UNIO. These most common freshwater mussels are to be found in ditches, ponds, lakes and streams. Their food is both vegetal and animal, as they subsist upon decaying vegetation, diatoms, algæ, infusoria and other water animalculæ. Their shells often contain pearls, either attached or free in the muscle and gills.

U. complanatus, Fig. 184, is the widely distributed species, found in ponds and streams. The valves vary in form but are usually oblong-ovate, rather compressed and posteriorly the broader. The umbones are mostly eroded and have an obtuse ridge to the posterior tip. The hinge has a single coarsely-striated cardinal tooth in the right and two nearly equal teeth in the left valves. The color is usually a yellowish-green in the younger and brownish-green in the older shells,

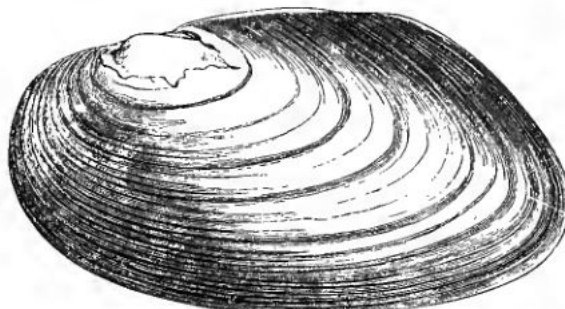


FIG. 184. *Unio complanatus*. Adult.

and is dark green posteriorly at the hinge. The lines of growth are faintly and evenly marked. The valves have an iridescent violet pearly nacre on the inner side with a delicate pink and salmon-yellow edge, and are 3 inches long, 2 inches broad and 1 inch thick at the umbones. The animal is yellowish-and greyish-white with a long foot. It occurs in almost every stream and river on the Atlantic slope and is a most active mussel, often moving several inches in a day. A good and desirable scavenger in the aquarium where it will often survive for years.

LAMP SILIS. This genus of the Unionidæ was formerly classed with the Unios and embraces most of the Eastern and Middle States species.

L. radiatum, Fig. 185, has broad oblong-ovate beautifully striated dull greenish-yellow valves showing distinct lines of growth and overlaid with green and brown rays radiating from the edges of the umbones. It is one

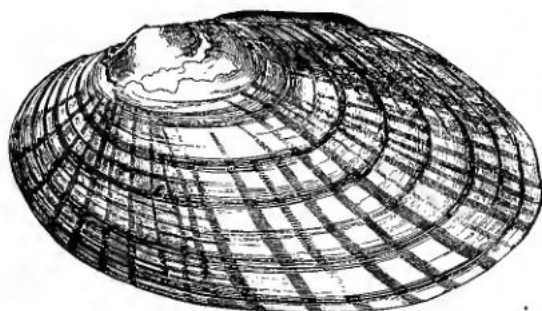


FIG. 185. *Lampsilis radiatum*. Adult.

of the handsomest freshwater mussels. The interior of the valves shows a delicate iridescent nacre and the hinge has erect cardinal teeth strengthened by a rib behind the anterior muscular impression. It grows to a length of 3 inches, nearly 2 inches broad and

1 $\frac{1}{4}$ inch thick; and may be found in most large ponds and streams, but is not as long-lived in the aquarium as the foregoing.

L. ochraceus, Fig. 186, is variable in form but usually has thin, transversely oblong, sub-ovate, translucent, inflated and widely gaping valves, with elevated and almost touching umbones. The color is yellowish-

brown, finely radiated and zoned with dark olive, and a very dainty rose color or violet tint on the inner side. The cardinal teeth are nearly parallel with the hinge margin and the lateral teeth short and less prominent. It grows to $2\frac{3}{4}$ inches in length, 2 inches broad and $1\frac{1}{4}$ inch thick, but is usually smaller in proportion. It is a New England species rarely found in the Middle and Western States.

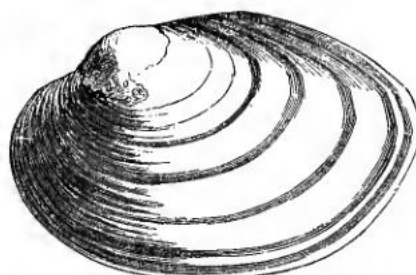


FIG. 186. *Lampsilis ochraceus*. Adult.

L. cariosus, Fig. 187, is also variable in form, has moderately thick inflated ovate or rounded valves, with the prominent umbones placed well towards the anterior end of the hinge, which has a straight narrow margin and a sharp obtuse ridge passing towards the posterior tip.



FIG. 187. *Lampsilis cariosus*. Adult.

The valves are sharply marked with lines of growth and have a smoothly polished surface. The color is greenish-yellow or light-olive, with rays of bright-green along the upper posterior margin; and the inside a bluish flesh-colored tint. The cardinal

teeth are oblique and the laterals short. It grows to a length of 3 inches, the male being $1\frac{3}{4}$ and the female $2\frac{1}{4}$ inches broad and $1\frac{1}{4}$ inch thick. It is quite generally distributed but most frequently occurs in the Connecticut River and its tributaries. No information is at hand as to its longevity in the aquarium.

ANADONTA. These mussels reach a considerable size and are usually more ovate in form than any of the foregoing. They have siphonal apertures, toothless hinges and sharply defined umbones. They are difficult to keep alive in smaller aquaria, as their food consist most largely of diatoms and infusoria, but will survive in those of running water or in large properly balanced aquaria having abundant plant life. There are two generally distributed species in the Eastern Atlantic States, both of which grow to large size.

A. cataracta, Fig. 188, more generally known as *A. fluviatilis*, greatly resembles *A. cygnia* of Europe and has thin transversely sub-oval inflated valves with distinctly outlined umbones, placed well to the anterior end of

the hinge, which has the margin compressed and considerably curved. The surface is smooth, except at the posterior portion, where it is wrinkled and shows a number of radiations from the upper edge of the umbone.

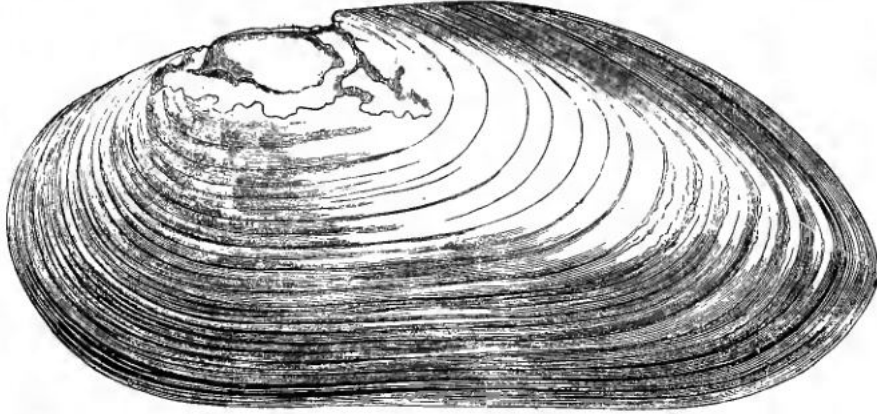


FIG. 188. *Anadonta cataracta*. Adult.

The color is a deep clear green, indistinctly radiated with a darker green and brown. On the inside the silvery nacre is tinged with blue and yellow and has a greenish margin. It reaches a large size and may be $4\frac{1}{2}$ inches long, $2\frac{3}{4}$ inches broad and $1\frac{1}{2}$ inch thick, though most of these mussels are about 3 inches long. It usually inhabits ponds and still water and occurs quite generally on the Eastern Atlantic slope.

A. implicata, Fig. 189, is a characteristic species with transversely oblong, sub-oval, thick, opaque, strong and heavy valves, almost as thick as broad; having the umbones distinct and usually eroded. It has ridges from the lower posterior edge of the umbone to the angular tip of the posterior edge. The valves are broadest behind the middle; the hinge margin is slightly curved. The outer surface is rough with coarse lines of growth, of a yellowish-olive color somewhat darker above, and the lines are marked with a dull brown. Older shells have a delicate salmon or flesh-color and the younger a silvery tint on the inside. It grows to 4 inches long, $2\frac{1}{4}$ inches broad and $1\frac{1}{3}$ inches thick, but average shells are usually about 3 inches long or under. It inhabits ponds and still water throughout the Eastern and Middle States but has a quite general distribution. This mussel is more elongate, narrower and thicker than the foregoing and may be distinguished by its obtuse ridge. The margin is also more convex.



FIG. 189. *Anadonta implicata*. Young shell.

MARGARITANA. This genus of the Unionidæ may be found in most running streams of fresh water, and has the valves transversely elongated, inequilateral, and the hinge differs from the Unios, with which some of the species have been classed by Conchologists.

M. margaritifera, Fig. 190, has the ovate or kidney-shaped thick and strong valves transversely much elongated, with the umbones but slightly raised above the line of the hinge and usually much eroded; and the hinge

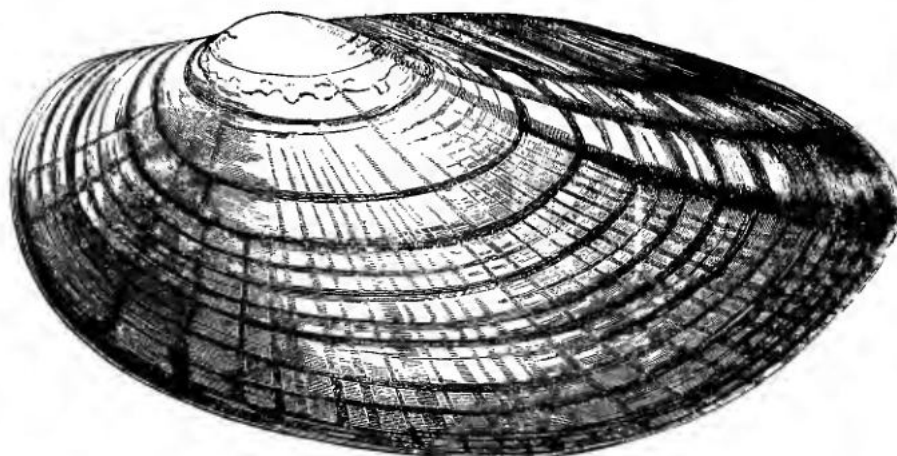


FIG. 190. *Margaritana margaritifera*. Adult.

and basal margin nearly as broad before as behind the hinge, which is usually curved and nearly parallel, with the tips slightly truncated. The surface is waved with lines of growth and loosely wrinkled posteriorly and towards the margin. The outside is pitchy-black, the inside has a greenish border at the margin while the nacre is bluish-white shading to flesh-color in the centre of the valves. There are two cardinal teeth in the left valve and one in the right. The mussel is $4\frac{1}{2}$ inches long, 2 inches broad and $1\frac{1}{4}$ inches thick, probably the largest freshwater mussel of the Atlantic slope, very generally distributed in the Eastern and Middle States.

M. marginata, Fig. 191, has thin-ovate, anteriorly wedge-shaped valves with small but elevated umbones, usually somewhat eroded. The posterior hinge margin declines abruptly to form a rounded tip and a well-

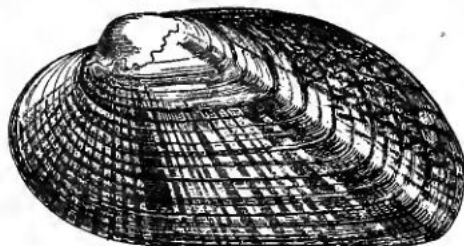


FIG. 191. *Margaritana marginata*. Nearly adult.

defined ridge extends from the umbone to the lower forward edge and the valves show rounded wrinkles and well-defined lines of growth. The color is a polished olive-green mottled with lighter and darker shades and having broken or obscure radiating darker green or brownish lines.

The interior has a chalky white margin and bluish-white nacre, overshot with delicate shades of green. The mature mussel is $2\frac{1}{2}$ inches long, $1\frac{1}{4}$ inch broad and 1 inch thick at the umbones. It is not as generally distributed as the foregoing, but may be found in almost all the river systems of the Eastern and Middle States, a Western species being *M. truncata*.

GENERAL REMARKS. What has been stated as to the colors of snail shells also applies to mussels. The presence of metallic oxides in the water affects the color and acidities erode the valves, principally on the umbones, the older portion of the valves; and when this has progressed to the extent of perforating the valves the mussel dies.

BEST AQUARIUM MUSSELS. Nearly all the mentioned species will thrive in the aquarium, instances being known of remarkable longevity. *Sphaerium*, *Lampsilis* and *Margaritana* will survive for years; some in the author's household aquaria at this writing having done most effectual duty as scavengers for three and a half years and are still active and of good appearance. The introduction of one mussel into the aquarium for each 8 or 10 gallons of water is to be recommended, but watch should be kept until they become acclimated, after which an occasional tap on the valves will give assurance that they are alive. They are the best means of eradicating the objectionable *Tubicolores* worms. If they die, the decay is rapid and will cause trouble in the aquarium.

FRESHWATER VERMES AND HYDROZOA

TUBICOLA AND HYDRA. In addition to the already described low forms of animal life in the aquarium the freshwater Worms and Polyps should be mentioned. The eggs, spores or young are introduced with the water supply, in pond mud and on the aquatic plants. They may increase to such numbers as to become objectionable, as the worms bring the soil and humus to the surface of the pebbles, and by their constant activity cause turbidities in the lower water levels; and the polyps become active enemies to the spawn and young fishes.

FRESHWATER WORMS. These belong to the order Annelida. The most usual forms are *Pristina leidyi* and *Stylaria lacustris* which live in the soil and mud. *Lumbriculus limosus*, about 2 inches long, and *Nais rivulosa*, about $\frac{5}{8}$ to $\frac{3}{4}$ inch long, live in the axils and under the leaves of aquatic plants. Of the Tubicolous worms, the objectionable *Trimnodrilus* is usually the only species present. As of these all but the last named are eaten by the fishes, no further mention is necessary.

Trimnodrilus claparadii, Fig. 192, and *T. montanus* are not eaten by goldfishes and may increase to such numbers that the whole bottom of the

aquarium will appear to be a living wriggling mass of threads that disappear when disturbed. These worms construct cases of the mud and of mucus secretions which they deposit, in which they live, consuming organic substances in the water and mud and bringing the residue to the surface. To dispose of them is difficult as the dipping-tube or siphon will not be effectual. A better method is to introduce one or more mussels, which cause their disappearance, or removing the other fishes introduce Sticklebacks, which, if not otherwise fed, will in a few days clear the aquarium of the pests. The *Tubifex* of Europe is sparsely represented in the United States.



FIG. 192. Common freshwater Tubicular Worms, *Timnodrilus claparadii*. Greatly enlarged.

FRESHWATER POLYPS. These belong to the order Hydrozoa, two classes of which, the Hydrida and Corynida, have frequently occurring freshwater forms, the Hydra and Cordylophora.

HYDRA. The freshwater hydra consists of a cylindrical body expanded into a single foot at one end, by which the animal attaches itself to any object, and having a mouth and a circle of from 5 to 12 tentacles at the other end. Those having short tentacles are of the species *H. viridis* and those with long filamentary tentacles *H. fusca*. The body contains a single large cavity, the rejected food being ejected from the mouth. Hydra possess the power of repairing mutilations and of multiplying artificially, and if cut into any number of pieces, each will develop into a perfect polyp. Reproduction is both sexual and by gemmation; the buds often developing and throwing out new shoots before they detach themselves from the parent. In the sexual method of reproduction, ova are developed and enclosed in sacs, which when mature are expelled through the body wall, the embryo appearing as a free-swimming tiny thread-cell, which attaches itself to foreign bodies and develops into the complete animal. Hydra occur in all waters and multiply rapidly when the temperature reaches 60° F., though cold water does not appear to injure them.

Hydra viridis. This is the most frequently met with form. Its power of changing its appearance is wonderful; those shown in Fig. 192, Nos. 1, 2, 3, 4 and 5, are all the same individual and the changes took place in

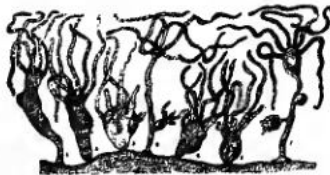


FIG. 193. Freshwater Polyps. Greatly enlarged. 1 to 5. *Hydra viridis*. 6 and 7. *Hydra fusca*.

less than one hour. The process of gemmation may be noticed, together with the growth of the young and its separation from the parent. The tentacles were not of the same form or length for even an instant, and seemed to ooze from and return to the body constantly.

Hydra fusca. This polyp, Fig. 193; Nos. 6 and 7, is more stalklike than *H. viridis*, and

has greater power of extending its tentacles, often to a stretch of 2 to 5 inches. Otherwise it resembles the foregoing.

Hydra are destructive to very young fishes. The observations of Mr. A. E. Beardsly, in the investigation of the deaths of small trout, at the hatchery of Leadville, Col., will illustrate this fact. The sediment from the hatching troughs was found to contain innumerable hydra about 1 to 2 centimeters in length. Some of this sediment was removed to a number of vessels into each of which five newly hatched trout in good health were placed, and in one, as a control, the clear water of the main supply. In this experiment 25% of the trout were killed in less than 30 minutes, 60% in 45 minutes, 80% in 60 minutes and 100% in 75 minutes; while those in the control jar were all alive and in good health the following day. He states that "the hydra were seen with their mouths closely applied to the surface of the fish, particularly on the yolksac. In some cases more than a dozen hydrams were attached to a single fish." This has also been the experience of a number of goldfish breeders.

CORDYLOPHORA. These polyps consist of single individuals or of a number joined by a common stalk, each developing gonosphores or germinating buds similar to those of the hydra. One species, *Cordylophora lacustra*, Fig. 194, frequently occurs in fresh-water attached to stones, shells or other firm objects. Its waving branches somewhat resemble some of the aquatic mosses but when touched the immediate change in form betrays its animal nature. It is not an active enemy to young fishes but should not be admitted to the hatching troughs.

Hydra and Cordylophora can be removed from the aquarium by the introduction of Sticklebacks, and Paradise fishes, or by its complete rearrangement. The plants should then be placed in a strong solution of Phenol-sodique, or in a bichloride of mercury solution of one tablet the pint of water, and to then carefully washed in clean water before they are returned to the aquarium; or the bichloride used directly in the aquarium after removing the animals, and the water afterwards removed and changed a number of times. The former is the preferred method, but unless the pests are very numerous, a few Paradise fishes, if not otherwise fed, will "clean them up" in a few days. Hydra are principally destructive when they are introduced into the spawning and hatching tanks.



FIG. 194. Freshwater polyp, *Cordylophora lacustra*. Enlarged.