

NORTH AMERICAN FRESHWATER SNAILS

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V. KEYS TO THE FRESHWATER GASTROPODS OF NORTH AMERICA

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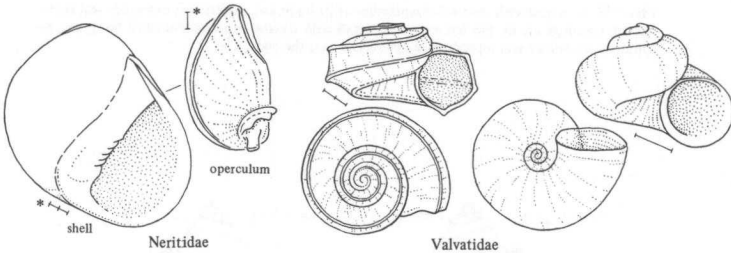
FAMILIES AND HIGHER TAXA

- 1 Animal with an operculum (which seals the shell aperture when the snail's body is withdrawn into the shell) (Fig. 772); respiration by gills; mantle opening facing anteriorly. Subclass **Prosobranchia** 2

Animal without an operculum to seal its shell aperture when withdrawn; respiration by the vascularized lining of the mantle cavity (true gills are lacking) or by a pseudobranch (false gill) outside the mantle cavity (Fig. 773a); mantle opening directed to the side (to the right or left, depending on whether the animal is dextral [right coiled] or sinistral [left coiled] (Fig. 773a,b)). Subclass **Pulmonata**, Order **Lymnophila** 11

- 2(1) Shell globose, subspherical or hemispherical (Fig. 21), solid, with a very low spire; aperture semi-circular or half-moon shaped, with "teeth" or tubercles on the parietal columellar margin of the aperture; operculum calcareous, paucispiral, with a pair of projecting processes on the inner columellar side (Fig. 22); shell usually with a pattern of pale variegations on a greenish-olive background; adult shell of medium size, its height about 20 mm; shell with three to four whorls, the last one making up most of the shell; gill bipectinate or feather-like, i.e., with gill laminae on both sides of the gill axis; radula rhipidoglossate (Fig. 782), with many marginal teeth. Florida and southern Georgia Family **NERITIDAE** [Order **NERITACEA**, Superfamily **NERITOIDEA**] (page 223)

Shell of various shapes and sizes, but if neritiform (see above, Neritidae; Fig. 779) the shell is small (no more than 5 mm in height); operculum without a projecting process on the inner side; shell color patterns variable, but not of the variegated kind (see above, Neritidae); gill monopectinate (except in the Valvatidae), i.e., with gill laminae only on one side of the gill axis (which is adnate along its entire length to the pallial wall); radula taenioglossate (Fig. 782), with few (two) marginal teeth. Order **Mesogastropoda** 3



- 3(2) Shell small (8 mm or less in diameter), spire generally depressed, some species with carina; operculum multispiral (Fig. 780a); gill bipectinate or feather-like, protruding from the mantle cavity when the snail is active (Fig. 781); pallial tentacle (Fig. 781) present. Superfamily **Valvatoidea** Family **VALVATIDAE** (page 223)

*Measurement lines on illustrations throughout this section indicate millimeters.

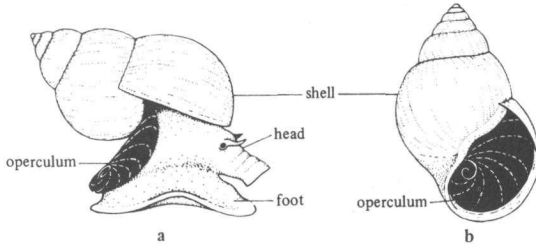


FIG. 772. An operculated snail, i.e., one which carries an operculum attached to its dorsal posterior foot. a, Position of the operculum when the snail is active; b, position of the operculum when the snail has withdrawn into its shell.

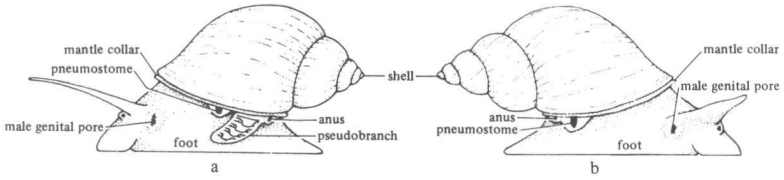


FIG. 773. a, A snail with *sinistral* organization of its body, i.e., respiratory, excretory and reproductive openings are on the *left* side; b, a snail with *dextral* organization of its body, i.e., respiratory, excretory and reproductive openings are on the *right* side.

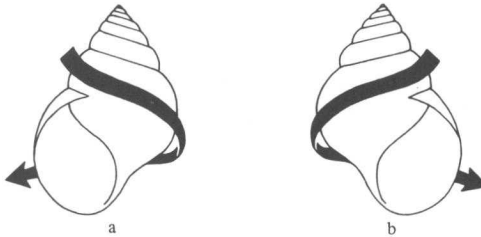
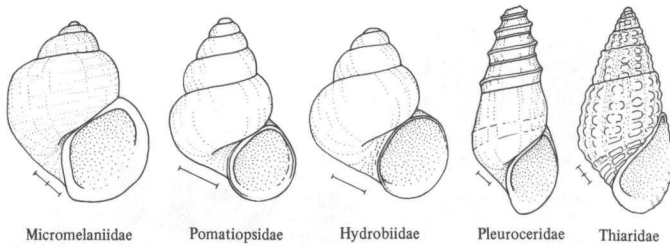


FIG. 774. Direction of coiling of gastropod shells. a, Shell coiled to the left, i.e., *sinistral*; b, shell coiled to the right, i.e., *dextral*.

- Shell small to large, spire depressed to elongate; operculum multispiral (Fig. 780a), paucispiral (Fig. 780b) or concentric (Fig. 780c,d); gill monopectinate; pallial tentacle absent 4
- 4(3) Operculum multispiral or paucispiral (Fig. 780a,b), the distal margins not concentric 5
- Operculum concentric (although the nucleus may be paucispiral) (Fig. 780c,d). Superfamily **Ampullarioidea** (Viviparioidea) 9
- 5(4) Adult shells usually less than 5 mm in length (but a few species reach this length or exceed it by 1 or 2 mm, and the shell of one hydrobiid species (*Fluminicola nuttalliana* Lea) reaches 10 mm in length); males possess a verge (see Figs. 83, 85-92). Superfamily **Truncatelloidea** (Rissooidea) 6
- Adult shells of medium to large size (usually more than 15 mm in length, but some shells are smaller, to 10 mm in length, and in several species the adult shells are no longer than 6-9 mm); males lack a verge. Superfamily **Vermetoidea** (Cerithioidea) 8
- 6(5) Shell globose-conic, sculptured with numerous spiral epidermal ridges; central radular tooth lacks basal denticles (Fig. 81a). Inhabits streams in caves in Indiana and Kentucky Family **MICROMELANIIDAE** (page 231)
- Shell of various shapes, usually smooth, but if sculpturing is present it does not consist of spiral epidermal ridges; central radular tooth with one or more basal denticles or cusps on each side (Fig. 81b, c) 7



- 7(6) Shell high-spired, turritiform; the head-foot region of the body is subdivided on each side by a longitudinal groove; central radular tooth with two or more basal cusps, which are situated on antero-posterior ridges (Fig. 81c); eyes in prominent swellings on the outer bases of the tentacles; amphibious or terrestrial in habit Family **POMATIOPSIDAE** (page 239)
- Shell high-spired to depressed; head-foot region not subdivided by a longitudinal groove; central radular tooth with 1-10 basal cusps attached to a thickened ridge along the lateral angle (Fig. 81b), not on antero-posterior ridges; eyes at the outer bases of the tentacles, but not on prominent swellings; totally aquatic in habit Family **HYDROBIIDAE** (page 231)
- 8(5) Mantle edge smooth; males always present, reproduction dioecious; females lay eggs, having an egg-laying sinus on the right side of the foot Family **PLEUROCERIDAE**²¹ (page 241)
- Mantle edge papillate; males generally absent (parthenogenetic reproduction common, often the rule); females brood their young in an adventitious ("subhaemocoelic"; not uterine) brood pouch in the postero-dorsal head-foot region. Introduced sporadically in the southernmost United States from Florida to Texas Family **THIARIDAE** (page 240)

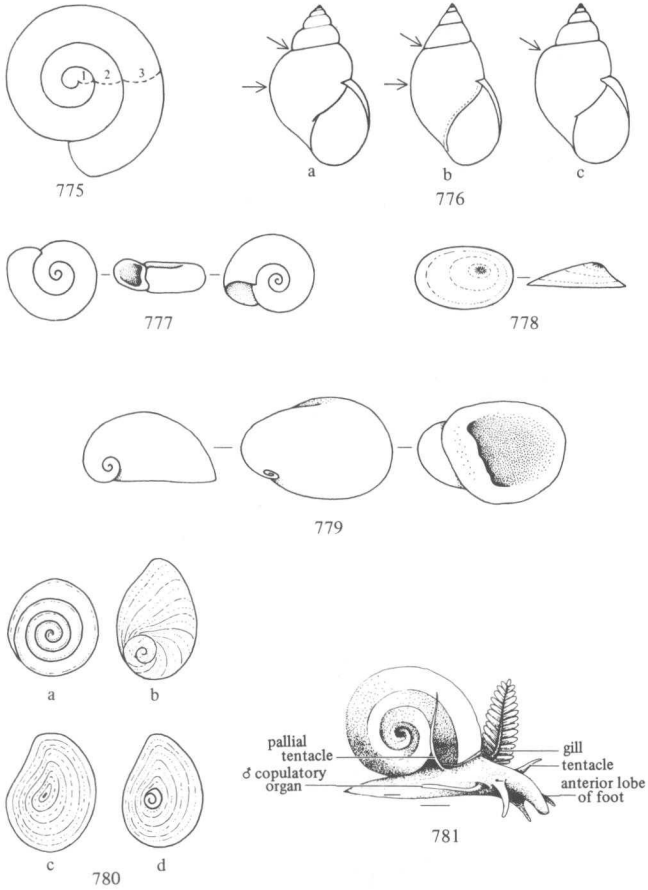
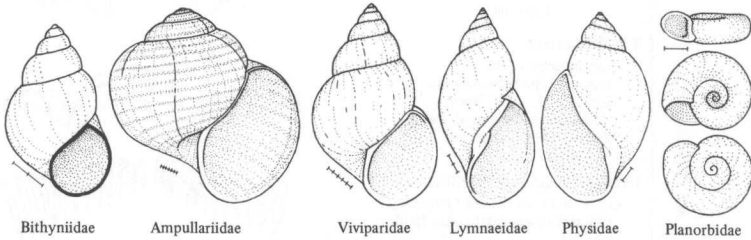


FIG. 775. Method of counting whorls. This shell has $3\frac{1}{4}$ whorls. FIGS. 776-779. Shell terminology. Fig. 776. a, Shell with well-rounded whorls and indented sutures; b, shell with flattened whorls and shallow sutures; c, shell with shouldered whorls. Fig. 777. Planorbiform or discoidal shell. Fig. 778. Ancyliiform or limpet-shaped shell. Fig. 779. Neritiform shell. FIG. 780. Types of opercula. a, Multispiral; b, paucispiral; c, concentric; d, concentric with spiral nucleus. FIG. 781. A valvate snail, showing bipectinate gill and pallial tentacle (from Harman & Berg, 1971, as modified from F. C. Baker, 1928c).

- 9(4) Shells of adults medium to large, more than 20 mm in shell length (in some species reaching more than 50 or 60 mm); operculum corneous 10
- Shells of adults smaller, less than 15 mm in length; operculum calcareous. Great Lakes and St. Lawrence regions from Wisconsin to Pennsylvania and New York Family BITHYNIIDAE (page 230)
- 10(9) Shell globose and large (height often up to or exceeding 60 mm), or shell planate (discoidal, with sunken spire), its width exceeding 40 mm; ends of labial palps whip-like; in males the penis arises from the right side of the mantle edge; females lay calcareous (*Pomacea*) or gelatinous (*Marisa*) eggs. Alabama, Florida and Georgia Family AMPULLARIIDAE (page 230)
- Shell subglobose to turreted, medium to large; ends of labial palps blunt, not whip-like; in males the right tentacle is modified as a penis sheath; females ovoviviparous. Found throughout the United States and Canada Family VIVIPARIIDAE (page 227)



- 11(1) Shell coiled 12
- Shell uncoiled, obtuse cone (limpet- or cap-shaped) (Fig. 778) 14
- 12(11) Animal and shell dextral (coiled to the right) (Figs. 773b, 774b). Superfamily **Lymnaeioidea**, in part Family LYMNAEIDAE, in part (page 247)
- Animal and shell sinistral (coiled to the left) (Figs. 773a, 774a). Superfamily **Ancyloidea**, in part 13
- 13(12) Shell with a raised spire; blood (haemolymph) nearly colorless (the respiratory pigment is haemocyanin); animal without pseudobranch (false gill); mantle margin digitate or lobed Family PHYSIDAE (page 253)
- Shell discoidal, with a sunken spire (Figs. 704, 777) (in some species the smaller (older) shell coils protrude on the umbilical side ("ultrasinistral" or pseudo-dextral shells)); blood (haemolymph) in nearly all species is red (contains haemoglobin); a pseudobranch (false gill) is situated near the pneumostome or anus (Fig. 773a); mantle margin simple Family PLANORBIDAE (page 254)
- 14(11) Adult shell relatively large (up to 12 mm in length), apex nearly central, not distinctly to the right or left of the median line; animal dextral. Pacific drainage. Superfamily **Lymnaeioidea**, in part Family LYMNAEIDAE, in part (page 247)
- Adult shell smaller (7 mm or less in length), apex may be nearly central but often to the right or left of the median line; animal dextral or sinistral 15
- 15(14) Animal and shell dextral (Fig. 755a). Several lakes in the Rocky Mountains, northeastern Ontario and northcentral Quebec. Superfamily **Acroloxoidea** Family ACROLOXIDAE (page 247)

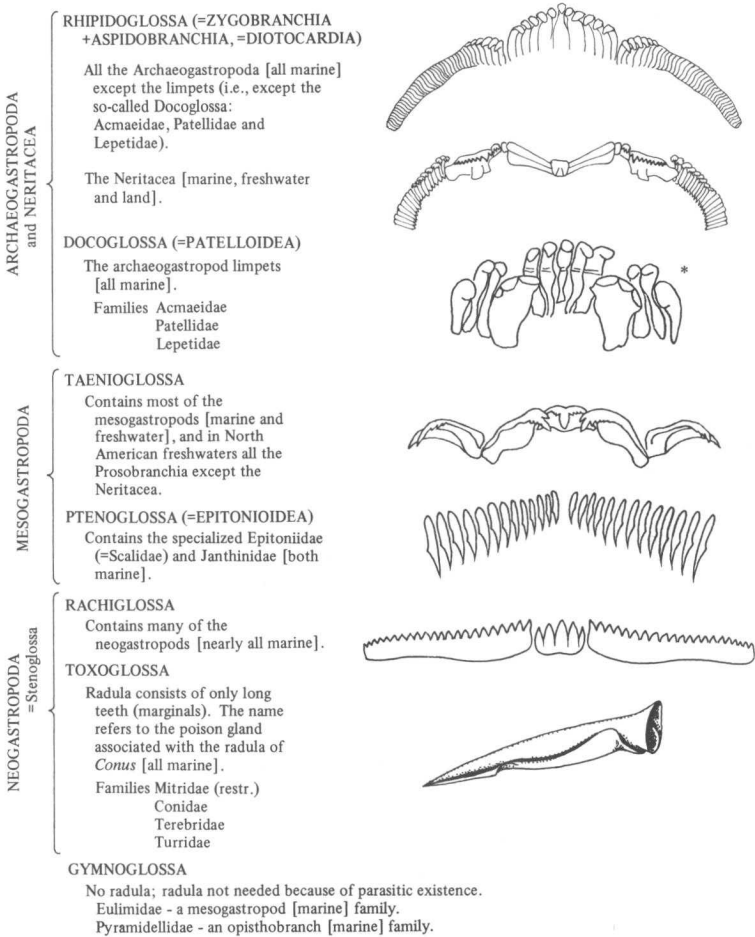
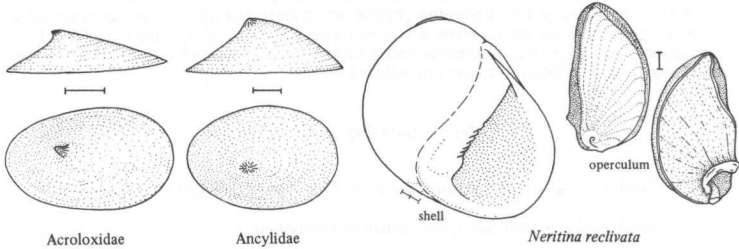


FIG. 782. Prosobranch snail classification based on radulae. The Prosobranchia have been divided in the past into a number of groups which take their names from the prevalent type of radulae they possess. This classification generally separates assemblages that are also distinct in their soft anatomy, but not always. North American freshwater prosobranchs possess only the rhipidoglossate (in the Neritidae) and the taenioglossate (in the other prosobranch families) types of radulae. [*Figure after Thiele (1929).]

Animal and shell sinistral (Fig. 755b). Generally distributed throughout North America. Superfamily Ancyloidea, in part Family ANCYLIDAE (page 261)



FAMILY NERITIDAE

The Neritidae¹ are largely marine and are well represented throughout the world, especially in tropical and subtropical regions. There has been a tendency for various lineages of neritids to invade estuarine habitats, and freshwater and terrestrial ones as well. Only one species occurs in the United States, *Neritina reactivata* (Say) (Figs. 21, 22). It is found from Florida to Mississippi. Dall (1885) named a subspecies (*palmae*) from near Palma Sola, Florida, and Pilsbry (1931) named a subspecies (*sphaera*) from Ojus, Florida. Both of these may be simply "forms" of *N. reactivata*.

The shells of neritids are usually subglobose or hemispherical, have few whorls, very reduced spires and very large body whorls. These characteristics, together with the generally thickened shell with heavily calloused and expanded parietal apertural margin, produce a rather typical shape, referred to as *neritiform* (Burch, 1968a) or *neritiniform*. The shell is generally smooth, often polished, and its columellar margin is toothed. The operculum (Fig. 22) is paucispiral, calcified, and contains a pair of projections, or apophyses, on the inner columellar side.

The shell of *Neritina reactivata palmae* Dall is "quite small [maximum length 1 cm], . . . black, with a cerous labrum, but the light zigzag lines, characteristic of some color varieties of *reactivata*, [are] beautifully clear by transmitted light" (Dall, 1885).

The shell of *Neritina reactivata sphaera* Pilsbry "is less elevated than *N. reactivata*, the spire extremely short, rising very little, the last whorl strongly convex above the periphery, not flattened and sloping as in *reactivata*. Color grape green, densely marked with fine black lines and with a black line following the suture, as in *reactivata*" (Pilsbry, 1931).

FAMILY VALVATIDAE*

The Valvatidae comprise a total of about 11 extant species inhabiting permanent standing and flowing fresh waters in the Northern Hemisphere. Except for *Borysthenea naticina* (Menke) of the Danube River drainage in eastern Europe, the family is represented by species of the genus *Valvata* Müller. The animals of *Valvata* are oviparous hermaphrodites. A single bipectinate gill is directed to the left, and a pallial tentacle occurs on the right side of the mantle cavity (Fig. 781).

The shells of North American *Valvata* are comparatively small (diameter up to 5 mm), have up to 4½ whorls, are dextral, and vary in form from discoid to high-turbinate. The nuclear whorls possess both axial and spiral sculpture; the rest of the shell contains lamellate to obsolete axial sculpture and is either spirally angulated, carinated or smooth. Several species are polymorphic in shell form and sculpture. The operculum is corneous, thin, flattened but slightly concave, circular in outline and multispiral (Fig. 780a).

Shell features are used to identify North American species of *Valvata*, several of which are polymorphic. For example, the "kinds" of *V. tricarinata* s.lat. are characterized by differing numbers and locations of spiral carinae or angulations. A single population usually contains several of these variants, which have often been treated taxonomically as subspecies. However, these variants are neither geographical races nor environmental forms (ecophenotypes), and they are treated as morphs here. *V. lewisi* morph *ontarioensis* (Fig. 27), which often comprises monomorphic populations, does

¹Superscript numbers throughout the text refer to corresponding comments under Supplemental Notes, which appear on pp. 268-283.

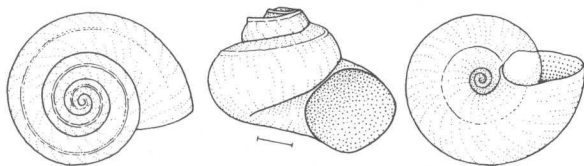
*From Heard (1982).¹⁰⁰

have a distinctive range, but it is called a morph because of its peculiar shell form. The nature of the variation in some other species is not understood at this time, and several variants are thus treated as possible forms.

The extensive polymorphism in some species has not precluded the construction of a dichotomous key comprised of two alternative choices per couplet, but has in four places provided for a more convenient choice among three alternatives (see "couplets" 2, 3, 5 and 8, below). Extremely rare, atypical variations (e.g., disjunctly coiled *Valvata sincera* s.str. and *V. tricarinata* s.str., and also tetracarinate *V. tricarinata* s.str.) are not included here.

Identification Key for the Valvatidae

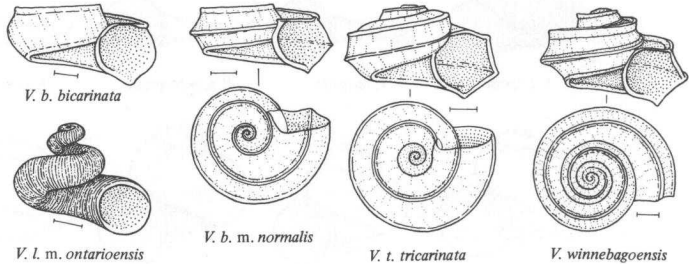
- 1 Shell with one to three postnuclear spiral carinae or angulations 2
- Shell lacking postnuclear spiral carinae or angulations 9
- 2(1) Shell with one spiral carina or angulation 3
- Shell with two spiral carinae or angulations 5
- Shell with three spiral carinae or angulations 8
- 3(2) Carina or angulation in dorsal location on the body whorl 4
- Carina or angulation in peripheral location on the body whorl. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *mediocarinata* F.C. Baker
- Carina or angulation in ventral location on the body whorl. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *infracarinata* Vanatta
- 4(3) Angulation incomplete, becoming obsolete toward the outer lip of the aperture (Fig. 34). Idaho and Utah *Valvata utahensis utahensis* Call



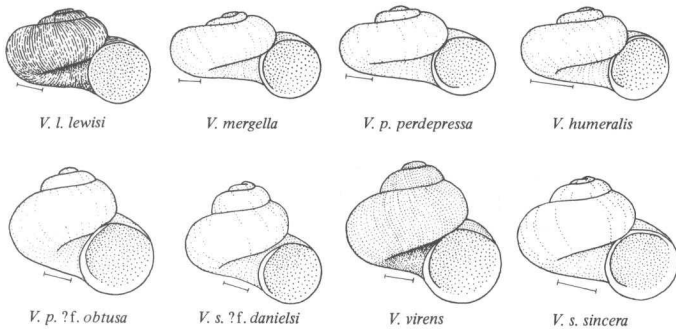
V. u. utahensis

- Carina or angulation complete, continuing to the outer lip of the aperture. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *unicarinata* DeKay
- 5(2) Carinae or angulations in dorsal and peripheral locations on the body whorl. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *basalis* Vanatta
- Carinae or angulations in peripheral and ventral locations on the body whorl. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *bakeri* Fluck
- Carinae or angulations in dorsal and ventral locations on the body whorl 6

- 6(5) Shoulder on the body whorl sloping upward from the dorsal carina or angulation to the suture 7
- Shoulder on the body whorl sloping downward from the dorsal carina to the suture (Fig. 23). Discontinuously distributed in eastern United States from New Jersey south to Alabama and west to Iowa *Valvata bicarinata bicarinata* Lea
- 7(6) Dorsal angulation incomplete, becoming obsolete on the body whorl. Idaho and Utah *Valvata utahensis* morph *horati* Baily & Baily
- Dorsal carina or angulation complete, continuing to the outer lip of the aperture. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *perconfusa* Walker
- 8(2) Shoulder of the body whorl sloping downward from the dorsal carina to the suture (Fig. 24). Discontinuously distributed in eastern United States from New Jersey south to Alabama and west to Iowa *Valvata bicarinata* morph *normalis* Walker
- Shoulder of the body whorl sloping upward from the dorsal carina or angulation to the suture (Fig. 33). Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata tricarinata* (Say)
- Shoulder of the body whorl sloping upward from the dorsal carina nearly to the suture, then turning downward (Fig. 36). Michigan, Minnesota and Wisconsin *Valvata winnebagoensis* F.C. Baker
- 9(1) Shell partly uncoiled with the body whorl broadly separated from the penultimate whorl (Fig. 27). Ontario in the region north of Lake Superior drained by the headwaters of the Attawapiskat, Albany and Severn river systems *Valvata lewisi* morph *ontarioensis* F.C. Baker
- Shell not disjunctly coiled 10
- 10(9) Shell of discoid shape. Lakes Erie, Huron, Michigan and Ontario *Valvata perdepressa* ?form *walkeri* F.C. Baker
- Shell with spire elevated above the body whorl 11
- 11(10) Shoulder of the body whorl flattened, sloping slightly upward toward the suture; often with a very faint angulation in dorsal location (and rarely also in peripheral locations). Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia *Valvata tricarinata* morph *simplex* Gould
- Body whorl evenly convex, not flattened above (or elsewhere) 12



- 12(11) Shell depressed-turbinate, spire but little elevated 13
 Shell high-turbinate or subconical, spire markedly elevated 16
- 13(12) Shell diameter exceeding 5 mm 14
 Shell diameter less than 5 mm 15
- 14(13) Axial striae lamellate; luster of shell dull (Fig. 26). Southern Canada from
 Quebec west to British Columbia, and northern United States from New
 York west to Minnesota *Valvata lewisi lewisi* Currier
 Axial striae obsolete; shell with a high gloss (Fig. 28). Alaska to Washington
 state *Valvata mergella* Westerlund
- 15(13) Color of the apical whorls of the shell usually dull purple, or violet or pink;
 luster of shell dull (Fig. 29). Lakes Erie, Huron, Michigan and Ontario
 *Valvata perdepressa perdepressa* Walker
 Color of the apical whorls of the shell pale green to white; shell glossy (Fig.
 25). Montana south to Colorado, west to British Columbia and California
 and south into Mexico *Valvata humeralis* Say
- 16(12) Shell high-turbinate 17
 Shell subconical 19
- 17(16) Apex of shell flattened, appearing truncated (Fig. 30). Lower Great Lakes
 *Valvata piscinalis* ?form *obtusa* Draparnaud
 Apex of shell acute 18
- 18(17) Shell color pale green; shell diameter greater than 5 mm (Fig. 32). Eastern
 Canada and north central United States *Valvata sincera* ?form *danielsi* Walker
 Shell color dark to often brilliant green; shell diameter less than 5 mm (Fig.
 35). California, Nevada and Oregon *Valvata virens* Tryon
- 19(16) Axial striae lamellate. Quebec and Maine west to Ontario and Minnesota
 *Valvata sincera nylanderi* Dall
 Axial striae fine (Fig. 31). Maine west to Alberta, and south to South Dakota
 and Illinois *Valvata sincera sincera* Say



FAMILY VIVIPARIDAE*

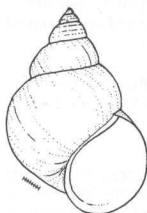
The Viviparidae are nearly world-wide in distribution and in North America occur throughout the eastern United States and Canada. *Campeloma*, *Lioplax* and *Tulotoma* are endemic to (i.e., restricted to) North America. *Viviparus* has a Holarctic distribution, and *Cipangopaludina* is an Asian genus. *Campeloma*, *Lioplax* and *Viviparus* are relatively common and have wide distributions. *Tulotoma* is confined to the Coosa-Alabama river system in Alabama and is rare, perhaps now nearly extinct. The two introduced species of the Asian *Cipangopaludina* have rather wide although sporadic distributions in the United States.

The Viviparidae are all "live-bearers", i.e., are ovoviviparous, giving birth to young crawling snails, rather than laying eggs that hatch in the external environment. It is this reproductive trait which has provided the family with its name.

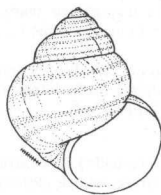
The sexes are separate in the Viviparidae, the males being readily distinguishable by their modified right tentacle, which serves as a copulatory organ. This modified tentacle in the males is shorter and thicker than the left tentacle or either of the bilaterally symmetrical tentacles of the females. Some populations of *Campeloma* are parthenogenetic, consisting entirely of females.

Identification Key for the Viviparidae

- 1 Shell large, adults over 35 mm and up to 50 mm in length; shell relatively thin; whorls not shouldered. Genus *Cipangopaludina* 2
- Shell medium to large, generally less than 35 mm in length, but if large, the shell is thick and ponderous, and the whorls are generally shouldered 3
- 2(1) Shell with acute spire and usually with spiral angulations or low carinae on the whorls; not malleated (Fig. 53). Sporadically but widely distributed in the United States *Cipangopaludina japonica* (Martens)
- Shell with obtuse spire and without spiral angulations or low carinae; generally with surface malleations (Fig. 52). Sporadically but widely distributed in the United States *Cipangopaludina chinensis malleata* (Reeve)



C. japonica



C. c. malleata

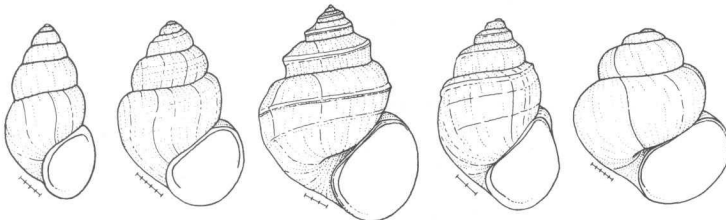


T. magnifica

- 3(1) Shell with or without one or two spiral rows of nodules; outer margin of shell aperture concave (when observed from an angle parallel to the plane of the aperture) and its oblique margin to the shell axis quite exaggerated (Fig. 783); columellar margin of operculum reflected inward (Figs. 44, 45). Restricted to the Coosa-Alabama river system in Alabama *Tulotoma magnifica* (Conrad)³
- Shell without rows of spiral nodules; outer margin of shell aperture not concave (when observed from an angle parallel to the plane of the aperture) and its oblique angle to the shell axis not exaggerated (Fig. 783); columellar margin of operculum not reflected inward 4
- 4(3) Operculum concentric, but with spiral nucleus; whorls commonly with a median spiral angle or low ridge or a spiral subsutural sulcus. Genus *Lioplax* 5

*From Burch & Vail (1982).

- Operculum entirely concentric, including its nucleus; whorls without spiral angles, ridges or sulci 10
- 5(4) Shell attenuate, compressed; whorls rarely angular (Fig. 43). Coosa-Alabama-Tombigbee river system in Georgia and Alabama, and Tensas River, Alabama *Lioplax cyclostomaformis* (Lea)
- Shell subglobose, not attenuate and compressed; at least some of the whorls are generally angular or with a spiral subsutural sulcus 6
- 6(5) Shell large for the genus, adults up to 30 mm in length, dark olive-green to nearly black (Fig. 67). Chipola River, Florida *Lioplax pilsbryi pilsbryi* Walker
- Shell smaller, adults less than 25 mm in length and seldom more than 20 mm, horn to pale or occasionally dark olive-green in color 7
- 7(6) Atlantic drainage and Gulf drainage 8
- Mississippi drainage (Minnesota to Arkansas and Ohio)⁷ *Lioplax sulculosa* (Menke)
- 8(7) Atlantic drainage (New York to South Carolina)⁷ (Fig. 68) *Lioplax subcarinata* (Say)
- Gulf drainage 9
- 9(8) Whorls generally with a spiral subsutural sulcus, which tends to constrict the posterior aperture (Fig. 69). Ochlockonee and Yellow river systems, Florida and Alabama *Lioplax talquinensis* Vail
- Whorls without a spiral subsutural sulcus; aperture rounded posteriorly. Choctawhatchee, Escambia, Flint and Suwannee river systems, Florida and Georgia *Lioplax pilsbryi choctawhatchensis* Vanatta⁶
- 10(4) Shell with or without spiral color bands; width and length of aperture usually nearly equal, making it round, or nearly so; lateral and marginal radular teeth with prominent cusps. Genus *Viviparus* 11
- Shell without spiral color bands; length of aperture noticeably greater than width; lateral and marginal teeth simple with very fine, difficult-to-distinguish cusps. Genus *Campeloma*⁴ 13
- 11(10) Shell dark yellowish-green to (usually) dark olivaceous-green, without spiral color bands; shell broadly ovate, whorls globosely rounded, spire obtuse (Fig. 48). Minnesota south to Louisiana, mainly in the Mississippi river drainage; Gulf drainage from Texas to Alabama; Atlantic drainage in Georgia and South Carolina *Viviparus intertextus* (Say)

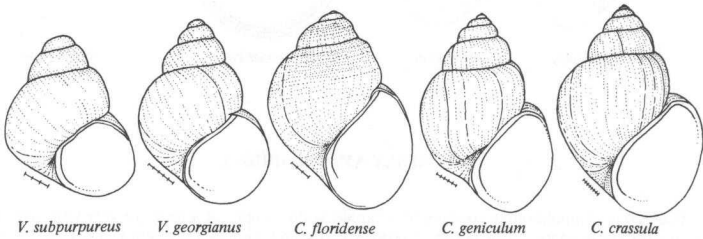


L. cyclostomaformis *L. p. pilsbryi* *L. subcarinata* *L. talquinensis* *V. intertextus*

Shell pale olivaceous-green to olivaceous-brown, with or without spiral color bands, ovate but not broadly so, whorls flattened to well rounded but not globose rounded, spire relatively acute 12

- 12(11) Shell yellowish-brown or olivaceous-brown; color bands, when present, three in number; shell rather heavy; whorls often flat-sided (Figs. 49-51). Mississippi river drainage from Iowa to Louisiana; Gulf drainage in Texas and Mississippi *Viviparus subpurpureus* (Say)

Shell yellowish-green or olivaceous-green; color bands, when present, usually four in number; shell relatively thin, but sturdy; whorls usually well rounded (Figs. 46, 47). Alabama, Florida and Georgia north to Illinois and Indiana; northern states from Wisconsin to New England and Quebec *Viviparus georgianus* (Lea)



- 13(10) Inside of shell aperture deep reddish-brown or brown (Fig. 62); shell of newborn young uniformly dark brown. Eastern Florida *Campeloma floridense* Call
- Inside of shell aperture white, bluish or faintly pinkish; shell of newborn young opaque white or light translucent beige 14

- 14(13) Shell whorls generally with angled shoulders. Southern in distribution 15
- Shell whorls unshouldered or with rounded shoulders 16

- 15(14) Shell broadly ovate (Figs. 63, 64). Northwestern Florida, southwestern Georgia and southeastern Alabama *Campeloma geniculum* (Conrad)
- Shell narrowly ovate (Fig. 41). Atlantic drainage from North Carolina to Georgia *Campeloma limum* (Anthony)

- 16(14) Shell narrow, relatively thin, generally with prominent raised spiral lines (Fig. 56). Northern Alabama *Campeloma decampi* Binney
- Shell broader, relatively thin to thick and ponderous, spiral lines on adult shells when present are not prominent 17

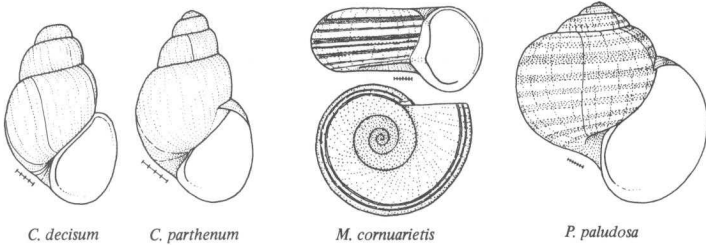
- 17(16) Spire typically depressed and obtuse, body whorl large and often cylindrical (Figs. 40, 66). Alabama-Coosa drainage *Campeloma regulare* (Lea)*
- Spire elongate, seldom depressed, body whorl rounded 18

- 18(17) Shell large, heavy and ponderous (Figs. 42, 54, 55). Midwestern United States in the Great Lakes-St. Lawrence and Mississippi drainages *Campeloma crassula* Rafinesque
- Shell medium or a little larger, relatively thin to strong, but not very large or heavy and ponderous 19

**Campeloma coarctatum* (pp. 86, 87, 91) is a synonym of *C. regulare*.

19(18) Widely distributed, from southern Canada to Texas, Louisiana, Mississippi, Alabama, northern Georgia and Virginia. Figs. 37-39, 57-61 *Campeloma decisum* (Say)

Ochlockonee river drainage in southern Georgia and northern Florida. Fig. 65 *Campeloma parthenum* Vail



FAMILY AMPULLARIIDAE

The family Ampullariidae contains the "apple snails", many of which are very large and globose or subglobose in shape. The family is represented world-wide in the tropics. They are mostly amphibious snails which can survive for long periods out of water, including during the dry season when they burrow into the mud. Their mantle cavity is divided into two compartments, the left one containing a gill for aquatic respiration and the right compartment serving as a lung for air-breathing. From the left side a long siphon extends, by which the snail can admit air to the pulmonary chamber when immersed.

Pomacea paludosa (Say) is the largest freshwater gastropod found in North America, its height and width commonly exceeding 60 mm. Its color is dark to light olive green with a dozen or more reddish or brownish spiral bands. The operculum is concentric, thin and corneous. Pilsbry (1899e) gave the name *miamiensis* to a small, reddish-brown population from the vicinity of Miami, Florida, but according to Clench & Turner (1956) this is a synonym of *paludosa* Say. A Brazilian species, *P. bridgesi* (Reeve), recently has been introduced to Florida (Clench, 1966).

Marisa cornuarietis is also a large snail, and its shell also has an olive color with spiral reddish or brown bands. However, the shell is peculiar in that its spire is sunken below the body whorl and the umbilicus is very wide.

Identification Key for the Ampullariidae

- 1 Shell subglobose in shape. Alabama, Florida and Georgia. Genus *Pomacea* 2
- Shell discoidal or planispiral in shape (Figs. 70, 71). Southern Florida
 *Marisa cornuarietis* (Linnaeus)
- 2(1) Shell large, often up to 60 mm or more in length, whorls with only weak or without shoulders, body whorl very wide, spire depressed, aperture narrowly oval (Figs. 72, 73). Alabama, Florida and Georgia *Pomacea paludosa* (Say)
- Shell smaller, less than 50 mm in length, whorls more strongly shouldered, body whorl narrower, spire projecting and turreted, aperture more broadly oval. Florida *Pomacea bridgesi* (Reeve)

FAMILY BITHYNIIDAE

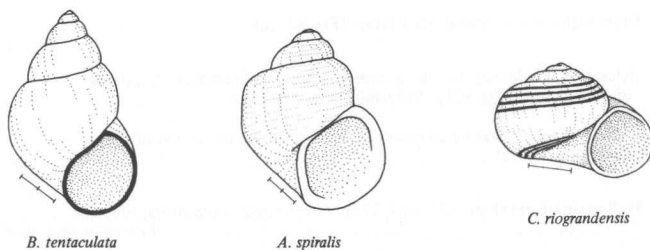
The Bithyniidae are found throughout Europe and Asia, and in Africa, Indonesia, the Philippines and Australia. The European *Bithynia tentaculata* (Linnaeus) was introduced long ago by man into

North America and has spread widely. However, *B. tentaculata* has been reported in Pleistocene deposits in Chicago, so it may already have been living in the Western Hemisphere when Europeans first arrived. F. C. Baker (1928c) gave the varietal name *magnalacustris* to the supposedly North American form, which he considered to have "more rounded whorls with deeper sutures and an apex that stands well above the second whorl."

The Bithyniidae traditionally have been included in the family Hydrobiidae. However, Taylor (1966b) has recently argued that the bithyniids should be separated from the hydrobiids and transferred to the Viviparoidea (Ampullarioidea). Viviparoid characters of *Bithynia* are its size (adult shells are more than 10 mm long), calcareous operculum with paucispiral nucleus and concentric edges, nuchal lobes of the head-foot, relatively long, flexible and acute tentacles, yellow and orange skin pigment granules, spirally constructed fecal pellets, use of the ctenidium in food gathering, palial innervation of the penis, and dimorphic sperm.

Bithynia tentaculata (Linnaeus) has a broadly conic or narrowly ovate shell (Fig. 74). It is larger than any of the Hydrobiidae, the shells of many adults measuring more than 12 mm in length. The color of the shell ranges from yellowish to greenish, and is covered by a thin brownish periostracum. Surface sculpture consists of fine transverse growth lines and fine incised spiral lines. In contrast to most hydrobiids, the concentric operculum just fits the outer aperture, and does not go past the peritreme when the animal withdraws its head-foot into the shell.

Bithynia tentaculata occurs in the Great Lakes region from Albany, New York, to Winnebago Lake, Wisconsin, and in the Potomac River in Virginia and Maryland (Pilsbry, 1932c; Marshall, 1933).



FAMILY MICROMELANIIDAE

The Micromelaniidae are a family of hydrobiid-like snails which lack basal denticles on their central radular teeth. They are found mainly in the ancient lakes Baical (Siberia) and Ohrid (Macedonia and Albania), the Caspian Sea, southeastern Europe, Asia Minor and eastern India. *Emmerciella* occurs in Mexico, and the monotypic *Antroselates* occurs in caves in southern Indiana and west-central Kentucky. The latter was transferred to the Micromelaniidae by Taylor (1966b) because of its radular characters.

Antroselates spiralis Hubricht has a small, solid, globosely conic, turbinate, narrowly perforate or rimate shell (Fig. 108). Its sculpture consists of numerous spiral periostracal threads. The operculum is paucispiral and hyaline. The animal is white. Males have a simple, long, slender, tapering verge. The central and lateral teeth have many small cusps of uniform size (Hubricht, 1963b).

FAMILY HYDROBIIDAE

The Hydrobiidae are one of the most common and widely distributed gastropod families, occurring in temperate, subtropical and tropical regions throughout much of the world. The family is a large one, comprising some 103 genera (Taylor & Sohl, 1962). Most hydrobiid species live in fresh water, although some are associated with brackish water. Only the North American freshwater species are dealt with in this manual.

Shells of hydrobiids are small (many are minute), generally elongate, dextral (Fig. 774b), nearly always drab and unicolored, and generally have relatively few whorls. The shells of most species are plain, but some species have prominent surface sculpture, and one species in North America (north of Mexico), *Cochliopina riograndensis* (Pilsbry & Ferriss), has spiral color bands (Fig. 140). The shell aperture is closed by an operculum, which is generally paucispiral (Fig. 780b), but some species have

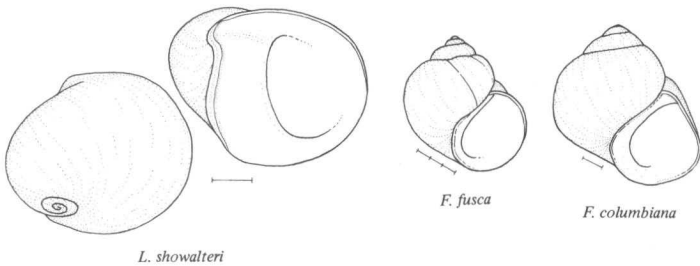
round, multispiral opercula (Fig. 780a). Like most North American freshwater prosobranch snails, the sexes are separate in the Hydrobiidae, and the shells of some genera exhibit sexual dimorphism.

Because of the similarity of the shells of many species occurring in different genera and subfamilies, reliance must be placed on anatomical characters, especially those of the verge (male copulatory organ), in making identifications and for assigning species to genera and genera to subfamilies (Fig. 82). Since the anatomical characteristics of some species (and even genera) are not known, their taxonomic placement in this manual is presumptive. Further studies may change their systematic status.

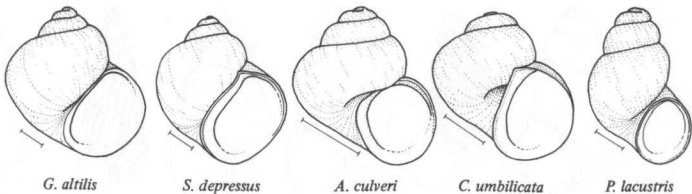
Since so few hydrobiids have been studied anatomically in any great detail, a subfamilial classification based entirely on the male verge may be proven eventually to be inadequate or inaccurate. However, from a standpoint of practicality for presenting a workable classification for this identification manual, the hydrobiid genera are grouped according to the major characters of the verges of their species and these groups assigned to previously named subfamilies. While this possibly may not represent the true systematic and phylogenetic relationships of the various genera, it is a useful system at present.

Identification Key for the Hydrobiidae

- 1 Males with single-ducted verges (Fig. 82a,b,c) 2
 - Males with two- or three-ducted verges (Fig. 82d,e) 52
- 2(1) Males with simple verges, lacking accessory lobes and glandular apical and subapical crests (Fig. 82a). Subfamily Lithoglyphinae 3
 - Males with verges bearing accessory lobes or glandular apical and subapical crests (Fig. 82b,c) 13
- 3(2) Shell neritiform (Figs. 192, 193, 779). Cahaba and Coosa rivers, Alabama
 - *Lepyrium showalteri* (Lea)
 - Shell conical, subglobose or heliciform 4
- 4(3) Shell depressed, heliciform, with spiral brown bands (Fig. 140). Texas
 - *Cochliopina riograndensis* (Pilsbry & Ferriss)
 - Shell conical to subglobose, without spiral color bands 5
- 5(4) Shell imperforate or narrowly perforate 6
 - Shell umbilicate 11
- 6(5) Western in distribution, in the Pacific drainage (Figs. 141, 142, 145-148, 152) Genus *Fluminicola*⁶³
 - Eastern in distribution, in the Mississippi, Gulf and Atlantic drainages 7



- 7(6) Shell generally thick and solid, columella thickened. Mississippi and Gulf of Mexico drainage (except for *S. pennsylvanicus* and *S. virginicus*). Genus *Somatogyrus* 8
- Shell rather thin, columella not thickened (Fig. 191). Atlantic drainage from New Jersey to South Carolina *Gillia altilis* (Lea)
- 8(7) Shell with spirally striate apical whorls. Subgenus *Walkerilla*⁶⁴ 9
- Shell without spirally striate apical whorls (Figs. 149, 151, 153-185, 194, 195). Widely distributed in eastern North America in the Midwest and South Subgenus *Somatogyrus* s.s.⁶⁵
- 9(8) Spire very depressed (Figs. 150, 186, 196). Catawba and Coosa rivers, Alabama *Somatogyrus* (*Walkerilla*) *coosaensis* Walker
- Spire not depressed. Georgia and Virginia 10
- 10(9) Shell perforate (Figs. 89, 197, 201). Broad River, Georgia *Somatogyrus* (*Walkerilla*) *tenax* Thompson
- Shell imperforate (Fig. 187). Rapidan River, Virginia *Somatogyrus* (*Walkerilla*) *virginicus* Walker
- 11(5) Shell small (less than 2.5 mm in length), aperture round, columella thin (Fig. 138). Missouri *Antrobia culveri* Hubricht
- Shell larger (3.0-3.5 mm in length), aperture ovate, columella thickened. Alabama. Genus *Clappia* 12
- 12(11) Shell aperture more elongate, spire less attenuate, umbilicus larger, animal black (Figs. 139, 143, 144). Coosa River, Alabama *Clappia umbilicata* (Walker)
- Shell aperture broader, less elongate, spire relatively attenuate, umbilicus smaller, animal white. Cahaba River, Alabama *Clappia cahabensis* Clench
- 13(2) Males with verges bearing accessory lobes (Fig. 82b). Subfamily Hydrobiinae⁶⁶ 14
- Males with verges bearing glandular apical crests (Fig. 82c). Subfamily Nymphophilinae 27
- 14(13) Top of shell spire truncated. The first several spire whorls coiled in the same plane (Figs. 107, 129-131). Widely distributed in eastern North America *Probythinella lacustris* (F. C. Baker)
- Top of shell spire not truncated, the first several spire whorls coiled in a descending spiral 15



15(14) Northern in distribution (Fig. 76). Lake Michigan, Wisconsin *Hoyia sheldoni* (Pilsbry)⁶⁷
 16
 Southern and western in distribution 16

16(15) Western in distribution. Texas, Arizona, Nevada and California. Genus
*Tryonia*⁶⁸ 17
 Southern in distribution. Georgia and Florida 22

17(16) Found in Texas 18
 Further western in distribution, Arizona, Nevada and California 20

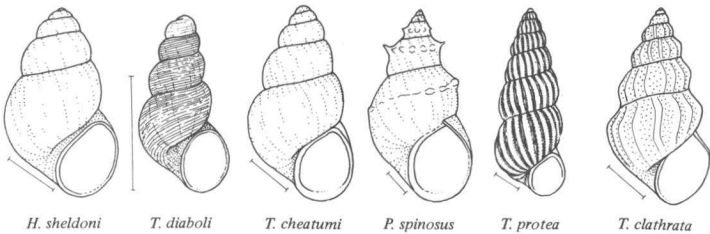
18(17) Shell minute, that of adults with four to five whorls less than 1.5 mm in
 shell length; umbilicus small but distinct (Fig. 135). Texas
 *Tryonia diaboli* (Pilsbry & Ferriss)
 19
 Shell larger, that of adults with about five whorls more than 3 mm;
 imperforate 19

19(18) Shell surface smooth, except for fine transverse growth lines (Figs. 127, 128,
 133). Texas *Tryonia cheatumi* (Pilsbry)
 20
 Shell surface sculptured with revolving striae or carinae which are commonly
 modified into spines (Fig. 126). Texas *Pyrgophorus spinosus* (Call & Pilsbry)

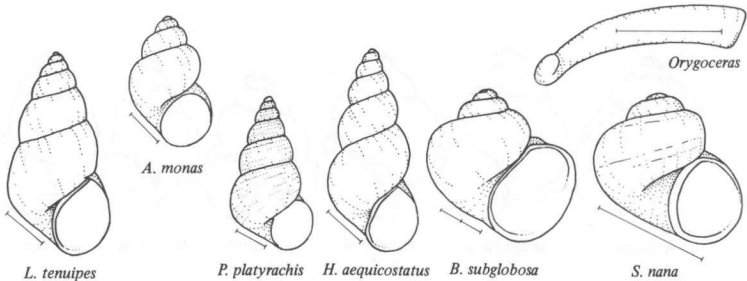
20(17) Shell surface smooth, except for fine transverse growth lines. California
 (in brackish water), Arizona *Tryonia imitator* (Pilsbry)
 21
 Shell surface sculptured with transverse ribs and sometimes with spiral
 lirae also 21

21(20) Shell narrowly conic, ribbed, with or without lirae, ribs not angular except
 where crossed by lirae (Figs. 136, 137). California (subfossil), Arizona
 *Tryonia protea* (Gould)
 22
 Shell elongately conic, ribbed, but without lirae, ribs angular (Fig. 134).
 Nevada *Tryonia clathrata* Stimpson

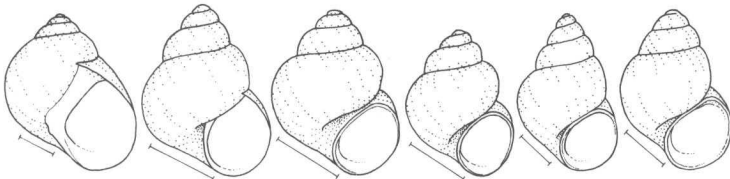
22(16) Periphery of whorls flattened, sutures shallow; verge with 7-50 papillae
 along its right margin, 1-4 papillae along the distal third of the left margin
 and with or without papillae about the base. Genus *Littoridinops* 23
 Periphery of whorls inflated, sutures impressed; verge with 1-7 papillae
 along the right margin and usually with one or two papillae on the left
 margin either at the base or distal end 24



- 23(22) Verge with a single row of 7-15 papillae along the right margin and 3-10 papillae around the base (Figs. 79, 87, 106, 125). Atlantic drainage of Florida and Georgia *Littoridinops tenuipes* Couper
- Verge with 17-50 papillae arranged in three to five rows along the right margin, and no papillae at the base (Figs. 80, 85, 86, 105). Florida
 *Littoridinops monroensis* (Frauenfeld)
- 24(22) Shell sculptured with fine spiral lines; verge with 1-7 papillae along the right margin and papillae along the left margin 25
- Shell without fine spiral sculpturing; verge with 0-6 papillae along the right margin, no other papillae present (Figs. 75, 95-103, 109-122). Florida Genus *Aphaostracon*⁶⁹
- 25(24) Spiral sculpturing consisting of raised threads; verge with 3-7 papillae along the right margin, left margin usually with a papilla near the base and 1-4 papillae on a projection near the distal end (Figs. 88, 132). Southern Florida *Pyrgophorus platyrachis* Thompson
- Spiral sculpturing consisting of fine incised striations; verge with one large papilla on the right margin near the base, and one or two smaller papillae on the left margin near the distal end. Genus *Hyalopyrgus* 26
- 26(25) Shell elongated conical, rimate or imperforate; verge with two papillae and an apical protrusion on the left margin (Figs. 77, 78, 83, 84, 104). Florida
 *Hyalopyrgus aequicostatus* (Pilsbry)
- Shell ovate, openly umbilicate; verge with one papilla on the left margin (Figs. 123, 124). Central Florida *Hyalopyrgus brevissimus* (Pilsbry)
- 27(13) Shell almost completely uncoiled (Fig. 248). Texas Genus *Orygoceras*
- Shell coiled 28
- 28(27) Shell relatively large (that of adults to nearly 10 mm in length), subglobose (Figs. 188, 198, 202). Widely distributed in central United States from the Great Lakes to Alabama and Arkansas *Birgella subglobosa* (Say)
- Shell smaller (that of adults generally less than 5 mm in length), globosely conic to broadly conic and rarely elongately conic, or subglobose, ovate or turbiniform 29
- 29(28) Shell turbiniform, minute (that of adults 1.2-1.4 mm long) (Figs. 265, 297). Alabama river system *Stiobia nana* Thompson
- Shell conic, subglobose or ovate 30

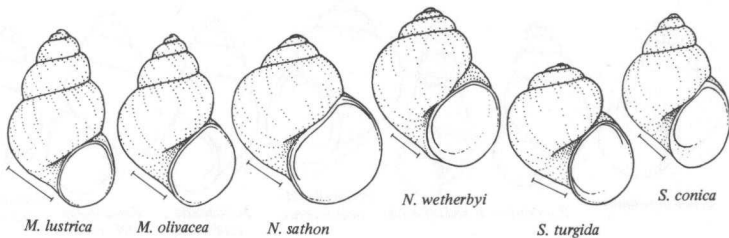


- 30(29) Verge with a relatively simple glandular pattern 31
 Verge with elaborate patterns of many glands 39
- 31(30) Shell elongate (conic or ovate); verge with a short terminal penis. Widely distributed in eastern North America. Genus *Marstonia*⁷⁰ 32
 Shell subglobose; verge with a long, slender flagellar penis (Figs. 91, 257, 262). Chipola river drainage, Florida⁷⁰ *Rhaphinema dacryon* Thompson
- 32(31) Shell minute, that of adults (with four or more whorls) less than 2.7 mm in length; verge with an elongate apical lobe, penis large and robust 33
 Shell larger, that of adults (with 4½ or more whorls) 3.5 mm long; verge with a squarish apical lobe, penis short and slender 35
- 33(32) Shell thin, fragile, transparent, conical, with an incomplete peristome across the parietal margin; verge with a single gland on the apical lobe (Figs. 214, 232). Ocmulgee river system, Georgia *Marstonia agarhecta* Thompson
 Shell thick, solid, nearly opaque, ovate-conical; peristome complete across the parietal margin; verge with two glands, one near the base and one on the apical lobe 34
- 34(33) Shell broadly ovate, 0.70-0.80 times as wide as high, whorls strongly shouldered, flattened at the shell periphery, umbilicus wide, suture descending in lateral profile (Figs. 217, 249). Ogeechee river system, Georgia *Marstonia halcyon* Thompson
 Shell ovately conical, 0.66-0.73 times as wide as high, whorls rounded, not strongly shouldered, umbilicus narrow, suture not descending to the aperture in lateral profile (Figs. 216, 234). Flint river system, Georgia *Marstonia castor* Thompson
- 35(32) Shell thick, solid, nearly opaque, umbilicus closed or narrowly rimate 36
 Shell thinner, transparent or translucent, openly umbilicate 37
- 36(35) Shell ovately conical in shape, spire convex in outline, outer lip straight in lateral profile, sutures shallow, whorls not shouldered; verge with two small glands on the apical lobe and a small raised gland near the base of the verge (Figs. 221, 253). Creeks in Limestone County, Alabama *Marstonia pachyta* Thompson
 Shell nearly conical, spire straight-sided, outer lip strongly curved in lateral profile, whorls shouldered, suture deep; verge with a single large gland on the apical lobe (Figs. 215, 233). Tennessee River, Alabama *Marstonia arga* Thompson

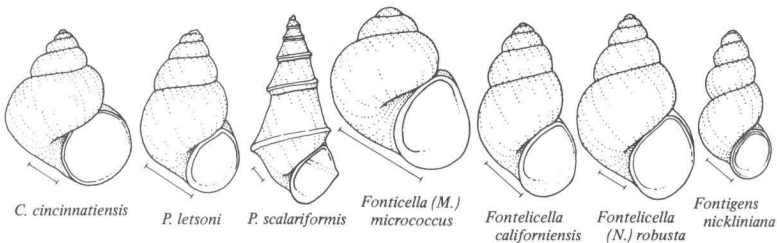


R. dacryon *M. agarhecta* *M. halcyon* *M. castor* *M. pachyta* *M. arga*

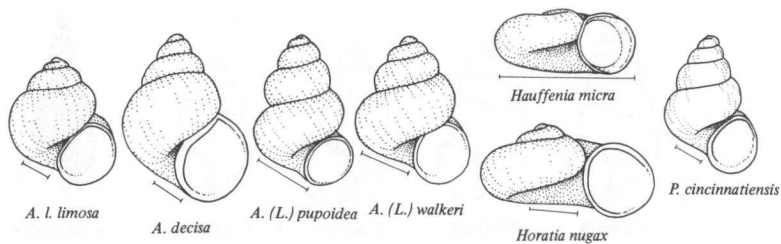
- 37(35) Shell sutures deep, whorls shouldered, outer lip arched slightly forward in lateral profile (Figs. 220, 252). Marion County, Tennessee *Marstonia ogmorphaphe* Thompson
- Shell sutures shallow, whorls not shouldered, outer lip straight in lateral profile 38
- 38(37) Northern in distribution: southern Canada, Maine west to Minnesota and Iowa (Figs. 218, 219, 245, 246, 250, 251) *Marstonia lustrica* (Pilsbry)
- Southern: Madison County, Alabama (Fig. 247) *Marstonia olivacea* (Pilsbry)
- 39(30) Shell subglobose or broadly ovate, imperforate. Alabama, Florida and Georgia. Genus *Notogillia* 40
- Shell conic or ovate, but if subglobose or broadly ovate then it is umbilicate 41
- 40(39) Shell subglobose, relatively small (that of adults is 4.0-4.5 mm in length), periostracum greyish white (Figs. 90, 254). Southcentral Georgia *Notogillia sathon* Thompson
- Shell broadly ovate, larger (that of adults is 4.5-7.5 mm in length), periostracum olivaceous-brown (Figs. 255, 260). Alabama, Florida and Georgia *Notogillia wetherbyi* (Dall)
- 41(39) Distribution east of the Continental Divide 42
- Distribution west of the Continental Divide 48
- 42(41) Penis relatively large, spatulate, and having a long narrow gland running along each margin from the base to near its tip. Georgia and Florida. Genus *Spilochlamys* 43
- Penis small, slender, conical 45
- 43(42) Shell subglobose, spire depressed (Fig. 259). Tributaries of the Ocmulgee River, Georgia *Spilochlamys turgida* Thompson
- Shell ovate, spire prominent. Florida 44
- 44(43) Shell solid, thick (Figs. 275, 276); apex of the accessory lobe of the verge without a terminal glandular crest (Fig. 264). St. Johns river drainage, Florida *Spilochlamys gravis* Thompson
- Shell thin or only moderately thick (Fig. 258); apex of the accessory lobe of the verge with an apical glandular crest (Figs. 92, 263). Gulf of Mexico drainage in northcentral Florida *Spilochlamys conica* Thompson



- 45(42) Shell elongately conical. Genus *Pyrgulopsis*, in part. Widely distributed 46
 Shell broadly conical, globosely conical or ovate. Widely distributed (Figs. 189, 190, 199, 200, 203-213, 222-228, 235, 236) Genus *Cincinnatia*⁷¹
- 46(45) Shell umbilicate (Fig. 261). Ontario and Michigan to New York
 *Pyrgulopsis letsoni* (Walker)
 Shell imperforate. Alabama and Arkansas 47
- 47(46) Whorls flat-sided, periphery angular or carinate (Fig. 273). Alabama
 *Pyrgulopsis scalariformis* (Wolf)
 Whorls rounded, periphery rounded. Arkansas *Pyrgulopsis ozarkensis* Hinkley
- 48(41) Shell elongately conical, whorls wholly or nearly flat-sided, or concave, usually angulate or carinate. Genus *Pyrgulopsis*, in part 49
 Shell conical, narrowly ovate to globosely conic, whorls rounded, not angulate or carinate. Genus *Fontlicella* 50
- 49(48) Periphery of body whorl concave (Fig. 274). Upper Klamath Lake, Oregon
 *Pyrgulopsis archimedis* S. S. Berry
 Periphery of body whorl flat-sided (Figs. 256, 270-272). Pyramid and Walker's lakes, Nevada *Pyrgulopsis nevadensis* (Stearns)
- 50(48) Shell conical or narrowly ovate 51
 Shell globosely conic, minute (that of adults is less than 2 mm in length) (Figs. 231, 244). Subgenus *Microamnicola*. California and Nevada
 *Fontlicella (Microamnicola) micrococcus* Pilsbry (in Stearns) 1893
- 51(50) Shell relatively small (that of adults is 5 mm or less in length); the terminal lobe of the verge is usually a little longer than the penis (Figs. 229, 237-239). California, Idaho, New Mexico, Oregon and Utah Subgenus *Fontlicella* s.s.⁷¹
 Shell relatively large (that of adults is up to 8 mm in length); terminal lobe of the verge is about twice as long as the penis (Figs. 230, 240-243). Idaho, Oregon and Wyoming Subgenus *Natricola*⁷¹
- 52(1) Males with two-ducted verges (Fig. 82d). Subfamily Amnicolinae 53
 Males with three-ducted verges (Fig. 82e). Subfamily Fontigentinae (Figs. 283, 310-315, 319). Widely distributed in eastern North America . . . Genus *Fontigenis*⁷¹



- 53(52) Shell ovate or turbinate to globosely conic. Widely distributed. Genus
Ammicola 54
- Shell discoidal or subdiscoidal. Texas (? also Alabama) 55
- 54(53) Nuclear whorl of shell relatively large (0.38-0.48 mm in diameter); mantle heavily mottled with black; penis and flagellum relatively stout (Figs. 93, 266-269, 277, 278, 284-291, 298-300). Widely distributed in eastern North America Subgenus *Ammicola* s.s.⁷²
- Nuclear whorl of shell small (0.29-0.36 mm in diameter); mantle diffusely shaded with pigment; penis and flagellum relatively slender and elongate (Figs. 94, 279-282, 292-296, 301-307, 309). Widely distributed in North America Subgenus *Lyogyrus*⁷²
- 55(53) Shell discoidal, spire hardly raised above the body whorl (Fig. 308). Texas
 *Hauffenia micra* (Pilsbry & Ferriss)⁷³
- Shell subdiscoidal, spire noticeably raised above the body whorl (Fig. 316).
 Texas *Horatia nugax* (Pilsbry & Ferriss)⁷³



FAMILY POMATIOPSIDAE

The Pomatiopsidae are represented in North America by six species, three in the east and three in California. Their general appearance is that of a hydrobioid, and in the past they frequently have been included in the Hydrobiidae as a subfamily (see Davis, 1967, for a review of familial classification). For the most recent diagnoses of the families Pomatiopsidae and Hydrobiidae, see Davis (1979).

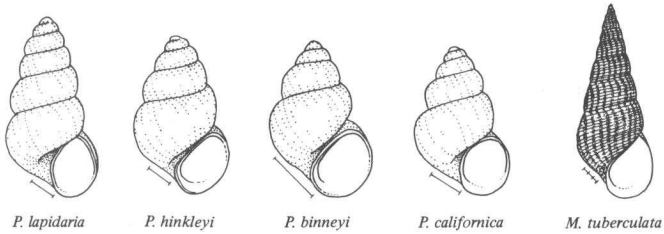
Because of their obvious close systematic relationship to the medically important Oriental genus *Oncomelania*, North American *Pomatiopsis*, especially *P. cincinnatiensis* (Lea) and *P. lapidaria* (Say), have received considerable attention.

The genus *Pomatiopsis* comprises a group of amphibious species which inhabit river banks or moist areas near streams. In contrast, the hydrobiids live in the water of springs, streams, pools and lakes.

Identification Key for the Pomatiopsidae

- 1 Eastern in distribution 2
- Restricted to California 4
- 2(1) Shell elongate, with relatively flattened whorls and oval aperture 3
- Shell more depressed, broadly conical, with rounded whorls and aperture (Fig. 323). Tennessee and southwestern Virginia to southern Michigan, Illinois and Iowa *Pomatiopsis cincinnatiensis* (Lea)

- 3(2) Spire more acute, body whorl proportionately smaller, aperture broadly oval, umbilicus wider, more open (Fig. 325). Widely distributed in the eastern United States, with occasional occurrences west to northern Texas and New Mexico *Pomatiopsis lapidaria* (Say)
- Spire more obtuse, body whorl proportionately larger, aperture narrowly oval, umbilicus nearly closed (Fig. 324). Found in several localities in Alabama, South Carolina and Tennessee *Pomatiopsis hinkleyi* Pilsbry²⁰
- 4(1) Shell quite small, that of adults with four to five whorls about 3 mm in length, light horn in color, imperforate (Fig. 321). Marin County, California *Pomatiopsis binneyi* Tryon
- Shell larger, that of adults more than 4 mm in length, brownish-olive or chestnut brown in color 5
- 5(4) Shell chestnut brown in color (Fig. 322). San Francisco area *Pomatiopsis californica* Pilsbry
- Shell brownish-olive in color. Northeastern California *Pomatiopsis chacei* Pilsbry



FAMILY THIARIDAE

The Thiaridae and the Pleuroceridae contain various genera with very similar shells, and because of this they were long considered to all belong to one and the same family, traditionally called the Melaniidae. The latter name is based on the genus *Melania* Lamarck 1799, a synonym of *Thiara* Röding 1798. Morrison (1954) used biological characters to separate the various melanoid/cerithioid families, and separated the Thiaridae and the Pleuroceridae as follows:

Thiaridae: Reproduction parthenogenetic, without males; brood pouch not uterine, but adventitious (subhaemocoelic) in the neck region, with opening on right side of neck.

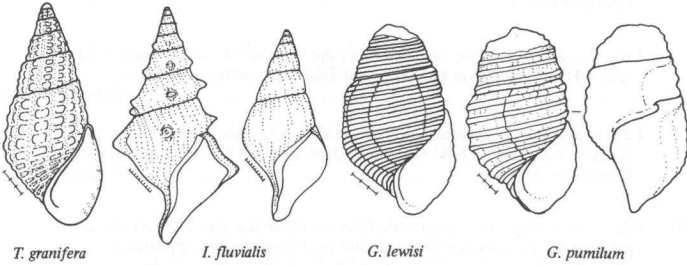
Pleuroceridae: Reproduction dioecious, with males present; females with egg-laying sinus on right side of foot; lays numerous eggs of small size.

A feature distinguishing *Thiara* and *Melanoidea* from the pleurocerids is their mantle edge, which in the thiarids has a number of fleshy protuberances or papillae. The mantle edge of the Pleuroceridae is smooth.

Identification Key for the Thiaridae

- 1 Shells with rounded whorls which are sculptured with spiral threads and grooves, and transverse lines which commonly develop into low costae; this type of sculpture sometimes produces a reticulate or nodular pattern where the spiral and transverse elements intersect (Fig. 327). Florida, Texas and Arizona *Melanoidea tuberculata* (Müller)

Shell with flattened whorls, especially those of the spire; sculpturing of spiral rows of beads and nodules which are generally aligned in transverse rows (Fig. 326). Florida and Texas *Thiara granifera* (Lamarck)



FAMILY PLEUROCERIDAE

The Pleuroceridae are widely distributed, occurring not only widely in North America, but in Central and South America, Africa and Asia as well. But, it is in North America that the family has reached its greatest development. Morrison (1954) has characterized the family as being dioecious, with the females having an egg-laying sinus on the right side of the foot. The types of eggs vary between some of the species, and attempts have been made to use egg-mass characteristics in generic taxonomy (see Dazo, 1965, for review). Unfortunately, egg-mass characters have been described for very few species. The generic groups traditionally have been distinguished on shell characters, and the classification of these groups as based on shells is not entirely satisfactory. Nevertheless, shell characters are useful in recognizing the genera and are essential for species identification.

As presented in this manual, the Pleuroceridae comprise seven nominal generic groups, several of which have subgroups. Many of the species within these groups exhibit considerable variation in shell characters, and in some cases this variation seems to be clinal. In other cases it may be ecological. *Io* is the only genus in which geographic variation has been carefully investigated, in a remarkable study by C. C. Adams (1915), which did much to clarify systematics within the genus.

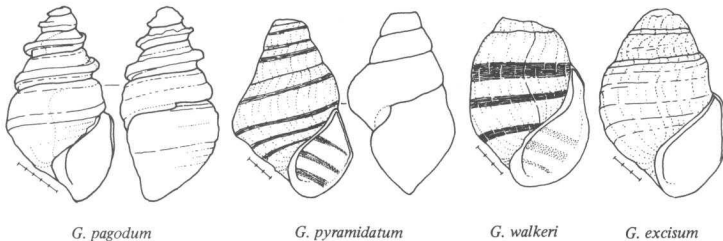
The shells of pleurocerids are thick and solid and vary in shape from elongately conical to subglobose. The aperture is frequently entire and in many species it is canaliculated anteriorly. The operculum is paucispiral and corneous.

Identification Key for the Pleuroceridae

- 1 Shell large, fusiform, periphery of whorls angulated or inflated, periphery commonly with elongated spines (although some forms are smooth); anterior end or "base" of aperture prolonged into a long canal (Figs. 429, 430, 461-465). Tennessee River and several of its main tributaries in western Virginia and eastern Tennessee *Io fluviatilis* (Say)³⁰
- Shell large to small, conical to subglobose*, surface smooth or sculptured, with or without short spines, nodules, lirae, carina and costae; anterior end or "base" of aperture without a long canal (a short canal may be present or the canal may be absent altogether) 2
- 2(1) Terminal whorl with a posterior slit along the sutural juncture. Coosa River, Alabama. Genus *Gyrotoma*^{28, 29} 3
- Terminal whorl without a posterior slit along the sutural juncture 8

*Shell shape refers to undecollated shells.

- 3(2) Shell sculptured with numerous and closely spaced lirae, nine or more on the body whorls of adults 4
- Shell relatively smooth or sculptured with eight or less lirae on the body whorls of adults 5
- 4(3) Lirae fine and numerous, 20 or more on the body whorl; color bands 8-10 (Fig. 441). Coosa River in Shelby and Talladega counties, Alabama *Gyrotoma lewisi* (Lea)
- Lirae coarser and less numerous, 9-12 on the body whorl; color bands seven or less (Figs. 444, 445). Coosa River, from Fort William Shoals to Wetumpka, Alabama *Gyrotoma pumilum* (Lea)
- 5(3) Spire with a single, very accentuated lira (sometimes a second lower lira is present) on the spire whorls, giving the shell a pagoda-like appearance (Figs. 442, 443). Coosa River, from The Bar to Wetumpka, Alabama *Gyrotoma pagodum* (Lea)
- Spire not pagoda-like 6
- 6(5) Whorls flattened, tapering and lumpy, giving the shell a pyramidal shape (Fig. 446). Coosa River in Shelby and St. Clair counties, Alabama *Gyrotoma pyramidatum* Shuttleworth
- Whorls not both flattened and tapering, or if so, not lumpy 7
- 7(6) Small, decollated adult shells rarely over 16 mm long; sutural fissure very shallow (Fig. 447). Coosa River in Coosa and Shelby counties, Alabama *Gyrotoma walkeri* Smith
- Larger, decollated adult shells usually more than 20 mm long; sutural fissure moderate to deep, not exceedingly shallow (Figs. 431-440). Coosa River in Chilton, Coosa, Elmore, Shelby, St. Clair and Talladega counties, Alabama *Gyrotoma excisum* (Lea)
- 8(2) Lateral radular teeth with broad, bluntly rounded or cleaver-like median cusps; shell medium to small, subglobose, globosely or broadly conic, or ovate. Genus *Leptoxis* 9
- Lateral radular teeth with narrow, pointed, spade-shaped or triangular median cusps; shell large to small, generally elongately or narrowly conic, but several species are broadly conic, ovate or cylindrical 34
- 9(8) Shell with an elongated or short spire, body whorl generally tapering and usually without prominent surface sculpture, although several species have spiral striae, carinae or small shoulder nodules; aperture broadly ovate, its anterior end nearly always rounded 10



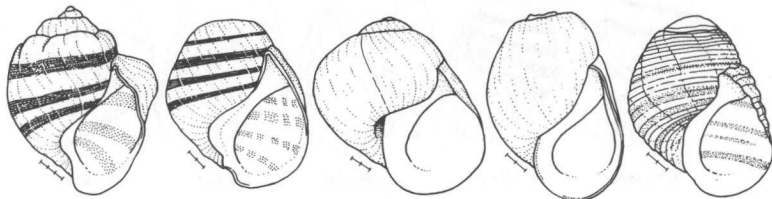
G. pagodum

G. pyramidatum

G. walkeri

G. excisum

- Shell with a very short spire and a nearly cylindrical body whorl with relatively large bumps or nodules on the shoulders; aperture pyriform, its anterior end pointed (Figs. 501, 502). Tennessee River and tributaries in Alabama and Tennessee. Subgenus *Athearnia* *Leptoxis (Athearnia) crassa* (Haldeman)³⁴
- 10(9) Shell generally thick and solid. Ohio and Alabama river drainages. Subgenus *Leptoxis* s.s.^{32, 74} 11
- Shell commonly relatively thin. Ohio river and Atlantic drainages and White River, Arkansas. Subgenus *Mudalia*⁷⁵ 28
- 11(10) Ohio river drainage, including the Tennessee, Cumberland, Duck and Elk river drainages 12
- Alabama river drainage 13
- 12(11) Base of adult shell without an umbilicus (Figs. 478-482). Cumberland, Duck, Ohio and Tennessee rivers and some of their drainages *Leptoxis praerosa* (Say)
- Base of adult shell with an umbilicus (Fig. 528). Elk, Red and Stone's rivers, Tennessee, and in Ringgold Creek of the Cumberland River *Leptoxis umbilicata* (Wetherby)
- 13(11) Species inhabiting the Alabama River proper and very short distances up the Cahaba or Coosa rivers from their mouths 14
- Species confined to tributaries of the Alabama River 15
- 14(13) Operculum ovate, loosely paucispiral (Fig. 476). Alabama and Coosa rivers, Alabama *Leptoxis picta* (Conrad)
- Operculum elongate, tightly paucispiral (Figs. 484-486). Alabama and Cahaba rivers and the Coosa River and tributaries *Leptoxis taeniata* (Conrad)⁷⁶
- 15(13) Species confined to the Coosa River and its tributaries 16
- Species confined to the Cahaba and Black Warrior rivers and their tributaries 25
- 16(15) Shell strongly lirate 17
- Shell smooth to spirally striate or weakly lirate, but not strongly lirate 19
- 17(16) Carinae may be well developed, but not highly accentuated (Figs. 484-486). Alabama and Cahaba rivers and the Coosa River and tributaries *Leptoxis taeniata* (Conrad)⁷⁶



L. (A.) crassa

L. praerosa

L. umbilicata

L. picta

L. taeniata

Carinae high, accentuated 18

18(17) Shell relatively large (that of adults 15-22 mm in length), spire rather depressed, body whorl and aperture wide (Fig. 483). Coosa River, Alabama *Leptoxis showalteri* (Lea)

Shell relatively small (that of adults 10-13 mm in length), high-spired, body whorl and aperture narrow. Coosa River, Alabama *Leptoxis lirata* (Smith)³³

19(16) Shell relatively large (that of adults more than 13 mm in length) 20

Shell relatively small (that of adults less than 12 mm in length) 24

20(19) Margin of operculum relatively smooth, without regular serrations 21

Margin of operculum serrated regularly either on the right or at the anterior ("base") 23

21(20) Operculum tightly paucispiral (Figs. 484-486). Alabama and Cahaba rivers and the Coosa River and tributaries *Leptoxis taeniata* (Conrad)⁷⁶

Operculum loosely paucispiral 22

22(21) Shell surface with widely spaced spiral striae (incised lines). Coosa River in Alabama and Georgia, and in Terrapin Creek, Cherokee County, Alabama *Leptoxis formosa* (Lea)⁷⁷

Shell surface smooth (Fig. 468). Coosa River, Alabama *Leptoxis clipeata* (Smith)

23(20) Right margin of operculum serrated regularly, anterior or "basal" margin smooth (Figs. 471, 472). Coosa River, Alabama *Leptoxis foremani* (Lea)

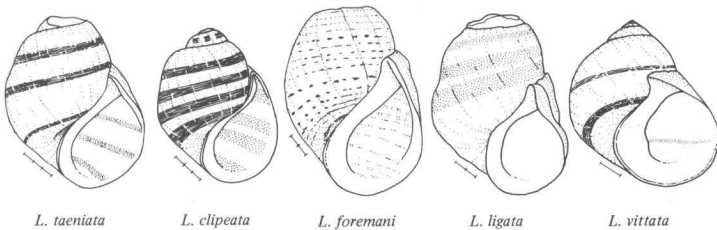
Right margin of operculum smooth, anterior or "basal" margin serrated regularly (Fig. 473). Coosa River, Alabama *Leptoxis ligata* (Anthony)

24(19) Shells of adults 8 mm or less in length, with a noticeable spire (Fig. 487). Coosa River, Alabama *Leptoxis vittata* (Lea)

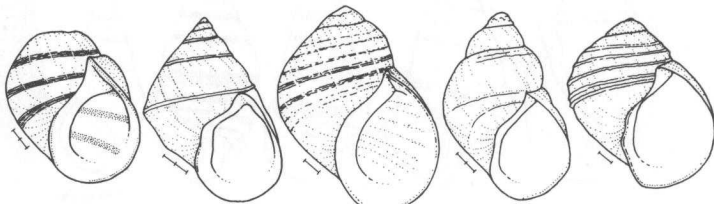
Shells of adults 10 mm or more in length, spire greatly depressed (Fig. 475). Coosa River, Alabama *Leptoxis occultata* (Smith)

25(15) Species confined to the Cahaba River 26

Species confined to the Black Warrior River 27



- 26(25) Shell with depressed spire and subglobose body whorl (Figs. 456, 457). Cahaba River, Alabama, and tributaries *Leptoxis ampla* (Anthony)
- Shell with elevated spire and elongated body whorl (Figs. 469, 470). Cahaba River and Buck Creek, Alabama *Leptoxis compacta* (Anthony)
- 27(25) Shell ovate, relatively large (that of adults more than 13 mm in length) (Fig. 477). Black Warrior River and Valley Creek, Alabama *Leptoxis plicata* (Conrad)
- Shell broadly conic, relatively small (that of adults less than 13 mm in length) (Fig. 474). Black Warrior River, Alabama *Leptoxis melanoides* (Conrad)
- 28(10) In streams of the Atlantic drainage 29
- In streams of the Mississippi river drainage 30
- 29(28) Shell of adults medium, 13 or more mm in length, commonly with one or several carinae (Figs. 489-492). New York to North Carolina *Leptoxis (Mudalia) carinata carinata* (Bruguière)
- Shells of adults small, about 10 mm in length, elongately conic, without carinae (Fig. 493). Hot Springs, Bath County, Virginia *Leptoxis (Mudalia) carinata nickliniata* (Lea)
- 30(28) In streams of the Ohio river drainage 31
- In the White River, Arkansas, and its North Fork, in Missouri; shell typically covered with thick whitish calcium deposits (Fig. 488) *Leptoxis (Mudalia) arkansensis* (Hinkley)
- 31(30) Shell small (that of adults 8 mm or less in length), periphery with a single angulation or carina (Fig. 495). Tennessee River at Muscle Shoals, Alabama *Leptoxis (Mudalia) minor* (Hinkley)
- Shell medium in size (that of adults 10 mm or more in length), periphery smooth or with one, two or three angulations or carinae 32
- 32(31) Shell relatively large (that of adults 15 mm or more in length), high-spired, ovately conic, nearly always without color bands and carinae (Fig. 494). Kanawha River and tributaries, West Virginia *Leptoxis (Mudalia) dilatata* (Conrad)
- Shell smaller (that of adults 10-13 mm in length), ovately or globosely conic to subglobose, with or without color bands and carinae 33
- 33(32) Shell subglobose, generally with one to several carinae, usually without color bands (Figs. 496, 497). Ohio River in western Ohio and northern Kentucky and tributaries *Leptoxis (Mudalia) trilineata* (Say)



L. ampla *L. (M.) c. carinata* *L. (M.) arkansensis* *L. (M.) dilatata* *L. (M.) trilineata*

Shell subglobose, without carinae, with spiral color bands (Figs. 498-500).
 Upper Tennessee River and tributaries *Leptoxis (Mudalia) virgata* (Lea)

34(8) Shell medium (except for one large species, *Lithasia lima*), elongately conic, subglobose, ovate, or cylindrical, surface of most species sculptured with obtuse spines or prominent nodules (one species is smooth and several nodulate species have smooth forms); columellar margin of the aperture thickened, meeting the anterior or "basal" lip with a channel or strong angle (except for *L. obovata* and *L. geniculata pinguis*³⁵); a calloused thickening usually occurs on the parietal wall at the posterior end of the aperture. Genus *Lithasia* 35

Shell large to small, narrowly or elongately conic, or cylindrical; surface smooth, carinate, lirate, costate, or occasionally with nodules; anterior or basal end of aperture either rounded and smooth or produced into a short canal; columellar margin of the aperture and posterior parietal wall without a thickening 36

35(34) The most prominent spiral row of nodules or tubercles is along the shoulder of the whorls (Figs. 503-513). Ohio and Tennessee rivers and their tributaries Subgenus *Lithasia* s.s.⁷⁸

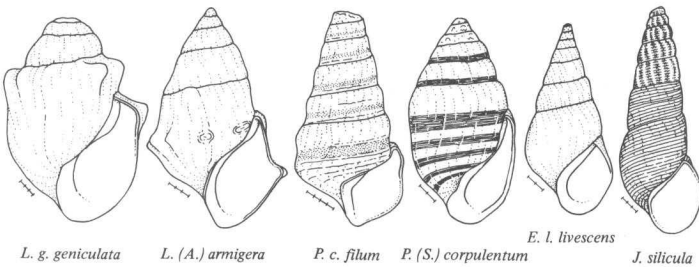
The most prominent spiral row of nodules, tubercles or spines is along or near the median periphery of the whorls (Figs. 514-520). Ohio and Tennessee rivers and their tributaries; Black and Spring rivers, Arkansas; Big Black River, Mississippi Subgenus *Angitrema*⁷⁸

36(34) Anterior or "basal" end of aperture prolonged into a short canal, producing an auger-shaped base to the shell (Figs. 521-527, 529-563). Mississippi river and Great Lakes drainages, and through the Erie Canal into the basin of the Hudson River Genus *Pleurocera*⁷⁸

Anterior or "basal" end of aperture not channeled or auger-shaped 37

37(36) Eastern in distribution, east of the Continental Divide, occurring in drainages of the Mississippi River, the Gulf of Mexico, the Atlantic slope, the Great Lakes-St. Lawrence River or Hudson Bay (Figs. 328-428, 458-460) Genus *Elimia*⁷⁸

Western in distribution, west of the Continental Divide, occurring in the drainages of the Great Basin or the Pacific slope (Figs. 448-455, 466, 467) Genus *Juga*⁷⁸

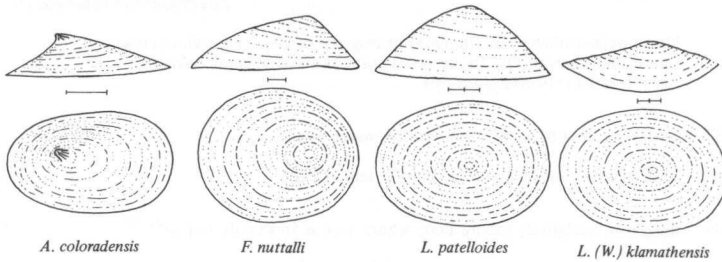


FAMILY ACROLOXIDAE

The family Acroloxiidae is mainly a Eurasian one of ancient lakes (Baikal and Ohrid), although one species, *Acroloxus lacustris* (Linnaeus), is the common, widespread pond and lake limpet of Europe. One species occurs in North America, *A. coloradensis* (Henderson), which has a spotty, probably relic, distribution. It is known from three localities in the Rocky Mountains, and from a few ponds and lakes in northern Quebec and eastern Ontario.

Acroloxus is peculiar for a freshwater limpet because its body has a *dextral* organization (Fig. 755a). The common freshwater limpets, members of the Ancyliidae, are all *sinistral* (Fig. 755b). The consequences of this right- and left-handedness can be seen in the reduced and very simplified patelliform shells of the two families. In *Acroloxus* the apex is inclined to the *left*, and in the Ancyliidae it is inclined to the *right*.

Acroloxus coloradensis has a small, depressed shell with a striate, projecting apex (Fig. 564). Shells which reach 5 mm in length are only about 1 mm high. The shell surface is covered with delicate radial striae and fine, regular growth lines.



FAMILY LYMNAEIDAE

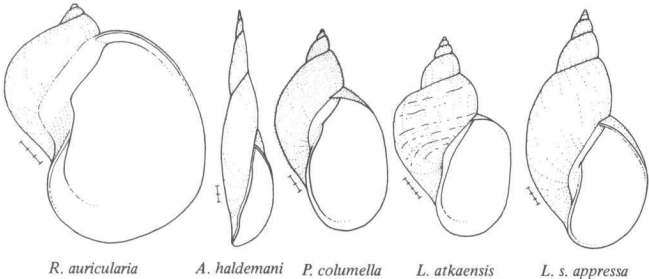
The Lymnaeidae are world-wide in distribution, but their greatest diversity is found in the northern United States and central Canada. Their shells range in shape from the coiled, needle-like *Acella haldemani* (Binney) (Fig. 565) to the uncoiled, limpet-shaped *Lanx* (Figs. 578-580, 633, 634) and *Fisherola* (Fig. 632). Those with coiled shells are easily distinguished from the Physidae by their dextral shells (the lone exception in the Lymnaeidae is the sinistral *Pseudisidora producta* (Mighels), which is restricted to Hawaii). No lymnaeids have planispiral shells, which immediately distinguishes them from the North American Planorbidae. The patelliform *Lancinae*, which occur only in the Pacific drainage region, can be distinguished from the Ancyliidae by their much larger size and by their anterior rather than posterior shell apex.

The tentacles of lymnaeids are broad, flat and triangular, rather than being long, thin and filamentous as in the Physidae, Planorbidae and Ancyliidae. Also, in contrast to the three latter families, all Lymnaeidae lack a respiratory pseudobranch.

Identification Key for the Lymnaeidae

- 1 Shell cap-shaped (ancyliform, limpet-shaped), not coiled. Western North America, in stream systems draining into the Pacific Ocean. Subfamily *Lancinae*⁴⁴ 2
- Shell coiled. Common throughout North America. Subfamily *Lymnaeinae* 4
- 2(1) Apex subcentral. Genus *Lanx* 3
- Apex close to the anterior end (Fig. 632). Columbia river drainage *Fisherola nuttalli* (Haldeman)
- 3(2) Entire shell or at least its apex elevated (Figs. 578-580, 633). Klamath and Sacramento rivers, California; Umpqua river system, Oregon Subgenus *Lanx* s.s.⁷⁹
- Shell and apex depressed (Fig. 634). Subgenus *Walkerola*. Klamath system in basin of Klamath River, Oregon *Lanx (Walkerola) klamathensis* Hannibal

- 4(1) Adult shell with large, globose body whorl, without spiral striations (Fig. 594). Widely distributed, but of spotty occurrence *Radix auricularia* (Linnaeus)
- Adult shell with narrow or globose body whorl, but if globose, the shell is well sculptured with microscopic spiral striations 5
- 5(4) Shell attenuate, very narrow, almost needle-like (Fig. 565). Southern Ontario; north central United States to Vermont *Acella haldemani* (Binney)
- Shell thicker, not especially narrow 6
- 6(5) Shell succiniform, i.e., thin and fragile, with a large, oval aperture and body whorl, and small spire; surface sculptured with microscopic, raised, spiral periostracal threads (Fig. 593). Eastern North America generally *Pseudosuccinea columella* (Say)
- Shell not succiniform, aperture may or may not be large and oval, but if so, the shell is not thin and fragile and is not sculptured with microscopic, raised, spiral periostracal threads 7
- 7(6) Shell large, that of adults more than 35 mm in length 8
- Shell smaller, that of adults less than 35 mm in length 13
- 8(7) Shell with a relatively narrow body whorl. Genus *Stagnicola*, in part^{43, 79} 13
- Shell with a wider, expanded, elongately oval to globose body whorl 9
- 9(8) Shell with a narrow, pointed spire. Genus *Lymnaea*⁴⁰ 10
- Shell with a relatively wider spire 12
- 10(9) Shell rimate, i.e., with a narrowly open umbilicus partially covered by the flare of the columellar lip (Fig. 590). Alaska and northwestern Canada *Lymnaea atkaensis* Dall
- Shell imperforate 11
- 11(10) Shell with a large, subglobose body whorl (Fig. 592). Lake Superior, northern Lake Huron, Wisconsin river and Winnipeg river drainages *Lymnaea stagnalis sanctaemariae* Walker
- Shell with an ample but not broad and subglobose body whorl (Fig. 591). Throughout much of Canada; in the northern United States and south to Colorado in the Rocky Mountains *Lymnaea stagnalis appressa* Say



12(9) Shell spire rather depressed, whorls shouldered (Fig. 621). Lakes in Maine
 *Stagnicola mighelsi* (Binney)

Shell spire more elongated, whorls not shouldered (Fig. 566). Great Lakes
 and St. Lawrence river drainage area and parts of the Canadian Interior
 Basin *Bulinna megasoma* (Say)

13(7,8) Adult shell medium to large, generally more than 13 mm (but occasionally
 13 mm or less) in length; surface sculptured with microscopic spiral stri-
 ations; columella usually with a well-developed twist or plait (Figs. 595-
 631). Widely distributed in North America Genus *Stagnicola*^{43, 79}

Adult shell small, generally less than 13 mm (but occasionally up to 15 or
 16 mm) in length; spiral sculpture usually absent, very weak when present;
 columella generally without a twist or plait. Genus *Fossaria*⁴¹ 14

14(13) Lateral teeth of the radula tricuspid (i.e., with three prominent cusps)⁸⁰.
 Subgenus *Fossaria* s.str. 15

[The genus *Fossaria* contains the small lymnaeids, very few specimens of which have shells
 more than 12 or 13 mm in length, most being smaller. The spiral striations of the shell, char-
 acteristic of most other members of the family, are absent or poorly developed. The colu-
 mella is most commonly smooth, without a twist or plait.

The type species of *Fossaria* is the Holarctic (but mainly Eurasian) *F. truncatula* (Mül-
 ler)⁸¹. *Galba* Schrank 1803 is another name sometimes used for the genus, especially in
 Europe, but the type species (*Galba pusilla* Schrank) on which the name is based is unidenti-
 fiable (Pilsbry & Bequaert, 1927). Other synonyms are *Simpsonia* F.C. Baker 1911, pre-
 occupied by *Simpsonia* Rochebrune 1905, and *Pseudogalba* F.C. Baker 1913, a replacement
 name for *Simpsonia* Baker.

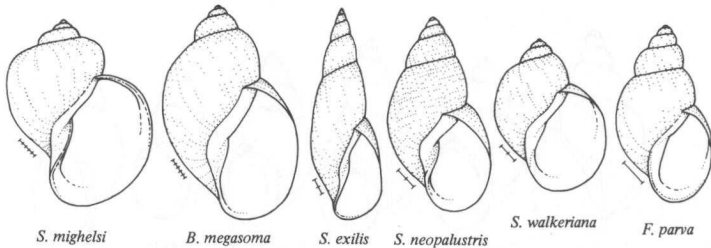
Some 40 species or subspecies of North American fossarias have been named, but the
 majority of these will prove to be synonyms. Hubendick (1951) recognized only three spe-
 cies ("*Lymnaea*" *bulimoides*, "*L.*" *cubensis* and "*L.*" *humilis*), but that amount of "lump-
 ing" seems excessive. A definitive determination of the *Fossaria* species must await careful
 and detailed biological/morphological/conchological studies.]

Lateral teeth of the radula bicuspid (i.e., with only two prominent cusps)⁸⁰.
 Subgenus *Bakerilymnaea* 21

[The main distinguishing feature of the subgenus *Bakerilymnaea* is the bicuspid lateral teeth
 of the radula, in contrast to the tricuspid lateral teeth of *Fossaria* s.str. Also, the species of
Bakerilymnaea are mostly more globose and larger, and frequently more glossy. Because of
 their bicuspid lateral radular teeth, F. C. Baker (1928c) grouped the bakerilymnaeas (as the
 subgenus *Nasonia*, preoccupied by *Nasonia* Ashmead 1904) with *Stagnicola*. However, they
 are more closely allied to *Fossaria*.]

15(14) Adult shell (with about five whorls) very small, less than 7 mm in length
 (Fig. 571). Widely distributed, absent from eastern Canada, most of New
 England, and the Gulf and South Atlantic states *Fossaria parva* (Lea)

Adult shell larger, more than 8 mm in length 16

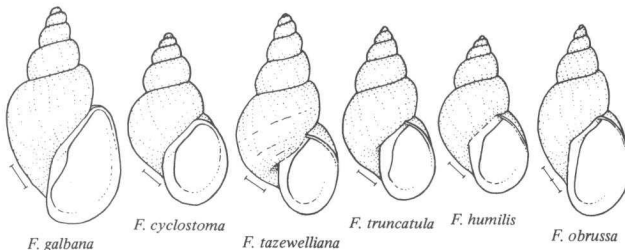


S. mighelsi *B. megasoma* *S. exilis* *S. neopalustris* *S. walkertiana* *F. parva*

- 16(15) Shell thickened, commonly whitish; spire generally obtuse, but it may be elongated; whorls usually strongly shouldered, especially at the aperture lip; outer apertural lip flattened. Inhabitant of northern cold-water lakes and streams (Fig. 568) *Fossaria galbana* (Say)
- Shell generally relatively thin, but it may be solid; spire elongate; whorls not shouldered, or with only weak or moderate shoulders; outer apertural lip rounded, sometimes compressed, but not flattened 17
- 17(16) Shell spire elongate and generally narrow, its length noticeably larger than the aperture length. Northern, from New York to Michigan and Iowa; southwestern Yukon and southern Alaska 18
- Shell spire broad to narrow, but in shells with narrow spires, the spire length is not much greater than the aperture length 20
- 18(17) Body whorl tumid, globular; aperture subcircular (cyclostomid) (Fig. 567). New York to Michigan *Fossaria cyclostoma* (Walker)
- Body whorl elongate-oval; aperture oval 19
- 19(18) Eastern North America, from New York to Iowa (Fig. 572) *Fossaria tazewelliana* (Wolf)
- Southwestern Yukon and southern Alaska (Fig. 583) *Fossaria truncatula* (Müller)⁸¹
- 20(17) Whorls regularly increasing in size, terminating in a tumid, ovate body whorl; whorls evenly convex; spire broad; aperture ovate. Eastern and southeastern United States in distribution (Fig. 569) *Fossaria humilis* (Say)
- Whorls regularly or irregularly increasing in size, terminating in an elongate-ovate, sometimes narrow body whorl; whorls convex to flattened; spire broad to narrow; aperture elongate-oval. Widely distributed in North America, but absent from the southeastern United States (Figs. 570, 573-577) *Fossaria obrussa* (Say) group

[Shells of the *Fossaria obrussa* group are rather variable, and about 15 forms have been described as "new" species. However, there are probably only several species in this group, and these are not defined by constantly different shell characters. Names that are in common use, in addition to *obrussa*, are *exigua* Lea, *modicella* Say, *peninsulae* Walker and *rustica* Lea. F. C. Baker (1928c) characterized these forms as follows:

obrussa [Figs. 570, 575] — "... one of the most widely distributed . . . [and] . . . most variable, of the American Lymnaeae. . . . Typically, *obrussa* may be known by its pointed spire, compressed body whorl and elongated and shouldered aperture, which is also strongly effuse at the anterior end; the inner lip is appressed to the body whorl about the middle of the aperture. The shape of the shell, of the aperture and of the inner lip is quite different from *modicella*, the shell being larger and more elongated, the last whorl not so convex; the aperture is longer and narrower and much more effuse, besides forming a distinct shoulder at its junction with the body whorl; the inner lip is more compressed in the middle where it joins the parietal wall. In shells of the same size, *modicella* has five whorls, while *obrussa* has four whorls; in form the young *obrussa* somewhat approach *modicella*. The shell is, typically, much larger than *modicella*, *parva* and the other members of the *humilis* group."



exigua [Fig. 573] — "... appears quite separable from *obrusa*. The spire is usually long and the whorls flatly rounded, the body whorl more or less compressed; the most noteworthy feature appears to be the very deep suture, which is almost channelled in some specimens, causing the whorls to be turban-shaped. This feature is present in the majority of the specimens examined. The aperture is also more regularly ovate than in *obrusa*, and the inner lip is peculiarly flattened near the umbilical region, giving rise to a pseudoapert. Some specimens resemble *modicella rustica*, but in that race the spire is acutely conical, the whorls regularly increase in size; the body whorl is not compressed in the middle, and the aperture is regularly ovate, while in *exigua* the spire is broadly turreted, the whorls are more or less disproportionate in size and the body whorl is very cylindrical."

modicella [Fig. 574] — "... closely related to the *humilis* of the southeastern part of the United States, differing in its narrower shell and longer aperture, and more or less impressed inner lip where it joins the parietal wall. ... *obrusa* is larger and more elongated and the inner lip is notably compressed and bent inward at its junction with the parietal wall."

peninsulæ [Fig. 576] — "... differs from typical *obrusa* in being more slender, with a longer, more turreted spire, deeper sutures and a more oval aperture. The body whorl is more cylindrical than in the typical form [*obrusa*]."

rustica [Fig. 577] — "... appears to be a modification of the *modicella* type of shell, characterized principally by its long, very acute spire and ovate aperture. Its long, pointed spire will distinguish it from any form of *modicella*. It is liable to be confounded with forms of *exigua*, but in that species the aperture is longer and narrower and inclined to be squarish, while in *rustica* it is more acutely rounded at the extremities. The spire in *rustica* is longer and more acute than in *exigua*, the spire whorls being less inflated. Half-grown specimens of *obrusa* are similar in general form, but differ in the form of the aperture, which is longer and narrower and forms a distinct shoulder at the junction of the outer lip with the body whorl, while in *rustica* this part of the lip is gracefully curved. The aperture is sometimes almost round and the spire varies much in height. *Rustica* is evidently more nearly related to *modicella* than to *obrusa* and may be considered a variety of the former."

- 21(14) Shell ovate, dark amber in color, very highly polished. Southwestern Alaska *Fossaria (Bakerilymnaea) perpolita* (Dall)

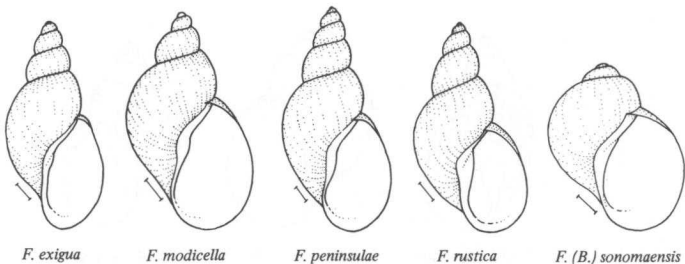
- Shell globose, subglobose, ovate or conic, horn, pale yellowish, light to dark brown or pearl gray in color, generally moderately glossy, but may be dull 22

- 22(21) Shell globose, thin and fragile, whorls rapidly expanding, producing a very small spire and an obese body whorl; umbilicus small to perforate (Fig. 589). Sonoma County, California *Fossaria (Bakerilymnaea) sonomaensis* (Hemphill (in Pilsbry & Ferriss) 1906)⁸²

- Shell ovate to conic, umbilicus relatively large to practically imperforate 23

- 23(22) Adult shell (with above five whorls) moderately small to very small, less than 10 mm in length 24

- Adult shell larger, nearly always more than 10 mm in length, generally 11-13 mm (occasionally up to 15 or 16 mm). Alabama west to northern Mexico and southern California, north to southern Canada from British Columbia to Saskatchewan (Figs. 584-586) *Fossaria (Bakerilymnaea) bulimoides* group



F. exigua *F. modicella* *F. peninsulæ* *F. rustica* *F. (B.) sonomaensis*

[Shells of the *Fossaria* (*Bakerilymnaea*) *bulimoides* group are quite variable, and several forms have been recognized as species, subspecies or morphs. The best known of these are *cockerelli* Pilsbry & Ferriss and *techella* Haldeman. Hibbard & Taylor (1960) believed *cockerelli* to be specifically distinct from *bulimoides* s.str. and *bulimoides'* subspecies *techella*. *Cockerelli* and *techella*, as well as *albata* and *perplexa*, were considered to be only "morphs" of *bulimoides* by Clarke (1973). Taylor (1975) lists *perplexa* with *Fossaria* s.str. All of these taxa must be studied much more thoroughly before their exact systematic status can be determined. Described characteristics of these forms, along with those of *hendersoni* and *vancouverensis*, are given below:

bulimoides [Fig. 584] — "*Bulimoides* may be distinguished from *techella* and other races by its more regularly ovate shape, less globose body-whorl, more elongate-ovate aperture and by the different manner in which the inner lip is appressed to the columellar region. There is considerable variation in the rotundity of the whorls and in the length and acuteness of the spire. The inner lip also varies greatly, in some specimens being rolled or folded over into the umbilical region while in others it is expanded, approaching the *techella* form. *Bulimoides* somewhat resembles *cubensis*, differing in its nearly closed umbilical chink, folded inner lip, shorter and broader spire and its ovate shell. The whorls of *cubensis* are also rounder and more distinctly shouldered than are those of *bulimoides*" (F.C. Baker, 1911a: 213).

albata — "... may be ... recognized by its elongate-ovate outline, strong spiral striation, and smooth, folded inner lip" (F.C. Baker, 1919e: 538)⁸³.

cockerelli [Fig. 585] — "Shell subglobose, pale yellowish-corneous. ... Spire very short, last whorl and aperture very large. Aperture short-ovate, its length three-fifths to two-thirds that of the shell. Columella broadly expanded, not folded. Umbilicus large. ... This form differs from *L. bulimoides* and *L. techella* by its more globose shape and shorter spire. ... *L. ... sonomaensis* Hemphill [Fig. 589], from Sonoma county, California, approaches *cockerelli*, but differs by the more rapidly expanding last whorl, narrower flat columella and narrower umbilicus, which is like that of typical *bulimoides*" (Pilsbry & Ferriss, 1906: 162-163).

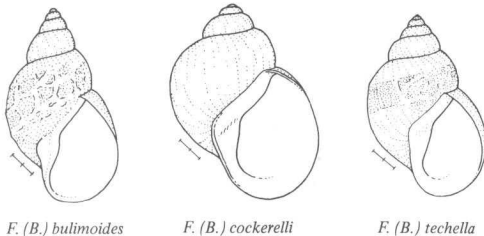
hendersoni — "Globose, very thin and fragile; periostracum light yellowish or brownish horn; ... spire very short, depressed. ... The only *Lymnaea*id likely to be confounded with *hendersoni* is *sonomaensis*, which differs in the form of the spire [higher] and the inner lip [not rolled over as much]. ... The outline of the shell is ... more ovate than in *sonomaensis* and the aperture is not expanded" (F.C. Baker, 1911a: 223, 224). "*Lymnaea hendersoni* Baker is within the range of variation of *S. ["Stagnicola"] cockerelli* as considered here. Two paratypes (USNM 570386) are smaller than usual for *S. cockerelli*, but can be matched by lots from Colorado and elsewhere. They probably were exposed to acid water, for the first one or two whorls have been etched; hence, on the low spire of these shells the effect is that of a truncate shell. This is an environmental, adventitious effect; the whorls are not 'coiled in the same plane' as Baker thought" (Hibbard & Taylor, 1960: 92).

perplexa — "... resembles both *parva* and *dalli*. It appears to stand midway between these species, being larger than *dalli* and smaller than *parva*. Its brown color of shell and aperture, deep sutures, fine, regular lines of growth without spiral lines, and its flattened and wide inner lip will distinguish it from related species" (F.C. Baker & Henderson, 1929: 104)⁸⁴.

techella [Fig. 586] — "Shell obese, with *acutely conic spire*, of five or six convex whorls; pale yellowish or light brown, finely striate and *usually malleated* ... Last whorl very ventricose, umbilicus large. Aperture short-ovate, about three-fifths the total length; basal lip expanded, *columellar lip broadly dilated*, without a fold. ... *Cubensis* has a more triangular and less broadly developed columellar expansion" (Pilsbry & Ferriss, 1906: 163, 164).

vancouverensis — "Shell differing from typical *bulimoides* in its larger size, more ovate and widely expanded aperture, wider inner lip which is less triangular than in typical *bulimoides*, and coarser sculpture which is almost rib-striate in some specimens" (F.C. Baker, 1939a: 144.)

24(23) Adult shell (with about five whorls) very small, less than 6 mm in length 25



F. (B.) *bulimoides*

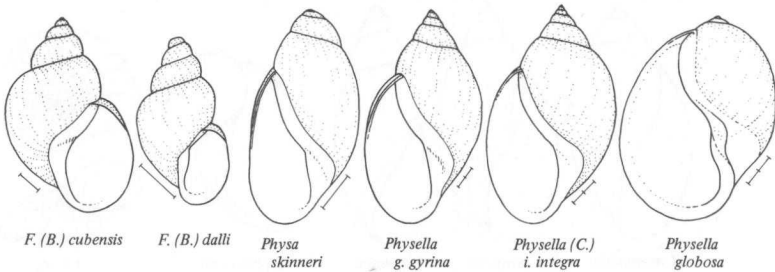
F. (B.) *cockerelli*

F. (B.) *techella*

Adult shell moderately small, 7 to 9 mm in length (Fig. 587). Southern United States from Florida to Texas *Fossaria (Bakerilymnaea) cubensis* (Pfeiffer)

25(24) Shell pale brown. Southern Manitoba and southern Alberta, western region of the Great Lakes system, upper Mississippi drainage, and south in the Rocky Mountains to Arizona (Fig. 588)
 *Fossaria (Bakerilymnaea) dalli* (F. C. Baker)

Shell dark brown. Found sporadically in Washington, California, Montana, Utah, Nevada and Arizona
 *Fossaria (Bakerilymnaea) bulimoides* form *perplexa* (F. C. Baker)⁸⁴



FAMILY PHYSIDAE

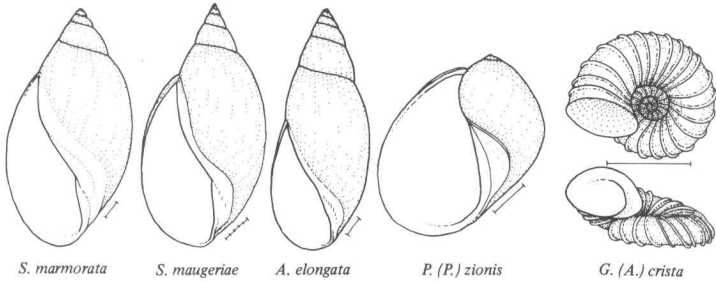
The Physidae are mainly a New World family, with only a few species occurring in Eurasia and Africa. In North America, the physids are readily recognized by a combination of several characters. Their lack of an operculum distinguishes them from all of the Prosobranchia. Their high-spired shell separates them from the Planorbidae and Ancyliidae, and their sinistral (left coiled) shell marks them as being different from the Lymnaeidae.

In North America, the Physidae are the most abundant and wide-spread of the freshwater gastropods. They may be found in all types of habitats, and some species seem to be the most resistant to pollution of all the freshwater mollusks. In addition to being highly adaptable, the physids have undergone considerable diversification, much of which is not clearly exhibited in their shells. Many of the species are not easy to identify on shell characters alone.

Identification Key for the Physidae⁸⁵

- 1 Mantle edge digitate (with finger-like projections) 2
- Mantle edge without digitations; mantle edge may or may not be serrated 3
- 2(1) Digitations occur on both sides of the mantle; tip of shell spire rounded (Figs. 635-637). Canada and northern United States Genus *Physa*⁸⁵
- Digitations occur only on the parietal side of the mantle (Figs. 581, 582, 638-698). Widely distributed and common throughout North America Genus *Physella*⁸⁵
- 3(1) Mantle edge smooth; mantle does not extend beyond the edge of the shell apertural lip 5
- Mantle edge serrated and extending beyond the edge of the shell apertural lip, partly overlapping the shell. Texas. Genus *Stenophysa*⁴⁷ 4

- 4(3) Shell relatively small, less than 16 mm in length, horn to light or dark tan in color, usually translucent, seldom variegated (Fig. 701). Texas *Stenophysa marmorata* (Gülding)
- Shell relatively large, up to 30 mm or more in length, tan to chestnut brown in color, opaque, commonly variegated (Fig. 702). Texas *Stenophysa maugeriae* (Gray)
- 5(3) Shell elongate, nearly spindle-shaped; shell surface glossy; spire long (Figs. 699, 700). Canada and northern United States *Aplexa elongata* (Say)⁸⁶
- Shell subglobose, globular; shell surface dull; spire very short (Fig. 698). Utah *Physella (Petrophysa) zionis* (Pilsbry)



FAMILY PLANORBIDAE

The Planorbidae in North America range in size from minute to relatively large (i.e., from about 1 mm in diameter to over 30 mm), but with few exceptions their shells are all discoidal, i.e., coiled in one plane. The animals are all sinistral, i.e., coiled to the left or in a counter-clockwise manner and having respiratory, excretory and reproductive systems terminating on the left side (Fig. 703). However, their shells do not always appear to be sinistral; those of many species seem to be dextral. This is because such shells tip to the left side in life and the type of apertural margin which develops in such cases is correspondingly slanted. In shells tipped to the left in such a fashion, the lower side (left side) is the spire side and the upper side (right side) is the umbilical side (Fig. 704). Such dextral-appearing shells on a sinistral animal are termed "pseudodextral" or "ultrasinistral".

A secondary gill (a pseudobranch) is situated on the left side of the animal, near the pneumostome and in close proximity to the anus (Fig. 703). The pseudobranch aids the mantle cavity in respiration.

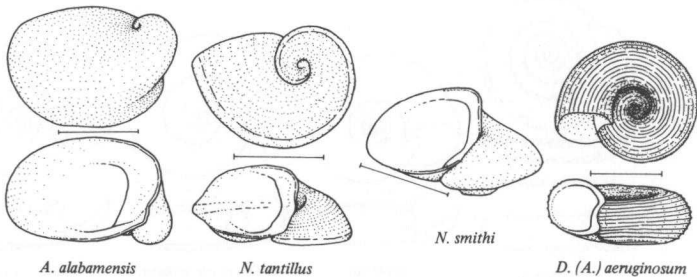
A striking characteristic of nearly all planorbid snails is that the respiratory pigment of the blood or haemolymph is haemoglobin. This gives a reddish appearance to the animal, if the color is not masked by melanin pigments of the skin. Albino snails, and those with little pigment, appear bright red. (The genus *Drepanotrema* apparently lacks red haemolymph.)

The Planorbidae appear to be closely related to the Ancyliidae, and some authors (e.g., Starobogotov, 1970) have combined the two as a single family.

Identification Key for the Planorbidae

- 1 Shell small, that of adults less than 8 mm in diameter 2
- Shell larger, that of adults more than 8 mm and up to or more than 30 mm in diameter 23
- 2(1) Shell costate (Fig. 706). Canada and northern United States *Gyraulus (Armiger) crista* (Linnaeus)
- Shell not costate 3

- 3(2) Shell minute, that of adults 2 mm or less in diameter. Coosa River, Alabama 4
 Shell larger, that of adults more than 2 mm in diameter 8
- 4(3) Shell crepidulaform in shape, i.e., limpet-like with a small coil at the apex (Fig. 749). Coosa River, Alabama *Amphigyra alabamensis* Pilsbry
 Shell planorboid. Genus *Neoplanorbis*^{62, 87} 5
- 5(4) Shell umbilicate, columella dentate 6
 Shell perforate, columella smooth 7
- 6(5) Shell periphery carinate, umbilicus narrow (Fig. 752). Coosa River, Alabama *Neoplanorbis carinatus* Walker
 Shell periphery obtusely angled, umbilicus wider (Fig. 754). Coosa River, Alabama *Neoplanorbis umbilicatus* Walker
- 7(5) Shell spirally striate, periphery carinate (Fig. 750). Coosa River, Alabama
 *Neoplanorbis tantillus* Pilsbry
 Shell without spiral striae, periphery rounded (Fig. 753). Coosa River, Alabama *Neoplanorbis smithi* Walker
- 8(3) Shell very compressed, body whorl relatively flattened; aperture or body whorl without "teeth" or lamellae 9
 Shell higher, body whorl moderately high; inside aperture or body whorl with "teeth" or lamellae. Genus *Planorbula*, in part 22
- 9(8) Shell either extremely flattened and multi-whorled or with numerous, low, close-set spiral ridges (lirae). Florida, Texas and southern Arizona. Genus *Drepanotrema* 10
 Shell flattened, but not extremely so; not multi-whorled; without spiral ridges (lirae) 12
- 10(9) Shell extremely flattened; multi-whorled; without spiral ridges (lirae). Subgenus *Fossulorbis* 11
 Shell not extremely flattened; with fewer, more rapidly enlarging whorls; sculptured with numerous, low lirae. Subgenus *Antillorbis*. (Fig. 710). Southern Arizona and southern Texas
 *Drepanotrema (Antillorbis) aeruginosum* (Morelet)



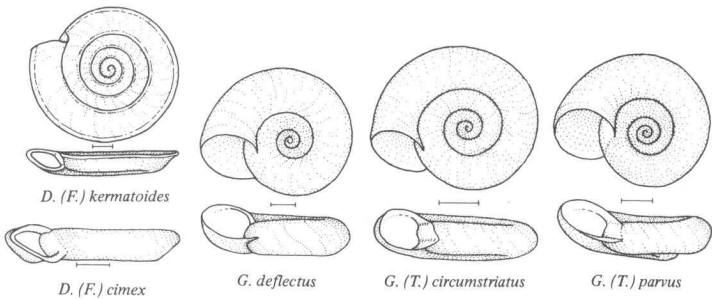
A. alabamensis

N. tantillus

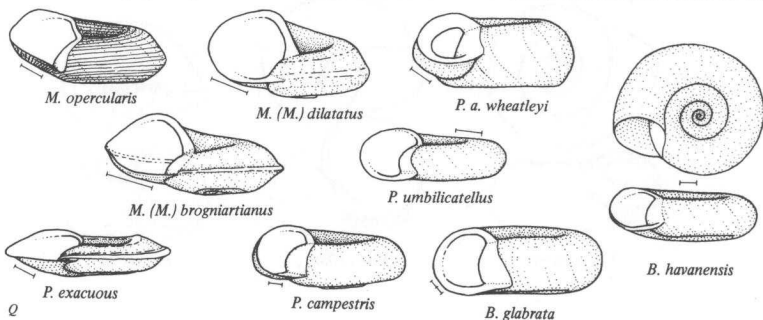
N. smithi

D. (A.) aeruginosum

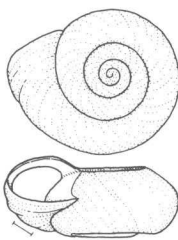
- 11(10) Shell periphery strongly keeled (Fig. 711). Florida, Texas
 *Drepanotrema (Fossulorbis) kermatoides* (d'Orbigny)
- Shell periphery rounded or obtusely angular (Fig. 715). Southern Texas
 *Drepanotrema (Fossulorbis) cimex* (Moricand)
- 12(9) Spire pit (on left side of shell) shallow and wide 13
- Spire pit (on left side of shell) relatively deep and narrow 17
- 13(12) Height of body whorl relatively rapidly increasing toward the aperture
 (Fig. 727). Illinois, Missouri and Arkansas
 *Menetus (Micromenetus) sampsoni* (Sampson)^{53, 54, 55}
- Height of body whorl nearly equal from one side to the other. Genus
Gyraulus 14
- 14(13) Adult shells 4 to 7 mm in diameter, variable, with the body whorl not
 evenly rounded or with a peripheral keel or with a hirsute periostracum
 or a malleated surface or with any combination of these features.⁸⁸
 Subgenus *Gyraulus* s.s. (Fig. 705). Canada and northern United States
 from Maine to Virginia and west to Idaho *Gyraulus deflectus* (Say)
- Adult shells 3 to 5 mm in diameter, variable, with the body whorl evenly
 rounded or with upper lateral surface slightly flattened; without a periph-
 eral keel or a hirsute periostracum or malleated surface.⁸⁸ Subgenus
Torquis 15
- 15(14) Shell relatively high (Fig. 708). Canada, North Dakota and Wisconsin
 *Gyraulus (Torquis) hornensis* F.C. Baker⁴⁸
- Shell relatively flattened 16
- 16(15) Shell whitish or yellowish, semi-transparent, entirely or nearly planispiral,
 appearing almost the same from both sides. Characteristic of aquatic
 habitats that are subject to periodic drying⁸⁸ (Fig. 707). Canada and
 northern United States, south in the Rocky Mountains to New Mexico
 *Gyraulus (Torquis) circumstriatus* (Tryon)
- Shell brownish, translucent but not transparent, not planispiral but with
 apical and umbilical aspects clearly different. Characteristic of permanent
 and (occasionally) temporary aquatic habitats⁸⁸ (Fig. 709). Widely dis-
 tributed throughout North America *Gyraulus (Torquis) parvus* (Say)
- 17(12) Shell with carinate periphery 18
- Shell with rounded, subangular or angular periphery 20



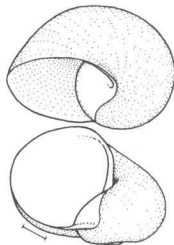
- 18(17) Western in distribution. Alaska south to Alberta and southern California (Figs. 722, 723) *Menetus opercularis* (Gould)⁵²
 Found east of the Rocky Mountains 19
- 19(18) Relative height of body whorl rapidly increasing toward the aperture (Fig. 725). Ohio, Alabama *Menetus (Micromenetus) brogniartianus* (Lea)^{53, 54, 55}
 Relative height of body whorl nearly equal from one side to the other (Fig. 746). Widely distributed in North America *Promenetus exacuus* (Say)
- 20(17) Relative height of body whorl rapidly increasing toward the aperture (Figs. 724, 726). Widely distributed in the eastern United States
 *Menetus (Micromenetus) dilatatus* (Gould)^{53, 54, 55}
 Relative height of body whorl nearly equal from one side to the other 21
- 21(20) Periphery of body whorl more or less angular or subangular (Figs. 722, 723). Alaska south to Alberta and southern California *Menetus opercularis* (Gould)
 Periphery of body whorl rounded (Fig. 747). Widely distributed in Canada, the western United States, and east to Oklahoma, Ohio and New York
 *Promenetus umbilicatellus* (Cockerell)^{58, 59}
- 22(8) Lamellae in last whorl prominent but not especially large; lower palatal lamella relatively short and straight or only slightly curved (Figs. 741, 742). Widely distributed in eastern North America *Planorbula armigera armigera* (Say)
 Lamellae in last whorl especially large; lower palatal lamella long, prominently curved (Figs. 743, 744). Alabama and Florida
 *Planorbula armigera wheatleyi* (Lea)⁵⁷
- 23(1) Shell thin, often rather fragile, body whorl relatively depressed 24
 Shell thicker, usually rather solid, body whorl may or may not be relatively depressed, often high 26
- 24(23) Southern in distribution (Florida to Texas and Arizona). Genus *Biomphalaria* 25
 Distribution northern and in the western mountains (Canada and North Dakota, south to New Mexico in the Rocky Mountains) (Fig. 745)
 *Planorbula campestris* (Dawson)
- 25(24) Shell medium in size, that of adults with five or more whorls larger than 15 mm in diameter (Fig. 712). Florida *Biomphalaria glabrata* (Say)
 Shell small, that of adults with five or more whorls less than 10 mm in diameter (Fig. 713). Florida to Texas and Arizona *Biomphalaria havanensis* (Pfeiffer)



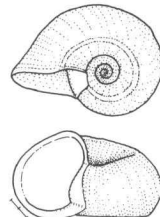
- 26(23) Body whorl containing lamellae or "teeth" (Figs. 741, 742). Widely distributed in eastern North America *Planorbula armigera armigera* (Say)
 Body whorl without lamellae or "teeth" 27
- 27(26) Shell with few, rapidly increasing whorls; body whorl disproportionately large. Genus *Vorticifex*, subgenus *Parapholyx*.⁶⁰ Western in distribution 28
 Shell with more than a few, often many whorls, that do not increase especially rapidly in size; body whorl not disproportionately large 29
- 28(27) Whorl angular or subangular around the concave columellar area (Fig. 751). Lakes in Nevada and California *Vorticifex (Parapholyx) solida* (Dall)⁶¹
 Whorl not angular or subangular around the basal columellar area (Fig. 748). Rivers and lakes in California and Oregon *Vorticifex (Parapholyx) effusa* (Lea)
- 29(27) Shell spire (left side) strongly inverted, with a more or less deep conical depression; spire side of body whorl with or without a strong keel. Genus *Helisoma* 30
 Shell spire (left side) not strongly inverted, with a shallow depression, no depression or exverted (raised above body whorl); spire side of body whorl rounded or angular. Genus *Planorbella* 35
- 30(29) Shell concave on both sides. Subgenus *Helisoma* s.s. 31
 Shell concave on the left side, convex on the right side. Western in distribution. Subgenus *Carinifex* 33
- 31(30) Shell smaller, less than 7 mm in diameter, umbilical (basal, right) side with two chestnut-brown spiral bands. Isolated localities in North Carolina and Louisiana *Helisoma eucosmium* (Bartsch)⁵⁰
 Shell larger, adults more than 7 mm in diameter, umbilical (basal, right) side without spiral color bands 32
- 32(31) Shell with basal (right) carina variously developed, but not close to the shoulder; transverse sculpture moderate to fine (Fig. 714). Widely distributed in most of North America *Helisoma anceps anceps* (Menke)⁵⁰
 Shell with basal (right) carina very accentuated and at or close to the lower basal peripheral angle; transverse sculpture coarse. Lake Superior and Albany, Attawapiskat and Winnipeg river systems, Ontario *Helisoma anceps royalense* (Walker)⁵⁰



P. a. armigera

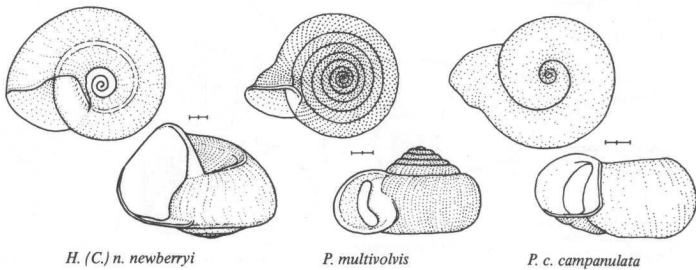


V. (P.) effusa

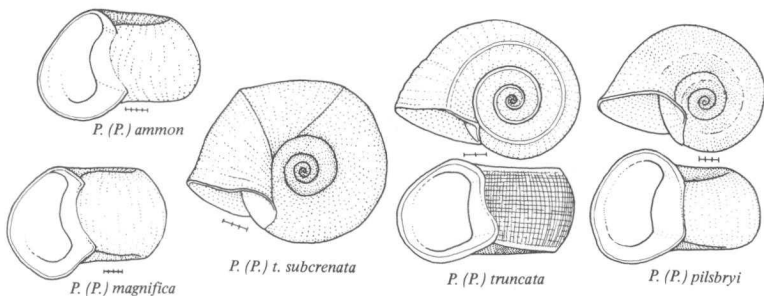


H. a. anceps

- 33(30) Widely distributed and quite variable (Figs. 720, 721). California, Idaho, Nevada, Oregon and Utah *Helisoma (Carinifex) newberryi newberryi* (Lea)⁵¹
 Restricted to either Jackson Lake, Wyoming, or Eagle Lake, California 34
- 34(33) Shell smaller (that of adults less than 12 mm in diameter), buff or tan in color (Figs. 716, 717). Jackson Lake, Wyoming
 *Helisoma (Carinifex) newberryi jacksonense* Henderson
 Shell larger (that of adults up to 13.5 mm in diameter), white or horn in color (Figs. 718, 719). Eagle Lake, California
 *Helisoma (Carinifex) newberryi occidentale* Hanna
- 35(29) Body whorl at shell aperture campanulate (flared). Subgenus *Planorbella* s.s.^{56, 89} 36
 Body whorl at shell aperture straight, not campanulate 38
- 36(35) Shell spire (left side) conically raised above body whorl (Fig. 729). Howe Lake, Michigan *Planorbella multivolvis* (Case)
 Shell spire (left side) either slightly inverted, flat or obtusely raised above body whorl 37
- 37(36) Shell spire (left side) slightly inverted, flat or very slightly raised above the body whorl (Fig. 728). Widely distributed in northern United States and Canada *Planorbella campanulata campanulata* (Say)
 Shell spire (left side) obtusely raised above body whorl. Northwestern Ontario *Planorbella campanulata collinsi* (F.C. Baker)
- 38(35) Shell surface usually dull, usually rough in texture, with raised transverse thread-like striae. Widely distributed in North America. Subgenus *Pterosoma*⁹⁰ 39
 Shell surface usually glossy, relatively smooth, without raised transverse thread-like striae (Figs. 738-740). Florida. Subgenus *Seminolina*⁹¹ 48
- 39(38) Species of western North America 40
 Species of central and eastern North America 42
- 40(39) Shell small, specimens with four whorls about 10 mm in major diameter. Southeastern Oregon and northwestern Utah
 *Planorbella (Pterosoma) oregonensis* (Tryon)
 Shell larger, adults 15-30 mm in major diameter 41⁹³



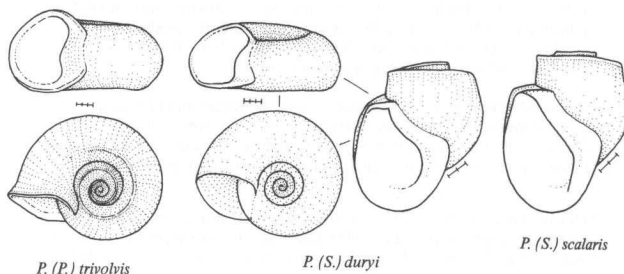
- 41(40) Greatest height of adults exceeding 12 mm; greatest width of shell less than twice the greatest height (Figs. 730, 733). Widely distributed in western North America *Planorbella (Pierosoma) ammon* (Gould) group⁹²
- Greatest height of adults 10-12 mm; greatest width of shell generally more than twice the greatest height (Fig. 734). Widely distributed in western North America *Planorbella (Pierosoma) trivolvis subcrenata* (Carpenter)⁹³
- 42(39) Carinae or strong angulations present on the outer edges of both the right (umbilical) and left (spire) side of the body whorl of the shell 43
- Carinae absent, although a rather strong angulation may be present on the upper surface of the body whorl of the spire 46
- 43(42) Shells larger, those of adults more than 18 mm in greatest diameter; spire may be flat or sunken into a bowl-like depression 44
- Shells smaller, those of adults less than 18 mm in greatest diameter; spire flat, not inverted or sunken into a bowl-like depression (Fig. 737). Michigan, northern Illinois and Wisconsin *Planorbella (Pierosoma) truncata* (Miles)
- 44(43) Carinae cord-like, strong and acutely angled; body whorl flat or concave abaxially. Northern Minnesota *Planorbella (Pierosoma) corpulenta vermilionensis* (F.C. Baker)⁹⁴
- Carinae not cord-like 45
- 45(44) Upper surface of shell almost entirely flat; maximum height at aperture 14 mm or more; ratio of greater height to greater diameter more than 0.75 in many specimens. Headwaters of Rainy River system, western Ontario *Planorbella (Pierosoma) corpulenta whiteavesi* (F.C. Baker)⁹⁴
- Body whorl higher than penultimate whorl, causing spire to be sunken; maximum height at aperture less than 14 mm; ratio of greater height to greater diameter less than 0.75. Western Ontario, Minnesota and Manitoba *Planorbella (Pierosoma) corpulenta corpulenta* (Say)⁹⁵
- 46(42) Shell height up to 24 mm or more; surface glossy, growth lines fine (Fig. 732). Lower Cape Fear River, North Carolina *Planorbella (Pierosoma) magnifica* (Pilsbry)
- Shell more compressed, less than 16 mm in height; surface dull, growth lines pronounced 47⁹³
- 47(46) Inverted portion of shell spire relatively wide, concavely smooth-sided and bowl-like (Fig. 731). Canadian Interior Basin and northern United States from Massachusetts west to Minnesota . . . *Planorbella (Pierosoma) pilsbryi* (F.C. Baker)⁹⁶



Inverted portion of shell spire narrower, generally not smooth-sided or bowl-like (Figs. 734, 736). Found throughout North America
 *Planorbella (Pierosoma) trivolvis* (Say)^{93, 97}

48(38) Shell either planate, with an inverted spire, or physoid, i.e., with an everted, raised spire; physoid individuals wider, usually more widely umbilicate and generally with the anterior aperture margin protruding more than the posterior shell margin (when viewed from the spire end) (Figs. 738, 739, 785). Northern to southern Florida *Planorbella (Seminolina) duryi* (Wetherby)⁹⁸

Shell physoid only, narrower, usually more narrowly umbilicate and generally with the posterior aperture margin protruding more than the anterior shell margin (when viewed from the spire end) (Figs. 740, 785). Southern Florida *Planorbella (Seminolina) scalaris* (Jay)



FAMILY ANCYLIDAE

The Ancyliidae are another of the gastropod families with a world-wide distribution. In North America, they all have small cap-shaped (patelliform, ancyliiform, limpet-shaped) shells in which the apices are on the right side, or tilted toward the right (Fig. 755b). Among freshwater limpets, such a shell has been derived from ancestors with sinistrally coiled shells, and in the Ancyliidae the arrangement of the body morphology is always sinistral, i.e., the "gill" (pseudobranch), and the pulmonary, reproductive and excretory openings are all on the animal's left side. The two other North American freshwater snail families with members having patelliform shells, the Acroloxidae and the Lymnaeidae (Lancinae), are dextral in organization.

The Ancyliidae seem to be closely related to the Planorbidae, but they differ from the latter in one conspicuous way: all ancyliids have haemocyanin as their blood pigment rather than haemoglobin (which gives the planorbids their red body color). Within the Ancyliidae, the North American genus *Rhodacmea* is most closely related to the Eurasian and North African genus *Ancylus*.

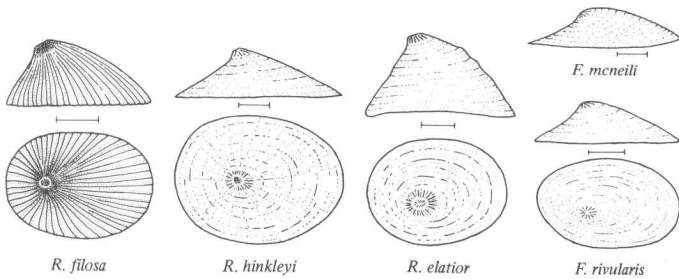
Among the ancyliid subfamilies, the Ferrissinae have the widest distribution, both naturally and artificially. Pond species seem to be easily transported through human activities; riverine species are less tolerant.

Identification Key for the Ancyliidae⁹⁹

1 Shell elevated, apex in midline, tinged with pink or red inside and out, radially striate, with a notch-shaped depression evident in unworn specimens. Apertural lip broad and flat. Radular teeth in rows about 30 microns apart, with prominent inner cusps (Fig. 786)¹⁰¹. Penis simple, without a flagellum. In rivers in the southeastern states. Genus *Rhodacmea* 2

Shell elevated or depressed, apex in midline or to the right, the same color as the rest of the shell, finely radially striate or smooth. Apertural lip arched or flat, broad or narrow. Radular teeth in rows about 6-10 microns apart, without prominent inner cusps (Fig. 786)¹⁰¹. Penis with or without a flagellum. Widely distributed in running or standing water 4

- 2(1) Shell more or less ribbed with strong radiating lines extending from the apex to the apertural lip (Figs. 757, 759) *Rhodacmea filosa* (Conrad)
 Shell smooth, or nearly so 3
- 3(2) Shell moderately elevated, apex usually conspicuous in older specimens. Posterior slope straight or slightly concave; anterior slope straight or slightly convex (Figs. 758, 760) *Rhodacmea hinkleyi* (Walker)
 Shell very elevated, apex usually eroded in older specimens. Posterior slope straight or slightly convex, anterior slope clearly convex (Fig. 756) *Rhodacmea elatior* (Anthony)
- 4(1) Shell usually elevated, but variable. Apex with fine radial striae, often eroded in older specimens. Aperture narrow to broadly ovate, entirely open or with a horizontal shelf-like septum closing the posterior part. Pseudobranch of one lobe, flat. Penis with a flagellum. Widely distributed in streams and standing water. Genus *Ferrissia* 5
 Shell usually depressed. Apex smooth, with no trace of radial striae. Aperture ovate to subcircular, always open. Penis with or without a flagellum. Pseudobranch of two lobes, the lower of which is elaborately folded. In standing water, principally in eastern states and south 9
- 5(4) Shell thin, fragile, very much depressed, often a glossy red-brown color. Apex fairly prominent as a rounded bump in the right posterior quadrant. Length of shell to about 5 mm (Fig. 766). In streams in southern Alabama *Ferrissia mcneili* Walker
 Shell not as above, usually more elevated, color variable from straw-yellow to dark gray. Apex prominent to obtuse, in the midline or to the right. Length from 2 to 10 mm. Widely distributed in various habitats 6
- 6(5) Shell robust, to 7 mm long, elevated, aperture elliptical. Apex in midline or slightly to the right; anterior slope convex, posterior slope gently concave, lateral slopes approximately straight. Calcareous material often thick inside the shell (Figs. 761, 767). Many populations are smaller, especially those west of the Rocky Mountains. Widely distributed in North America in rivers and streams *Ferrissia rivularis* (Say)
 Shell not as above; habitat in standing water 7
- 7(6) Shell large, elevated, very narrow, length to 9 mm. Apex obtuse, in the midline; posterior slope flat or gently concave; lateral slopes straight or faintly concave. Apertural lip often arched. Canada and adjacent states, on vegetation in lakes *Ferrissia parallelus* (Haldeman)
 Shell in standing water, but not as above 8



- 8(7) Shell depressed or moderately elevated, less than 4 mm long, rarely exceeding 3.5 mm, with or without a shelf-like septum across the posterior part of the aperture. When non-septate, the aperture is distinctly oval, wider anteriorly. When septate, the shell is evenly elliptical. Secondary growth may be present (Figs. 764, 765). Widely distributed in eastern United States in ditches and other small bodies of standing water, often temporary, and usually stagnant *Ferrissia fragilis* (Tryon)

Shell to 6 mm long, usually depressed; aperture clearly oval, wider anteriorly, septum never present. Apex subacute, often far in the right posterior quadrant. Anterior and left slopes convex, posterior and right slopes concave (Fig. 768). Widely distributed, reported from Arkansas, Michigan and southern California on vegetation and debris in ponds *Ferrissia walkeri* (Pilsbry & Ferriss)

- 9(4) Apex subacute, distinctly eccentric, to the right of the midline (Figs. 762, 769). Penis with a long glandular flagellum terminating in a bulbous tip; preputium without pigment. Tentacles colorless. In southern Florida, and perhaps Texas, in canals, etc. *Hebetancyus excentricus* (Morelet)

Apex very obtuse, almost in the midline of the shell. Penis without a flagellum; preputium flecked with pigment spots. Tentacles with a central core of black pigment. Principally east of the Mississippi in ponds and river backwaters; occasionally in streams in south-central states. Genus *Laevapex* 10

- 10(9) Shell ovate, smooth or with fine raised riblets usually on the anterior slope (Figs. 763, 771). Widely distributed in eastern North America in still water on submerged vegetation or debris, typically in the back-water areas of rivers or in lakes *Laevapex fuscus* (Adams)

Shell subcircular, smooth, often encrusted with dark material (Fig. 770). In slowly flowing streams, south-central and eastern states *Laevapex diaphanus* (Haldeman)

