NORTH AMERICAN FRESHWATER SNAILS

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V. KEYS TO THE FRESHWATER GASTROPODS OF NORTH AMERICA

* * *

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1 Animal with an operculum (which seals the shell aperture when the snail's body is withdrawn into the shell) (Fig. 772); respiration by gills; mantle opening facing anteriorly.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

Animal without an operculum to seal its shell aperture when withdrawn; respiration by the vascularized lining of the mantle cavity (true gills are lacking) or by a pseudobranch (false gill) outside the mantle cavity (Fig. 773a);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

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 columnellar margin of the aperture; operculum calcareous, paucispiral, with a pair of projecting processes on the inner columnellar 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

2 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 monoplectinate (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(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

3 Family VALVATIDAE (page 223)

*Measurement lines on illustrations throughout this section indicate millimeters.

(217)
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.
IDENTIFICATION KEYS

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 (Viviparoidea) .................................................. 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. 81 a). 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, turriform; 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 (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 3/4 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. Ancyliform 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 valvatid 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 VIVIPARIDAE (page 227)

11(1) Shell coiled ............................................................................. 12

Shell an uncoiled, obtuse cone (limpet- or cap-shaped) (Fig. 778) ..................... 14

12(11) Animal and shell dextral (coiled to the right) (Figs. 773b, 774b). Superfamily Lymnaeoida, 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 pseudodextral 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 Lymnaeoida, 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 Acroloxoidae ....................................................... Family ACROLOXIDAE (page 247)
NORTH AMERICAN FRESHWATER SNAILS

RHIPIDOGLOSSA (=ZYGOBRANCHIA + ASPIDOBRANCHIA, =DIOTOCARDIA)
All the Archaeogastropoda [all marine] except the limpets (i.e., except the so-called Docoglossa: Acmaeidae, Patellidae and Lepetidae).

The Neritacea [marine, freshwater and land].

DOCOGLOSSA (=PATELLOIDEA)
The archaeogastropod limpets [all marine].
Families Acmaeidae Patellidae Lepetidae

TAENIOGLOSSA
Contains most of the mesogastropods [marine and freshwater], and in North American freshwaters all the Prosobranchia except the Neritacea.

PTENOGLOSSA (=EPITONIOIDEA)
Contains the specialized Epitoniidae (=Scalidae) and Janthinidae [both marine].

RACHIGLOSSA
Contains many of the neogastropods [nearly all marine].

TOXOGLOSSA
Radula consists of only long teeth (marginals). The name refers to the poison gland associated with the radula of Conus [all marine].
Families Mitridae (restr.) Conidae Terebridae Turridae

GYMNOGLOSSA
No radula; radula not needed because of parasitic existence.
Eulimidae - a mesogastropod [marine] family.

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 Ancylidea, in part ............ Family ANCYLIDAE (page 261)

Acroloxidae
Ancylidae
Neritina reclivata

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 reclivata (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 Ojos, Florida. Both of these may be simply “forms” of N. reclivata.

The shells of neritids are usually subglobose or hemispherical, have few whorls, very reduced spires and very large body whors. 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 reclivata palmae Dall is “quite small [maximum length l cm], . . . black, with a cerous labrum, but the light zigzag lines, characteristic of some color varieties of reclivata, [are] beautifully clear by transmitted light” (Dall, 1885).

The shell of Neritina reclivata sphaera Pilsbry “is less elevated than N. reclivata, the spire extremely short, rising very little, the last whorl strongly convex above the periphery, not flattened and sloping as in reclivata. Color grape green, densely marked with fine black lines and with a black line following the suture, as in reclivata” (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 Borysthenia 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 whors, are dextral, and vary in form from discoid to high-turbinate. The nuclear whors 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

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1 Superscript 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

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 *unicarinata* DeKay

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

\[\text{V. } b. \text{ bicarinata} \quad \text{V. } b. \text{ m. normalis} \quad \text{V. } b. \text{ m. ontarioensis} \quad \text{V. } t. \text{ tricarinata} \quad \text{V. winnebagoensis}\]
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)

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)
   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).*
Oперкулum 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 Campeloma4 ..................................... 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)
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 globosely 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 .............................. \textit{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 .............................. \textit{Viviparus georgianus} (Lea)

\begin{center}
\begin{tabular}{ccc}
& \textit{V. subpurpureus} & \textit{V. georgianus} \\
& \textit{C. floridense} & \textit{C. geniculum} \\
& \textit{C. crassula} & \\
\end{tabular}
\end{center}

13(10) Inside of shell aperture deep reddish-brown or brown (Fig. 62); shell of newborn young uniformly dark brown. Eastern Florida .... \textit{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 .............................. \textit{Campeloma geniculum} (Conrad)

Shell narrowly ovate (Fig. 41). Atlantic drainage from North Carolina to Georgia .............................. \textit{Campeloma limum} (Anthony)

16(14) Shell narrow, relatively thin, generally with prominent raised spiral lines (Fig. 56). Northern Alabama .............................. \textit{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 .............................. \textit{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 .............................. \textit{Campeloma crassula} Rafinesque

Shell medium or a little larger, relatively thin to strong, but not very large or heavy and ponderous ............................. 19

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

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**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)

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**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, pallial 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. *Emmericiella* occurs in Mexico, and the monotypic *Antroselates* occurs in caves in southern Indiana and western 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 neritiniform (Figs. 192, 193, 779). Cahaba and Coosa rivers, Alabama .............. Lephyrium 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
   Eastern in distribution, in the Mississippi, Gulf and Atlantic drainages ................. 7

L. showalteri

F. fusca
F. columbiana

Fluminicola
IDENTIFICATION KEYS

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

8(7) Shell with spirally striate apical whorls. Subgenus *Walkerilla* 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.* 9

9(8) Spire very depressed (Figs. 150, 186, 196). Catawba and Coosa rivers, Alabama. *Somatogyrus (Walkerilla) coosaensis* Walker 9

Spire not depressed. Georgia and Virginia ........................................ 10

10(9) Shell perforate (Figs. 89, 197, 201). Broad River, Georgia. *Somatogyrus (Walkerilla) tenax* Thompson 10

Shell imperforate (Fig. 187). Rapidan River, Virginia. *Somatogyrus (Walkerilla) virginicus* Walker 10

11(5) Shell small (less than 2.5 mm in length), aperture round, columella thin (Fig. 138). Missouri. *Antrobia culveri* Hubricht 12

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) 14

Shell aperture broader, less elongate, spire relatively attenuate, umbilicus smaller, animal white. Cahaba River, Alabama. *Clappia cahabensis* Clench 14

13(2) Males with verges bearing accessory lobes (Fig. 82b). Subfamily Hydrobiinae 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) 15

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 ............................... 16

Southern and western in distribution ................................................ Hoyia sheldoni (Pilsbry) 67

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)

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)

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)

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)

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. *Aphaostracon*

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. *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), globose 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
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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 Marstonia70 .................................. 32
Shell subglobose; verge with a long, slender flagellar penis (Figs. 91, 257,
262). Chipola river drainage, Florida70 .................................................. Rhapinema 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 ogmophaphe* 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

Shell broadly conical, globose or ovate. Widely distributed (Figs. 189, 190, 199, 200, 203-213, 222-228, 235, 236) Genus *Cincinnatis* 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 carinate 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

Shell conical, narrowly ovate to globose conic, whorls rounded, not angulate or carinate. Genus *Fontelicella*

49(48) Periphery of body whorl concave (Fig. 274). Upper Klamath Lake, Oregon

............................................... *Pyrgulopsis archimedes* 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

Shell globose conic, minute (that of adults is less than 2 mm in length) (Figs. 231, 244). Subgenus *Microamnicola*. California and Nevada

............................................... *Fontelicella (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 *Fontelicella* 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

Males with three-ducted verges (Fig. 82e). Subfamily Fontigentinae (Figs. 283, 310-315, 319). Widely distributed in eastern North America Genus *Fontigens* 71
IDENTIFICATION KEYS

53(52) Shell ovate or turbinate to globosely conic. Widely distributed. Genus *Amnicola* ........................................................... 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 *Amnicola* 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 micro* (Pilsbry & Ferriss)73

Shell subdiscoidal, spire noticeably raised above the body whorl (Fig. 316). Texas .................. *Horatia nugax* (Pilsbry & Ferriss)73

A. I. limosa

A. decisa

A. (L.) pupoidea

A. (L.) walkeri

Horatia nugax

P. cincinnatiensis

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

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**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/serithoid 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 *Melanoides* 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. *Melanoides 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. *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 canalculated 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 fluvialis* (Say)

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(1) Terminal whorl with a posterior slit along the sutural juncture. Coosa River, Alabama. Genus *Gyrotoma* ..................... 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 ................................................. Gyrotroma 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 ................................ Gyrotroma 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 ................................. Gyrotroma 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 ................................................. Gyrotroma 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 ................................................. Gyrotroma 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 ................................................. Gyrotroma excisum (Lea)

8(2) Lateral radular teeth with broad, bluntly rounded or cleaver-like median cusps; shell medium to small, subglobose, globose 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
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)

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)

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)

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*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 globosey 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)
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*); 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

\[ L. \text{ g. geniculata} \quad L. \text{ (A.) armigera} \quad P. \text{ c. filum} \quad P. \text{ (S.) corpulentum} \quad E. \text{ l. livescens} \quad J. \text{ silicula} \]
IDENTIFICATION KEYS

FAMILY ACROLOXIDAE

The family Acroloxidae 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 Ancylidae, 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 Ancylidae 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.

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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 Lanciae, which occur only in the Pacific drainage region, can be distinguished from the Ancylidae 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 Ancylidae. 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 Lanciae

   2

   Shell coiled. Common throughout North America. Subfamily Lymnaeinae

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  

   4

   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 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

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* .......... 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 arkaensis* 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 ................................ Bulinnea 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 striations; columella usually with a well-developed twist or plait (Figs. 595-631). Widely distributed in North America ................. Genus Stagnicola43, 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 Fossaria41 .................. 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, characteristic of most other members of the family, are absent or poorly developed. The columella is most commonly smooth, without a twist or plait.

The type species of Fossaria is the Holarctic (but mainly Eurasian) F. truncatula (Müller)11. 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 unidentifiable (Pilsbry & Bequaert, 1927). Other synonyms are Simpsonia F. C. Baker 1911, preempted 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 species ("Lymnaea" bulimoides, "L." cubensis and "L." humilis), but that amount of "lumping" 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, preempted by Nasonia Ashmead 1904) with Stagnicola. However, they are more closely allied to Fossaria.]

15(14) Adult shell (with about five whors) 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. walkeriana  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 (cyclostomoid) (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)

20(17) Whorls regularly increasing in size, terminating in a tumid, ovate body whorl; whorls evenly convex; aperture oval. 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 Lymnaeas. ... 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."

![Fossaria shells](image-url)
exigua [Fig. 573] — "... appears quite separable from obrussa. The spire is usually long and a whorls flatter rounded, the body whorls 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 obrussa, and the inner lip is peculiarly flattened near the umbilical region, giving rise to a pseudoplaat. Some specimens resemble modicella rustic a, 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 roundly 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. Obrussa is larger and more elongated and the inner lip is notably compressed and bent inward at its junction with the parietal wall."

peninsulae [Fig. 576] — "... differs from typical obrussa 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 [obrussa]."

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 confused with forms of exigua, but in that species the aperture is longer and narrower and inclined to be squarish, while in rustic a it is more acutely rounded at the extremities. The spire in rustic a is longer and more acute than in exigua, the spire whorls being less inflated. Half-grown specimens of obrussa 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 rustic a 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 obrussa 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)

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) bullimoides group

F. exigua  F. modicella  F. peninsulae  F. rustic a  F. (B.) sonomaensis
[Shells of the Fossaria (Bakerilymnae) 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 alberta 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).

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

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 Lymnaeidae 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 the similar forms of the type locality. They were probably 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).

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
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)

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**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 Ancylidae, 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 Physidae

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 *Stenophyta*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 (Guilding)

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)

Shell subglobose, globular; shell surface dull; spire very short (Fig. 698).
Utah ........................................... Physella (Petrophysa) zionis (Pilsbry)

S. marmorata  S. maugeriae  A. elongata  P. (P.) zionis  G. (A.) crista

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 dex-
tral-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 pneumo-
stome 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 Ancylidae, and some authors (e.g., Staroboga-
tov, 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
IDENTIFICATION KEYS  

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 Neoplanorbis62, 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.  
\[\text{Drepanotrema (Fossulorbis) kermatoides (d'Orbigny)}\]

Shell periphery rounded or obtusely angular (Fig. 715). Southern Texas.  
\[\text{Drepanotrema (Fossulorbis) cimex (Moricand)}\]

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.  
\[\text{Menetus (Micromenetus) sampsoni (Sampson)}\]

Height of body whorl nearly equal from one side to the other. Genus \textit{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. 
\[\text{Subgenus \textit{Gyraulus} s.s. (Fig. 705). Canada and northern United States from Maine to Virginia and west to Idaho. \textit{Gyraulus deflectus} (Say)}\]

Adult shells 3 to 5 mm in diameter, variable, with the body whorl evenly rounded or with upper lateral surface slightly flattened; without a peripheral keel or a hirsute periostracum or malleated surface. 
\[\text{Subgenus \textit{Torquis}}\]

15(14)  Shell relatively high (Fig. 708). Canada, North Dakota and Wisconsin.  
\[\text{Gyraulus (Torquis) hornensis F.C. Baker}\]

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 drying (Fig. 707). Canada and northern United States, south in the Rocky Mountains to New Mexico.  
\[\text{Gyraulus (Torquis) circumstriatus (Tryon)}\]

Shell brownish, translucent but not transparent, not planispiral but with apical and umbilical aspects clearly different. Characteristic of permanent and (occasionally) temporary aquatic habitats (Fig. 709). Widely distributed throughout North America.  
\[\text{Gyraulus (Torquis) parvus (Say)}\]

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)

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)

Relative height of body whorl nearly equal from one side to the other (Fig. 746). Widely distributed in North America .................. *Promenetus exacuous* (Say)

20(17) Relative height of body whorl rapidly increasing (Figs. 724, 726). Widely distributed in the eastern United States ..................

........................................... *Menetus (Micromenetus) dilatatus* (Gould)

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)

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)

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. \( \text{Planorbula armigera armigera} \) (Say)

Body whorl without lamellae or “teeth” ........................................ 27

27(26) Shell with few, rapidly increasing whorls; body whorl disproportionately large. Genus \( \text{Vorticifex} \), subgenus \( \text{Parapholyx} \).\(^6\) 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. \( \text{Vorticifex (Parapholyx) solida} \) (Dall)\(^6\)

Whorl not angular or subangular around the basal columellar area (Fig. 748). Rivers and lakes in California and Oregon. \( \text{Vorticifex (Parapholyx) effusa} \) (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 \( \text{Helisoma} \) .................................................. 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 \( \text{Planorbella} \) ........................................ 35

30(29) Shell concave on both sides. Subgenus \( \text{Helisoma} \) s.s. ........................................ 31

Shell concave on the left side, convex on the right side. Western in distribution. Subgenus \( \text{Carinifex} \) ........................................ 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. \( \text{Helisoma eucosmium} \) (Bartsch)\(^5\)

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. \( \text{Helisoma anceps anceps} \) (Menke)\(^5\)

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. \( \text{Helisoma anceps royalense} \) (Walker)\(^5\)
IDENTIFICATION KEYS

33(30) Widely distributed and quite variable (Figs. 720, 721). California, Idaho, Nevada, Oregon and Utah. \[ Helisoma (Carinifex) newberryi \] newberryi (Lea)

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. 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 \[ Pierosoma \] 39

Shell surface usually glossy, relatively smooth, without raised transverse thread-like striae (Figs. 738-740). Florida. Subgenus \[ Seminolina \] 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. \[ Planorbella (Pierosoma) oregonensis \] (Tryon)

Shell larger, adults 15-30 mm in major diameter. 41

\[ H. (C.) \] \textit{n. newberryi} \quad P. multivolvis \quad P. c. campanulata
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) group.

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).

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

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).

Carinae cord-like, strong and acutely angled; body whorl flat or concave abaxially. Northern Minnesota. .................. Planorbella (Pierosoma) corpulenta vermitionensis (F.C. Baker).

Carinae not cord-like. .................. 45

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).

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).

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. .................. 47

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).
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 Ancylidae are another of the gastropod families with a world-wide distribution. In North America, they all have small cap-shaped (patelliform, ancyliform, 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 Ancylidae 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 Ancylidae seem to be closely related to the Planorbidae, but they differ from the latter in one conspicuous way: all ancylids have haemocyanin as their blood pigment rather than haemoglobin (which gives the planorbid their red body color). Within the Ancylidae, the North American genus *Rhodacmea* is most closely related to the Eurasian and North African genus *Ancylus*.

Among the ancylid 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 Ancylidae**\(^99\)

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: 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 ........................................ Ferrisia 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 ........................................ Ferrisia 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. .................... Hebetancylus 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 backwater 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)
VI. GENERIC SYNONYM

Acroluxus Keep 1887 = misspelling of Acroloxus Beck 1837. ("Acroluxus Nuttalli, Hald." in Keep (1887) = Fisherola nuttalli (Haldeman 1841).)

Alleghenya Clench & Boss 1967 = Mudalia Haldeman 1840.

Anarula Sowerby 1842 = Thiara Röding 1798.

Amblostopoma Rafinesque (in Binney) 1865 = Ambioxis Rafinesque 1818, which is an unidentifiable name. Both names have the same type species, A. eburnea Rafinesque (in Binney) 1865.

Ambioxis Rafinesque 1818 = an unidentifiable name; occasionally mentioned as possibly being the same as Campeloma Rafinesque 1819.

Ambloxis Rafinesque 1831 = Thiara Röding 1798.

Ameria Dall 1870, preoccupied = Seminolina Pilsbry 1934.

Ampullaria Lamarck 1799 = Pila Röding 1798, a genus of Africa and Asia. In the earlier literature, species of Pomacea were erroneously assigned to the genus Ampullaria.

Ampullarius Montfort 1810 = Pomacea Perry 1810.

Anaplocamus Dall 1895 = Mudalia Haldeman 1840.

Anculosa Say 1821 = Leptoxis Rafinesque 1819.

Anculotus Say 1825 = emendation of Anculosa Say 1821 = Leptoxis Rafinesque 1819.

Ancylus Müller 1774 = a genus of the Palaearctic and Ethiopian regions. In the earlier literature, many or most ancylid species of the Western Hemisphere, as well as the patelliform Lymnaedi-, were erroneously assigned to the genus Ancylus.

Apella ‘Mighels’ Anthony 1843 = Gyrotoma Shuttleworth 1845. Apella is an invalid name based on an unknown species.

Aphella "‘Mighels’ Anthony” Hannibal 1912 = misspelling of Apella ‘Mighels’ Anthony 1843 = Gyrotoma Shuttleworth 1845.


Australorbis Pilsbry 1934 = Biomphalaria Preston 1910.

Bithinia Gray 1824 = Bithynia Leach (in Abel) 1818.

Bovillina Dall 1924 = Orygoceras Brusina 1882.

Bulimnea ‘Haldeman’ Hubendick 1951 = misspelling of Bulimnea Haldeman 1841.

Bulimula Dall 1885 = Bithynia Leach (in Abel) 1818.

Bulimus Scopoli 1777, suppressed by the International Commission on Zoological Nomenclature, Opinion 475, 1957 = Bithynia Leach (in Abel) 1818.

Bulinus Müller 1781 = a planorbid genus of Africa, the Mediterranean region, the Middle East, and some of the Indian Ocean islands. In the earlier literature, it was occasionally used erroneously for members of the Physidae, including North American Aplexa.

Bythinella Moquin-Tandon 1856 = a European genus; it is not known to occur in North America.

Bythina MacGillivray 1843 = Bithynia Leach (in Abel) 1818.

Callina Hannibal 1912 = Viviparus Montfort 1810.

Carnifex Keep 1893 = misspelling of Carinifex W.G. Binney 1865.

Ceratodes Guilding 1828 = Marisa Gray 1824.

Ceriphasia Swainson 1840 = Pleurocera Rafinesque 1818.

Chilocyclus Gill 1863 = Pomatiopsis Tryon 1862.
Cincinna Hübner 1810 = Valvata Müller 1774.
Cochliopa Stimpson 1865 = a genus of Panama; not found in North America (see Morrison, 1946).
Conchylium Cuvier 1816 = Pomacea Perry 1810.
Costella Meek 1876 = Costatella Dall 1870.
Cyclemis Rafinesque 1819, undeterminable = ? Viviparus Montfort 1810.
Cyclostoma Lamarck 1799 = Epitonium Röding 1798, a marine snail; Cyclostoma Draparnaud 1801 = Pomatias Studer 1789, a land snail. Some North American freshwater truncatelloid snails have previously been erroneously assigned this generic name.
Dentatus ‘Beck’ Gray 1847 = Planorbula Haldeman 1840.
Discus Haldeman 1840, preoccupied = Planorbula Haldeman 1840.
Elliptostoma Rafinesque 1818 = an unidentifiable name.
Euamnicola Crosse & Fischer 1891 = Amnicola Gould & Haldeman 1840.
Eurycaelon Lea 1864 = Lithasia Haldeman 1840.
Galba Schrank 1803 = a nomen dubium, based on an unidentifiable species (Galba pusilla Schrank 1803). In the past, Galba has been used unfortunately sometimes in place of Fossaria or Stagnicola.
Glottella Gray 1847 = Angitremia Haldeman 1841.
Goniobasis Lea 1862 = Elimia H. & A. Adams 1854. The type species of Goniobasis is Goniobasis osculata Lea 1862, selected by Hannibal (1912), which he said is the same as Melania olivula Conrad 1834. However, Goodrich (1936, 1941c) considered Lea's osculata to be a synonym of Melania ['Goniobasis'] alabamensis Lea 1861 and Conrad's olivula to be a distinct species. Both belong to the genus Elimia.
Gundulacia Pfeiffer 1849, type G. ancylliformis Pfeiffer 1849, by monotypy = a growth variant of Ancylus havanensis Pfeiffer 1839, which is a synonym of Ancylus radiatus Guilding 1829 (fide Harry & Hubendick, 1964). Not known to occur in the continental U.S.A. or Canada. Septate ancylids of North America (north of Mexico) are referable to the genus Ferrissia.
Haldemania Clessin 1880, preoccupied = Ferrissia Walker 1903.
Haldemania Tryon 1862 = Lioplax Troschel 1856.
Haldemanina Dall 1905 = Planorbula Haldeman 1840.
Helicosoma Agassiz 1846 = Helisoma Swainson 1840.
Hydrobia Hartmann 1821 = a genus of Europe; it does not occur in North American fresh waters.
In the earlier literature, many species of freshwater truncatelloid snails of the Western Hemisphere were assigned erroneously to this genus.
Hydrognoma Gistel 1848 = Thiara Röding 1798.
Hypsogyra Lindholm 1927 = Planorbella Haldeman 1842.
Ibicornu Dall 1924 = Orygoceras Brusina 1882.
Incilicornu Dall 1924 = Orygoceras Brusina 1882.
Kincalidilla Hannibal 1912 = Ferrissia Walker 1903.
Laphrostoma Rafinesque 1815, nomen nudum = Neritina Lamarck 1816.
Lecythoconcha Annandale 1920 = Cipangopaludina Hannibal 1912.
Leptolimnea Swainson 1840, type species Buccinum glabra Müller 1774 = a European species.
Limnaea Blainville 1824 = Lymnaea Lamarck 1799.
Limnea Link 1807 = Lymnaea Lamarck 1799.
Limnesus Draparnaud 1801 = Lymnaea Lamarck 1799.
Limnophyse Fitzinger 1833 = Stagnicola Leach (in Jeffreys) 1830.
Lithogyphus Hartman 1821 = a European genus, possibly congeneric with the North American Pluminicola Stimpson 1865 (see note 10, p. 269).
Lithopariches Gistel 1848 = Thiara Röding 1798.
Lutella Haldeman 1840 = Bithynia Leach (in Abel) 1818.
Lymnaeus Cuvier 1817 = Lymnaea Lamarck 1799.
Lymneus Brand 1810 = Lymnaea Lamarck 1799.
Lynmula Rafinesque 1819 = Lymnaea Lamarck 1799.
Lymnulus Rafinesque (in Binney) 1865 = Ambloxis Rafinesque 1818, which is an unidentifiable name. Both names have the same type species, A. eburnea Rafinesque (in Binney) 1865.

Lymnus Montfort 1810 = Lymnaea Lamarck 1799.

Lythasia 'Lea' H. & A. Adams 1854 = spelling variation of Lithasia Haldeman 1840.

Macrolimen Lea 1862 = Elimia H. & A. Adams 1854.

Megara H. & A. Adams 1854 = Angitrema Haldeman 1841.

Megasystropha Walker 1918 = misspelling of Megasy神州pha Lea 1864.


Melacantha Swainson 1840 = Thiara Roding 1798.

Melafusus Swainson 1840 = Lea 1831.

Melania Lamarck 1799 = Thiara Roding 1798.

Melanidia Rafinesque 1815 = Melania Lamarck 1799 = Thiara Roding 1798.

Melantho Bowdich 1822 = Campeloma Rafinesque 1819.

Melas Montfort 1810 = Thiara Roding 1798.

Melasma H. & A. Adams 1854 = Elimia H. & A. Adams 1854.

Melatoma Swainson 1840 = a marine group.

Meseschiza Lea 1864 = Angitrema Haldeman 1841.

Meseshiza Lea 1876 = spelling error of Meseschiza = Angitrema Haldeman 1841.


Nauta Leach (in Turton) 1831 = Aplexa Fleming 1820.

Nautilus Linnaeus 1758 = a tetrabranch cephalopod. Used for Gyraulus (Armiger) crista (Linnaeus 1758) in the original species description.

Nerita Linnaeus 1758 = a marine genus, not found in North American fresh waters.

Nitocris H. & A. Adams 1854 = Mudalia Haldeman 1840.

Nystalia Rafinesque 1819, undeterminable = ? Viviparus Montfort 1810.

Omphesina Rafinesque 1819 = an unidentifiable name.

Oxytrema Rafinesque 1819 = nomen dubium.

Paludina Lamarck (in Ferussac) 1812 = Viviparus Montfort 1810.

Paradines Dall 1924 = Vorticifex Meek (in Dall) 1870.


Physina Rafinesque 1815 = Physa Draparnaud 1801.

Physodon Haldeman 1843 = Physella Haldeman 1843.


Planorbus Müller 1774 = a genus of the Palaeartic and Ethiopian regions. In the earlier literature, many or most planorbid species of the Western Hemisphere were assigned erroneously to the genus Planorbus.

Planorbulina Martens 1899, preoccupied = Planorbulina Haldeman 1840.

Pleurovalvata Haas 1939 = Valvata Müller 1774.

Pompholycodea Lindholm 1927 = Parapholyx Hanna 1922.

Pompholyx Lea 1856, preoccupied = Parapholyx Hanna 1922.

Potamopyrgus Stimpson 1865 = a New Zealand genus; P. jenkinsi (Smith) has been introduced to and is widely distributed in Britain and Europe, but as yet no species of Potamopyrgus is known to occur in North America. North American species previously referred to Potamopyrgus are now assigned to other genera.

Pseudagalba F.C. Baker 1913 = Fossaria Westerlund 1885.
Pyrgula Cristofori & Jan 1832 = a genus of Europe; it does not occur in North American fresh waters. In earlier literature, some species of North American truncatelloid snails were assigned erroneously to this genus.

Rhodocephala Walker 1917 = Rhodacmea Walker 1917.

Scaphe 'Clein' Mörch 1852 = Vitta Mörch 1852, the North American subgenus of freshwater Neritinia.

Schizochilus Lea 1853 = Gyrotema Shuttleworth 1845.

Schizostoma Lea 1843, preoccupied = Gyrotema Shuttleworth 1845.

Segmentina Fleming 1817 = a genus of the Palaeartic region. In the earlier literature, species of Planorbula sometimes erroneously were assigned to the genus Segmentina.


Spirodon ‘Anthony’ Tryon 1873 = Mudalia Haldeman 1840.

Stimpsonia Clessin 1878, preoccupied = Fontigens Pilsbry 1933.

Strepoma ‘Rafinesque ms.’ Haldeman 1863 = Pleurocera Rafinesque 1818.


Telescopella Gray 1847 = Pleurocera Rafinesque 1818.

Thomsonia Ancey 1886, preoccupied = Seminolina Pilsbry 1934.

Tiara Hermannsen 1849, preoccupied = Thiara Röding 1798.

Tropidina H. & A. Adams 1854 = Valvata Müller 1774.

Trypanostoma Lea 1862 = Pleurocera Rafinesque 1818.

Tylotoma ‘Haldeman’ Fischer 1885 = emendation for Tulotoma Haldeman 1840.


Velletea Haldeman 1841 = spelling variation of Velletia Gray (in Turton) 1840 = Acroloxus Beck 1837. (Ancylus (Velletea) nuttalli Haldeman 1841 = Fisherola nuttalli (Haldeman 1841).)

Vivipara Sowerby 1818 = Viviparus Montfort 1810.

Viviparella Rafinesque 1815 = Viviparus Montfort 1810.
VII. SUPPLEMENTAL NOTES*

1 The name Neritidae has been credited consistently to Rafinesque (1815). However, the family name he used was Neritinia [=Neritinidae] ("Les Neritines"). In this family he listed two subfamilies and a number of generic names, which included Nerita and Nerita (both under "Famille, Neritinia"). But, since Neritinidae is a nomen oblitum, it seems best to use the better known name Neritidae.

2 The following figures are by John L. Tottenham: Figs. 21-80, 125, 128-142, 188, 189, 191-200, 222-234, 249-259, 290, 305-308, 319-344, 355-367, 391-414, 426-457, 468-527, 550-572, 581-702, 705-714, 716-724, 728-750, 759-763. Many of the other figures are by the author. Additionally, various illustrations were taken from published sources, and in each case credit is given in the legends beneath the figures. Figs. 83-106, 109-124, 201, 204-218, 220, 221, 247, 260, 262-267, 269, 275, 276, 278-281 and 284 are used with permission of the University of Florida Press.

3 Shells of the genus Tulotoma are unique among North American Viviparidae by their usual nodular appearance, and by their oblique apertures with concave margins (Fig. 783).

Only one species of Tulotoma is recognized here, T. magnifica (Conrad), although a second species, T. angulata (Lea), is occasionally recognized, as well as a third, T. coosaensis (Lea). A fourth species has been named, T. bimontilfera (Lea), but it is clearly a synonym of T. magnifica. According to Goodrich (1944b), T. coosaensis is the smooth upstream form; T. angulata is transitional between it and the tuberculate T. magnifica. Although in museum collections T. angulata seems to intergrade completely with T. magnifica, the relationship between the two nominal species may not be so simple. Patterson (1965) found T. angulata to have one pair of chromosomes more than Pollister & Pollister (1940, 1943) reported for T. magnifica.

4 Clench (1962a: 277-280) listed 49 names for Campeloma, 34 of which he considered as synonyms of the 14 names he did not synonymize (one species listed (Paludina humerosa Anthony 1860) is not a viviparid, but a pleurocerid). Although not claiming for them the status of species (or subspecies), the names Clench did not synonymize were brevispirum F.C. Baker 1928, crassa Laorfinesque 1819, decampi 'Currier' Binney 1865, decisa Say 1816, exits Anthony 1860, floridense Call 1886, genicula Conrad 1834, gibba Currier 1867, integra Say 1821, leptom Mattox 1940, lima Anthony 1860, milesi Lea 1863, regularis Lea 1841 and tannum Mattox 1940. Clarke (1973: 220) considered "Campeloma leptom and C. tannum [to] differ from C. decisum and C. integra by trivial characters only. They are certainly not distinct species but are simply slightly aberrant populations of C. integra (and probably of C. decisum)." Further, Clarke (loc. cit.) suggested that C. integra, as well as C. milesi, are the same as C. decisum.

5 The name Paludina integra Say 1821 has been applied commonly to a viviparid (as Campeloma integra) (Say...

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*The comments in this section refer to the superscript numbers located at various places in the text.
A. lapidaria [Pomatiopsis lapidaria Paludina glyphus synonymy of nomen dubium) Somatogyrus. Lioplax of Haldeman's (1840) earlier introduction of (1846) designated Say's (1821) (not as listed by Haldeman (1840)), placed the previous description of the genus and of the species (by subsequent wise, Nomenclature will rule favorably on H.B. long to the genus have been published. Until it is shown conclusively that the European and American species are indeed congeneric, is much larger." The shells of Decisum fully belonging to it would seem best to retain the well-known American name, distinction between the two genera "being in the form of the verge." Pilsbry saw "no advantage in recognizing son 1865 and the European should be transferred to 9According to Morrison (1940a), 1847 as type species of Probythinella Thielle 1928.

According to Morrison (1940a), Somatogyrus tryoni Pilsbry & F.C. Baker 1927 and S. virginicus (Walker 1904) should be transferred to Clappia.

According to Pilsbry (1934b), there is no difference in the shell between the American genus Fluminicola Stimpson 1865 and the European Lithoglyphus Hartman 1821 [type species: Paludina naticoides C. Pfeiffer 1828], the distinction between the two genera "being in the form of the verge." Pilsbry saw "no advantage in recognizing Lithoglyphus in America, since its presence does not seem demonstrable" [at that time]. Taylor (1966a,b) combined the two genera, mentioning having examined the verge in most American species, but as yet none of the anatomical data have been published. Until it is shown conclusively that the European and American species are indeed congeneric, it would seem best to retain the well-known American name, Fluminicola.

F.C. Baker (1928c), H.B. Baker (1964) and La Rocque (1968) placed Say's (1829) Melania integra in the genus Somatogyrus.

Somatogyrus virginicus Walker is placed in the subgenus Walkerilla following Thompson (1969).

Pyrgulopsis letsoni (Walker), P. ozarkensis Hinkley, P. scalariformis (Wolf) and P. wabashensis Hinkley may belong to the genus Marstonia (Thompson, 1977).

Marstonia lastrica (Pilsbry 1890) is used here in the expectation that the International Commission on Zoological Nomenclature will rule favorably on H.B. Baker's (1960c) petition to suppress Say's (1821) Paludina lastrica. Otherwise, Amnicola lastrica Pilsbry 1890 is preoccupied by Amnicola lastrica (Say 1821), should the latter (actually a nomen dubium) be considered a member of the genus Amnicola.

Amnicola Gould & Haldeman, as listed in Haldeman (1840, p. 3 and on inside back cover), has as its type species (by subsequent designation by Haldeman, 1840) Paludina lastrica Say 1821. Gould (1841a) gave the first detailed description of the genus and of the species Amnicola porata (Say 1821), and mentioned as included in the genus Paludina limosa Say 1817 and Paludina lastrica Say 1821, although the latter species was considered as only doubtfully belonging to Amnicola (H.B. Baker, 1906c). Later, Haldeman (1845) accepted Amnicola as described by Gould (1841a) (not as listed by Haldeman (1840)), placed the previous "Amnicola lastrica" Haldeman (not of Say) in the synonymy of Amnicola limosa (Say) and recognized Amnicola lastrica (Say) as a distinct species "closely allied to A. lapidaria [Pomatiopsis lapidaria (Say 1817)], of which it may possibly be the young." A year later, Hermannsen (1846) designated Say's (1821) Paludina porata as type species for Amnicola Gould 1841, apparently being unaware of Haldeman's (1840) earlier introduction of Amnicola and designation of Paludina lastrica Say as its type species.
A. walkeri), micra designated as the lectotype of Clarke (1973) selected a "neotype" for mission on Zoological Nomenclature use its plenary powers to suppress the specific be a synonym of Texas, and in a subterranean stream in Manitou Cave, near Fort Payne, Alabama. though still close to subgenus placement in the genus Hubricht (1940b) reported finding specimens of Bourguignat or "Valvata" of the genus Amnicola clarkei, Hubricht (1975) placed into the subgenus Lyogyrus Gill 1863 (see Thompson, 1968), not to Amnicola s.s. as it has been perceived for some 130 years. Thus, Lyogyrus would become a junior subjective synonym of Amnicola s.s. and would contain the group of A. walkeri/pupoidea, and the group of A. porata/limosos would be left without a subgeneric name (unless the European Marstoniopsis should be shown to be cogeneric). Therefore, it seems best to retain the customary concept of Amnicola (with Paludina porata Say 1821 as type species) in hope that the International Commission on Zoological Nomenclature will adopt H. Therefore, Thompson, who has done the most intensive recent work on North American Hydrobiidae (Thompson, 1968, 1969, 1977, 1979) has written (1974) in support of Baker's proposal. The reproductive anatomy has not been described, to my knowledge, of aldrichii Call & Beecher (and its subspecies), bakeriana Pilsbry, clarkei Pilsbry, decisa Haldeman, missouriensis Pilsbry and proserpina Hubricht, so their placement in the genus Amnicola is presumptive. Subsequent studies may alter the generic placement of these species.

From drift debris of the Guadalupe River near New Braunfels, Texas, Pilsbry & Ferriss (1906) named "Valvata" micra and "Valvata" micra nugax, mentioning that they might prove to be "amnicoloid" snails comparable to Horatia Bourguignat or Daudebardiella Boettiger in the Palearctic fauna. Pilsbry (1916d) referred micra and nugax to the subgenus Hauffenia of the genus Horatia. Bole (1970) raised Hauffenia to the status of an independent genus, although still close to Horatia. Taylor (1975) placed micra in the genus Hauffenia and nugax in the genus Horatia. Hubricht (1940b) reported finding specimens of "Horatia" in an artestian well at the U.S. fish hatchery at San Marcos, Texas, and in a subterranean stream in Manitou Cave, near Fort Payne, Alabama.

"Fontigens binneyana (=obtusa Lea 1841 (Paludina), preoccupied by Paludina obtusa Troschel 1837) may prove to be a synonym of Fontigens nickliniana (Lea 1838).

"Fontigens weberi may be extinct. "Fontigens weberi was described as a recent species from a 'bone' specimen from West Lake, Everglades National Park. This species does not occur in the region at present, although shells of this species are common in Pleocene road fill near the lake" (Thompson, 1968: 12).

Hubricht (1960) believes that Pomatiopsis hinkleyi Pilsbry is only a wet habitat form of P. lapidaria (Say).

Following H.B. Baker (1963), I (1978, 1979) previously utilized the family name Paludomidae Gill 1871 instead of the recently commonly used Pleuroceridae Fischer 1885, the previously commonly used Streptomatiidae Haldeman 1863 (based on an invalid manuscript name of Rafinesque), or Pachychilidae Troschel 1857 ("Of the 5 familial names prior to Pleuroceridae Fischer, 1885, all apparently are 'nomen oblitum' except Paludominae Gill, 1871, which was used by Pilsbry as late as 1956"). In spite of its illegal or at least questionable nomenclatural status, Starobogatov (1970) used Pachychilidae Troschel, with Ceriphasudae Gill 1863 and Pleuroceridae Fischer listed as synonyms, for all the North American pleurocerids (Elimia, Gyrotoma, Io, Juga, Mudalia, Pleurocera, etc.). The family name Pachychilidae is based on the Middle American Pachychilus. Starobogatov restricted the Paludomidae to Afro-Asian genera. On the other hand, Morrison (1954) placed the Asiatic Paludomus with the pleurocerids.

However, in spite of the above nomenclatural activity, there are as yet no really solid bases for adequately comparing Pleurocera and its allies with Paludomus and its related taxa or Pachychilus and its relatives. Until the necessary comparative studies have been completed and evaluated, perhaps it is best to retain the family name Pleuroceridae.

A critical revision of the pleurocerids has not yet been made. The generic groups used here are based on classical shell characters, even though it is realized that these characters mostly seem to interpolate at one point or another.
SUPPLEMENTAL NOTES

Animal characteristics of value in pleurocerid systematics are currently so incompletely known that they cannot be used to precisely characterize biological generic groups or to assign the great majority of species to definite nomenclatural generic groups. Pleurocera is used as though *P. acuta* were its type species, in the expectation that the International Commission on Zoological Nomenclature will adopt the long-standing petition to preserve this usage. The identity of *Elliptoma gibbosum* Rafinesque 1818 is too doubtful to give nomenclatural validity to *Elliptoma* Rafinesque 1818.

23 *Elimia* H. & A. Adams 1854 (type species *Melania acutocarinata* Lea 1841 = *Melania clavaeformis* Lea 1841) is used in place of its better known synonym *Goniobasis* Lea 1862 (type species *Goniobasis osculata* Lea 1862).

The classification in the genus *Elimia* presented here, and the distribution of the various recognized species and subspecies, is that of Goodrich (1930a, 1936, 1939d, e, 1940d, 1941a, b, c, 1942b, 1944d, 1945, 1950). No attempt has been made to assess the taxonomic validity of the species and subspecies.

24 *Ellimia perstriata decampi* (Lea) is "possibly only an aberrant form" (Goodrich, 1940d: 16).

25 *Goniobasis (= Elimia) pilsbryi* Goodrich is a replacement name for *Melania (= Elimia) showaltleri* Lea 1861, which is not *Lithasia (= Elimia) showaltleri* Lea 1860.

26 Goodrich (1941c: 20) said that *Elimia ampla* (Anthony) "may simply be an enlarged and conic phase of the [E.] clara of the transition zone."

27 Goodrich (1944d: 44) thought that *Elimia ornata* (Lea) is probably a hybrid of *E. gerhardti* (Lea) and *E. caelatura* (Conrad).

28 The genus *Gyrotoma* is now undoubtedly extinct, due to the biological destruction of the Coosa River. Goodrich (1924a) recognized 13 species in the genus, which he placed into five species groups. However, later (1944d: 46, 47) Goodrich was less certain about this arrangement. "In a study of this genus in 1924 with the unexampled H. H. Smith collections as a basis, the shape and depth of the sutural fissure were relied upon for differentiation among the species. The writer is not so sure, after twenty years, that the thirteen species then recognized by this standard are actually good species. For one thing, the range of the whole genus is only about one hundred and twenty miles of river. The habitats are shoals and reefs over which the currents are heavy. In all the forms, the operculum is large, thick and leathery, the spiral lines nearly obsolete. The radulae, too, are alike. Considering how greatly a given species of *Goniobasis* may vary, and a member of *Pleurocera* more so, it is reasonable to suppose that variation in *Gyrotoma*, including its fissure, may be greater than was supposed in 1924. But in the absence of better information on the subject, the species are listed here as they were then recognized."

In general, I have disregarded the depth of the sutural fissure as a taxonomic character in *Gyrotoma*. Of the 13 species recognized by Goodrich, I have included six in the key: *G. excisum* (Lea), *G. lewisi* (Lea), *G. pagodium* (Lea), *G. pumilum* (Lea), *G. pyramidatum* Shuttleworth and *G. walkeri* Smith. *Gyrotoma hendersoni* Smith, which has a shallow fissure, is placed in the synonymy of *G. pumilum* (Lea), which has a deep fissure. *Gyrotoma alabamensis* (Lea), *G. amplum* (Anthony), *G. cariniferum* (Anthony), *G. incisum* (Lea), *G. laciniatum* (Lea) and *G. spillmani* (Lea) are placed in the synonymy of *G. excisum* (Lea). *Gyrotoma excisum* have deep sutural fissures, as do *G. alabamensis*, *G. cariniferum* and *G. laciniatum*. *Gyrotoma amplum*, *G. incisum* and *G. spillmani* have shallow fissures. These nominal species, here placed in synonymy, are illustrated in Figs. 435-440, 445.

Distributions (all in the Coosa River basin of Alabama) given by Goodrich (1944d) for *Gyrotoma* species are as follows:

- *G. alabamensis*, Peckerwood Shoals, Talladega County, to Duncan’s Riffle, Chilton County;
- *G. amplum*, Talladega to Coosa County;
- *G. cariniferum*, confined to a reef at Fort William Shoals, Talladega County, in swift water;
- *G. excisum*, Three Island Shoals, Talladega County, to Wetumpka;
- *G. hendersoni*, Fort William Shoals only;
- *G. incisum*, Weduska Shoals to Wetumpka;
- *G. laciniatum*, Fort William Shoals to Wetumpka;
- *G. lewisi*, confined to two shoals of Talladega County;
- *G. pagodium*, a lower river form; The Bar, Chilton County, to Wetumpka, Elmore County;
- *G. pumilum*, Weduska Shoals, Shelby County, to Wetumpka;
- *G. pyramidatum*, Ten Island Shoals, St. Clair County, to the mouth of Yellowleaf Creek, Shelby County ("the
first of the genus to appear in the river”

G. spilimanii, known only from two shoals of Talladega County;

G. walkerii, Weduska Shoals to Butting Ram Shoals, Coosa County, a range of only a few miles.

Displacing the well-described and well-known Gyrotoma Shuttleworth 1845 by the obscure and long forgotten “Apella ‘Mighels’ Anthony 1843” (e.g., see Turner, 1946; Clench, 1959a; Davis, 1977) would certainly be an injustice. Apella entered the literature in a sentence in a published (1843) letter from J.G. Anthony as follows. “I have, within two months past, received one species of this genus ["Melatoma Swainson"] from Dr. Mighels, of Portland, Maine, under the name of ‘Apella scissura’.” In 1860, after rejecting Melatoma as pertaining to a North American freshwater snail, Anthony stated, “In 1841 or 1842, Dr. J.W. Mighels sent me specimens of one species under the name of Apella scissura: but his generic name was never published, and his species, if not identical with any which Mr. Lea afterwards described seems to have been overlooked and forgotten.” Anthony then adopted Shuttleworth’s name Gyrotoma, which has been the recognized name (with the exceptions of the use of Lea’s preoccupied Schizostoma, and of Turner’s, Clench’s and Davis’ use of Apella) for the past 118 years. Apella scissura was and is still both a nomen nudum and a nomen dubium.

Io fluvialis (Say) is the largest of the North American Pleuroceridae. It varies in shell form from the smooth fluvialis described by Say (1825), to spinose forms such as spinosa Lea and turrita Anthony. C.C. Adams (1915) treated admirably the monotypic genus Io and its geographic variation. He recognized 14 races or population forms of I. fluvialis: angitreemoides C.C. Adams, brevis Anthony, clinchenensis C.C. Adams, fluvialis Say, loudonensis C.C. Adams, lyttonensis C.C. Adams, nolichuckeyensis C.C. Adams, paulensis C.C. Adams, powellensis C.C. Adams, recta Reeve, spinosa Lea, turrita Anthony, unakensis C.C. Adams and verrucosa Reeve. Several of these forms are illustrated on p. 153 (from Tryon, 1873b).

Io fluvialis form turrita Anthony was reported (Clench, 1928) in the Little River, but this “purported finding has not been verified” (Goodrich, 1940d).

Leptoxis s.s. of the Alabama river drainage is a variable group. Goodrich’s (1922) monograph of them was one of his earliest publications on the Pleuroceridae. In it, clear-cut differences between most of the recognized taxa are not clearly expressed. Later (1941h, 1944d), Goodrich revised slightly his earlier concepts regarding a few of the species, but it would seem that he still recognized too many taxa. However, the Alabama Leptoxis, mostly confined to the Coosa river drainage, are undoubtedly now largely extinct, due to degradation of their habitats.

Leptoxis lilata may be only a form of L. showalteri (Goodrich, 1944d).

In shell characters, especially the nodulose shoulders, Leptoxis crassa seems closer to Lithasia s.s., and is that where I placed it in my 1979 list (Burch, 1979). However, in this manual L. crassa is placed with Leptoxis on radular characters (cf. Goodrich, 1931a, 1932d). Leptoxis crassa and its form anthonyi commonly have been assigned to the genus Eurycaelon on the belief that anthonyi was its type species. However, as pointed out by Morrison (1971), Neville (1885) designated Gonobiastis umberata Lea 1864 (=Anculosa (Lithasia) geniculata Haldemar 1840, s.l. Goodrich (1940d), Morrison (1971)) as the type species of Eurycaelon, which makes Eurycaelon a synonym of Lithasia. Morrison (1971) proposed Athearnia (type species Anculosa anthonyi Redfield 1854) as a replacement name, and this taxon is used here as one of the three subgenera of Leptoxis.

Although Leptoxis crassa anthonyi is given in the list of species (p. 160) as though it were a subspecies of L. crassa, it may not deserve such nomenclatural status. Leptoxis crassa s.s. is probably only a localized race or form (in much the same sense as those of Io, cf. C.C. Adams, 1915) of a much larger complex which customarily has gone under the nomenclaturally junior name anthonyi. In L. crassa, the lumpiness of the shoulders is strongly emphasized, becoming strong, well-developed tubercles. In L. anthonyi, the spine is generally not so depressed as in crassa, and the shoulder is often absent or not prominent and is commonly smooth or with only slight undulations. In both forms, the lower columella terminates in a flange.

On shell characters, Lithasia obovata would seem to belong more naturally to the Elimia/Pleurocera group, and L. geniculata pinguis to Leptoxis (Mudalit). However, these two species are placed with Lithasia because of their radular characters.

*Melatoma Swainson 1840 is not the same as Melatoma Anthony 1843 (Gray, 1847; Anthony, 1860).*
The variability seen in *Lithasia salebrosa* (Conrad) would seem to include *L. geniculata* (Haldeman). Goodrich (1940d) separated the two, but (in 1941f) remarked that “the distinction between *geniculata* of the Cumberland River system and *salebrosa* of that of the Tennessee River is chiefly that the latter commonly has two or more rows of nodules.” Specimens of *salebrosa* with but a single row of nodules do occur, but are not common. These have the conchological characters of *geniculata*. Several specimens of the single lot labelled “*Lithasia salebrosa*” from the “lower Cumberland River, Tennessee” in the Museum of Zoology collections (UMMZ 132477) have only a hint of a second row of nodules. The other specimens in this lot have only a single row at the shoulder of the whorls. Basically, they are *L. geniculata*.

Davis (1974) treated *Lithasia salebrosa* and *L. geniculata* as separate species, and listed the distribution of “*Io*” *salebrosa* as the Cumberland River and Caney Fork, and the Duck and Tennessee rivers. Goodrich (1940d) did not include the middle and upper Cumberland River, Caney Fork or the Duck River in the distribution of *L. salebrosa*; he reported *L. geniculata* in these streams. According to Davis (1974), “The one population found in the Duck River is not pure *salebrosa* as given in Fig. 45 by Tryon (1873). Two individuals were found in a population of over 200 snails where specimens reflected genetic mixtures of *geniculata*, *fuliginosa*, *geniculata x fuliginosa*, *fuliginosa x duttoniana*. Pure *salebrosa* is probably extinct.”

According to Tryon (1873b), “Generally but one row of tubercles is developed on this species [*L. geniculata*], but occasionally a second and less prominent row is visible. The whorls are more shouldered, and the tubercles larger and less numerous than in *L. salebrosa*, Conrad. . . . Mr. Lea considers *geniculata* to be the same as *salebrosa*.”

Curiously, some specimens of *Lithasia salebrosa* seem little different from *L. vermicosa* (Rafinesque). Further, *L. salebrosa subglobosa* (Lea) and some specimens of *L. geniculata* differ but little from *Leptoxis* (*Athearnia*) *crassa* (Haldeman), the latter also a species of the Tennessee river drainage. [Because of this close similarity, I (1979) previously included *Athearnia* in the synonymy of *Lithasia*] The essential conchological difference separating *Leptoxis* (*Athearnia*) *crassa* from the *Lithasia salebrosa-geniculata* complex is the flange of the lower columellar lip of the aperture, perhaps a character of dubious generic value.

Davis (1974) treated *Pinguia* *Lea and fuliginosa* *Lea* as headwaters and small rivers forms respectively of *geniculata*. Goodrich (1934a, 1941f) also discussed variation in this complex of races and forms. “*Lithasia geniculata* and *salebrosa* has each upstream or side-stream forms, distinguished by an elongation of the spire and an alteration of proportions of altitude to diameter, together with the curious characteristic of a development of nodulous sculpture, when that exists, at the periphery of the shell and not at the shoulder” (Goodrich, 1941f).

36. The classification in the genus *Pleurocera* presented here, and the distribution of the various recognized species and subspecies, is that of Goodrich (1917, 1924b, 1927, 1928a,b, 1929b, 1930a, 1934c, 1935b, 1936, 1939d, e, 1940d, 1941b, c, 1942b, 1944d). No attempt has been made to assess the taxonomic validity of the species and subspecies.

37. According to Goodrich (1940d), *Pleurocera currierianum* (Lea) is possibly only a depauperate form of *P. brumbyi* (Lea).

38. Goodrich (1940d) thought that *Pleurocera viridulum* (Anthony) might be only a fast water modification of *P. pyrennellum*.

39. The genus *Lymnaea* Lamarrck 1799 has been used variously to include nearly all members of the Lymnaeidae (e.g., see Hubendick, 1951; Walter, 1969; Harman & Berg, 1971) or only *Lymnaea stagnalis*, its varieties, and several very closely related species (e.g., F.C. Baker, 1928c; Burch, 1979). In this latter system, the family contains a number of species groups (genera) equal in rank to *Lymnaea* s.s. A third system, more or less a compromise between the two, uses *Lymnaea* as a large inclusive genus, but recognizes various subgeneric groups within it. These subgenera correspond to the genera of the F.C. Baker scheme. As a convenience for species-group separation, the less conservative scheme is used here. Aside from convenience, there is some scientific justification for handling the lymnaeids in this fashion (Burch, Lindsay & LoVerde, 1971; Burch & Lindsay, 1973a).

40. *Fossaria* Westerlund 1885 is used for the group of small lymnaeids rather than *Galba auct.* (which is only doubtfully the same as *Galba* Schrank 1803, type species *Galba pusilla* Schrank 1803 by monotypy; see Hesse, 1923; Pilsbry & Bequaert, 1927; F.C. Baker, 1928c; Clarke, 1973).

41. The genus *Stagnicola* Leach (in Jeffreys) 1830 is based on the European *Buccinum palustre* Müller 1774. The work of Jackiewicz (1959) has shown that several distinct species have masqueraded under the name *palustris*. Just which anatomical type is represented by Müller’s species is not known, and until that is settled, and it is determined
that such a species does indeed occur in North America, then it seems advisable not to use *S. palustris* here but the first name applied specifically to a North American *palustris*-like snail instead, i.e., Say's (1821) *Lymneus elodes*.

43. The largest group of Lymnaeidae in North America are the stagnicoline lymnaeids, members of the genus *Stagnicola*. Their taxonomy, based only on shell shape, has always been troublesome. Conditions of the water in which stagnicoline snails live can have some influence on the exact shape of their shells (ecophenotypic variation), whole populations exhibiting the abnormal characters when they occur. However, other cases of constant population differences seem to be due to small genetic differences between populations. The great problem in systematics of stagnicoline snails is in accurately assessing which characters are ecophenotypic and which are genetic, and of the genetic differences which are great enough to conclude that any particular population(s) is (are) distinct enough to deserve a binomial (or trinomial) name of its (their) own. Since there have been almost no experimental breeding studies to evaluate the taxonomic importance of any shell characters in *Stagnicola*, schemes for classifying the genus have all been quite subjective. Accordingly, systematic interpretations have varied widely, from the "splitters" to the "lumpers".

In reviewing North American *Stagnicola*, it seems to me that they fall into two general groups, the *Stagnicola elodes* group and the *Stagnicola catascopium/emarginata* group. Typically, species of the *Stagnicola elodes* group have an elongated, rather narrow, brown shell, and are inhabitants of quiet standing waters, such as ponds, pools, ditches, marshes, swamps, etc. The *Stagnicola catascopium/emarginata* group typically have compressed spires and subglabose body whorls, broader, light-colored shells, and are inhabitants of rivers and lakes.

Because of the fundamental uncertainties of their taxonomy, it is not easy to decide on a nomenclatural scheme for the stagnicolas. The one adopted here reflects a rather conservative approach.

44. Hubendick (1951) recognized a separate subfamily, the Lancinae, for the limpet-shaped *Lanx*, in contrast to the subfamily Lymnaeinae, which included all other lymnaeids. However, whether or not a patelliform shell in the Lymnaeidae is, per se, enough to warrant the recognition of a subfamily, or whether sets of peculiar anatomical characteristics not related or only partially related to shell shape will eventually define subfamilies is not known at present. Walter (cf. 1969) mentioned certain close anatomical similarities of *Lanx* to "*Lymnaea catascopium* Say" (= *Stagnicola emarginata/serata* Haldeman). However, the use of anatomical characters for showing relationships in the Lymnaeidae needs to be reassessed (cf. Burch, Lindsay & LoVerde, 1971).

45. It may not be worthwhile to distinguish between *Fisherola nuttalli nallutti*, *F. nuttalli kootaniensis* and *F. nuttalli lancides*, but a more detailed study of *Fisherola* is needed to decide this. "*Fisherola lancides*" is another subspecies of the Snake River, in which the apex is a little more anterior, but some of the original lot before me run close to *nuttalli" (Pilsbry, 1925a). In describing *Fisherola lancides*, Hannibal (1912) gave the locality as "Snake River (H. Hemphill)." According to Henderson (1936c), "The Spokane River specimens obtained by Hemphill are doubtless the ones afterwards described from his specimens as *lancides*." Classification of the Physidae follows Te (1978). Subsequent to the preparation of this list, Te (1980) listed an "unnamed species" of *Physella (Physella)*, an "unnamed species" of *Physella (Costatella)*, an "unnamed subspecies" of *Physella (Physella) ancilla* (Say 1825), an "unnamed morph" of *Physella (Costatella) osculans* (Haldeman 1841), and introduced as a subspecies of *Physella (Costatella) hensondi* (Clench 1925) the nomen *nudum floridana* "Pilsbry ms."

46. Species of the genus *Stenophyza* Martens 1898, native to Central America and Mexico, have been found in Texas (Te, 1978).

47. The validity of *Gyraulus (Torquis) hornensis* is open to some doubt. It was named by F.C. Baker (1934e) for specimens that he had earlier (e.g., 1928c) called *Gyraulus arcticus* Beck (in Möller) 1842. Clarke (1973) placed *hornensis* in the synonymy of *G. deflectus*.

48. If *Drepanotrema* and the Brazilian *Acrorbis* Odhner 1937 (type species: *Acrorbis petricola* Odhner 1937) are shown conclusively to belong to the same tribe, then apparently the earliest name for this taxon is *Acrorbis* Starobogatov 1958, predating Zilch's (1959) *Drepanotremae* and Harry's (1962) *Drepanotremaeae*. (Starobogatov placed *Drepanotrema* in his *Acrorbis* (Starobogatov, 1970), and Harry (1962) placed *Acrorbis* in his *Drepanotremaeae*, but Zilch (1959) placed (questionably) *Acrorbis* in the tribe *Segmentinae*.)

50. *Helisoma aniceps* (Menke) exhibits considerable variation over its wide range, which has resulted in many varietal

In Canada, Clarke (1973) recognized Walker’s (1909e) variety *royalense* as a valid subspecies of *Helisoma anceps*. He considered *H. anceps rushi* F.C. Baker to be a synonym of *H. a. royalense*. Clarke considered ten other “subspecies” of *H. anceps* recorded from Canada: *antarcticum* F.C. Baker 1945 (a Pleistocene fossil), *aoostokeense, cahnii, latchfordi, percinaratum, politum, portagensis, savi, striatum and unicarinatum*. He concluded (p. 443) that “it is probable that most of the ‘subspecies’ currently recognized [in the Canadian Interior Basin] are not geographically distinct and are taxonomically invalid but firm decisions on this must be deferred until analysis of more populations, including toptype populations can be made.”

*Helisoma eucosmium* (Bartsch 1908) may be simply a form or juvenile of *H. anceps anceps* (Menke).

The generic name *Carinifex* was first presented by Binney (1863), in combination with Lea’s (1858a) *newberryi* (*Planorbis*), as a name without description in a pamphlet (“Smithsonian Miscellaneous Collection 000”) containing a catalogue of North American Pulmonata. In 1865b, c, Binney described the genus and figured for the first time Lea’s *Carinifex newberryi*. In 1864c, Lea “provisionally” introduced the generic name *Megasystropha for newberryi*. The International Commission on Zoological Nomenclature in Opinion 432 [1956] suppressed the generic names *Carinifex Binney 1863* and *Megasystropha Lea 1864* in favor of *Carinifex Binney 1865*. *Carinifex* has been used for many years as a generic name for the *newberryi* group of North American planorbids. In subordinating it as a subgenus of *Helisoma*, I am following Henderson (1931b) and D.W. Taylor (1966a).

Whether there are more than one species of *Carinifex* is doubtful. “This [Helisoma/Carinifex newberryi] has long been known as a very protean species, but conchologists have not been inclined to establish varietal names, as the variations are very numerous and intergrade thoroughly. If one begins naming them it is difficult to see where any lines may be satisfactorily drawn. It is doubtful whether the variations can be properly called even mutations. The variation is chiefly in the amount of elevation of the spire above the last whorl and a marked tendency toward scalariformity, with inevitable effect upon the general shape of the shell, and upon the width of the last whorl and of the umbilicus. The variation is so great and the gradation so minute that it is almost impossible to determine just what should be the normal form” (Henderson, 1931b). “I am disposed to look upon all of the described species and varieties of *Carinifex* as subspecies of a widely spread stock . . .” (Pilsbry, 1934a).

Ten nominal species or subspecies are associated with *Menetus* s.s. in addition to its type species, *M. opercularis* Gould 1847. Two of the names are replacements for preoccupied names, *multilineatus* Vanatta 1899 for *oregonensis* Vanatta 1885 (*non oregonensis Tryon 1865*) and *cooperi* F.C. Baker 1940 for *planulatus J.G. Cooper* (in W. Cooper) 1859 (*non planulatus Deshayes 1824*). The other six names are *calliglyptus Vanatta 1885*, *centerville* Tryon 1871, *crassilabris* F.C. Baker 1945, *labiatus* F.C. Baker 1945, *planospirus* F.C. Baker 1945 and *portulandensis* F.C. Baker 1945. Whether any of these are more than forms or synonyms of *opercularis* is not presently known. The subgenus needs critical study. Dall (1905) was of the opinion that there was only one species, and, from my own limited observations, I agree. “The sculpture [of *M. opercularis*] is like that of *Promenetus* exacuous, the spiral sculpture being faint and sometimes absent in southern specimens, and tending to be emphasized in northern ones. As a rule the margin of the aperture is not thickened except in young specimens which have been overtaken by drought or winter before maturity. The keel is generally, but not always, present in southern shells, but those from Oregon and northward show a tendency to form a shell either without a noticable keel, or with the keel forming a margin to
a plane upper surface, rather than a median carina. When compared with Cooper's types in the National Museum Mr. Vanatta's P. ["Planorbis"] calliogyptus is seen to be identical. The variety oreonensis retains the typical form but has stronger spiral sculpture. I regard P. centervillensis of Tryon as a P. planulatus with the keel obsolete. What appear to be intergradational forms are numerous in the large series in the National Museum; though it would seem incredible to any one possessing only the extremes that they can belong to the same species" (Dall, 1905: 93).

53 F.C. Baker (1945) said the following about his subgenus Micromenetus. "The group here separated as Micromenetus differs from typical Menetus in the size of the shell which is always much smaller, none exceeding 4 mm. in diameter. The form of the shell is lenticular and there is usually a peripheral carina more or less well developed. The penial gland has a duct which has almost three times as long as the gland and is attached to the inner wall of the prepubium for the greater part of its length ... In typical Menetus, this duct is short and enters the diaphragm directly without being attached to the wall of the prepubium ... The pseudobranch in Micromenetus is also very long and narrow while in typical Menetus it is short and wide ... These are small differences, perhaps, but they appear constant. Micromenetus differs from both Promenetus and Planorbula in the shape of the penial gland. As far as examined the radulae of the two groups differ in formula, that of Menetus being 20-1-20 while in Micromenetus it is 15-1-15."

54 If it turns out that the eastern subgenus Micromenetus is represented by only one variable species, M. dilatatus (i.e., if the nominal species M. brogniartianus and M. sampsoni fall within the normal variation of M. dilatatus), as the western Menetus s.s. is represented by only the variable M. opercularis, then separating the two species each into a separate subgenus does not seem justified.

55 How many species to recognize in the subgenus Micromenetus is difficult to decide without an intensive study of the group. Eight names for Recent planorbids are associated with the subgenus. Menetus dilatatus (Gould 1841) is the type species. Other names are alabamensis Pilsbry 1895, brogniartianus Lea 1842, buchanensis Lea 1841, floridensis F.C. Baker 1945, lens Lea 1838, lenticularis Lea 1844, pennsylvanicus Pilsbry 1916 and sampsoni 'Aneyce' Sampson 1885. F.C. Baker (1945) listed buchanensis, floridensis and pennsylvanicus as subspecies of M. dilatatus. However, whether these are true subspecies or simply forms or synonyms is not known, but judging from Baker's 'splitting' in other groups they probably do not justify recognition by latinized names. Lea's brogniartianus and Pilsbry's alabamensis are both carinate forms at present not separable by their descriptions. They may prove to be only variations of dilatatus. From the specimens that I have observed, M. sampsoni differs from dilatatus by its rounder, less flared aperture and wider, shallower umbilicus. Whether or not these are constant characters is not known at present. Lea's lens (preoccupied) and lenticularis are synonyms of brogniartianus.


57 Dall (1905) proposed the section Haldemanina for Lea's (1858) Planorbis wheatleyi. F.C. Baker (1945) was "disposed to accept Haldemanina as a subgroup under Planorbula," and this arrangement was followed by Zilch (1959). However, Pilsbry & Ferriss (1906) considered Haldemanina to be an absolute synonym of Planorbula, and, on inspecting specimens of Planorbula wheatleyi in the Academy of Natural Sciences of Philadelphia, I am inclined to agree with them.

58 Names associated with the genus Promenetus are carus Pilsbry & Ferriss 1906, coloradoensis F.C. Baker 1945, exacuous Say 1821, harri 'Pilsbry' Hart 1891, hudsonicus Pilsbry 1934, hyalina Lea 1838, megas Dall 1905, rubellus Sterki 1894, umbilicatellus Cockerell 1887 and umbilicatus J.W. Taylor 1885. Haldeman (1842-45 [1844]) and subsequent authors have considered hyalina to be a scalariform P. exacuous. Hart's (1891) harri is a nomen nudum, which Pilsbry (1899d) synonymized with P. rubellus. Cockerell's umbilicatellus is a replacement name for J.W. Taylor's umbilicatus (non Planorbis umbilicatus Müller 1774). F.C. Baker (1945) described (posthumously) coloradoensis as a member of the genus Menetus. H.B. Baker (1946) placed it with Promenetus. Hibbard & Taylor (1960) synonymized it, along with hudsonicus, megas and rubellus, with exacuous. In regard to differentiae as based on shell characters, I agree with the synonymies above. We have not seen the type specimens of P. carus, but I anticipate
that they will prove to be the same as \textit{P. umbilicatellus}.

59 D.W. Taylor (1960) erected a subgenus, \textit{Phreatomenetus}, for \textit{Promenetus umbilicatellus} (Cockerell) (type species), the Texan \textit{P. carus} (Pilsbry & Ferriss) and the Central American and Caribbean \textit{P. circumlineatus} (Shuttleworth). However, because of the small number of species known from \textit{Promenetus} s.l. (only two of which have been studied anatomically), and the considerable variability which exists between species of Planorbidae, Clarke (1973) did not consider it prudent to recognize subgenera in the genus \textit{Promenetus}.

60 The genus \textit{Vorticifex} is based on the fossil species \textit{V. tryoni} Meek (in Dall) 1870. Living species are included in the subgenus \textit{Parapholyx}. Separating the fossil species from the Recent ones by placing them in different subgenera may not be desirable. "The variability of the species [of \textit{Vorticifex} s.l.], and the intergradations of form, are so great that no subordinate groupings within the genus seem practicable at this time" (Taylor, 1966a).

61 \textit{Vorticifex (Parapholyx) solida} (Dall) may not be specifically distinct from \textit{V. (P.) effusa} (Lea).

62 Walter (1970) was of the opinion that all four species of \textit{Neoplanorbis} are only variants of \textit{Amphigryra alabamensis} Pilsbry. I have not had time to investigate this.

63 The species of \textit{Fluminicola} are not dealt with in the identification key. A list of species with distributions can be found on pp. 102, 104.

64 In spite of the several publications which deal with the subgenus \textit{Walkerilla}, it is still not well defined. For example, in proposing the subgenus, Thiele (1928) mentioned that the radula of its type species, \textit{Somatogyrus (Walkerilla) coosaensis} Walker, has a central tooth with a finely serrated cutting edge (in his fig. 25 he shows a central tooth with a non-prominent central cusp flanked on each side by nine lateral cusps) and on each side a row of 8-10 basal denticles. The central tooth of \textit{S. isogonus} (Say) he illustrated as having a prominent central cusp flanked by four basal cusps, and a row of three basal cusps on each side. Yet Thompson (1969) illustrated \textit{S. (W.) tenax} Thompson as having a relatively prominent central cusp flanked by six lateral cusps, and a row of three basal cusps on each side. Thompson (1969) figured the verge of \textit{S. (W.) tenax} (it is a simple tapering structure with a single duct leading to its apex) and indicated that this type of verge is subgenerically distinct from that of \textit{Somatogyrus} s.s. The sculpture of the apical whorls of \textit{S. (W.) tenax} is also considered subgenerically distinct, and is described as "fine spiral striations which begin on first quarter of whorl as minute punctations, then become more intense and coalesce into distinct striations that terminate at the end of the apical whorl where the striations are slightly oblique."

65 The species of \textit{Somatogyrus} s.s. are not dealt with in the identification key. A list of species with distributions can be found on pp. 104, 106.

66 Much of the key on the southern, especially Floridanian, Hydrobiinae is based on the detailed studies of Thompson (1968, 1969).

67 The monotypic genus \textit{Hoyia} is distinguished by its radula (F.C. Baker, 1926a). Its anatomy has not been studied, so its subfamilial placement is presumptive. "The radula of [\textit{Hoyia} shektoni] is totally unlike that of any other American amnicoloid observed or published. The teeth are all very small, about a third the size of those of \textit{Amnicola limosa}, and the denticulations are very fine, all teeth beyond the central being multicuspid, with the cusps of equal size" (F.C. Baker, 1928c).

68 Taylor (1966b) characterizes \textit{Tryonia} as follows: "Shell turritiform, with more whorls, a narrower outline, smaller aperture, and a deeper suture than in most \textit{Pyrgophorus}. The sculpture may consist only of growth line[s], or may be coarsely lirate, plicate, or reticulate. Spines of the shoulder of the shell (characteristic of \textit{Pyrgophorus}) are unknown in \textit{Tryonia}.

"Virtually all of the species are known by shell alone, so that no trenchant characterization of the genus is possible. \textit{Tryonia cheatumi} is known to be ovoviviparous like \textit{Pyrgophorus} (Pilsbry, 1935b[a]).""

69 The species of \textit{Aphaostracon} are not dealt with in the identification key. A list of species with distributions can be found on pp. 92, 98.
The keys for the genera *Marstonia* and *Rhapinema* are from Thompson (1977).

The species of *Cincinnatia, Fontellicella s.s., Natricola* and *Fontigens* are not dealt with in the identification key. Lists of species with distributions are given on pp. 110, 114, 126, 130.

Distinguishing characters for *Amnicola s.s. and Lyogyrus* are from Thompson (1968). The species of neither of these two subgenera are dealt with in the identification key. Lists of species with distributions can be found on pp. 120, 124, 126.

Pilsbry & Ferriss (1906) described small discoidal shells found in drift debris of the Guadalupe River in Texas as *Valvata micra* and *V. micra nugax*, but called attention to similarities of the shells to the Palaearctic hydrobids *Horatia* Bourguignat and *Daudebardiella* Boettiger. Pilsbry and Ferriss stated further that, until fresh specimens with soft parts or opercula were found, the taxonomic position of these tiny mollusks would remain uncertain. In 1916, Pilsbry placed them in the genus *Horatia* and the subgenus *Hauffenia* Pollonera. Bole (1970) separated *Hauffenia* as a genus distinct from *Horatia*, using characters of the seminal receptacle and operculum to distinguish the two taxa. Taylor (1975) placed *micra* in *Hauffenia* and *nugax* in *Horatia*. As yet, there are no published anatomical or opercular data on the American species, so it is not known to which, if either, genus they belong.

There is considerable local variation in *Leptoxis s.s.*, which has been responsible for the creation of many nominal species and a large synonymy. "It is clear to the eye [that] the Anculosa [= *Leptoxis s.s.*] of the main parts of the Cumberland and Tennessee rivers are higher in proportion to diameter than are shells of headwaters and tributaries. ... In Anculosa [= *Leptoxis s.s.*], environmental polymorphism ... is less simple than in the lithasias that have been studied. The main river anculosae follow the rule of having shorter spires than the upriver and tributary colonies. There is also another environmental modification. The body whorls of main river anculosae are higher in proportion to diameter than those of head and tributary waters. ... The changes are irregularly progressive" (Goodrich, 1934a: 12, 15). "A. subglobosa Say is the headstream representative in the Tennessee River system. It is replaced downstream by *A. [Leptoxis] praerosa* Say in the main river, and those forms of Anculosa [Leptoxis] which penetrate the lower tributaries are, with only one or two exceptions, either this species or obvious offshoots of it. The group can be spoken of as the subglobosa-praerosa complex" (Goodrich, 1938: 4-6).

Goodrich (1940d: 19) mentions that the radula of *Mudalia [ Nitocris*" ] is distinctly different from that of *Leptoxis s.s.* ["the true Anculosa"] . As yet, I have not been able to confirm this. Any future study of the generic/subgeneric relationships of these two groups should include an inspection of their radulae with the scanning electron microscope.

The shell of *Leptoxis taeniata* is quite variable in regard to spiral sculpturing, ranging from completely smooth to lirate. In the past, populations with lirate forms have been called *L. griffithiana* (Lea).

Smooth shells may occur in various populations of *Leptoxis formosa*, but spiral striae are characteristic of the species.

The species of *Elimia, Juga, Lithasia s.s., Angitrema* and *Pleurocera* are not dealt with in the identification key. Lists of species with distributions can be found on pp. 131, 132, 134, 136, 138, 140, 142, 144, 148, 152, 154, 160, 162, 164, 166, 170.

The species of *Stagnicola* and *Lanx s.s.* are not dealt with in the identification key. A list of species with distributions can be found on pp. 176, 180, 182.

Various lymnaeids are characterized by having radulae with either bicuspid or tricuspid lateral teeth. In the genus *Fossaria*, members of the subgenus *Fossaria s.s.* have tricuspid lateral teeth (Fig. 784a), whereas members of the subgenus *Bakerilymnaea* have bicuspid laterals (Fig. 784b). Because of possession of bicuspid lateral teeth (characteristic of North American *Stagnicola*), *Bakerilymnaea* was previously placed with the stagnantolas.

![tricuspid](a) ![bicuspid](b)

FIG. 784. Lymnaeid radular teeth. a, a central tooth and a tricuspid 1st lateral tooth; b, a central tooth and a bicuspid 1st lateral tooth.
The relationships of the Alaskan representatives of the Holarctic *Fossaria truncatula* to Eurasian members of the species, as well as to the more eastern American fossarias, have not been critically studied.

The shape of the shell of *Fossaria (Bakerilymnaea) hendersoni* from Colorado is quite similar to that of *F. (B.) sonomaensis*. Hibbard & Taylor (1960) considered the shell of *F. (B.) hendersoni* to fall within the range of variation of *F. (B.) cockerelli*. *F. (B.) sonomaensis* also may prove to be merely a morph of *cockerelli*, or of *bulimoides*, as suggested by Clarke (1973).

The strong spiral striation of "Galba" *alberta* F.C. Baker suggests that this morph or species may belong to *Stagniola* rather than to *Fossaria (Bakerilymnaea)*.

The distinction between *Fossaria dalli* and *F. perplexa* seems a bit dubious. The latter has been reported from Washington (F.C. Baker & Henderson, 1929) and (as a morph of *bulimoides*) from California, Montana, Utah, Nevada and Arizona (Clarke, 1973).

The Physidae are taken to genera in this key, except for *Aplexa* and *Stenophysa*, which are keyed to species. Lists of species with distributions can be found on pp. 182, 188, 190, 194.

North American snails of the genus *Aplexa* have generally been referred to the Eurasian species *A. hypnorum* (Linnaeus). Starobogatov & Strelitzkaja (1967) and Te (1978, 1980) recognized the Western Hemisphere *Aplexa* as *A. elongata* (Say). Starobogatov & Strelitzkaja reported *A. elongata* also in eastern Siberia.

Couplets 5, 6 and 7 are from Walker (1908c).

From Clarke (1973).

F.C. Baker (1945) recognized only two species of *Planorbella* s.s., *P. campanulata* (Say) and *P. multivolvis* (Case), but for *campanulata* he recognized the nine subspecies [as *Helisoma (Planorbella) campanulatum*] listed below. [I have omitted three subspecies known only as fossils.]

*P. campanulata campanulata* (Say 1821). Vermont west to North Dakota, south to Ohio and Illinois, northward to Great Slave Lake (F.C. Baker, 1928c).

*P. campanulata wisconsinensis* (Winslow 1926). Wisconsin, Michigan, and probably Quebec, Ontario and Manitoba (Winslow, 1926; F.C. Baker, 1928c).


*P. campanulata rudentis* (Dall 1905). Knee Lake, on Hayes River, Keewatin, northern Manitoba, Canada (Dall 1905; F.C. Baker & Cahn, 1931).


Clarke (1973) placed *rudentis* Dall, *wisconsinensis* Winslow, *davisi* Winslow and *canadensis* F.C. Baker & Cahn in the synonymy of *campanulata* s.s. He recognized *collinsi* F.C. Baker and also apparently *multivolvis* Case as subspecies of *campanulata*.

subcrenata (Carpenter), subcrenata disjecta (Cooper), tenuis californiensis F.C. Baker, tenuis sinuosa (Bonnet), traski (Lea), trivolvis trivolvis (Say), trivolvis fallax (Haldeman), trivolvis lenta (Say), trivolvis macrostoma (Whiteaves), trivolvis turgida (Jeffreys), truncata (Miles) and winslowi (F.C. Baker). Baker (op. cit.) included P. horni and P. plexata as subspecies of subcrenata on plates 90, 92 and 93. He named additional taxa later in the same work: randolphi (a variety of binneyi), columbiensis, kennicotti, preblei (a variety of pilsbryi), perdisjuncta (a variety of subcrenata) and marshalli (a variety of trivolvis).

Clarke (1973) placed fallax Haldeman and macrostoma (Whiteaves) in the synonymy of trivolvis (Say), horni (Tryon) and plexata (Ingersoll) in the synonymy of subcrenata (Carpenter), kennicotti F.C. Baker and preblei F.C. Baker in the synonymy of pilsbryi infracarinata F.C. Baker, and multicosata F.C. Baker in the synonymy of corpulenta (Say). He (op. cit.) considered subcrenata to be a subspecies of trivolvis.

The subgenus Seminolina was named by Pilsbry (1934a) to include “Helisoma” scalaris (Jay 1839) (the type species), “Helisoma” duryi (Wetherby 1879) and its subspecies and forms, and the Pliocene “Helisoma” conanti (Dall 1890) and “Helisoma” disstoni (Dall 1890). He (p. 31) characterized them as, “Helisomas in which the external duct from penial gland to upper sac is short and adnate. Shell shaped like Pierosoma or with the spire produced on the left side and scalar, Physa-shaped. The smooth or malleate surface is not thread- striate, usually glossy.” F.C. Baker (1945: 130, 134) further characterized the subgenus: “Shell . . . Large; sinistral, physa-shaped or planorboid, with every gradation between these forms, usually widely or deeply umbilicated; surface smooth, usually glossy, without the thread-like striae of Pierosoma. . . . Seminolina is a notable group of the subfamily Helisomatinae and one of the most variable genera as regards species. The physoid aspect of its type species, Paludina scalaris Jay, led the older conchologists to include it in Physa and the genus Ameria of the family [sic] Bulinidae. The largest species, [sic] Helisoma duryi (Wetherby), is perhaps more variable than any other species found in America, its extremes being from typical Physa-shaped to flatly discoidal shell. The elongation of the spire always produces a physoid aspect. The races of duryi blend into each other and often three forms will occur in the same lot, as normale, intercalare, and duryi.”

FIG. 785. Diagram showing relations of Florida forms of Planorhella of the subgenus Seminolina (from Pilsbry, 1934a).
SUPPLEMENTAL NOTES

92 The Planorbella (Piersoma) ammon (Gould) group includes the nominal species ammon Gould 1855, traski Lea 1856, binneyi Tryon 1867, occidentalis Cooper 1870 and columbiaensis F.C. Baker 1945. "H. binneyi, H. ammon, H. occidentalis, and H. traski are all closely related and may be found to belong to 1 species when the problem is investigated thoroughly" (Clarke, 1973: 465).

Henderson (1934a) discussed and figured the latter four nominal species. Of P. ammon he said, "An important character is the strong slope of the lateral outline, giving the shell somewhat the shape of a truncated cone. This is shared by most Helisoma species, but is more marked than usual in this species. Many much depressed specimens of similar diameter from California might easily be assigned to ammon, and there seem to be some intergrades, but I am inclined to believe there is no close relationship between them." Regarding P. traski, Henderson said, "The resemblance of this species to binneyi is notable, but it is more nearly barrel shaped, considerably higher proportionally, and the sculpture less pronounced, especially on the last whorl, where the striae are very fine, but just in front of the aperture they are coarser, and the apical whorls are deeply sunken. Young specimens of ammon from the same region much resemble traski, but they soon begin to lose their barrel shape and take on the truncated cone shape of ammon, the carina is not so sharp and the apex not so deeply sunken." Henderson (op. cit.) selected a neotype for P. occidentalis from Klamath Lake, Oregon. "The neotype measures 27.5 mm. in diameter and 15 mm. in altitude just back of the slightly everted lip, approximating Cooper's maximum measurements. The last whorl is not carinate, but is shortly rounded above and more broadly below. . . . Though somewhat resembling H. binneyi (Tryon) in the strap-like whorls, occidentalis differs markedly in the less pronounced sculpture and the disappearance of the carina at an early stage of growth."

"Helisoma columbiense shows relationship to the binneyi group in its sculpture and the carination of its whorls. It differs from the members of that group in that it is of smaller size, has less relative axial height, its rib striae are less widely spaced and the whorls are usually more angulate. It differs from the subcrenatum group in having more regular and less widely spaced rib striae, in its angulated base and spire depression, and in the shape of the aperture" (F.C. Baker, 1945: 223).

93 A second nominal species will also fit the diagnosis provided by the second halves of key couplets 40 and 46, Planorbella (Piersoma) tenuis (Fig. 735). It is not clear to me just which shell features can be used to separate it from P. (P.) trivolvus subcrenata. My general impression is that tenuis is usually smaller and more finely sculptured than typical subcrenata. F.C. Baker (1934a) named a subspecies from Santa Clara County, California, Helisoma tenuis californiense. "This race is widely distributed in California from Santa Clara County southward. Helisoma tenuis is widely distributed in California and does not differ materially from the species as found in Mexico and Arizona." F.C. Baker (1945) figured "Helisoma tenuis sinuosum (Bonnet)" from Arizona, Texas, New Mexico and Mexico.

94 Key couplets 44 and 45 are from Clarke (1973).

95 A second nominal species or subspecies will also fit the diagnosis provided by the second half of key couplet 44, Planorbella (Piersoma) winslowi (F.C. Baker 1926). It is not clear to me just which shell features can be used to separate it from P. (P.) corpulenta corpulenta. F.C. Baker (1926b) named it originally as "a very distinct variety of trivolvus. It resembles pilski byi in some respects, but is smaller, only about half the size of adult individuals of that variety, and the body whorl is sharply angulated and more flat-sided. It was first thought to represent a distinct species, but the presence of individuals varying toward trivolvus in the type lot, as well as in nearby waters, indicate a relationship to this large planorb. Further, the shell characteristics of P. (P.) winslowi merge into P. (P.) pilski byi infracarinata, which merge with P. (P.) pilski byi s.s., which in turn seem to merge into P. (P.) trivolvus. (See note 96.)

96 Clarke (1973: 459 ff.) recognized the subspecies Helisoma [=Planorbella] (Piersoma) pilski byi infracarinata F.C. Baker 1932, but not without some hesitation. "Since reliable criteria are lacking for any new evaluation of the biological relationship between this taxon and the more southern Helisoma [=Planorbella] pilski byi Baker, the most recent opinion (Baker, 1945: 138) is followed and the name H. p. infracarinatum is used. . . . Baker [1936b] . . . commented on the 'perplexing variation' in this subspecies. The variation is so great, in fact, that one is initially tempted to consider it analogous to the variation exhibited by Gyraulus deflectus and to regard Helisoma [=Planorbella (Piersoma)] pilski byi infracarinatum as a frequently occurring morphological variant of H. trivolvus (Say). . . . It is also possible that Helisoma pilski byi infracarinatum is a morph which is intermediate between H. corpulenta (s. str.) and H. trivolvus (s. str.) derived from sporadic introgressive hybridization or representing a surviving parental stock from which H. corpulenta arose. The status of H. p. infracarinatum as a separate taxon requires additional research" (Clarke, 1973: 461-462).

From a comparison of authentic material of *pilsbryi* (paratypes, ANSP 140269) and *infracarinata* (paratypes, ANSP 158589), as well as *winslowi* F.C. Baker 1926 (paratypes, ANSP 158596), and considering variation seen in other museum lots and presented in the literature, I can see no compelling reason to separate the three forms taxonomically with latinized names. Further, I suspect that *Planorbella pilsbryi* is not taxonomically distinct from *P. trivolvis*.

The spire carinae in the form *infracarinata* have a tendency to be better developed than in *pilsbryi*; these carinae are rather prominent in the form *winslowi*, the shell of which also has well-developed basal carinae.

97 F.C. Baker's opinions regarding *Planorbella (Pierosoma) trivolvis* (Say) changed over the years. In his final (1945) publication, he recognized the eight subspecies [as *Helisoma (Pierosoma) trivolvis* listed below and gave various localities.


Clarke (1973) added *subcrenata* Carpenter 1857 as a subspecies of *Planorbella* ["*Helisoma*"] *trivolvis*, giving its distribution as California to British Columbia and Yukon Territory and east to Utah, Colorado, Minnesota and Manitoba. He placed *fallax* Haldeman and *macrostoma* Whiteaves in the synonymy of *trivolvis* s.s., and *horni* Tryon 1865 and *plexata* Ingersoll 1876 in the synonymy of *subcrenata*.

I doubt if it is advisable at this time to recognize varieties or subspecies of *Planorbella trivolvis*, at least until a careful study is undertaken and completed on this common and widespread complex of North American planorbid snails. However, if geographic subspecific names fit a need, then perhaps four can be tentatively adopted: *P. trivolvis* s.s. (northern North America east of the Rocky Mountains, south to Nebraska, northern Illinois, Pennsylvania and New Jersey), *P. trivolvis lenta* (central U.S.A. south of Nebraska and central Illinois to Texas (?)) and Louisiana), *P. trivolvis turgida* (southeastern U.S.A., south of Pennsylvania and west to Alabama, Arkansas and possibly Texas), and *P. trivolvis subcrenata* (Rocky Mountain and Pacific states and provinces, possibly east in the north to Manitoba and Minnesotas). 98 Pilsbry (1934a) recognized six races of *Planorbella (Seminolina) duryi*: *duryi* s.s., *intercalaris* Pilsbry 1887, *preglabrata* Marshall 1926, *eadiscus* Pilsbry 1934, *normalis* Pilsbry 1934 and *seminolis* Pilsbry 1934. These, along with *P. (S.) scalaris*, are illustrated in Fig. 785.

*Planorbella (Seminolina) duryi seminolis* is the subspecies which is characterized by an everted spire of varying degrees. Higher spired individuals are very similar in appearance to *P. (S.) scalaris*, but the latter is narrower and generally less widely umbilicate. Also, in *P. (S.) duryi seminolis*, the "lower [i.e., anterior] margin of [the] aperture is generally advanced beyond [that of] the upper [i.e., posterior]" margin (except in exceptionally long individuals) (Pilsbry, 1934a: 35), whereas in *P. (S.) scalaris* the upper (posterior) margin of the aperture (when viewed from the spire end of the shell) projects further than the lower (anterior) margin.

99 The identification key for the Ancylidae is adapted from Basch (1963).

100 Clarke's (1973) treatment of the Valvatidae differs in several respects from that of Heard (1982). Clarke considered *Valvata lewisi* and *V. sincera nylanderi* as morphs of *V. sincera*, and *V. ontariensis* as a subspecies of *V. sincera* (rather than as a morph of *V. lewisi*).
The lateral teeth of Rhodaecia are distinct from other North American ancylids by the possession of an "enormous mesocone, the blade-like cusp extending beyond the base, the ectocone is back of the mesocone, entirely separated from it and has several small cusps; there is no endocone" (Walker, 1918b) [Fig. 786].

Central and 1st radial teeth of ancylid limpets. Rhodaecia is on the left.

CORRIGENDA

The endings of the trivial names of Cipangopaludina [p. 86] should be C. chinensis malleata and C. japonica. These two introduced snails, which are widely spread in the United States, were restricted originally to the Far East. There is some doubt as to whether they are actually two distinct species, rather than different forms of the same widespread variable species.

The name Campeloma regularae (Lea 1841) should replace C. coarctatum (Lea 1844) [pp. 86, 87 (Fig. 40), 91 (Fig. 66)]. C. deciscum (Say) dates from 1817, rather than 1816 [p. 86].

Loiopax chostawhatchiensis [p. 90] should be placed as a subspecies of L. pilsbryi and its distribution listed as Choctawhatchee, Escambia, Flint and Suwannee river systems, Florida and Georgia. The distribution of L. pilsbryi pilsbryi is restricted to the Chipola River, Florida (see Burch & Vail, 1982).

Pilbry (1899b) should be Pilbry (1899a) on pp. 102, 103 [see Flumincola erythopoma, F. nutalliana, F. seminula and F. vires].

Murray (1964, 1976) should be added as references for the introduced Melanoidea tuberculata on p. 130.

The endings of some of the trivial names given on pp. 149 and 198-206 should be changed as follows: Gyrototha amplum, G. cariniferum, G. incisum, Helisoma (Carinifex) newberryi jacksonense [pp. 198, 199], H. (C.) newberryi occidentale [pp. 199, 202], Menetus (Micromenetus) bronniartianus [pp. 201, 202], Planorbella (Pierosoma) colombiensis [p. 202], P. (P.) corpulenta corpulenta [p. 202], P. (P.) corpulenta vermi/ionensis [p. 204], P. (P.) corpulenta whiteavesi [p. 204], P. (P.) magnifica [pp. 204, 205], P. (P.) occidentalis [pp. 204, 205], P. (P.) pilsbryi infracarinata [pp. 203, 204], P. (P.) subcrenata (= trivolvis subcrenata) [pp. 204, 205], P. (P.) tenuis [pp. 204, 205], P. (P.) trivolis intercrixta (= turgida Jeffreys 1830) [p. 204], P. (P.) truncata [pp. 204, 206], (P. Seminolina) scalaris [pp. 204, 206].

Lithasia genticulata pinguis (p. 160) is included in Supplemental Note 35 (p. 272).

The date of Pilbry's Physa cubensis peninsularis [Physella (Costatella) cubensis peninsularis] (see p. 188) is 1899. Helisoma eucosния (Bartsch 1908) was omitted under the subgenus Helisoma s.s. (p. 198). This is the name given to small shells with spiral reddish bands from Greenfield Pond near Wilmington, North Carolina, and Burks Place, Louisiana. These shells may represent merely a form of H. anceps.

A revised list of the species of Planorbella, subgenus Pierosoma (ref. pp. 202-204) is as follows.

Subgenus Pierosoma Dall 1905

Planorbella (Pierosoma) ammon (Gould 1855) [Fig. 730]

Cienaga Grande, or Colorado Low Desert (Gould, 1855a; Henderson, 1936d); Sacramento and San Joaquin river drainages and near Watsonville, California (Henderson, 1934a).

Planorbella (Pierosoma) binneyi (Tryon 1867)

California to British Columbia in the Pacific drainage area and British Columbia and Alberta in the headwaters of the Peace and North Saskatchewan river systems (Clarke, 1973).

Planorbella (Pierosoma) colombiensis (F. C. Baker 1945)

Lac La Hache, Cariboo District, British Columbia (F. C. Baker, 1945).

Planorbella (Pierosoma) corpulenta corpulenta (Say 1824)

Western Ontario, eastern Manitoba and northern Minnesota in the Winnipeg River system; upper Mississippi River system in northern Minnesota (Clarke, 1973).

Planorbella (Pierosoma) corpulenta vermi/ionensis (F. C. Baker 1929)

Vermilion Lake, St. Louis County, Minnesota (F. C. Baker, 1929b).

Planorbella (Pierosoma) corpulenta whiteavesi (F. C. Baker 1932)

Greenwater Lake and Lac des Mille Lacs, Thunder Bay District, Ontario (Clarke, 1973).

Planorbella (Pierosoma) magnifica (Pilbry 1903) [Fig. 732]

Greenfield Pond, near Wilmington, North Carolina (Bartsch, 1908).

Planorbella (Pierosoma) occidentalis (Cooper 1870) [Fig. 733]

Lakes, rivers, creeks, ditches, sloughs and swamps in California, Oregon and Washington (see Henderson, 1936c).
Planorbella (Pierosoma) oregonensis (Tryon 1865)
    Pueblo Valley, Oregon (Tryon, 1865); Tooele County, Utah (F. C. Baker, 1945).
Planorbella (Pierosoma) pilsbryi (F. C. Baker 1926) [Fig. 731]
    Massachusetts west to Minnesota, northern New York and central Wisconsin northward (F. C. Baker, 1928c) [form pilsbryi s.s.]; St. Lawrence River drainage area in Georgian Bay and the St. Lawrence River and Rideau River, Canadian Interior Basin from eastern Ontario to central Saskatchewan (Clarke, 1973) [form infracarinata]; Vilas County, Wisconsin (F. C. Baker, 1928c) [form winslowi].
Planorbella (Pierosoma) tenuis (Dunker 1850) [Fig. 735]
    Texas, Arizona, New Mexico, southern California and Mexico (Bequaert & Miller, 1973).
Planorbella (Pierosoma) traski (Lea 1856)
    California: Kern Lake (Lea, 1856), Stockton (Henderson, 1934a), Bakersfield, Kern County, and Buena Vista Lake (F. C. Baker, 1945).
Planorbella (Pierosoma) trivolvis trivolvis (Say 1817) [Fig. 736]
    Northern North America east of the Rocky Mountains, south to Nebraska, northern Illinois, Pennsylvania and New Jersey.
Planorbella (Pierosoma) trivolvis lenta (Say 1834)
    Central United States from Kansas and central Illinois to (?) Texas and Louisiana.
Planorbella (Pierosoma) trivolvis subcrenata (Carpenter 1857) [Fig. 734]
    California to British Columbia and Yukon Territory and east to Utah, Colorado, Minnesota and Manitoba (Clarke, 1973).
Planorbella (Pierosoma) trivolvis turgida (Jeffreys 1830)
    From Long Pine Key, in the southern Everglades, throughout peninsular Florida and north along the coast to Lake Waccamaw, North Carolina (Pilsbry, 1934a) and Delaware and Maryland, west to Alabama, Arkansas and (?) Texas.
Planorbella (Pierosoma) truncata (Miles 1861) [Fig. 737]

The name Drepanotrema (Antillorbis) cimex on p. 199 (legend of Fig. 715) should be Drepanotrema (Fossulorbis) cimex.

The generic name in the legend of Fig. 741 (p. 207) should be Planorbula (not Planorbella).
VIII. GLOSSARY

Abaxial. Directed away from the shell axis (i.e., the central line or central column of a coiled gastropod shell) outward.

Acrolooxid. A common-name adjective referring to a member of the family Acroloxidae.

Acute. Sharp at the end.

Ampullariid. A common-name adjective referring to a member of the family Ampullariidae.

Ancylid. A common-name adjective referring to a member of the family Ancylidae.

Ancyliform. Limpet-shaped; patelliform; shaped like an obtuse cone (see Fig. 778).

Angular, angulate. Having an angle (or having the tendency to form an angle), rather than a round contour.

Angulation. Edge along which two surfaces in different planes meet at an angle.

ANSP. Abbreviation, usually associated with museum specimen catalogue numbers, for Academy of Natural Sciences of Philadelphia.

Aperture. The opening or “mouth” of a snail shell through which the head-foot protrudes when the snail is active.

Attenuate. Slender; elongated; long and narrow.

Auctorum (abbr. auct.). Of authors.

Auger-shaped. Shaped like an auger, i.e., with a flattened base terminating in a sharp, pointed twist.

Axial. Parallel to the axis or columella of a shell, i.e., transverse to the direction of the shell’s spiral coil.

Base. The part of the shell opposite the apex. When a shell is held with the apex directed upward, the base is the “bottom” part of the shell. In regard to the natural position of the shell as carried by the snail, the “base” is the anterior end.

Bithyniid. A common-name adjective referring to a member of the family Bithyniidae.

Body whorl. The last complete whorl or volution of a spiral snail shell, measured from the outer lip back to a point immediately above the outer lip. It is normally the largest whorl of the shell, and is called the body whorl because it encloses the greatest part of the snail’s body.

Callus. A layer of calcareous material on a shell secreted by the snail’s mantle.
Campanulate. Flared at the end; bell-shaped.

Canaliculate. Bearing a channel or groove.

Carina (pl. carinae). A sharp spiral edge, ridge or “keel” on the outer shell surface.

Carinate. Having one or more sharp spiral edges, ridges or keels on the outer shell surface.

Central tooth. The median or rachidian tooth of a transverse row of radular teeth. It is flanked by lateral teeth (see Fig. 784).

Channelled. Bearing a channel or groove.

Clavate. Club-shaped; growing gradually thicker toward one end.

Cleaver-like. Shaped like a butcher’s cleaver, i.e., like a short, flat, broad cutting instrument.

Color bands. Revolving spiral stripes of a darker hue or different color from the ground or background color which occur on some species of gastropod shells.

Columella. The internal column around which the whorls revolve; the axis of a spiral shell.

Columellar lip. The apertural margin at the columellar region of a coiled gastropod shell.

Compressed. Refers to the spire of a gastropod shell which is relatively flattened, i.e., is not elongated.

Concentric. Having the same center, e.g., the nucleus, and expanding outward in parallel (i.e., equidistant) lines, as in the lines of growth of an operculum (Fig. 780c).

Continental Divide. The highland which divides the North American continent into two very large drainage regions, one in which the streams flow generally eastward into the Gulf of Mexico, Atlantic Ocean, Hudson Bay and the Arctic Ocean, and the other in which the streams flow generally westward into the Great Basin, the Gulf of California, the Pacific Ocean and the Bering Sea.

Corneous. Horn-like.

Costa (pl. costae). A transverse rib or rounded ridge of considerable size on the surface of a shell.

Costate. Refers to a shell in which the surface is sculptured with heavy, regular transverse ridges or ribs.

Crassate. Gross; thick; coarse; neither thin nor fine.

Crepidulaform. Shaped like Crepidula, i.e., limpet-like with a small, coiled apex.

Ctenidium. The characteristic respiratory appendage or gill of mollusks.

Cusp. The cutting blade or blades projecting from each tooth of the molluscan radula.

Cylindrical. Shaped like a cylinder; round in cross-section with nearly parallel sides.
Decollate. Cut off, i.e., as with the shell of some snails where the top several whorls of the spire break off or erode away.

Depauperate. Condition in which an individual, colony or race exhibits the outward manifestation of disease, accident or malnutrition, or a reaction to adverse environment. See depauperization.

Depauperization. The outward manifestation of disease, accident or malnutrition, or a reaction to inimical environment. It affects individual mollusks fairly frequently, but also it sometimes involves whole colonies and races. Symptoms of depauperization are dwarfing, lack of nacreous material (in certain bivalves), loose coiling and simplification of shell characters (Goodrich, 1939a).

Depressed. Flattened dorso-ventrally or postero-anteriorally, as the spire of a shell.

Elongate. Lengthened; extending length-wise; especially higher than wide.

Entire. Refers to the lip or peritreme of a shell that forms a continuous circle or oval, i.e., it is not broken by a space where it meets the parietal wall of the body whorl.

Fissure. A narrow slit.

Fusiform. Spindle-shaped, i.e., with a relatively thick middle and tapered to a point at each end.

Geniculate. Having a joint or bend.

Gibbous. Very convex or swollen; tumid.

Gradate. Arranged in steps, as a spire with shouldered whorls.

Growth lines. Minute lines on the outer shell surface indicating minor rest periods during growth. Not to be confused with the major “rest marks” or varices, caused by prolonged growth arrest (as during winter).

Heliciform. Shaped like Helix, i.e., with the characteristic shape of the majority of land snails, which have a somewhat depressed spire and whors that increase regularly in diameter.

Hydrobiid. A common-name adjective referring to a member of the family Hydrobiidae.

Hyaline. Glassy; glossy and translucent or nearly transparent.

Imperforate. Refers to a spiral gastropod shell which has no opening or external cavity at its base. In such a case, the inner sides of the coiled whorls are appressed, leaving no cavity, or, if they are not appressed and a cavity is formed, then its opening is completely covered by a callus or the reflected columellar apertural lip.

Incised. Grooved; engraved.

Inflated. Refers to snail shells or individual whorls which are bulbous or swollen in appearance.

Labrum. The outer part of the apertural lip of a coiled gastropod shell, as opposed to the parietal or umbilical lip and the basal (anterior) lip.
Lateral teeth. The teeth on each side of the central or rachidian tooth in a transverse row of radular teeth (see Fig. 784).

Lira (pl. lirae). A ridge, specifically a spiral ridge on the outer surface of a snail shell.

Lirate. Refers to a shell with spiral ridges on its external surface.

Longitudinal. Refers to shell sculpturing that is at right angles to the spiral direction of the shell’s coil; transverse.

Lymnaeid. A common-name adjective referring to a member of the family Lymnaeidae.

Malleated. Dented as if hit by a hammer.

Marginal teeth. The longitudinal rows of teeth at each edge of the molluscan radula.

MCZ. Abbreviation, usually associated with museum specimen catalogue numbers, for Museum of Comparative Zoology (Harvard University).

Median cusp. The middle cusp of a molluscan radular tooth, generally flanked by smaller lateral cusps.

Median tooth. The central or rachidian tooth of a transverse row of radular teeth. It is flanked by lateral teeth (see Fig. 784).

Micromelaniid. A common-name adjective referring to a member of the family Micromelaniidae.

Multispiral. Refers to an operculum in which there are numerous, very slowly enlarging spirals, coils or whorls (Fig. 780a).

Neritid. A common-name adjective referring to a member of the family Neritidae.

Neritiform. Shaped like *Nerita*, i.e., subglobose or hemispherical, with few rapidly enlarging whorls, very reduced spire, and a heavily calloused and expanded parietal apertural margin (Fig. 779).

Nodule. A small knot, lump or irregularly shaped mass, such as the projections occurring on the shell surface of some freshwater snails.

*Nomen dubium* (pl. *nomina dubia*). A dubious name; one that cannot be applied with certainty to any known taxon.

*Nomen nudum* (pl. *nomina nuda*). A newly introduced species name without sufficient description to justify its acceptance in the zoological literature.

*Nomen oblitum* (pl. *nomina oblita*). A forgotten name. A name that has not been used as a senior synonym in the primary zoological literature for more than 50 years. Such a name has no validity in zoological nomenclature.

Nuchal lobe. One of the two right and left lobes at the anterior head-foot margin on either side of the mouth.

Nucleus. The first-formed (earliest) part of beginning of a shell or operculum (e.g., see Fig. 780d).
Oblique. Slanting; greater or less than a right angle; neither parallel with nor perpendicular to.

Obsolete. Obscure; indistinct; very rudimentary.

Obtuse. Blunt or rounded at the end, not acute or pointed.

Operculum (pl. opercula). A cornaceous or calcareous plate borne on the dorsal posterior foot of prosobranch snails which closes the aperture when the snail withdraws into its shell (Fig. 772).

Oval, ovate. In the shape of the longitudinal section of a hen’s egg, i.e., oblong and curvilinear, with one end narrower than the other.

Ovoviviparus. Condition in which the young snails are formed within an egg, but hatch while still inside the mother snail, from which they emerge as young crawling snails.

Pagoda-like. Shaped like a pagoda, i.e., with a tapering, tower-like, storied, carinate shell spire (see Fig. 443).

Patelliform. Limpet-shaped; ancyliform; shaped like an obtuse cone (see Fig. 778).

Parietal. Pertains to the inside wall of the shell aperture.

Paucispiral. Refers to an operculum in which there are few rapidly enlarging spirals, coils or whorls (Fig. 780b).

Perforate. Refers to a spiral gastropod shell which has a very narrow perforation at its base, formed where the inner sides of the coiled whorls do not join.

Periostracum. The thin proteinaceous external layer covering most mollusk shells.

Periphery. The edges of a shell as seen in outline.

Peritreme. The peristome, apertural “lip” or apertural margin of a gastropod shell (does not include the parietal wall in shells without an entire (continuous) apertural margin).

Physid. A common-name adjective referring to a member of the family Physidae.

Physoid. Shaped like the shell of a member of the family Physidae, i.e., sinistral and with a raised spire.

Planispiral. Coiled in one plane (Fig. 777).

Planorbid. A common-name adjective referring to a member of the family Planorbidae.

Pleurocerid. A common-name adjective referring to a member of the family Pleuroceridae.

Plica (pl. plicae). A transverse or “vertical” ridge or “rib” on the outer shell surface.

Plicate. Bearing plicae, which are transverse or “vertical” ribs on a shell.

Plicate-striate. Refers to a shell having longitudinal (transverse) folds or ribs on its surface that are crossed by raised spiral lines.
Pomatiopsid. A common-name adjective referring to a member of the family Pomatiopsidae.

Ponderous. Very heavy; very thick.

Pseudobranch. A “false” or secondarily derived gill; a vascularized, fleshy outgrowth near the opening to the pulmonary cavity (pneumostone) of aquatic pulmonate snails which aids in respiration (see Fig. 773a). Not a true ctenidium.

Pyriform. Pear-shaped, i.e., large and round at one end and tapering at the other end.

Radula (pl. radulae). A rasp-like structure in the anterior end of the digestive tract of all mollusks except pelecypods which is used to scrape off food during feeding. The radula consists typically of a number of longitudinal and transverse rows of minute sharp “teeth”, each with one or more cutting blades or “cusps”.

Revolving lines. A term sometimes used for spiral striae; occasionally also called “spirals”.

Rinate. Refers to a coiled gastropod shell that has at its base a narrow “umbilical” opening that is partially closed by the expansion of the anterior columellar lip.

Rounded. Having a more or less evenly curved contour, in contrast to being angular.

Scalar. Pertaining to or like a flight of steps, i.e., a shell with elevated spire formed of right-angular whorls.

Scalariform. Shell form, usually pathologically produced, in which the whorls are disjoined or tend to become so.

Sculpture. The natural surface markings, other than those of color, usually found on snail shells, and often furnishing identifying marks for species recognition.

Sensu lato (abbr. s.lat. or s.l.). In the broad sense.

Sensu stricto (abbr. s.str. or s.s.). In the strict sense.

Shouldered. Refers to the appearance (in outline) of the posterior outer peripheral part of a whorl that is sharply rounded in contrast to the more even curvature of the rest of the shell (Fig. 776c).

Sic. Thus (to indicate exact transcription).

Sinuous. Wavy or S-shaped.

Spade-shaped. Shaped like a spade, i.e., like a broad, flat blade tapering rapidly at one end.

Spatulate. Shaped like a spatula, i.e., broad and oblong at one end, tapering rapidly near the center, and continuing as a narrower elongation at the other end.

Spindle-shaped. Fusiform; shaped like a spindle, i.e., with a relatively thick middle and tapered to a point at both ends.

Spiral. Winding, coiling or circling around a central axis; winding around a fixed point and continually receding from it; the form of the shell of most snails.
Spiral sculpture. Surface markings of a snail shell which pass continuously around the whorls more or less parallel to the suture.

Spire. The whorls of a snail shell, excepting the last or body whorl. The spire is measured as the distance (parallel to the columella) from the suture where the apertural lip meets the body whorl to the shell apex.

Stria (pl. striae). A slight superficial spiral groove or furrow on the outer shell surface, or a fine spiral threadlike line or streak. Commonly used also, in a less precise sense, for raised spiral ridges on the shell surface.

Striate. Refers to a shell having spiral incised lines on its surface. Also used, less precisely, to describe shells with spiral raised lines, or for shells covered with fine transverse lines.

Subglobose. Nearly globular or spherical in shape.

Succiniform. Succinea-like, i.e., with a thin and fragile shell, which has a large oval aperture and body whorl and a small spire.

Suture. The line on the shell surface where two adjoining whorls meet.

Taxon (pl. taxa). Any taxonomic group, e.g., a race, subspecies, species, genus, family, order, etc.

Thiarid. A common-name adjective referring to a member of the family Thiaridae.

Transverse. At right angles to the spiral direction of the whorls; parallel to the columella or axis of the shell; in the same direction as (i.e., parallel to) the growth lines of a snail shell.

Truncatelloid. A common-name adjective referring to a member of the superfamily Truncatelloidea.

Tuberculate. Covered with tubercles or rounded knobs.

Tubercle. A nodule or small eminence, such as a solid elevation occurring on the shell surface of some gastropods.

Tumid. Swollen or enlarged.

Turbinate, turbiniform. Shaped like a turban; refers to a shell in which the whorls decrease rapidly in diameter and taper broadly from a circular base to the apex.

Umbilicate. Refers to a spiral gastropod shell which has an opening or cavity at its base, and more specifically to one in which the opening is more than a very narrow perforation. This cavity is formed in those shells in which the inner sides of the coiled whorls do not join.

UMMZ. Abbreviation, usually associated with museum specimen catalogue numbers, for the University of Michigan Museum of Zoology (sometimes incorrectly cited as MZUM).

USNM. Abbreviation, usually associated with museum specimen catalogue numbers, for the United States National Museum (National Museum of Natural History).

Valvatid. A common-name adjective referring to a member of the family Valvatidae.
Viviparid. A common-name adjective referring to a member of the family Viviparidae.

Whorl (spelled "whirl" in early literature). One complete turn or coil of a spiral gastropod shell.
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