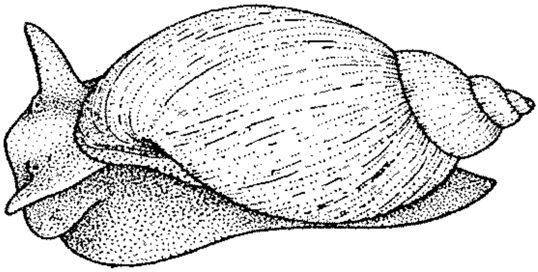
NORTH AMERICAN

FRESHWATER SNAILS



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PREFACE

The purpose of this book is to help students of North American freshwater malacology identify the many species of freshwater snails found on the continent north of the Mexican border. This is a large fauna, beset with many taxonomic problems, which often make species determinations in particularly troublesome groups difficult. But the first step in resolving these problems is to make the freshwater snail fauna better known to a wider audience and to assist developing researchers in taxa identification.

This book was written in three parts, which accounts for its peculiar overall format. The first section to be prepared and printed was the Species List and Ranges [Section IV], which is the most basic part of the book. The purpose of the rest of the text, prepared and printed at later dates, is to augment the list of species and ranges.

This book is a modification of a 1982 manual that I prepared for the United States Environmental Protection Agency entitled *Freshwater Snails (Mollusca: Gastropoda) of North America* [Environmental Monitoring and Support Laboratory, United States Environmental Protection Agency, EPA-600/3-82-026, Cincinnati, Ohio 45268, pp. i-vi, 1-294]. That publication was printed in a limited edition which was exhausted in a few months after printing, and in spite of a large demand, the EPA does not intend to reprint it. Accordingly, the present publication will take its place until such time as a new revision appears.

A further drawback in the original printing, due to the cheap lithography, was the poor reproduction of the excellent illustrations of John Tottenham in section IV. This current reprinting not only makes the contents of the E.P.A. manual again available, but also presents the opportunity to reproduce Mr. Tottenham's drawings properly. This new printing contains all the material in the original E.P.A. publication, as well as some additional introductory material (see Sections I-III, pp. 1-80), and figures to illustrate the identification keys (see Section V, pp. 217-263).

The present publication contains all freshwater gastropod species recognized as possibly valid as of 1982 for North America (north of Mexico). Newly described species and the conclusions of new taxonomic revisions will be presented in an *addendum*.

I wish to express my appreciation to Paul and Janet Rudolph, and to Younghun Jung, for their assistance in the preparation of this book.

J. B. BURCH
Ann Arbor, May 31, 1989

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CONTENTS

I. INTRODUCTION

North America is a vast area with abundant freshwater resources. Its lakes rank among the largest and its rivers among the most extensive in the world. The Great Lakes by themselves hold over 20% of the earth's freshwater reserves. The Mississippi River, with its major tributaries, the Missouri and Red Rock rivers, is 3,860 miles in length and drains an area of some 1,234,700 square miles. With such an extensive freshwater system, it is not surprising that a prominent freshwater snail fauna has developed on the continent. This fauna in North America (north of Mexico) comprises about 500 species.

The freshwater snails of North America are common, and most extant species are relatively easy to collect. But, in spite of this, their taxonomy, especially at the species level, has not been definitively established in most groups. This is unfortunate, because a number of Recent species, and even whole genera, are now extinct due to the biological destruction of their habitats, and many more species are threatened or endangered.

One reason for the lag in modern taxonomic studies of North American freshwater snails is that readily available comprehensive guides for identification are not available. Most of the previous publications are out-of-print, and now are available in only a few of the largest libraries. And, most such publications are now badly out-of-date.

Previous comprehensive accounts of the species of North American freshwater snails are those of Say (1830-34), Haldeman (1840-71; continued by Tryon, 1870-71), Binney (1865c,d) and Burch (1982a,b) [see Bibliography, pp. 293-337]. The first three are old publications, found only in a few specialized institutions and several private libraries. The latter publication, commissioned and published in one limited edition by the U.S. Environmental Protection Agency, was out-of-print only several months after it appeared. The present publication, an extension of the E.P.A. manual, is now presented to make more readily available a modern introduction to the North American freshwater snail fauna.

Binney's manual, which also included the land snails (W.G. Binney & T. Bland, 1869, *Land and fresh water shells of North America. Part I. Pulmonata Geophila*, Smithsonian Miscellaneous Collections, No. 194), was the only such reference available on North American non-marine mollusks for more than a century. But, during the years since Binney's book, various regional handbooks or monographs were published on, or included, North American freshwater snails. The more prominent of these publications, listed by geographic regions, are presented below.

Alaska

William H. Dall. 1905. *Land and fresh water mollusks of Alaska and adjoining regions.* Smithsonian Institution Harriman Alaska Expedition.

Canada

Arthur H. Clarke. 1973. *The freshwater mollusks of the Canadian Interior Basin.* Malacologia, Vol. 13.

Arthur H. Clarke. 1981. *The freshwater molluscs of Canada.* National Museum of Natural Sciences, National Museums of Canada.

United States (exclusive of Alaska)

George W. Tryon, Jr. 1870-71. *A monograph of the fresh-water univalve Mollusca of the United States.* Academy of Natural Sciences of Philadelphia.

Western United States (including Colorado)

Joseph C. Bequaert & Walter B. Miller. 1973. *The mollusks of the arid Southwest, with an Arizona check list.* The University of Arizona Press, Tucson.

R. Ellsworth Call. 1884. *On the Quaternary and Recent Mollusca of the Great Basin, with descriptions of new forms.* Bulletin of the U.S. Geological Survey, No. 11.

Ralph V. Chamberlain & David T. Jones. 1929. *A descriptive catalogue of the Mollusca of Utah.* Bulletin of the University of Utah, Vol. 19.

Harold Hannibal. 1912. *A synopsis of the Recent and Tertiary freshwater Mollusca of the California Province, based upon an ontogenetic classification.* Proceedings of the Malacological Society of London, Vol. 10.

Junius Henderson. 1907/1912. *The Mollusca of Colorado.* University of Colorado Studies, Vols. 4 (1907) and 9 (1912).

Junius Henderson. 1924. *Mollusca of Colorado, Utah, Montana, Idaho and Wyoming.* University of Colorado Studies, Vol. 13. (A supplement was published in 1936.)

Junius Henderson. 1929. *Non-marine Mollusca of Oregon and Washington.* University of Colorado Studies, Vol. 17. (A supplement was published in 1936.)

Josiah Keep. 1887. *West Coast shells.* Bancroft Brothers, San Francisco.

Josiah Keep. 1904. *West American shells.* Whitaker and Ray, San Francisco.

Josiah Keep. 1911 [1910]. *West Coast shells.* [Includes a chapter on "Shells of lakes and streams" by Harold Hannibal.] Whitaker and Ray-Wiggin, San Francisco.

Henry A. Pilsbry & J.H. Ferriss. 1905-1923. *Mollusca of the southwestern states.* Proceedings of the Academy of Natural Sciences of Philadelphia.

North Central United States

Frank Collins Baker. 1902. *The Mollusca of the Chicago area. Part 2, The Gastropoda.* Chicago Academy of Science.

Frank Collins Baker. 1928. *The fresh water Mollusca of Wisconsin.* Wisconsin Geological and Natural History Survey, Bull. 70.

R. Ellsworth Call. 1900. *A descriptive illustrated catalogue of the Mollusca of Indiana.* 24th Annual Report of the Department of Geology and Natural Resources of Indiana. (Revised [without figures] by Calvin Goodrich & Henry van der Schalie, 1944.)

Alan M. Cvancara. 1983. *Aquatic mollusks of North Dakota.* Report of Investigation No. 78, North Dakota Geological Survey.

Calvin Goodrich. 1932. *The Mollusca of Michigan.* Museum of Zoology, The University of Michigan.

Aurèle La Rocque. 1968. *Pleistocene Mollusca of Ohio.* Division of Geological Survey, Department of Natural Resources, State of Ohio, Bull. 62. (Includes Recent species.)

A. Byron Leonard. 1959. *Handbook of gastropods in Kansas.* University of Kansas Museum of Natural History Miscellaneous Publication, No. 20.

Eastern United States

William K. Emerson & Morris K. Jacobson. 1976. *Guide to shells, land, freshwater, and marine, from Nova Scotia to Florida.* Alfred A. Knopf, New York.

Northeastern United States

Augustus A. Gould. 1870. *Report on the Invertebrata of Massachusetts.* Edited by W.G. Binney. Wright and Potter, Boston.

Willard N. Harman & Clifford O. Berg. 1971. *The freshwater snails of central New York, with illustrated keys to the genera and species.* Search, Agriculture, Entomology (Ithaca) 2, Vol. 1.

Eileen H. Jokinen. 1983. *The freshwater snails of Connecticut.* State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Bulletin 109.

Imogene C.S. Robertson & Clifford L. Blakeslee. 1948. *The Mollusca of the Niagara Frontier region.* Bulletin of the Buffalo Society of Natural Science, Vol. 19.

Southeastern United States

William J. Clench & Ruth D. Turner. 1956. *Freshwater mollusks of Alabama, Georgia, and Florida from the Escambia to the Suwannee River.* Bulletin of the Florida State Museum (Biological Science), Vol. 1.

Fred G. Thompson. 1984. *Freshwater snails of Florida. A manual for identification.* University of Florida Press, Gainesville.

Also since Binney's (1865c,d) manual, various taxonomic groups of snails have been monographed, either regionally or totally. These are listed below.

Hydrobiidae

Elmer G. Berry. 1943. *The Amnicolidae of Michigan: distribution, ecology, and taxonomy.* Miscellaneous Publications of the Museum of Zoology, University of Michigan, No. 57.

Fred. G. Thompson. 1968. *The aquatic snails of the family Hydrobiidae of peninsular Florida.* University of Florida Press, Gainesville.

Fred G. Thompson. 1977. *The hydrobiid snail genus* Marstonia. Bulletin of the Florida State Museum (Biological Science), Vol. 21.

Pleuroceridae

Chas. C. Adams. 1915. *The variations and ecological distribution of the snails of the genus* Io. Memoirs of the National Academy of Science, Vol. 12.

Calvin Goodrich. 1917-44. [Numerous papers revising the large family Pleuroceridae, mostly published in the *Occasional Papers of the Museum of Zoology, University of Michigan* and the *Miscellaneous Publications of the Museum of Zoology, University of Michigan*.]

George W. Tryon, Jr. 1873. *Land and fresh-water shells of North America. Part IV. Strepomatidae (American melanians).* Smithsonian Miscellaneous Collections, Vol. 16.

Lymnaeidae

Frank Collins Baker. 1911. *The Lymnaeidae of North and Middle America, Recent and fossil.* Chicago Academy of Science.

Bengt Hubendick. 1951. *Recent Lymnaeidae. Their variation, morphology, taxonomy, nomenclature, and distribution.* Kungliga Svenska Vetenskapsakademiens Handlingar, Vol. 3.

Physidae

George A. Te. 1975. *Michigan Physidae, with systematic notes on* Physella *and* Physodon *(Basommatophora: Pulmonata).* Malacological Review, Vol. 8.

Planorbidae

Frank Collins Baker. 1945. *The molluscan family Planorbidae.* University of Illinois Press, Urbana.

Ancylidae

Paul F. Basch. 1963. *A review of the Recent freshwater limpet snails of North America (Mollusca: Pulmonata).* Bulletin of the Museum of Comparative Zoology at Harvard College, Vol. 129.

The taxonomic philosophies of the authors above have varied considerably, and the taxonomic treatments in the older publications especially need revision. But, the publications of the two lists above have been invaluable source material for the present manual, and may prove to be especially useful to current biologists who must deal with mollusks of the geographical areas or taxonomic groups covered.

In addition to the major publications listed above (and hundreds of more minor ones not listed here), an additional publication should be mentioned: Bryant Walker's (1918) *A synopsis of the classification of the freshwater Mollusca of North America, north of Mexico, and a catalogue of the more recently described species, with notes*, Miscellaneous Publications of the Museum of Zoology, University of Michigan, No. 6. Although this publication is now out-of-print and out-of-date, it has been one of the landmark publications on the classification of North American mollusks for the past 70 years.

II. SYSTEMATICS, NOMENCLATURE, IDENTIFICATION AND MORPHOLOGY

* * *

SYSTEMATICS

Interest in the systematics of North American freshwater snails began in the 17th century in Europe, but it was Thomas Say (1787-1834), an American, who made the most significant early advances in taxonomic malacology on this continent. Say recognized and described many new mollusks, most of which still stand today as valid species. A contemporary of Say's was C.F. Rafinesque, who added many more new taxa (and much confusion). Say and Rafinesque were followed by T.A. Conrad, A.A. Gould, S.S. Haldeman, James Lewis, Wm. G. Binney, G.W. Tryon, H.A. Pilsbry and scores of other authors who described hundreds of additional taxa.

This fauna in North America (north of Mexico), as currently recognized, comprises about 500 species, which are divided into 78 genera and 15 families. These snails are grouped into two large subclasses, the gill-breathing, operculated Prosobranchia and the lung-breathing, non-operculated Pulmonata (Order Lymnophila). The prosobranch snails are represented by 49 genera and about 350 species, and the pulmonate snails by 29 genera and about 150 species. Systematics are not well worked out in many groups of North American freshwater snails, and future studies undoubtedly will change these numbers. An outline of classification is presented below.

Subclass PROSOBRANCHIA
Order Neritacea (Neritopsina)
Superfamily Neritinoidea

NERITIDAE Rafinesque 1815
Neritina Lamarck 1816 (*Nerita pulligera* Linnaeus 1766)*
Vitta Mörch 1852 (*Nerita virginea* Linnaeus 1758)

*Type species are placed in parentheses after each generic-group name.

Order Mesogastropoda
Superfamily Valvatoidea

VALVATIDAE Gray 1840
Valvata Müller 1774 (*Valvata cristata* Müller 1774)

Superfamily Ampullarioidea

VIVIPARIDAE Gray 1847
Viviparinae
Tulotoma Haldeman 1840 (*Paludina magnifica* Conrad 1834)
Viviparus Montfort 1810 (*Helix vivipara* Linnaeus 1758)
Bellamyinae Röhrbach 1937
†*Cipangopaludina* Hannibal 1912 (*Paludina malleata* Reeve 1862)
Lioplacinae Gill 1863
Campeloma Rafinesque 1819 (*Campeloma crassula* Rafinesque 1819)
Lioplax Troschel 1857 (*Limnaea subcarinata* Say 1817)

AMPULLARIIDAE Guilding 1828
†*Marisa* Gray 1824 (*Helix cornuarietis* Linnaeus 1758)
Pomacea Perry 1810 (*Pomacea maculata* Perry 1810)

BITHYNIIDAE Troschel 1857
Bithynia Leach (in Abel) 1818 (*Helix tentaculata* Linnaeus 1758)

?MICROMELANIIDAE Thiele 1928
Antroselates Hubricht 1963 (*Antroselates spiralis* Hubricht 1963)

Superfamily Truncatelloidea

HYDROBIIDAE Troschel 1857
Hydrobiinae
Aphaostracon Thompson 1968 (*Aphaostracon rhadinus* Thompson 1968)

†Recent introduction to North America.

Hoyia F. C. Baker 1926 (*Amnicola sheldoni* Pilsbry 1890)
Hyalopyrgus Thompson 1968 (*Bythinella aequicostata* Pilsbry 1889)
Littoridinops Pilsbry 1952 (*Amnicola tenuipes* Couper (in Haldeman) 1844)
Probythinella Thiele 1928 (*Paludina emarginata* Küster 1852 = *Probythinella lacustris limafodens* Morrison 1947)
Pyrgophorus Ancey 1888 (*Pyrgulopsis spinosus* Call & Pilsbry 1886)
Tryonia Stimpson 1865 (*Tryonia clathrata* Stimpson 1865)
Lithoglyphinae Troschel 1857
Antrobia Hubricht 1971 (*Antrobia culveri* Hubricht 1971)
Clappia Walker 1909 (*Clappia clappi* Walker 1909 = *Somatogyrus umbilicatus* Walker 1904)
Cochliopina Morrison 1946 (*Cochliopa riograndensis* Pilsbry & Ferriss 1906)**
Fluminicola Stimpson 1865 (*Paludina nuttalliana* Lea 1838)
Gillia Stimpson 1865 (*Melania altilis* Lea 1842)
Lepyrium Dall 1896 (*Neritina showalteri* Lea 1861)
Somatogyrus Gill 1863
Somatogyrus s.s. (*Amnicola depressa* Tryon 1862)
Walkerilla Thiele 1928 (*Somatogyrus coosaensis* Walker 1904)
Nymphophilinae Taylor 1966
Birgella F. C. Baker 1926 (*Paludina subglobosa* Say 1825)
Cincinnatia Pilsbry 1891 (*Paludina cincinnatiensis* Anthony 1840)
Fontelicella Gregg & Taylor 1965
Fontelicella s.s. (*Fontelicella californiensis* Gregg & Taylor 1965)
Microamnicola Gregg & Taylor 1965 (*Amnicola micrococcus* Pilsbry (in Stearns) 1893)
Natricola Gregg & Taylor 1965 (*Pomatiopsis robusta* Walker 1908)
Marstonia F. C. Baker 1926 (*Amnicola lustrica* Pilsbry 1890)
Notogillia Pilsbry 1953 (*Hydrobia wetherbyi* Dall 1885)
Orygoceras Brusina 1882 (*Orygoceras cornucopiae* Brusina 1882)

**See Thompson (1984, p. 109) for subfamilial placement of *Cochliopina*.

Pyrgulopsis Call & Pilsbry 1886 (*Pyrgula nevadensis* Stearns 1883)
Rhapinema Thompson 1969 (*Rhapinema dacryon* Thompson 1969)
Spilochlamys Thompson 1968 (*Spilochlamys conica* Thompson 1968)
Stiobia Thompson 1978 (*Stiobia nana* Thompson 1978)
Amnicolinae Tryon 1862
Amnicola Gould & Haldeman 1840
Amnicola s.s. (*Paludina porata* Say 1821 = *Paludina limosa* Say 1817)
Lyogyrus Gill 1863 (*Valvata pupoidea* Gould 1841)
?*Hauffenia* Pollonera 1898 (*Horatia tellini* Pollonera 1898)
?*Horatia* Bourguignat 1887 (*Horatia klecakiana* Bourguignat 1887)
Fontigentinae Taylor 1966
Fontigens Pilsbry 1933 (*Paludina nickliniana* Lea 1838)

POMATIOPSIDAE Stimpson 1865
Pomatiopsis Tryon 1862 (*Cyclostoma lapidaria* Say 1817)

Superfamily Cerithioidea

THIARIDAE Troschel 1857
†*Melanoides* Olivier 1804 (*Nerita tuberculata* Müller 1774)
†*Thiara* Röding 1798 (*Helix amarula* Linnaeus 1758)

PLEUROCERIDAE Fischer 1885 (Strepomatidae Haldeman 1863, ?Paludomidae Gill 1871)
Elimia H. & A. Adams 1854 (*Melania acutocarinata* Lea 1841 = *Melania clavaeformis* Lea 1841) [synonyms: *Goniobasis, Macrolimen, Melasma*]
Gyrotoma Shuttleworth 1845 (*Gyrotoma ovoidea* Shuttleworth 1845 = *Melania excisa* Lea 1843) [synonyms: *Apella*; *Schizostoma* Lea 1843, non Bronn 1835; *Schizocheilus* Lea 1852]
Io Lea 1831 (*Fusus fluvialis* Say 1825) [synonym: *Melafusus*]

†Recent introduction to North America.

Juga H. & A. Adams 1854
Juga s.s. (*Melania silicula* Gould 1847)
Calibasis Taylor 1966 (*Melania* (?*Goniobasis*) *acutifilosa* Stearns 1890)
Oreobasis Taylor 1966 (*Melania newberryi* Lea 1860 = ?*Melania bulbosa* Gould 1847)
Leptoxis Rafinesque 1819 (*Melania praerosa* Say 1821) [synonyms: *Anaplocamus, Anculosa*]
Mudalia Haldeman 1840 (*Paludina dissimilis* Say 1819 = *Bulimus carinatus* Bruguière 1792) [synonyms: *Alleghenya, Nitocris, Spirodon*]
Lithasia Haldeman 1840 (*Anculosa (Lithasia) geniculata* Haldeman 1840) [synonyms: *Angitrema, Athearnia, Eurycaelon, Glottella, Megara, Meseschiza*]
Pleurocera Rafinesque 1818 (*Pleurocera acuta* Rafinesque (in Blainville) 1824) [synonyms: *Ceriphasia, Oxytrema, Strepoma, Telescopella, Trypanostoma*]
Strephobasis Lea 1861 (*Strephobasis cornea* Lea 1861 = *Melania plena* Anthony 1854)

Subclass PULMONATA

Order Lymnophila

Suborder Archaeopulmonata

Superfamily Acroloxoidea

ACROLOXIDAE Thiele 1931
Acroloxus Beck 1837 (*Patella lacustris* Linnaeus 1758)

Suborder Branchiopulmonata

Superfamily Lymnaeoidea

LYMNAEIDAE Rafinesque 1815
Lymnaeinae
Acella Haldeman 1841 (*Lymnaea gracilis* Jay 1839, preocc. = *Limnaea haldemani* "Deshayes" W. G. Binney 1867)
Bulimnea Haldeman 1841 (*Lymnaeus megasomus* Say 1824)
Fossaria Westerlund 1885
Fossaria s.s. (*Buccinum truncatulum* Müller 1774)

Bakerilymnaea Weyrauch 1964 (*Limnaea cubensis* Pfeiffer 1839)
Lymnaea Lamarck 1799 (*Helix stagnalis* Linnaeus 1758)
Pseudosuccinea F.C. Baker 1908 (*Lymnaea columella* Say 1817)
†*Radix* Montfort 1810 (*Radix auriculatus* Montfort 1810 = *Helix auricularia* Linnaeus 1758)
Stagnicola Leach (in Jeffreys) 1830
Stagnicola s.s. (*Buccinum palustre* Müller 1774)
Hinkleyia F. C. Baker 1928 (*Lymnaeus caperatus* Say 1829)
Lancinae Hannibal 1914
Fisherola Hannibal 1912 (*Fisherola lancides* Hannibal 1912)
Lanx Clessin 1882
Lanx s.s. (*Ancylus newberryi* Lea 1858 = *Ancylus patelloides* Lea 1856)
Walkerola Hannibal 1912 (*Lanx (Walkerola) klamathensis* Hannibal 1912)

Superfamily Ancyloidea

PHYSIDAE Fitzinger 1833
Physinae
Physa Draparnaud 1801 (*Bulla fontinalis* Linnaeus 1758)
Physella Haldeman 1843
Physella s.s. (*Physa globosa* Haldeman 1841)
Costatella Dall 1870 (*Physa costata* Newcomb 1861)
Petrophysa Pilsbry 1926 (*Physa (Petrophysa) zionis* Pilsbry 1926)
Aplexinae Starobogatov 1967
Aplexa Fleming 1820 (*Bulla hypnorum* Linnaeus 1758)
Stenophysa Martens 1898 (*Physa sowerbyana* d'Orbigny 1853)

PLANORBIDAE Rafinesque 1815
Planorbinae
Planorbini
Gyraulus "Agassiz" Charpentier 1837
Gyraulus s.s. (*Planorbis hispidus* Draparnaud 1805 = *Planorbis albus* Müller 1774)

†Recent introduction to North America.

Armiger Hartmann 1840 (*Planorbis cristatus* Draparnaud 1805 = *Nautilus crista* Linnaeus 1758)
Torquis Dall 1905 (*Planorbis parvus* Say 1817)
Drepanotremini Zilch 1959 (?Acrorbini Starobogatov 1958)
Drepanotrema Fischer & Crosse 1880 (*Planorbis yzabalensis* Crosse & Fischer 1879 = *Planorbis anatinus* d'Orbigny 1835)
Antillorbis Harry & Hubendick 1964 (*Planorbis circumlineatus* Shuttleworth 1854 = *Planorbis aeruginosus* Morelet 1851)
Fossulorbis Pilsbry 1934 (*Planorbis cultratus* d'Orbigny 1841 = *Planorbis kermatoides* d'Orbigny 1835)
Biomphalariini Watson 1954
Biomphalaria Preston 1910 (*Biomphalaria smithi* Preston 1910)
Helisomini F. C. Baker 1928
Helisoma Swainson 1840
Helisoma s.s. (*Planorbis bicarinatus* Say 1817, preocc. = *Planorbis anceps* Menke 1830)
Carinifex W.G. Binney 1865 (*Planorbis newberryi* Lea 1858)
Menetus H. & A. Adams 1855
Menetus s.s. (*Planorbis opercularis* Gould 1847)
Micromenetus F.C. Baker 1945 (*Planorbis dilatatus* Gould 1841)
Planorbella Haldeman 1842
Planorbella s.s. (*Planorbis campanulatus* Say 1821)
Pierosoma Dall 1905 (*Planorbis trivolvis* Say 1817)
Seminolina Pilsbry 1934 (*Paludina scalaris* Jay 1839)
Planorbula Haldeman 1840 (*Planorbis armigerus* Say 1821)
Promenetus F. C. Baker 1935 (*Planorbis exacuous* Say 1821)
Vorticifex Meek (in Dall) 1870
Vorticifex s.s. (*Carinifex (Vorticifex) tryoni* Meek (in Dall) 1870)
Parapholyx Hanna 1922 (*Pompholyx effusa* Lea 1856)
Neoplanorbinae Hannibal 1912
Amphigyra Pilsbry 1906 (*Amphigyra alabamensis* Pilsbry 1906)
Neoplanorbis Pilsbry 1906 (*Neoplanorbis tantillus* Pilsbry 1906)

ANCYLIDAE Rafinesque 1815
Ancylinae
Rhodacmea Walker 1917

Rhodacmea s.s. (*Ancylus filosus* Conrad 1834)
Rhodocephala Walker 1917 (*Rhodacmea (Rhodocephala) rhodacme* Walker 1917)
Ferrissinae Walker 1917
Ferrissia Walker 1903 (*Ancylus rivularis* Say 1817)
Laevapecinae Hannibal 1912
Hebetancylus Pilsbry 1914 (*Ancylus moricandi* d'Orbigny 1836)
Laevapex Walker 1903 (*Ancylus fuscus* C.B. Adams 1841)

The sizes of the various genera vary enormously, a variation which in some cases undoubtedly reflects real numbers of valid species, but perhaps more often simply indicates the disparate quality of current taxonomy. Below is a taxonomic list of North American freshwater snail genera showing the number of species and subspecies presently recognized for each.

	Number of North American (north of Mexico) Species	Number of Subspecies [and recognized "morphs" or "forms"] *
Subclass Prosobranchia		
Order Neritacea		
Superfamily **Neritinoidea**		
Family NERITIDAE		
Genus *Neritina*		
Subgenus *Vitta*	1	3
Order Mesogastropoda		
Superfamily **Valvatoidea**		
Family VALVATIDAE		
Genus *Valvata*	11	2 [+ 18 "morphs" or "forms"]
Superfamily **Ampullarioidea**		
Family VIVIPARIDAE		
Subfamily Viviparinae		
Genus *Tulotoma*	1	
Genus *Viviparus*	3	
Subfamily Bellamyinae		
Genus *Cipangopaludina*	2	
Subfamily Lioplacinae		
Genus *Campeloma*	8	[9 "forms"]
Genus *Lioplax*	5	2
Family AMPULLARIIDAE (PILIDAE)		
Genus *Marisa*	1	
Genus *Pomacea*	2	
Family BITHYNIIDAE		
Genus *Bithynia*	1	2
Superfamily **Truncatelloidea**		
Family MICROMELANIIDAE		
Genus *Antroselates*	1	
Family HYDROBIIDAE		
Subfamily Hydrobiinae		
Genus *Aphaostracon*	9	
Genus *Hoyia*	1	
Genus *Hyalopyrgus*	2	
Genus *Littoridinops*	2	
Genus *Probythinella*	1	
Genus *Pyrgophorus*	2	
Genus *Tryonia*	5	
Subfamily Lithoglyphinae		
Genus *Antrobia*	1	
Genus *Clappia*	2	
Genus *Cochliopina*	1	
Genus *Fluminicola*	12	
Genus *Gillia*	1	
Genus *Lepyrium*	1	
Genus *Somatogyrus*		
Subgenus *Somatogyrus* s.s.	32	
Subgenus *Walkerilla*	3	
Subfamily Nymphophilinae		
Genus *Birgella*	1	
Genus *Cincinnatia*	14	
Genus *Fontelicella*		
Subgenus *Fontelicella* s.s.	6	
Subgenus *Microamnicola*	1	
Subgenus *Natricola*	3	
Genus *Marstonia*	8	
Genus *Notogillia*	2	
Genus *Orygoceras*	1	
Genus *Pyrgulopsis*	5	2
Genus *Rhapinema*	1	
Genus *Spilochlamys*	3	
Genus *Stiobia*	1	
Subfamily Amnicolinae		
Genus *Amnicola*		
Subgenus *Amnicola* s.s.	11	7
Subgenus *Lyogyrus*	7	
Genus *Hauffenia*	1	
Genus *Horatia*	1	
Subfamily Fontigentinae		
Genus *Fontigens*	8	

*The numbers in this column are the subspecies [or "morphs" or "forms"] listed in this manual for the various species of each genus. Singly listed subspecies of species in which all other subspecies occur extralimitally are not enumerated.

Incertae Sedis	3	
Family POMATIOPSIDAE		
Genus *Pomatiopsis*	6	
Superfamily **Vermetoidea**		
Family THIARIDAE		
Genus *Melanoides*	1	
Genus *Thiara*	1	
Family PLEUROCERIDAE		
Genus *Elimia*	83	41
Genus *Gyrotoma*	6	
Genus *Io*	1	
Genus *Juga*		
Subgenus *Juga* s.s.	3	2
Subgenus *Calibasis*	2	3
Subgenus *Oreobasis*	4	
Genus *Leptoxis*		
Subgenus *Leptoxis* s.s.	16	
Subgenus *Athearnia*	1	2
Subgenus *Mudalia*	6	2
Genus *Lithasia*		
Subgenus *Lithasia* s.s.	3	6
Subgenus *Angitrema*	7	
Genus *Pleurocera*		
Subgenus *Pleurocera* s.s.	18	13
Subgenus *Strephobasis*	3	2
Subclass Pulmonata		
Order Lymnophila		
Superfamily **Acroloxoidea**		
Family ACROLOXIDAE		
Genus *Acroloxus*	1	
Superfamily **Lymnaeoidea**		
Family LYMNAEIDAE		
Subfamily Lymnaeinae		
Genus *Acella*	1	
Genus *Bulimnea*	1	
Genus *Fossaria*		
Subgenus *Fossaria* s.s.	11	
Subgenus *Bakerilymnaea*	11	
Genus *Lymnaea*	2	2
Genus *Pseudosuccinea*	1	
Genus *Radix*	1	
Genus *Stagnicola*		
Subgenus *Stagnicola* s.s.	21	
Subgenus *Hinkleyia*	3	
Subfamily Lancinae		
Genus *Fisherola*	1	3
Genus *Lanx*		
Subgenus *Lanx* s.s.	3	
Subgenus *Walkerola*	1	
Superfamily **Ancyloidea**		
Family PHYSIDAE		
Subfamily Physinae		
Genus *Physa*	2	

Genus *Physella*		
Subgenus *Physella* s.s.	16	16 [+5 "morphs"]
Subgenus *Costatella*	14	14 [+4 "morphs"]
Subgenus *Petrophysa*	1	
Subfamily Aplexinae		
Genus *Aplexa*	2	[1 "morph"]
Genus *Stenophysa*	2	
Family PLANORBIDAE		
Subfamily Planorbinae		
Tribe Planorbini		
Genus *Gyraulus*		
Subgenus *Gyraulus* s.s.	1	
Subgenus *Armiger*	1	
Subgenus *Torquis*	3	
Tribe Drepanotremini		
Genus *Drepanotrema*		
Subgenus *Antillorbis*	1	
Subgenus *Fossulorbis*	2	
Tribe Biomphalariini		
Genus *Biomphalaria*	2	
Tribe Helisomini		
Genus *Helisoma*		
Subgenus *Helisoma* s.s.	2	2
Subgenus *Carinifex*	1	3
Genus *Menetus*		
Subgenus *Menetus* s.s.	1	
Subgenus *Micromenetus*	3	
Genus *Planorbella*		
Subgenus *Planorbella* s.s.	2	2
Subgenus *Pierosoma*	12	7
Subgenus *Seminolina*	2	[6 "races" or "forms"]
Genus *Planorbula*	2	2
Genus *Promenetus*	2	
Genus *Vorticifex*		
Subgenus *Parapholyx*	2	
Subfamily Neoplanorbinae		
Genus *Amphigyra*	1	
Genus *Neoplanorbis*	4	
Family ANCYLIDAE		
Subfamily Ancylinae		
Genus *Rhodacmea*	3	
Subfamily Ferrissinae		
Genus *Ferrissia*	5	
Subfamily Laevapecinae		
Genus *Hebetancylus*	1	
Genus *Laevapex*	2	

NOMENCLATURE

Nomenclature in the North American freshwater snails has been the subject of considerable controversy and seemingly continuing change. Part of this changing nomenclature has been the discovery from time to time of older names for currently used taxa. Another factor that has caused some nomenclatural instability has been the changing of the rules of nomenclature over the years. Hopefully, the nomenclature is now reasonably stable, but it will no doubt still be subject to some change in the several groups for which there is not yet enough information from which to provide a reasonably definitive classification. Also, probably there will still be some differences in the names used for several taxa because of differing attitudes among individual malacologists regarding application of nomenclature, and about how much difference between taxa is significant enough to warrant the recognition of particular grades of taxa.

Perhaps the greatest subjects of controversy in the past have been the application of some of the ill-defined names of C.S. Rafinesque. These debates are still going on, although one of the longest running disputes was recently settled by a 1981 ruling (Opinion 1195) of the International Commission on Zoological Nomenclature in designating for *Pleurocera* Rafinesque 1818 the type species *P. acuta* Rafinesque (in Blainville) 1824 (see p. 24).

During various periods in the history of North American freshwater malacology, certain familial and generic names were in common use, only to be changed later. Also, there was some confusion as to the authorship of familial names. For example, Rafinesque (1815) is credited now as the first to use formally the family-group names Neritidae*, Lymnaeidae, Planorbidae and Ancylidae, but since his authorship of these families was not generally recognized until relatively recently, most workers credited these names to other authors. In fact, North American authors succeeding Rafinesque, and foreign authors as well, did not divide the freshwater gastropods into the basic groups that we recognize today. Haldeman (1840-71) included all the freshwater pulmonates in the family "Physadae." Tryon (1870-71), who continued Haldeman's monograph, used this

*Rehder (1980) credited the introduction of the family name Neritidae to the vernacular form ["Neritacées" (sic)] used by Lamarck (1812, p. 117). However, there are even earlier vernacular versions of this name (e.g., see Férussac, 1807). Incidentally, Lamarck's "Néritaces" contained only four names as included taxa, all in the vernacular.

same family name, but divided the family into subfamilies, several of which are no longer recognized as family-group assemblages (Pompholiginae Dall 1866; Megasistrophinae Tryon 1870). For the North American freshwater prosobranchs, Haldeman (1845, see pp. 1-3) placed them all in the families Turbidae (based on the marine genus *Turbo*) and Melaniadae* [Pleuroceridae], although he acknowledged other familial arrangements made by Europeans, including that of J.E. Gray (1821), who split the freshwater operculates into several families, represented by the genera *Ampullaria*, *Paludina* and *Valvata*. [For these latter three groups, modern usage has not changed: these families are Ampullariidae [= Pilidae], Viviparidae (*Paludina*†) and Valvatidae (*Valvata*). Tryon (1870-71) used Turbidae on the cover page of his monograph for the freshwater prosobranchs, but in the text he recognized as families the Ampulariidae, Amnicolidae§ [= Hydrobiidae], Valvatidae and Strepomatidae [= Pleuroceridae].

The nomenclature followed here (pp. 7-14 and Section IV) adheres to the Rules, Recommendations, Opinions and Directions set forth by the International Commission on Zoological Nomenclature. In following the Law of Priority, one well-known generic name now regrettably falls by the wayside: *Goniobasis* Lea 1862 (type species *Goniobasis osculata* Lea 1862 by subsequent designation (Hannibal, 1912)) (= *Elimia* H. & A. Adams 1854, type species *Melania acutocarinata* Lea 1841 by subsequent designation (Pilsbry & Rhodes, 1896)). Getting a ruling by the Commission to conserve the name *Goniobasis* would seem to be virtually impossible, if the case of fixing the type species of *Pleurocera* is taken as an example. It took more than 56 years (from January 20, 1925, until November 1981) to get a ruling on a case less

*Excluding the pleurocerid *Anculosa*, which Haldeman included in the Turbidae.

†*Paludina* Lamarck (in Férussac) 1812, a synonym of *Viviparus* Montfort 1810, was the name given to all members of the Viviparidae in the early literature, to be replaced by *Melantho* Bowdich 1822 for the *P. decisa* Say 1817 group. *Melantho* was later replaced in the literature by *Campeloma* Rafinesque 1819, and this is the name still in use today.

§ In the Hydrobiidae (also referred in past literature to Rissoidae, a family name now restricted to a group of marine prosobranch snails related to the Hydrobiidae, and included with them and several other families in the superfamily Rissoacea [= Truncatelloidea]) and Amnicolidae [a synonym for, or subfamily of, the Hydrobiidae] was *Amnicola* Gould & Haldeman 1840, but today that generic name is used in a much more restricted sense. Many of the species once included in "*Amnicola*" are now placed in various other hydrobiid genera.

clearcut in nature, but of more serious consequence in regard to nomenclatural stability.

Opinions and Directions of the International Commission on Zoological Nomenclature that specifically affect the nomenclature of freshwater snails in North America are listed below and on the several pages following (pp. 20-24).

The Status of Proof Sheets in Nomenclature. This topic brought to question whether *Megasystropha* Lea 1864 (type species *Planorbis newberryi* Lea 1858) should be used rather than *Carinifex* W.G. Binney 1865 (same type species), since the latter was introduced two years earlier (1863) in publically distributed proof-sheets. OPINION 87, December 16, 1925: Printer's proof-sheets do not constitute publication and, therefore, have no status under the International Rules of Zoological Nomenclature. [However, in Opinion 432 (see below), the Commission ruled in favor of *Carinifex* Binney 1865, suppressing *Megasystropha*.]

Twenty-two Mollusk and Tunicate Names Placed in the Official List of Generic Names. These names have priority and therefore do not have to be adopted as *"nomina conservanda"* under "Suspension of the Rules." OPINION 94, October 8, 1926: The following names are hereby placed in the Official List of Generic Names: MOLLUSCA: *Anodonta, Argonauta, Buccinum, Calyptraea, Columbella, Dentalium, Helix, Limax, Mactra, Mya, Mytilus, Ostrea, Physa, Sepia, Sphaerium, Succinea, Teredo.* TUNICATA: *Botryllus, Clavelina, Diazona, Distaplia, Molgula.* [Of interest here to North American freshwater gastropod malacology is the name *Physa.*]

Bulimus Scopoli, 1777, vs. *Bulinus* Mueller, 1781, vs. *Bulimus* Bruguière, 1792. Of importance to North American freshwater malacology is whether or not the name *Bulimus* Scopoli would replace the generic name *Bithynia.* OPINION 116, January 10, 1931: The Commission does not interpret *Bulimus* Scopoli, 1777, as an obvious typographical error; the premises do not show that the genotype (which must be selected from the four originally included species) has been definitely and properly designated. *Bulinus* Mueller, 1781, has for its type *Bulinus senegalensis*, and is not invalidated by *Bulimus*, 1777. *Bulimus* Bruguière, 1792, type *haemastomus* seu *oblonga* is a dead homonym of *Bulimus*, 1777. [In Opinion 475 (see below), the Commission suppressed the name *Bulimus* Scopoli 1777 in favor of *Bithynia* Leach (in Abel) 1818.]

Six Molluscan Generic Names Placed in the Official List of Generic Names. These names have priority and therefore do not have to be adopted as *"nomina conservanda"* under "Suspension of the Rules." OPINION 119, January 10, 1931: The following six generic names of *MOLLUSCA* are hereby placed in the Official List of Generic Names, with types as stated: *Cerion* (*uva*), *Oleacina* (*voluta*), *Neritina* (*pulligera*), *Clausilia* (*rugosa*), *Vitrina* (*pellucida*), *Tornatellina* (*clausa*). [Of interest here to North American freshwater malacology is the name *Neritina.*]

Addition to the "Official List of Generic Names in Zoology" of the names of thirty-four non-marine genera of the Phylum Mollusca. OPINION 335, March 17, 1955:- ... (2) The under-mentioned names of non-marine genera of the Class Gastropoda are hereby placed on the *Official List of Generic Names in Zoology* with the Name Nos. 810 to 841 respectively:- ... (iii) *Aplexa* Fleming, 1820 (gender of name: feminine) (type species by monotypy: *Bulla hypnorum* Linnaeus, 1758). ... (xxix) *Valvata* Müller (O.F.), 1774 (gender of name: feminine) (type species, by monotypy: *Valvata cristata* Müller (O.F.), 1774). ... (5) The under-mentioned specific names, being the names of type species of genera of the Class Gastropoda placed on the *Official List of Generic Names in Zoology* under (2) above, are hereby placed on the *Official List of Specific Names in Zoology* with the Name Nos. 292 to 315 respectively:- ... (vii) *cristata* Müller (O.F.), 1774, as published in the combination *Valvata cristata* (specific name of the type species of *Valvata* Müller (O.F.), 1774). ... (xii) *hypnorum* Linnaeus, 1758, as published in the combination *Bulla hypnorum* (specific name of type species of *Aplexa* Fleming, 1820) ... .

Addition to the "Official List of Specific Names in Zoology" of the Specific names of one hundred and twenty-two non-marine species of the Phylum Mollusca. OPINION 336, March 17, 1955: (1) the under-mentioned specific names of non-marine species of the Class Gastropoda are placed on the *Official List of Generic Names in Zoology* with the Name Nos. 324 to 425 respectively:- (i) *acuta* Draparnaud, [1805], as published in the combination *Physa acuta;* (ii) *albus* Müller (O.F.), 1774, as published in the combination *Planorbis albus;* ... (x) *auricularia* Linnaeus 1758, as published in the combination *Helix auricularia;* ... (xx) *crista* Linnaeus, 1758, as published in the combination *Nautilus crista;* ... (xxiv) *dilatatus* Gould, 1841, as published in the combination *Planorbis dilatatus;* ... (xxxii) *fontinalis* Linnaeus, 1758, as published in the combination *Bulla fontinalis;* ... (lxxxvii) *stagnalis* Linnaeus, 1758, as published in the combination *Helix stagnalis;* ... (xcv) *truncatulum* Müller (O.F.), 1774, as published in the combination *Buccinum truncatulum;* ...

Addition to the "Official List of Family-Group Names in Zoology" of Family-Group Names Based on the Names of Certain Genera of Non-marine Mollusca Placed on the *Official List of Generic Names in Zoology* by the Ruling Given in "Opinion" 335. "DIRECTION 27, August 5, 1955:- (1) The under-mentioned family-group names, each of which is the name of a family-group taxon, the type genus of which was placed on the *Official List of Generic Names in Zoology* by the Ruling given in Opinion 335, are hereby placed on the *Official List of Family-Group Names in Zoology* with the Name Nos. severally specified below:- ... (xi) PLANORBIDAE Gray (J.E.), 1840 (type genus: *Planorbis* Müller (O.F.), 1774 (Name No. 47) [Planorbia Rafinesque 1815, subfamily, = Planorbinae (now Planorbidae), has priority]; ... (xviii) VALVATIDAE Gray (J.E.), 1840 (Type genus: *Valvata* Müller (O.F.), 1774) (Name No. 54); ... .

Designation, Under the Plenary Powers, of a Type Species in Harmony with Accustomed Usage for the Nominal Genus *"Ancylus"* Müller (O.F.), 1774 (Class Gastropoda). OPINION 363, November 4, 1955:- (1) Under the Plenary Powers (a) selections of type species for the nominal genus *Ancylus* Müller (O.F.), 1774 (Class Gastropoda) made prior to the present Ruling are hereby set aside, and (b) the nominal species *Ancylus fluviatilis* Müller (O.F.), 1774, is hereby designated to be the type species of the foregoing genus. (2) The under-mentioned generic names are hereby placed on the *Official List of Generic Names in Zoology* with the Name Nos. 884 and 885 respectively:- (a) *Ancylus* Müller (O.F.), 1774 (gender: masculine) (type species, by designation under the Plenary Powers under (1)(b) above: *Ancylus fluviatilis* Müller (O.F.), 1774: 199-200); (b) *Acroloxus* Beck, 1837 (gender: masculine) (type species, by selection by Herrmannsen (1846): *Patella lacustris* Linnaeus, 1758, as interpreted by Müller (O.F.), 1774: 199-200); (3) The under-named specific names are hereby placed on the *Official List of Specific Names in Zoology* with the Name Nos. 502 and 503 respectively:- (a) *fluviatilis* Müller (O.F.), 1774, as published in the combination *Ancylus fluviatilis* (specific name, by designation under the Plenary Powers under (1)(b) above, of type species of *Ancylus* Müller (O.F.), 1773; (b) *lacustris* Linnaeus, 1758, as published in the combination *Patella lacustris*, as interpreted in the manner specified in (2)(b) above (specific name of type species of *Acroloxus* Beck, 1837). ... .

Addition to the "Official List of Family-Group Names in Zoology" ... of the Family-Group Names Involved in Volume 11 of the "Opinions and Declarations Rendered by the International Commission on Zoological Nomenclature", Other Than Family-Group Names Already Dealt With in Those "Opinions". DIRECTION 41, February 24, 1956:- (1) The under-mentioned family-group names involved in the cases dealth with in the *Opinions* included in volume 11 of the *Opinions and Declarations Rendered by the International Commission on Zoological Nomenclature* are hereby placed on the *Official List of Family-Group Names in Zoollogy* with the Name Numbers severally specified below:- ... (c) ANCYLINAE (correction of ANCYLIDIA) Rafinesque (C.S.), 1815 (type genus: *Ancylus* Müller (O.F.), 1774) (name proposed by Rafinesque as the name for a "sous-famille"; first published with an approved termination (as ANCYLINAE) by Fischer (P.), [1883]) (Class Gastropoda) (*Opinion* 363) (Name No, 78); (d) ACROLOXINAE Thiele (J.), 1931 (type genus: *Acroloxus* Beck, 1837) (Class Gastropoda) (*Opinion* 363) (Name No. 79); ... .

Proposed Use of the Plenary Powers to Validate the Generic Name *"Carinifex"* Binney, 1865 (Class Gastropoda). Joshua L. Bailey, Jr., reopened the case of *Megasystropha* Lea vs. *Carinifex* Binney, giving additional relevant information and pointing out the almost universal use of *Carinifex* over *Megasystropha*. OPINION 432, November 14, 1956: Rejection, as an unpublished proof, of the paper by Binney (W. G.) dated "9th December 1863" and entitled *Synopsis of the Species of Air-breathing Mollusks of North America* (confirmation of Ruling given in *Opinion* 87) and validation under the Plenary Powers of the generic name *Carinifex* Binney, 1865 (Class Gastropoda).

Proposed Validation under the Plenary Powers of the Generic Name *"Bithynia"* Leach, 1818 (Class Gastropoda). The purpose of this application was to prevent "the appalling confusion and disturbance which would result from the disappearance of this long-established name as a junior synonym of *Bulimus* Scopoli, 1777." OPINION 475, July 31, 1957: Under the Plenary Powers the undermentioned generic name is hereby suppressed for the purposes of the Law of Priority but not for those of the Law of Homonymy: *Bulimus* Scopoli, 1777. (2) The under-mentioned generic names are hereby placed on the *Official List of Generic Names in Zoology* with the Name Numbers severally specified below:- (a) *Bithynia* Leach, 1818, as validated under the Plenary Powers in (1) above (gender: feminine) (type species, by original designation: *Helix tentaculata* Linneaus, 1758) (Name Number 1195); ... . (3) the under-mentioned specific names are hereby placed on the *Official List of Specific Names in Zoology* with the Name Numbers severally specified below:- (a) *tentaculata* Linnaeus, 1758, as published in the combination *Helix tentaculata* (specific name of type species of *Bithynia* Leach, 1818) (Name No. 1301). ... (5) The under-mentioned family-group name is hereby placed on the *Official List of Family-Group Names in Zoology* with the Name Number 181:- BITHYNIIDAE (correction of BITHINIADAE) Gray (J.E.), 1857 (type genus: *Bithynia* Leach, 1818) for use by specialists who on taxonomic grounds consider that the genus *Bithynia* Leach is not referable to any nominal family-group taxon having an older name). ... .

Proposed use of the Plenary Powers to give precedence to the generic name *Biomphalaria* Preston. OPINION 735, May, 1965: (1) Under the plenary powers it is hereby ruled that the generic name *Biomphalaria* Preston, 1910, is to be given precedence over the generic names *Planorbina* Haldeman, 1842, *Taphius* H. & A. Adams, 1855, and *Armigerus*, Clessin, 1884, by any zoologist who considers that any or all of these names apply to the same taxonomic genus. (2) The following names are hereby placed on the Official List of Generic Names in Zoology with the Name Numbers specified: (a) *Biomphalaria smithi* Preston, 1910 (Name No. 1675); (b) *Planorbina* Haldeman, 1842, (gender: feminine), type-species, by designation by Dall, 1905, *Planorbis olivaceus* Spix, 1827 (by direction under the plenary powers, not available for use in preference to *Biomphalaria* Preston, 1910, by any zoologist who considers the type-species of these two nominal genera to be congeneric) (Name No. 1676); (c) *Taphius* H. & A. Adams, 1855 (gender: masculine), type-species, by original designation, *Planorbis andecolus* d'Orbigny, 1835 (by direction under the plenary powers, not available for use in preference to *Biomphalaria* Preston, 1910, by any zoologist who considers the type-species of these two nominal genera to be congeneric) (Name No. 1677); (c) *Armigerus* Clessin, 1884, (gender: masculine), type-species, by designation by Morrison, 1947, *Planorbis albicans* Pfeiffer, 1839) (by direction under the plenary powers, not available for use in preference to *Biomphalaria* Preston, 1910, by any zoologist who considers the type-species of these two nominal genera to be congeneric) (Name No. 1678). (3) The following specific names are hereby placed on the *Official List of Specific Names in Zoology* with the Name Numbers specified: (a) *smithi* Preston, 1910, as published in the binomen *Biomphalaria smithi* (type-species of *Biomphalaria* Preston, 1910) (Name No. 2079); (b) *olivaceus* Spix, 1827, as published in the binomen *Planorbis olivaceus* (type-species of *Planorbina* Haldeman, 1842) (Name No. 2080); (c) *andecolus* d'Orbigny, 1835, as published in the binomen *Planorbis andecolus* (type-species of *Taphius* H. & A. Adams, 1855) (Name No. 2081); (d) *albicans* Pfeiffer, 1839, as published in the binomen *Planorbis albicans* (type-species of *Armigerus* Clessin, 1884) (Name No. 2082).

Completion and in certain cases correction of entries relating to the names of genera of the phyla Mollusca, Brachiopoda, Echinoderma and Chordata made on the "Official List of Generic Names in Zoology" by rulings given in "Opinions" rendered in the period up to the end of 1936. DIRECTION 72, September 20, 1957. Ruling: - ... (2) In the case of the names of each of the undermentioned genera belonging to the Classes severally noted below the entry made on the *Official List of Generic Names in Zoology* by the Ruling given in *Opinion 94* is hereby completed by the insertion of the particulars as to the manner in which the type species was determined under Article 30 specified below. (i) Class Gastropoda, ... (d) *Physa* Draparnaud, [1801]: by selection by Children (J.G.) (1823). ... (16) The under-mentioned generic names or reputed generic names are hereby placed on the *Official Index of Rejected and Invalid Generic Names in Zoology* with the Name Numbers severally specified below: - ... (xix) *Physa* Raffray, 1890 (a junior homonym of *Physa* Draparnaud, [1801]; (name No. 978) ... .

Conservation of *Marstonia* Baker, 1926 and of *Amnicola lustrica* Pilsbry, 1890 (Mollusca: Gastropoda). OPINION 1108, October, 1978: (1) Under the plenary powers, the specific name *lustrica* Say, 1821, as published in the binomen *Paludina lustrica*, is hereby suppressed for the purposes of both the Law of Priority and the Law of Homonymy. (2) The following names are hereby placed on the Official List of Generic Names in Zoology with the name numbers specified: (a) *Amnicola* Gould & Haldeman, 1840 (gender: feminine), type-species, by subsequent designation by Herrmannsen, 1846, *Paludina porata* Say, 1821 (Name Number 2061); (b) *Marstonia* Baker, 1926 (gender: feminine), type-species, by original designation, *Amnicola lustrica* Pilsbry, 1890 (Name Number 2062). (3) The following names are hereby placed on the Official List of Specific Names in Zoology with the Name Numbers specified: (a) *limosa* Say, 1817, as published in the binomen *Paludina limosa* (Name Number 2640); (b) *lustrica* Pilsbry, 1890, as published in the binomen *Amnicola lustrica* (specific name of type-species of *Marstonia* Baker, 1926) (Name Number 2641). (4) The generic name *Euamnicola* Fischer & Crosse, 1891 (a junior objective synonym of *Amnicola* Gould & Haldeman, 1840) is hereby placed on the Official Index of Rejected and Invalid Specific Names in Zoology with the Name Numbers specified: (a) *lustrica* Say, 1821, as published in the binomen *Amnicola lustrica*, and as suppressed under the plenary powers in (1) above (Name Number 1037); (b) *lacustris* Pilsbry, 1891, as published in the binomen *Amnicola lacustris* (an erroneous subsequent spelling or junior objective synonym of *Amnicola lustrica* Pilsbry, 1980) (Name Number 1038). (6) The name AMNICOLIDAE Tryon, 1862 (type-genus *Amnicola* Gould & Haldeman, 1840) is hereby placed on the Official List of Family-Group Names in Zoology with the Name Number 489.

Proposed Futher Use of the Plenary Powers in the Case of the Generic Name *Pleurocera* Rafinesque, 1818 (Class Gastropoda). Z.N.(S.)83. OPINION 1195, November, 1981: (1) the authorship of the specific name *acutus*, as published in the binomen *Pleurocerus acutus*, is to be cited as "Rafinesque *in* Blainville, 1824". (2) Under the plenary powers, all designations of type species for the nominal genus *Pleurocera* are hereby set aside and *Pleurocerus acutus* Rafinesque *in* Blainville, 1824 is hereby designated as type species of that genus. (3) The following generic names are hereby placed on the *Official List of Generic Names in Zoology* with the Name Numbers specified: (a) *Pleurocera* Rafinesque, 1818 (gender, feminine), type species, by designation under the plenary powers as in (2) above, *Pleurocerus acutus* Rafinesque *in* Blainville, 1824 (Name Number 2137); (b) *Lithasia* Haldeman, 1840 (gender: feminine), type species, by monotypy, *Anculosa (Lithasia) geniculata* Haldeman, 1840 (Name Number 2138). (4) The following specific names are hereby placed on the *Official List of Specific Names in Zoology* with the Name Numbers specified: (a) *acutus* Rafinesque *in* Blainville, 1824, as published in the binomen *Pleuroceras acutus* (specific name of type species of *Pleurocera* Rafinesque, 1818) (Name Number 2768); (b) *geniculata* Haldeman, 1840, as published in the combination *Anculosa (Lithasia) geniculata* (specific name of type species of *Lithasia* Haldeman, 1840) (Name Number 2769).

IDENTIFICATION AND MORPHOLOGY

Shell Morphology

All freshwater snails possess a shell, which is a hard, calcareous structure that covers the soft parts of the animals bodies, providing protection. In most snails, the shell is twisted in a continually increasing spiral. The characteristics of this shell are different for each species. Therefore, the individual characters of the shells of freshwater snails (see Figs. 1, 2) are very important in species recognition and usually for generic and familial placement as well. Especially useful are the size (Fig. 3) and general form (Figs. 4, 5, 6) of the shell. Among the many species, the shell may take various shapes (Fig. 4), yet, for any one species, the shell shape is usually quite constant (excepting, of course, individual differences and the minor clinal, populational and ecophenotypic variations exhibited by some species). The shells among the various species may vary from very elongate (Fig. 5a,b) to nearly globose (Fig. 4c), depressed (Fig. 4d) and discoidal (Fig. 4e).

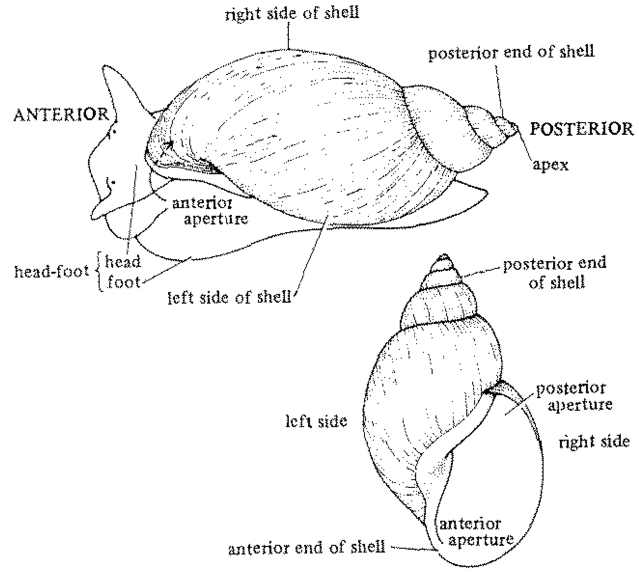

FIG. 1. Orientation of the shell in relation to the snail.

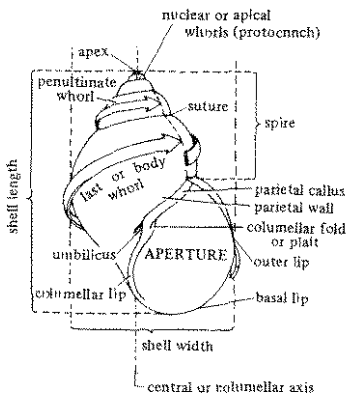

FIG. 2. Shell terminology.

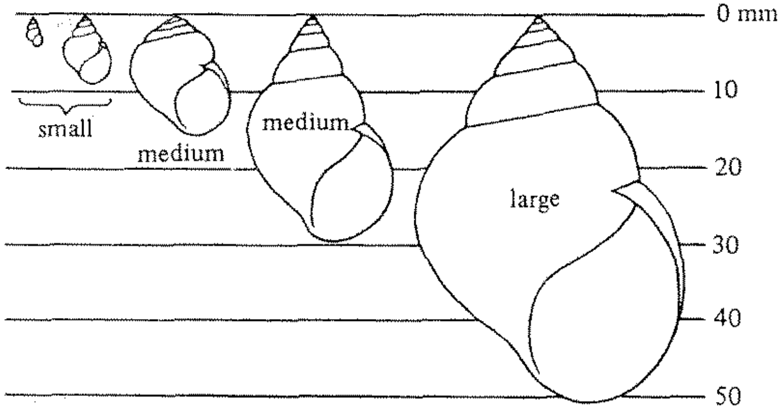

FIG. 3. Shell sizes: up to 10 mm = small; 10-30 mm = medium; over 30 mm = large.

The shell may be longer than wide (Figs. 4a,b; 5a,b,c,d) or wider than long (Figs. 4d, 5e) [the columella determining the antero-posterior shell axis]. The shell's coil (whorls) may turn either to the left (Figs. 773a, 774a, Sect. V, p. 218) or to the right (Figs. 773b, 774b),

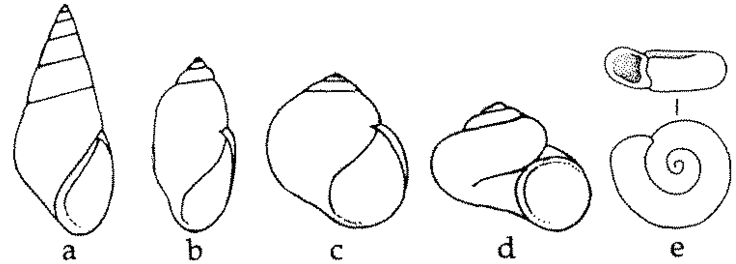

FIG. 4. Shell shapes. **a**, Elongate conic; **b**, elongate cylindrical; **c**, globose; **d**, depressed; **e**, discoidal.

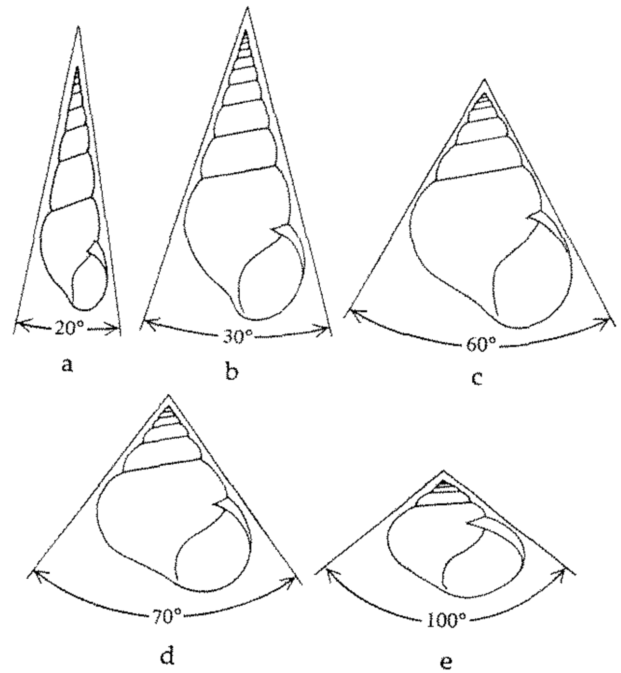

FIG. 5. Shell shapes. **a**, Narrowly conic; **b**, elongately conic; **c**, broadly (ovately) conic; **d**, globosely conic; **e**, depressed conic.

be round (Fig. 776a, Sect. V, p. 220), angular, flattened (Fig. 776b), or shouldered (Fig. 776c,) and may have impressed (Fig. 776a) or shallow sutures (Fig. 776b) The shell may have few (Fig. 6a)

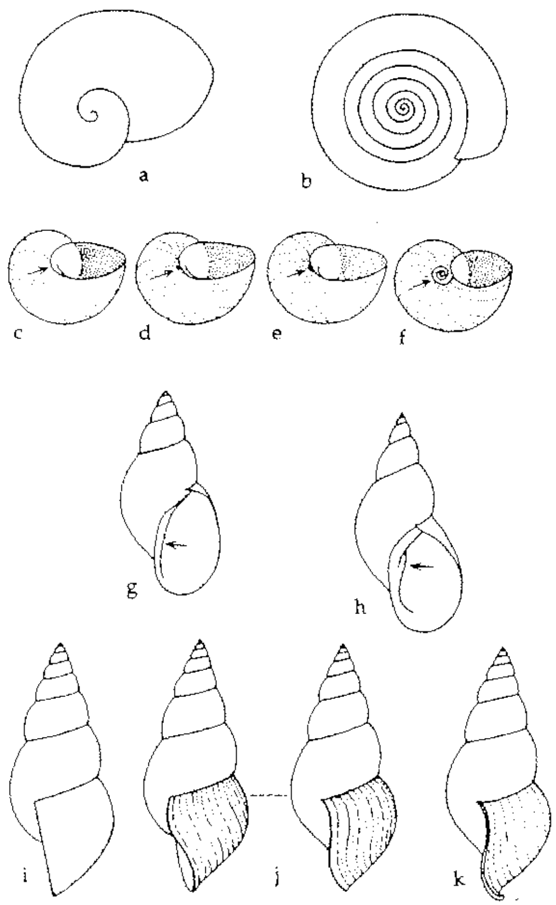

FIG. 6. Shell characters. **a**, Shell with few, rapidly increasing whorls; **b**, shell with many, slowly increasing whorls; **c**, imperforate shell; **d**, perforate shell; **e**, rimately perforate shell; **f**, umbilicate shell; **g**, straight columella; **h**, twisted columella, with plait; **i**, straight apertural lip; **j**, curved apertural lips; **k**, curved and reflected lip.

or many (Fig. 6b) whorls, may lack an opening (umbilicus) at its "base" (Fig. 6c), or may have either a narrow (Fig. 6d) or wide (Fig. 6f) opening. The columella or central axial column of the shell may be straight (Fig. 6g) or twisted (Fig. 6h) and may or may not end abruptly. The outer margin of the shell aperture may be either

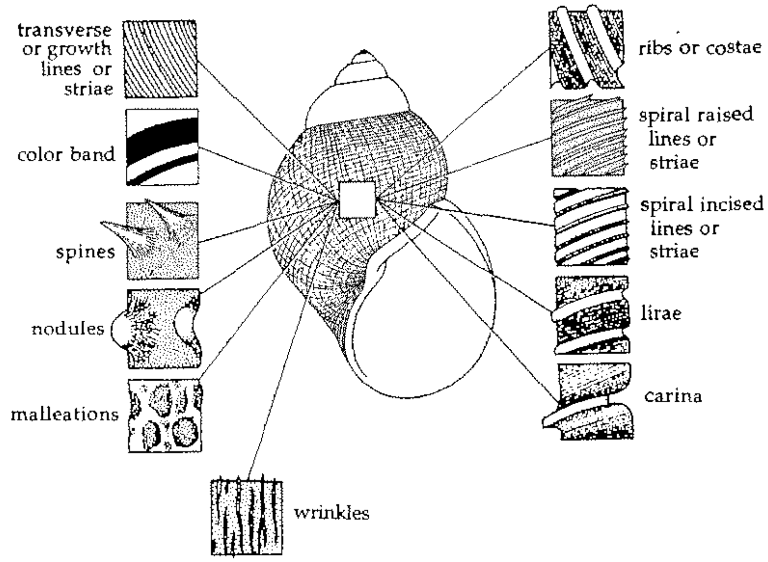

FIG. 7. Shell surface characters.

straight (Fig. 6i) or variously curved (Fig. 6j) and is sometimes turned back or reflected (Fig. 6k). The surface of the shell may be marked in various ways, i.e., it may be differentially colored (Fig. 8f) or sculptured (Figs. 7, 8), or it may be simply unicolored and smooth. The sculpturing of the shell, i.e., its surface texture, is sometimes almost perfectly smooth, but usually there is a definite three-dimensional pattern which is characteristic for the species. One pattern possessed by nearly all shells, in addition to any other pattern they may have, is a series of close-set, more or less equidistant lines paralleling the shell aperture. These are lines indicating incremental shell growth, and are most commonly referred to as "growth lines," but also as "transverse lines" or "transverse striae" (see Fig. 7). On the shells of some species, somewhat larger and more noticeable transverse elevations more distantly apart are superimposed on the growth lines. These are called "riblets." When such shell surface structures are even larger and strikingly noticeable, the are called "ribs" or "costae" (see also Fig. 8d). Similar shell surface elevations running perpendicular (i.e., in the direction of the shell's spiral) to the growth lines are called "lirae" (see also Fig. 8b). When such

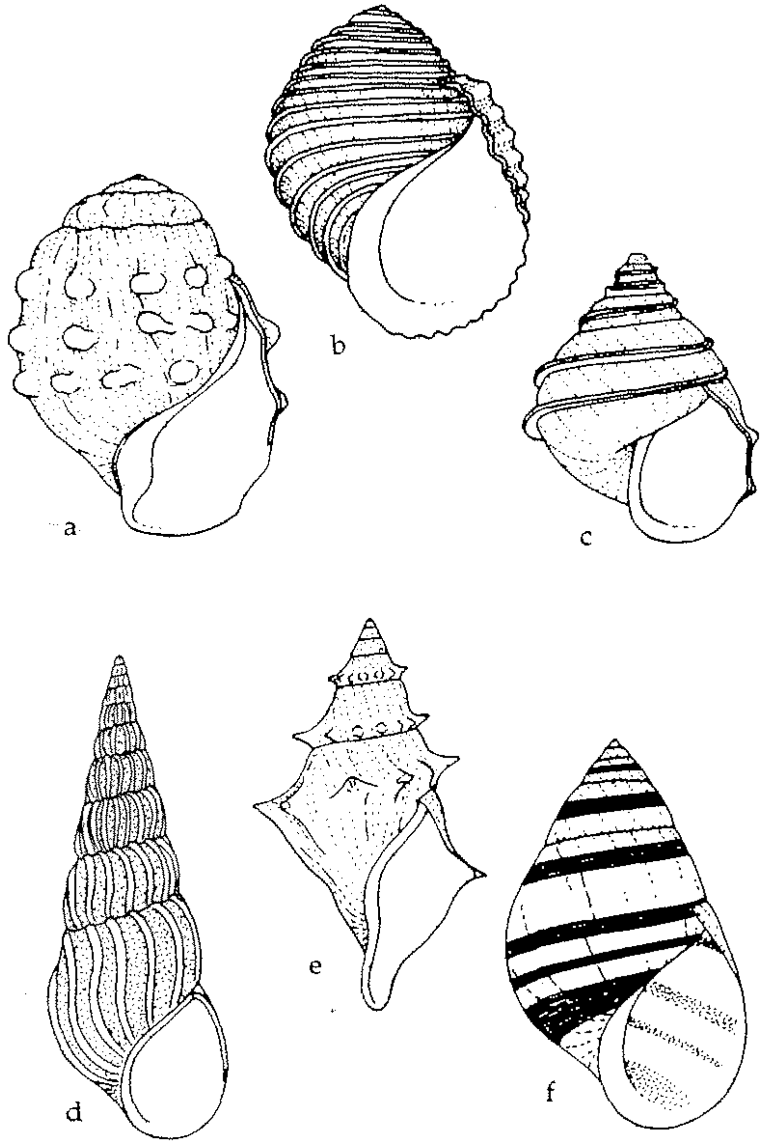

FIG. 8. Shell types. **a**, Nodulose; **b**, lirate; **c**, carinate; **d**, costate; **e**, spinose; **f**, smooth, with spiral color bands.

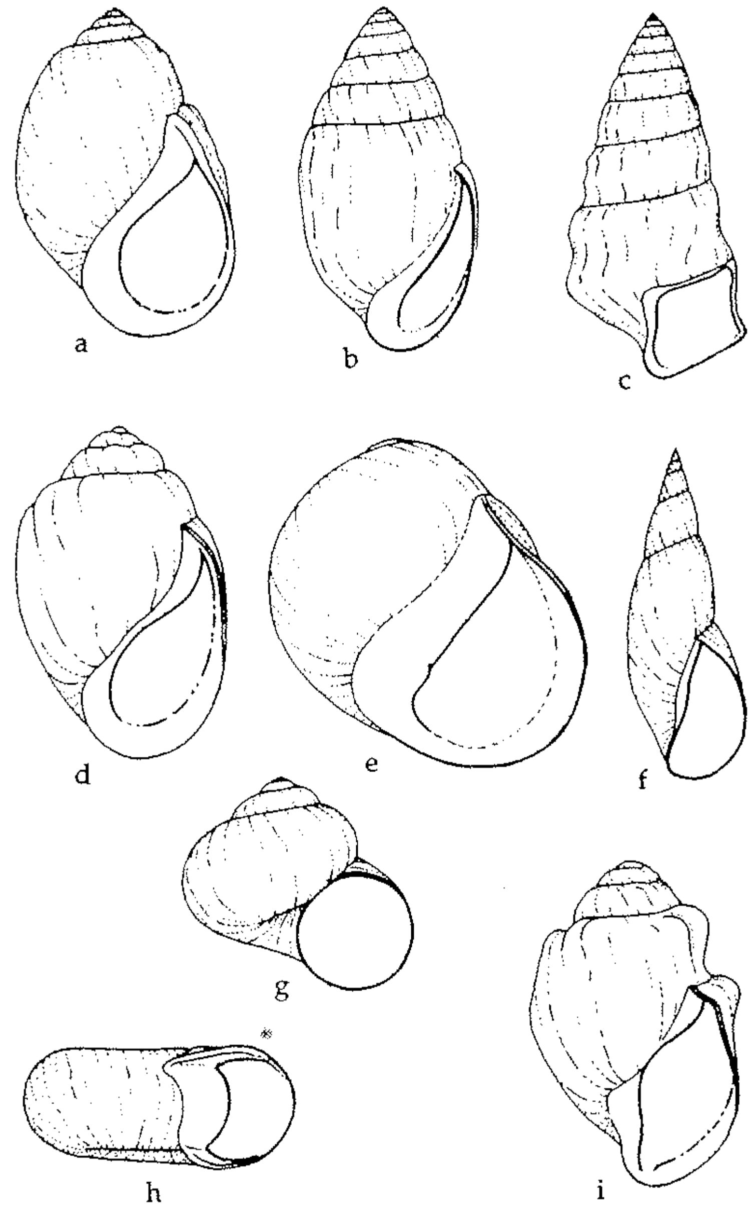

FIG. 9. Shell aperture shapes. **a**, Broadly ovate; **b**, narrow; **c**, rectangular; **d**, elongately ovate; **e**, semicircular; **f**, D-shaped; **g**, round; **h**, lunate; **i**, fusiform or spindle-shaped.

surface structures are exceptionally large and reduced in number to one or several, they are called "carinae" (see also Fig. 8c). Small and fine spiral lines are called "spiral lines" or "spiral striae," and may be either raised or incised. Other shell surface sculpture may consist of wrinkles, malleations, hairs, spines (see also Fig. 8e) or nodules (see also Fig. 8a).

The outline of the shell aperture may take various forms (Fig. 9) due to the shape and relation of the whorls to each other. The aperture may or may not be closed by an operculum (Fig. 772, Sect. V, p. 218). The operculum also has important recognition characters (Sect. V, Fig. 780, p. 220; p. 223). It may be round (Fig. 780a), oval (Fig. 780b,c,d) or spindle-shaped, and its growth lines spirally (Fig. 780a,b) or concentrically (Fig. 780c,d) arranged, depending on the way in which the aperture is formed.

Especially useful in viewing the very fine sculpture of snail shells is the Scanning Electron Microscope (SEM). Such sculpture is often difficult to see clearly with light microscopes. Examples of the value of the SEM in a family of small gastropods, the Ancylidae, in which the shell sculpture is important for identification and classification, are shown in Fig. 10.

Soft Anatomy

There are few papers that can be used adequately as guides to anatomy of North American freshwater snails. Several of the noteworthy papers for North America (in chronological order) are H. B. Baker (1925) [Lymnaeidae (Lancinae)], Abbott (1952) [Thiaridae], van der Schalie & Dundee (1956) [Pomatiopsidae], Basch (1959) [Ancylidae], Dazo (1965) [Pleuroceridae], Davis (1967) [Pomatiopsidae] and Walter (1969) [Lymnaeidae (Lymnaeinae)]. Fretter & Graham (1962), although on functional morphology (and ecology) of British prosobranch snails (mainly marine), has useful anatomical information that can be applied at the family level to North American freshwater snails (Neritidae, Valvatidae, Viviparidae, Ampullariidae, Bithyniidae and Hydrobiidae).

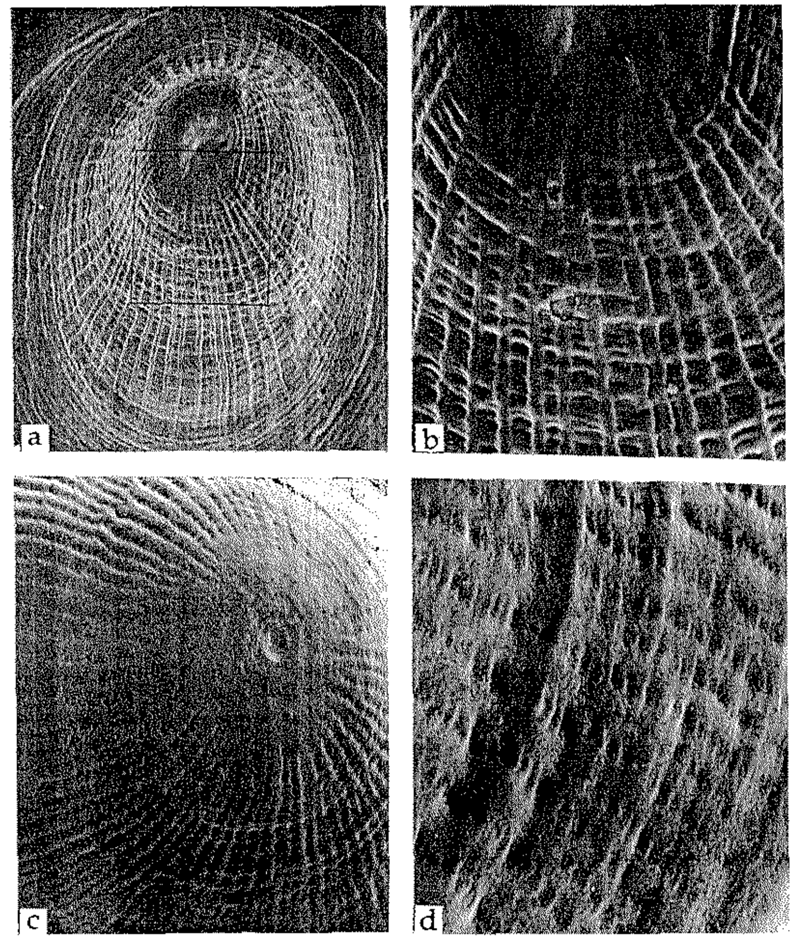

FIG. 10. Apical shell surface sculpture of some North American freshwater limpets (Ancylidae). a, b, *Rhodacmea filosa*, apical sculpture of strong radiating and weaker cords (b is an enlargement of the area marked in a); c, *Ferrissia walkeri*; apical sculpture of prominent radiating, regularly spaced, narrow grooves; d, *F. shimeki*, apical sculpture similar to *F. walkeri*. SEM photographs; a, ca. x52; b,c, ca. x190; d, ca. x625.

External Anatomy

Shelled snails have a peculiarly coiled body with asymmetrically arranged visceral organs. Because of the coiled body, most snails

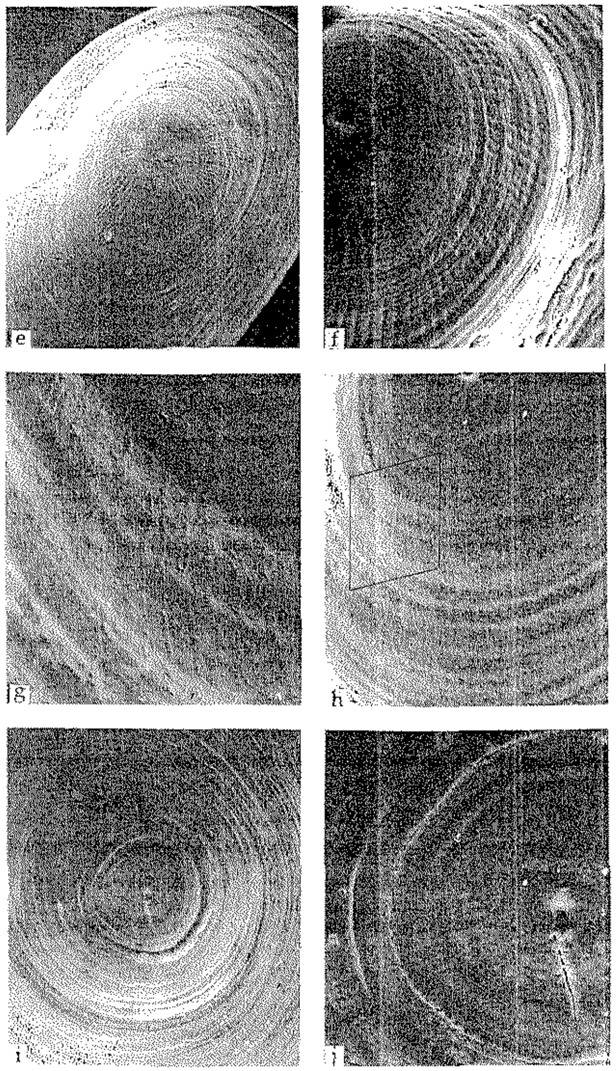

FIG. 10 (cont.). SEM photographs of ancylid apical shell sculpture (cont.). e, *Ferrissia "californica"* [*fragilis*], with apical sculpture similar to *F. shimeki* and *F. walkeri*; f, *F. shimeki*; g, h, *Hebetancylus excentricus*, in which the apical sculpture is very weak and shallow, with a radiating pattern (under the light microscope, the apex looks smooth, or nearly so); i, j, *Laevapex diaphanus*, with apical sculpture of very faint, irregularly spaced, very shallow, radiating grooves (like *H. excentricus* and *L. fuscus*, the apex looks more or less smooth under the light microscope). e, i, ca. x44; f, h, j, ca. x134; g, ca. x440.

have a coiled shell, which exhibits spiral symmetry. However, in the limpet-shaped aquatic gastropods, the shell has lost its spiral form and may be more of less bilaterally symmetrical. External aspects of the head and foot may appear to be bilaterally symmetrical as well, but the internal organs nevertheless display the typical asymmetry of gastropods. This asymmetry of the gastropods makes dissection difficult for beginning students of molluscan anatomy and taxonomy.

When a shelled snail is active, the head and foot protrude from the shell aperture, while the visceral mass remains within the shell. Nearly all snails can withdraw their head-foot into the shell when disturbed or during unfavorable climatic periods. This withdrawal is accomplished by the contraction of the columellar muscle, which is formed by a coalescence of muscle fibers from the foot which attach to the shell's columella. In a coiled shell, the columellar muscle insertion is the only attachment of the snail's body to the shell. In operculated snails (i.e., mostly the prosobranchs), the operculum, which is attached to the posterior dorsal surface of the foot, reaches the peristome last when the snail withdraws and thus effectively seals the shell aperture.

In gastropods, the foot is a wide, dorsally convex and ventrally flat, muscular organ, covered with a tough skin containing numerous mucous glands. The integument is generally pigmented by melanin granules, especially on the dorsum and sides.

The head is rather well separated from the foot in prosobranch snails, but in pulmonate snails it is not externally delimited from the foot (hence the term "head-foot" is often applied to these two combined structures in pulmonates). The head bears two tentacles in freshwater snails; at the base of each of the tentacles is an eye. The tentacles are tactile sensory structures, and may vary from one taxon to another in degree, color and arrangement of pigment, in shape, in bluntness of the tip, in length, and in possession and arrangement of surface ciliation.

Externally, gastropods have a number of orifices for various of the organ systems. These openings are the mouth, anus, mantle cavity or pulmonary cavity, the nephridiopore and the male and female reproductive openings. The mouth may be little more than an opening in the head, but in many snails it is placed at the end of a rather long anterio-ventrally directed proboscis. This is especially noticeable in the prosobranchs. In the pulmonates, the proboscis is much shorter, and is often referred to as a "snout." The mouth is at the anterior end, medianly placed on the ventral side, as would be expected. However, the other end of the digestive tract, the anus, is not located posteriorly, but, because of torsion, is placed anteriorly. Near it are the nephridiopore and, on the side of the foot, the female gonopore. The male opening in pulmonate snails is on the head-foot, near one of the tentacles. Torsion also brings the mantle cavity and its external opening forward. Except for the medianly placed mouth, the side of the body on which these various openings are located depends on the direction of coiling of the snail. The openings are on the right side in dextral snails and on the left side in sinistral snails (see Fig. 773, Sect. V, p. 218).

The external characteristics of the snails' bodies are useful in identification and are often especially pertinent in classification. For example, among the prosobranchs, the Valvatidae have two structures lacking in other North American freshwater operculates (Fig. 781, Sect. V, p. 220): an externally protruding bipectinate gill and a mantle tentacular appendage. In Valvatidae and male Neritidae, an external penis is located on the head under the right tentacle. In other North American freshwater prosobranch snails, the penis, when present, is located elsewhere. In the Viviparidae, each male has a noticeable thickened right tentacle, which functions as a modified penis. In the Bithyniidae, Hydrobiidae (Figs. 83, 85-92, Sect. IV, pp. 94, 95) and Pomatiopsidae (Fig. 18, p. 51 (B)), the males have a large external male organ located dorsally behind the head. Males in the Pleuroceridae (Fig. 18, p. 61 (A)) lack male intromittent organs. [Males are absent in *Melanoides tuberculata* and *Thiara granifera* (Thiaridae).]

The Thiaridae have very noticeable papillae projecting from the mantle collar (Fig. 18A,B, p. 54). The closely related pleurocerid snails lack such mantle papillae, as do the other North American freshwater prosobranchs. The Ampullariidae have a long siphon, used to take air into the lung portion of the mantle cavity. Such a structure is lacking in other freshwater prosobranchs. The Bithyniidae have a peculiar lobe or siphon (external accessory excretory organ?) on the right side of the body near the mantle cavity opening.

The pigmentation patterns of the mantle in the Hydrobiidae often have distinctive specific patterns (e.g., see Figs. 83-94, Sect. IV, pp. 94, 95). But especially useful for taxonomic recognition in the Hydrobiidae are the external male copulatory organs, the verge and penis,

which are distinctive for many of the genera, and can be used also to recognize subfamilies (Fig. 82, Sect. IV, p. 94). In some hydrobiid groups, such aspects of the external soft anatomy are ***essential*** for identification, because the various taxa in these groups have shells which are relatively uniform or have few distinctive characteristics. In such groups as these, identification is very difficult for samples in which only empty shells are available. In these cases, identification can be aided by taking into account the known distributions of the various species, and by making especially careful observations of shell characters.

Among the pulmonates, the Acroloxidae, Planorbidae (see Fig. 773a, Sect. V, p. 218) and Ancylidae have pseudobranchs (false gills), but the Lymnaeidae and Physidae do not; the lymnaeids have broad, flat, triangular tentacles (see Fig. 1, p. 25; 773b, Sect. V, p. 218), while the tentacles of members of the other freshwater pulmonate families are filiform; the Physidae have digitate mantle lobes, while the mantle border is smooth in the other pulmonate families. Within the Physidae, the number and arrangement of the digitate mantle lobes have some taxonomic significance. In the Ancylidae, the arrangement of the dorsal shell adductor muscles are useful for generic recognition (Fig. 11, pp. 38, 39), as are mantle pigmentation patterns.

Internal Anatomy

In some families, characters of the internal soft anatomy are important in classification, and often identification as well, because the shells of various of the lower taxa do not exhibit clearly any distinguishing features. For this reason, it is of some practical value to be familiar with the organ systems of freshwater snails.

The two most conspicuous organ systems in a snail are the digestive system (Fig. 12, p. 41; Fig. 18, pp. 50, 56, 59, 63, 70) and the reproductive system (Fig. 18, pp. 49, 51, 52, 58, 61, 62, 65, 68, 73). Together, the two systems make up the greater portion of a snail's body mass. In the digestive system, the mouth opening leads into a short buccal atrium, the pharynx or oral cavity (Fig. 12b, p. 41; Fig. 18, p. 55). The alimentary tract then expands into a relatively large, highly muscular buccal mass, which contains the radula, radular sac, jaw and odontophoral cartilage. Salivary ducts open into the oral cavity near the radular sac. Leading posteriorly from the buccal mass is the esophagus, a long,

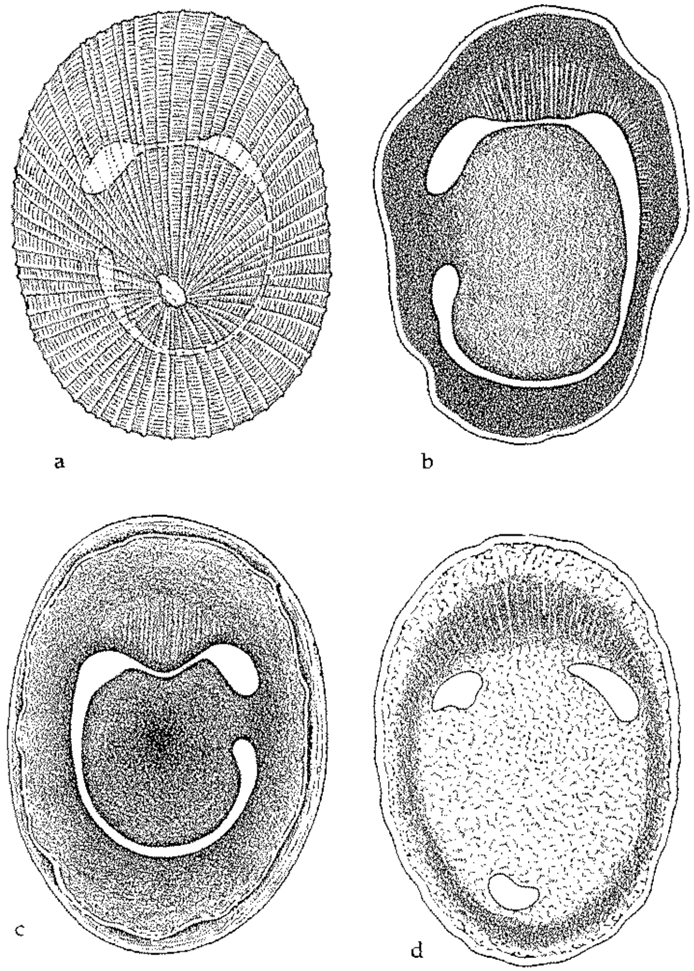

FIG. 11. Shell adductor muscles in freshwater limpets (Ancylidae). **a**, *Rhodacmea filosa*, shell adductor muscles showing through the translucent shell; **b**, *R. "cahawbensis"* [*elatior*], dorsal mantle; **c**, *R. elatior*, underside of mantle with rest of animal removed; **d**, *Ferrissia rivularis*, dorsal mantle.

narrow tube which leads to the stomach. Running along side the esophagus are the salivary glands.

In freshwater pulmonate snails, the stomach consists of an anterior expanded crop, a large bulbous gizzard, and a posterior pylorus. The crop is a vestibule for food accumulation before it passes into the

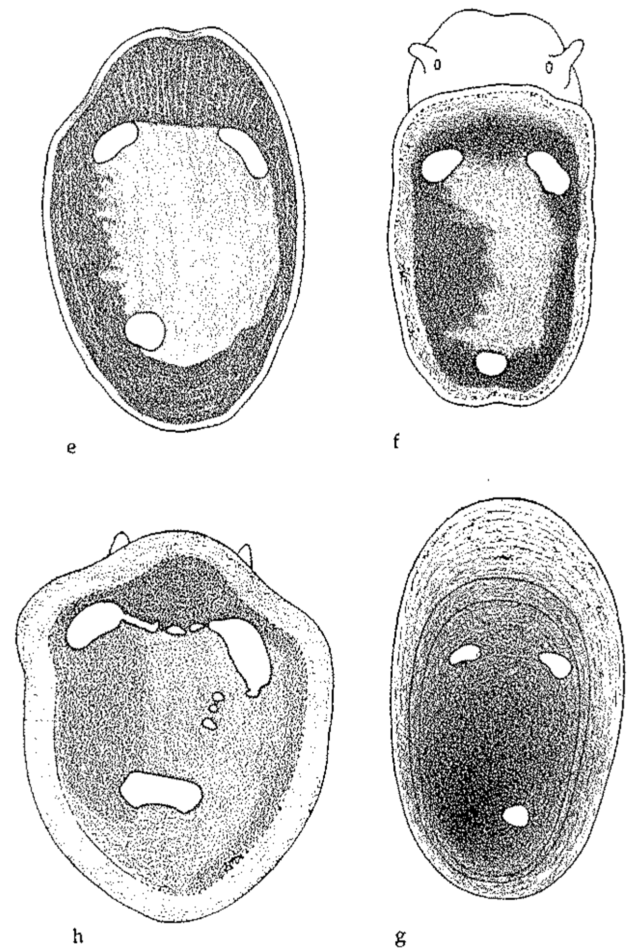

FIG. 11 (cont.). Shell adductor muscles in freshwater limpets (Ancylidae) (cont.). **e**, *Ferrissia "tarda"* [*rivularis*], dorsal mantle; **f**, *F. parallela*, dorsal mantle (with snail's head protruding from anterior part); **g**, *F. parallela*, underside of shell showing adductor muscle attachment scars; **h**, *Laevapex* sp., dorsal mantle.

gizzard. The gizzard is a highly muscular organ for grinding food. The pylorus is a short expansion of the alimentary tube between the gizzard and the intestine. Into the posterior pylorus empty the ducts from the digestive glands. Leading from the posterior pylorus is a small, short pocket, the cecum. The pylorus leads into the prointestine, at the beginning of which is a relatively thin-walled cavity, the atrium (see Fig. 18, p. 63). After the atrium, the prointestine continues a short distance to the muscular pellet compressor. Between the atrium and pellet compressor, the intestine has a large inner fold, the typhlosole. From the pellet compressor to the rectum, the intestine is a long, relatively thin-walled tube. This part of the intestine lacks a typhlosole. The terminal section of the digestive tract is the rectum. It is thick-walled, and apparently glandular. The anus is located near the posterior mantle collar, close to the pneumostome.

The digestive tract of prosobranch snails is, in general, similar to that described above, except in place of the cecum there is a large sac (Fig. 18, pp. 50 (B), 56 (D,G), 59 (B)) containing the crystalline style. The crystalline style aids in digestion mechanically by grinding food, and chemically by releasing an enzyme.

The radula (Fig. 13, p. 41), and particularly its teeth (e.g., Figs. 14, 15, 16, pp. 43, 44, 45), both part of the buccal apparatus and essential for feeding, are also useful in identification and classification. The radula is especially valuable at the ordinal (e.g., see Fig. 782, Sect. V, p. 222) and familial (e.g., see Figs. 14 and 16, and Fig. 81, Sect. IV, p. 94) levels of identification, but it is useful in the lower systematic categories as well. As with fine sculpture of the shell, the scanning electron microscope is especially useful for clearly distinguishing characteristics of the small radular teeth (Figs. 15, 16).

The reproductive system of a gastropod accounts for a significant part of its body mass, especially during reproductively active periods. Prosobranch snails generally are monosexual, individuals being either female or male (Fig. 18, pp. 49, 51, 52, 58, 61). Sexual dimorphism occurs in many freshwater species, but, other than the presence or absence of the obvious external male intromittent organ, the dimorphism is confined mainly to size, females in some species being somewhat larger than males.

The snail's primary sex gland, the gonad, is located posteriorly or apically in the visceral mass, and generally is covered by or embedded in the digestive gland. The male gonad, the testis, produces great numbers of male sex cells, spermatozoa (sperm), which are stored until copulation in one or more seminal vesicles in the proximal part of the male tract (e.g., see Fig. 18, p. 51). During mating, the sperm pass from the seminal vesicle(s) through the sperm duct, past or through the prostate gland and continue on through the narrow

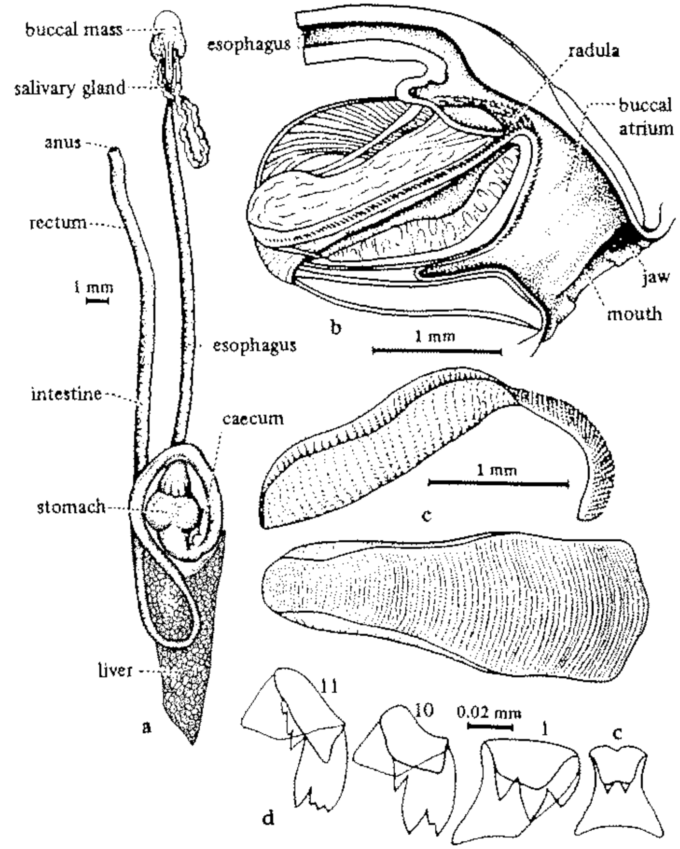

FIG. 12 The radula of a freshwater pulmonate snail (*Biomphalaria*) and its relation to the alimentary system. **a**, The alimentary system, mainly dorsal view; **b**, longitudinal section through the buccal mass, showing the orientation of the radula as viewed from the right side; **c**, right side and dorsal views of the radula; **d**, four teeth from one transverse row of the radular ribbon; c= central tooth, 1 = 1st tooth (a lateral tooth) to the right of the central tooth; 10,11 = 10th and 11th teeth (marginal teeth) to the right of the central tooth. From Barbosa et al. (1968), after Demian.

ciliated vas deferens to the genital pore for transfer to the female for fertilization. Among the various taxa, there are many variations in the parts of this basic system. For example, the seminal vesicle may be a single sac-like structure, or it may consist of many acini along the sperm duct, or it may be simply an enlargement of the sperm duct (vas deferens). The prostate gland also may take many forms, and

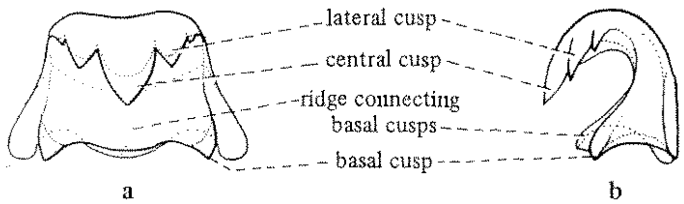

FIG. 13. Central tooth of a gastropod (a truncatelloid pomatiopsid snail) showing the arrangement of the cutting edges. a, Tooth from above; b, profile (side) view of tooth (from Pilsbry & Bequaert, 1927).

may have a separate duct leading to the vas deferens, or the acini of the gland may empty directly into the vas deferens, or the prostate gland may be simply a glandular enlargement of the sperm duct.

The male genital pore is usually located at the end of the male intromittent organ, the penis, or, in families were there is no penis (e.g., in the Pleuroceridae), it may be on a small papilla. [In *Thiara granifera* (Thiaridae), males are lacking.] The vas deferens in freshwater snails is usually a continuous tube from the gonad to the genital pore at the tip of the penis, but in the Ampullariidae, the penis and the vas deferens are not directly connected by a closed tube.

The female gonad, the ovary, is generally a lobulated structure lying next to or embedded in the digestive gland. From the ovary leads a duct, the oviduct, for passage of eggs to the outside of the female's body. Various parts of the oviduct are specialized to secrete food material and protective layers to the ovum as it passes down the tract. The first of these accessory structures is the albumen gland, which coats the egg with albumen to nourish the developing embryo. Next distally is either a jelly gland or a capsule gland, which secretes a protective layer. Other specializations of the tract include a bursa copulatrix, which receives the male intromittent organ during copulation, and a seminal receptacle, which is a pouch for storing male sex cells from the mating partner until they are needed for fertilization. The nature of the various parts of the female tract may vary considerably among the various gastropod families.

The Valvatidae differ from the other freshwater prosobranch families in being hermaphroditic. Here the gonad produces both male and female sex cells, and the duct leading from the gonad is a hermaphrodite duct, which allows passage of both types of sex cells.

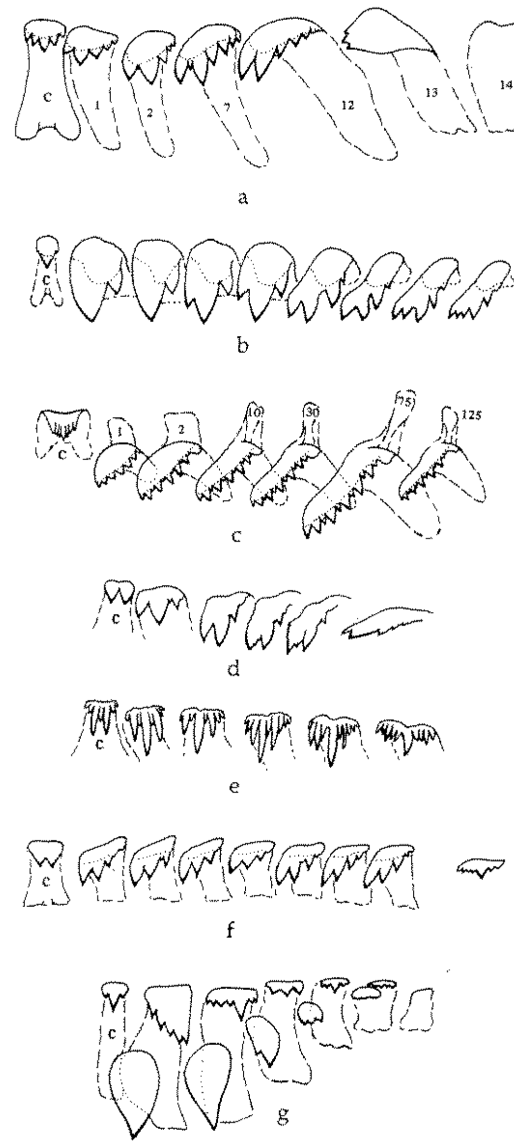

FIG. 14. Radulae of North American Pulmonata. a, Acroloxidae; b, Lymnaeidae; c, Physidae; d, e, Planorbidae; f,g, Ancylidae. c = Central tooth; numbers refer to vertical rows of radular teeth counted distally from the median row of central teeth. Fig. 14a adapted from H.B. Baker (in Walker, 1925); b,c from F.C. Baker (1928); f,g from Basch (1963).

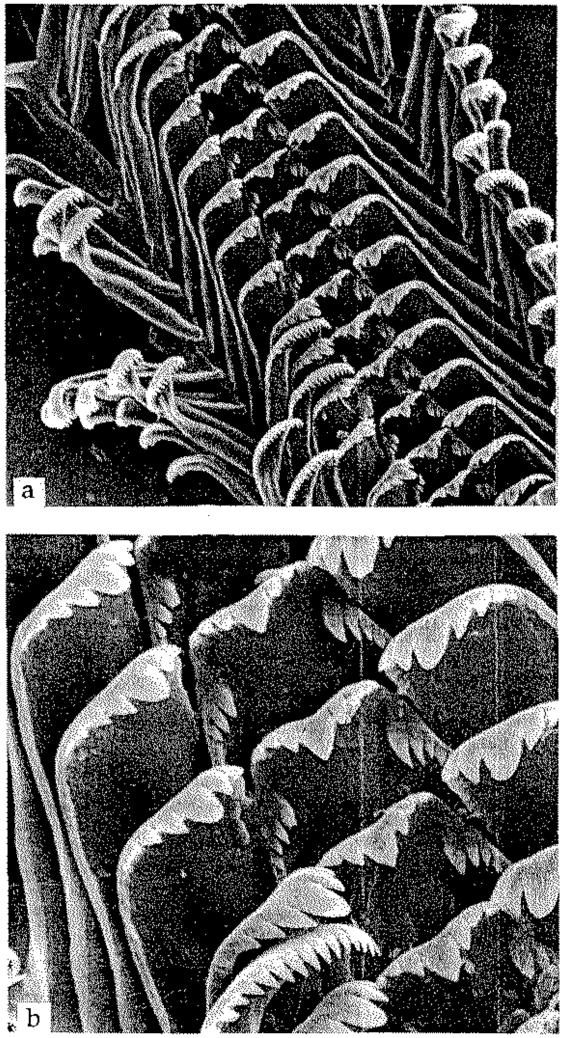

FIG. 15. SEM photographs of radular teeth of North American freshwater snails. *Bithynia tentaculata*. a, ca. x260; b, ca. x735. (From Chung, 1984).

In *Valvata*, each animal has two genital openings, the male opening at the tip of the penis on the head or neck, and the female opening near the entrance into the mantle cavity.

Pulmonate snails are *all* hermaphroditic, and like *Valvata*, each

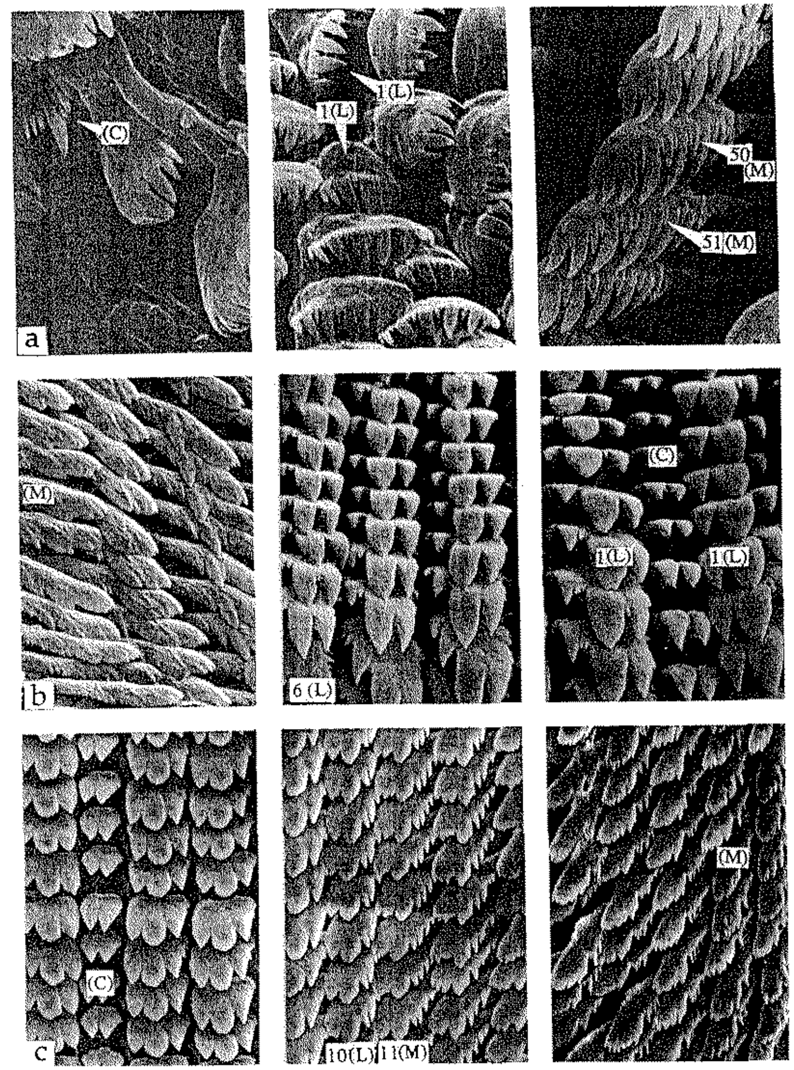

FIG. 16. SEM photographs of radular teeth of North American freshwater snails (cont.). a, *Physella gyrina* (Physidae); b, *Helisoma anceps* (Planorbidae); c, *Planorbella trivolvis* (Planorbidae). (c) = central tooth; L = lateral tooth; M = marginal tooth; 1 = a tooth of the 1st vertical row [counted distally from the central tooth]; 2 = tooth of the 2nd vertical row; 6 = a tooth of the 6th vertical row, etc. Fig. a is from Te & Mardinly (1974). Fig. a, ca. x1660; Figs. b, c, ca. x595.

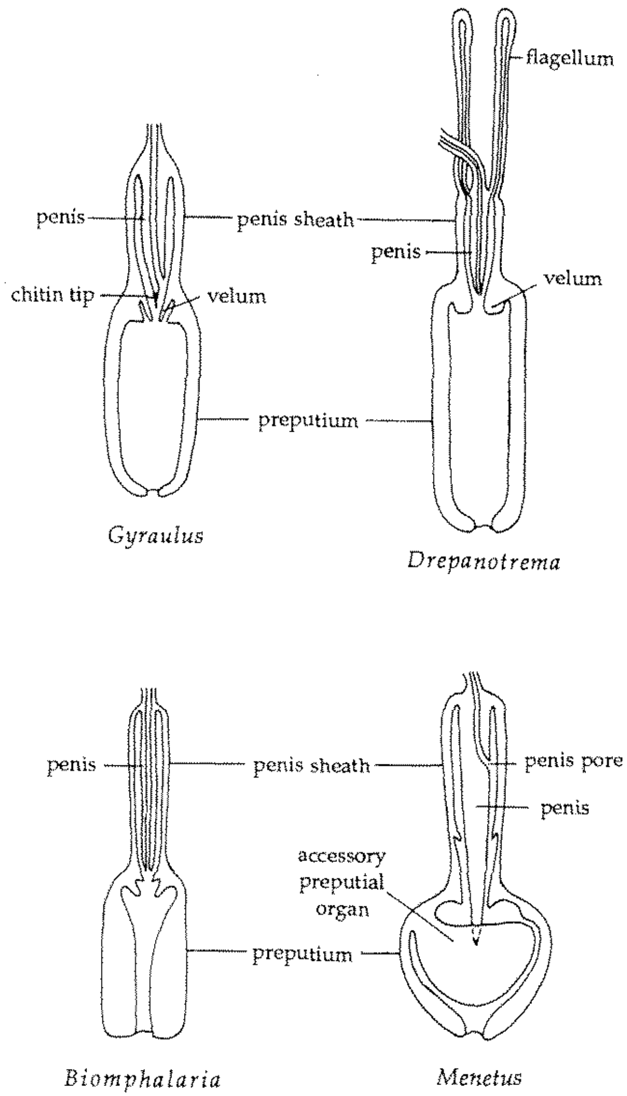

FIG. 17. Diagrammatic sagittal sections of terminal male genitalia of genera of North American Planorbidae (after Hubendick, 1955).

individual has a complete male and female system (Fig. 18, pp. 62 (A), 65; Fig. 19, pp. 68, 73). The gonad, an ovotestis, is embedded in the digestive gland, or as in the Planorbidae, precedes the digestive gland

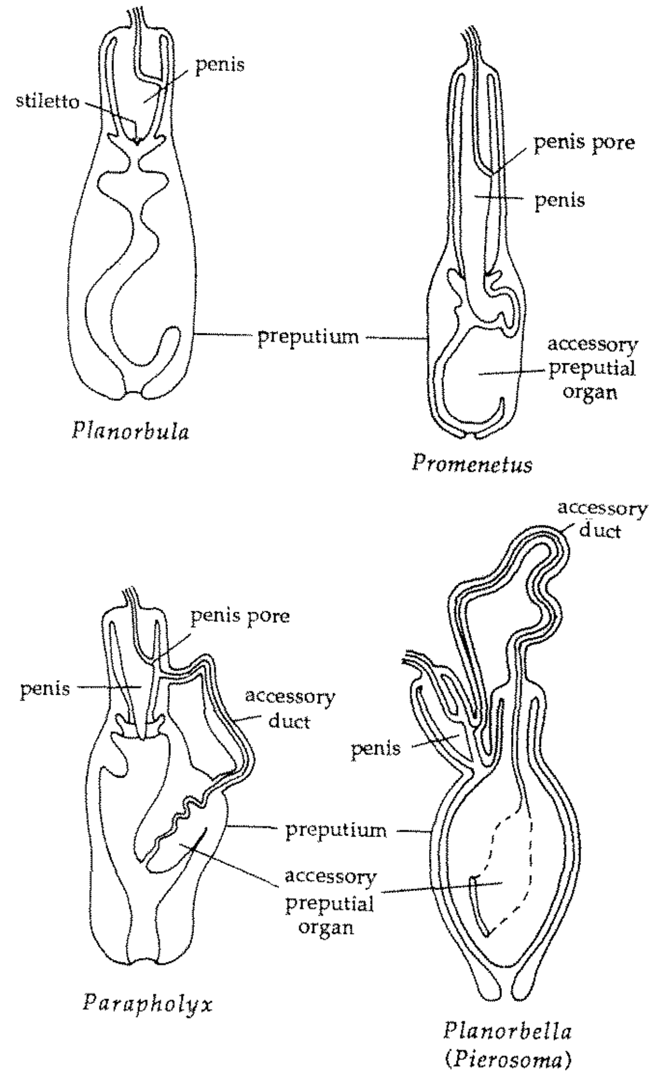

FIG. 17 (cont.). Diagrammatic sagittal sections of terminal male genitalia of genera of North American Planorbidae (cont.). (After Hubendick, 1955).

apically. The hermaphrodite duct also serves as a seminal vesicle, being either enlarged and convoluted, or having outpocketings along its course. Where the genital duct bifurcates into separate male and

POMATIOPSIDAE

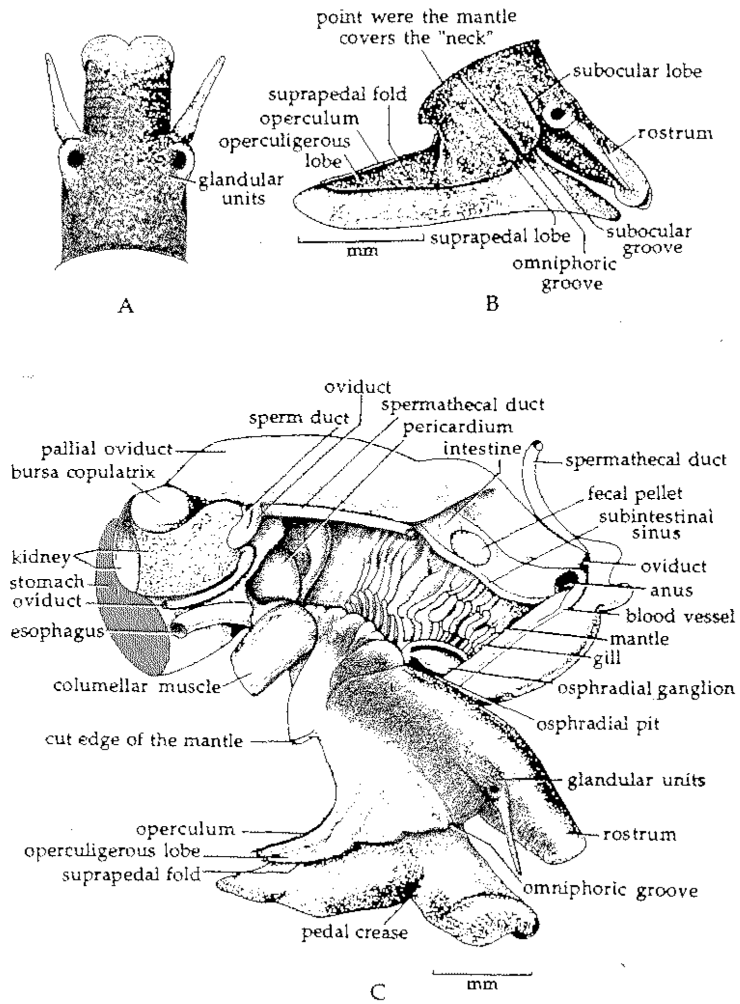

FIG. 18. Anatomy of North American freshwater snails. Aspects of the anatomy of *Pomatiopsis lapidaria*. **A**, Dorsal view of the head; **B**, head-foot, right side; **C**, head, foot and mantle region. (From Davis, 1967).

female tracts, there is a small insemination pocket where fertilization takes place (Fig. 18, p. 65 (B)). Here the sperm from the male-functioning mating partner, which have travelled up the female tract,

POMATIOPSIDAE

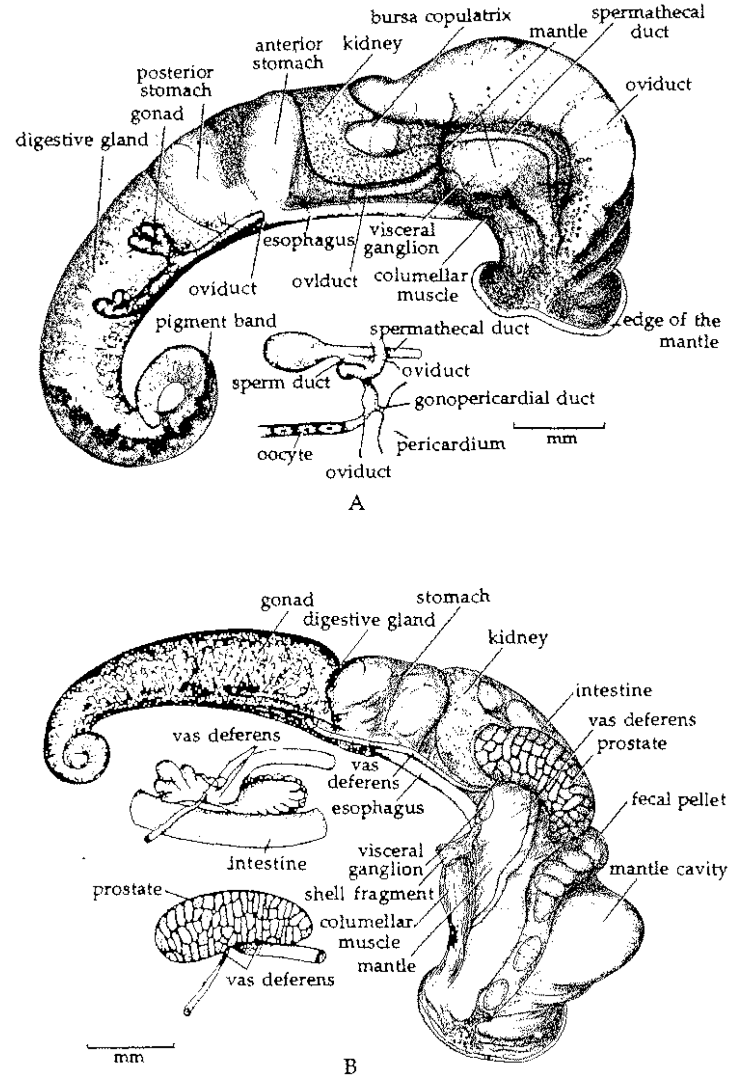

FIG. 18 (cont.). *Pomatiopsis lapidaria* (cont.). Uncoiled viscera. **A**, Female; **B**, male. (From Davis, 1967).

meet the ovum, which has just arrived from the ovotestis.

The male system in pulmonate snails consists of a prostate gland (Fig. 18, p. 65; Fig. 19, pp. 68, 73), of differing shapes and construction in

POMATIOPSIDAE

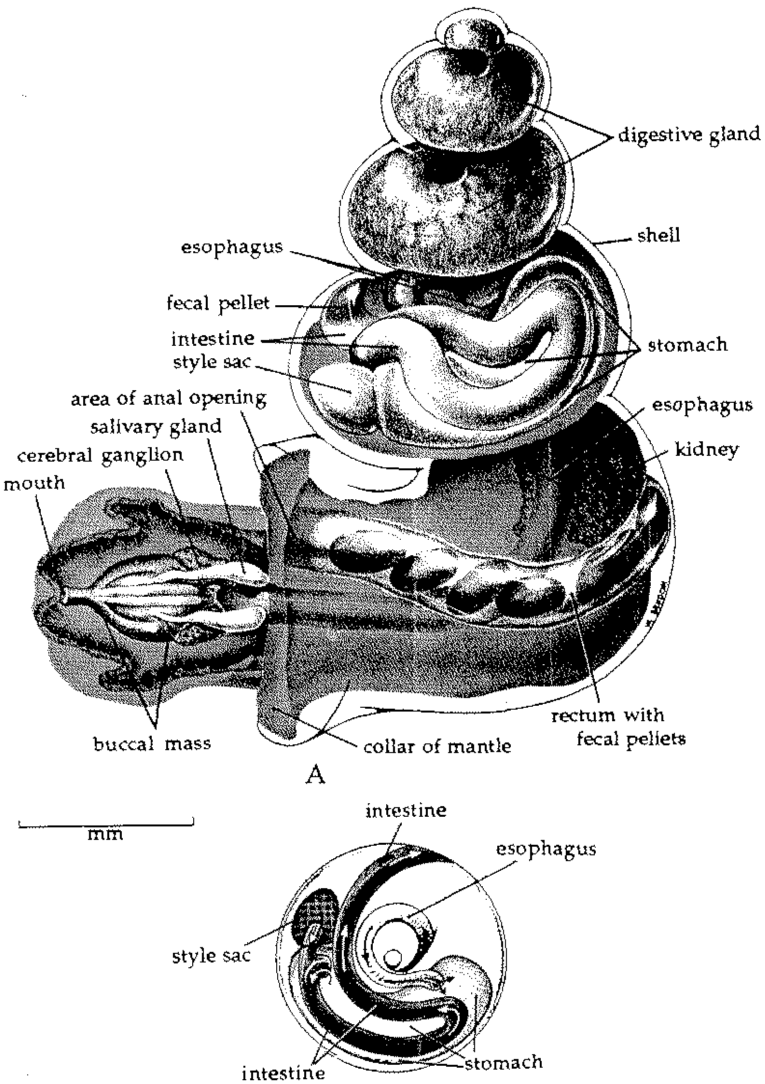

FIG. 18 (cont.). *Pomatiopsis cincinnatiensis*. **A**, Digestive system; **B**, spatial relationship of the esophagus, stomach, crystalline style and intestine. (From van der Schalie & Dundee, 1956).

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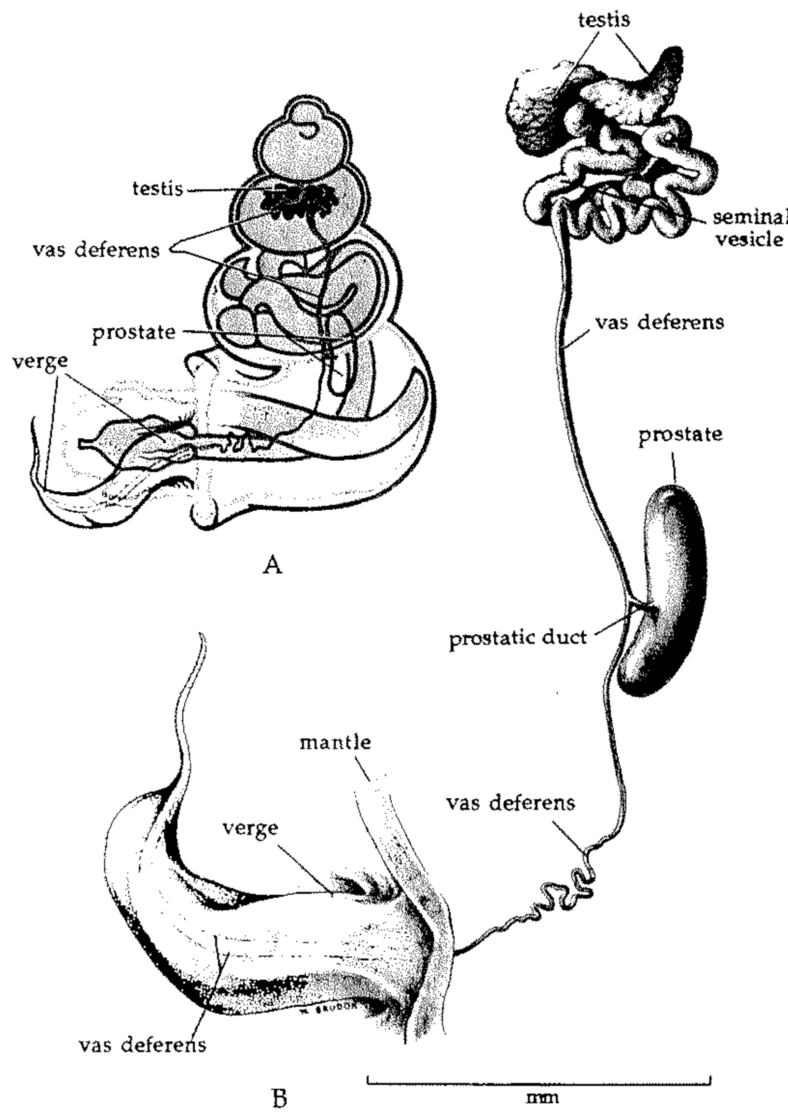

FIG. 18 (cont.). *Pomatiopsis cincinnatiensis* (cont.). Male reproductive system. **A**, position of the male organs in the snail; **B**, male organs. (From van der Schalie & Dundee, 1956).

POMATIOPSIDAE

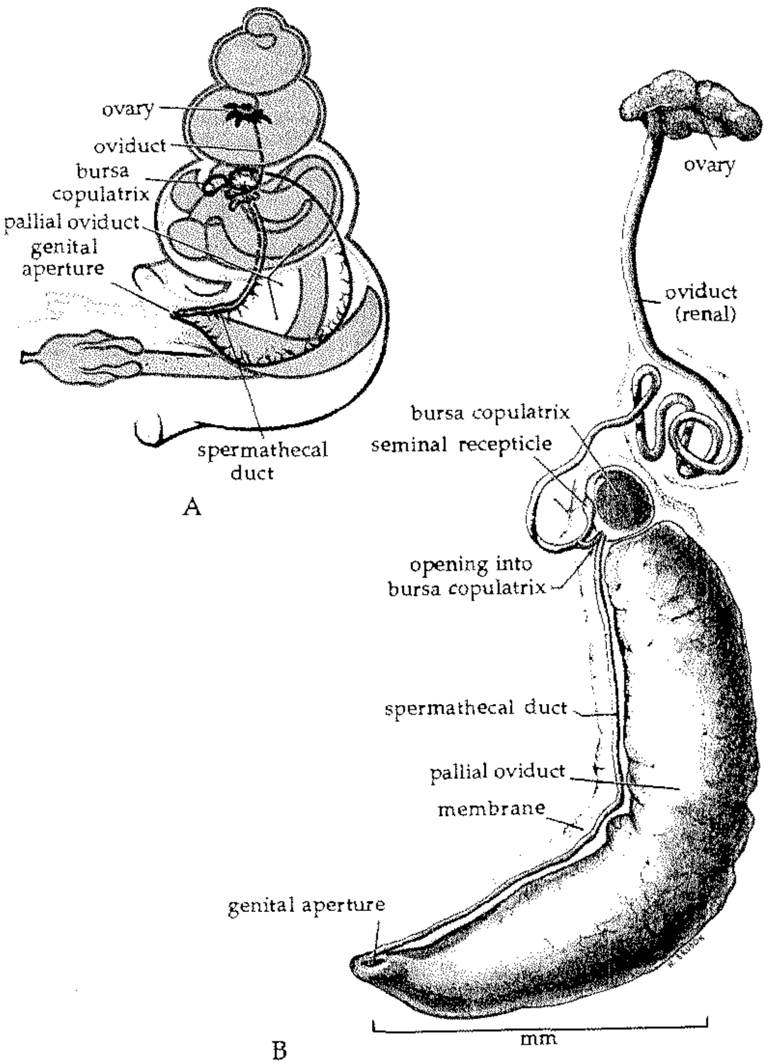

FIG. 18 (cont.). *Pomatiopsis cincinnatiensis* (cont.). Female reproductive system. **A**, Position of the female organs in the snail; **B**, female organs. (From van der Schalie & Dundee, 1956).

different taxa, from which leads a long, narrow, muscular vas deferens. The vas deferens courses through the body wall along the side of the foot (Fig. 18, p. 65 (A)) before entering the head-foot hemocoel near the male genital opening. The vas deferens joins the penis, which is also in the hemocoel (Fig. 18, p. 62 (A)). The penis in freshwater pulmonates is contained in a penis sheath, which connects distally to the tubular preputium (Fig. 18, p. 65 (A)). The preputium is attached to the body wall at the male gonopore.

Pulmonate snails differ from prosobranchs in carrying the penis internally when not sexually active. The preputium and penis sheath are everted by turgor pressure during copulation, and withdrawn by penial retractor muscles after completion of mating. In some families, the penis and preputium vary considerably between various taxa, in which case these structures are given considerable taxonomic attention (e.g., see Fig. 17, pp. 46, 47).

The female system in pulmonate snails (see Fig. 18, p. 65 (A); Fig. 19, p. 73 (B)) consists of the albumen gland, nidamental gland, uterus, seminal receptacle (spermatheca) and vagina (that part of the female duct between the opening of the seminal receptacle and the female genital pore).

Freshwater gastropods obtain oxygen by gills (in the Prosobranchia) or by a lung (in the Pulmonata). The gill is usually well hidden within the protective enclosure of the mantle cavity (Fig. 18, pp. 48, 54, 59, 60). In most of the freshwater prosobranchs, the unipectinate gill is attached to the wall of the mantle cavity and consists of a long series of parallel, often triangularly-shaped, leaflets. In the Valvatidae, the gill is bipectinate, and, when the snail is active, it protrudes to the exterior from the mantle cavity (Fig. 781, sect. V, p. 220).

The lung in freshwater pulmonate snails is located in the same general area as the mantle cavity in prosobranchs (Fig. 18, p. 62 (A)). The surface of the lung is highly vascularized (Fig. 18, p. 64 (B)) to facilitate O_2/CO_2 exchange. The lung is generally reduced in freshwater limpets, where oxygen uptake is mainly through other body surfaces. While freshwater pulmonates do not have true gills, three families, the Acroloxidae, Planorbidae and Ancylidae (Fig. 19, p. 69) have secondarily derived gills, called "pseudobranchs."

The respiratory pigment in nearly all gastropods is hemocyanin, but in the Planorbidae it is hemoglobin, which gives the planorbid body a red appearance (unless the color of the blood is masked by body melanin pigment).

THIARIDAE

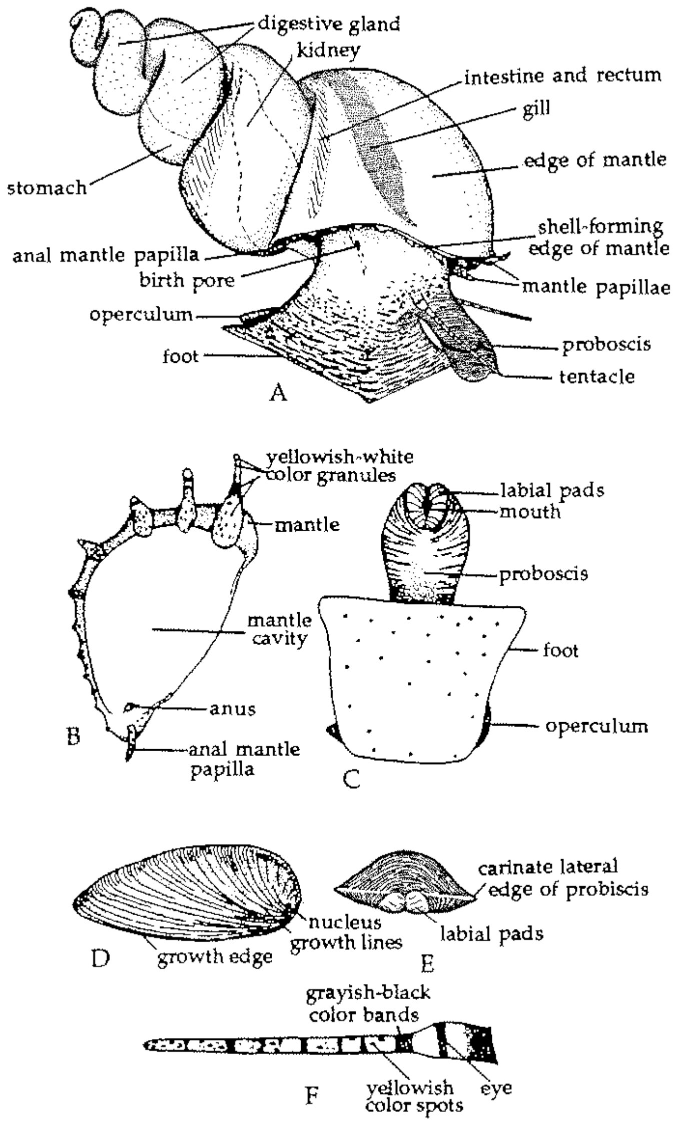

FIG. 18 (cont.). *Thiara granifera.* **A**, Right side of the animal; **B**, mantle edge, frontal aspect. C, underside of crawling animal; **D**, operculum; E, proboscis, anterior view; **F**, rlght tentacle, dorsal view. (From Abbott, 1952).

THIARIDAE

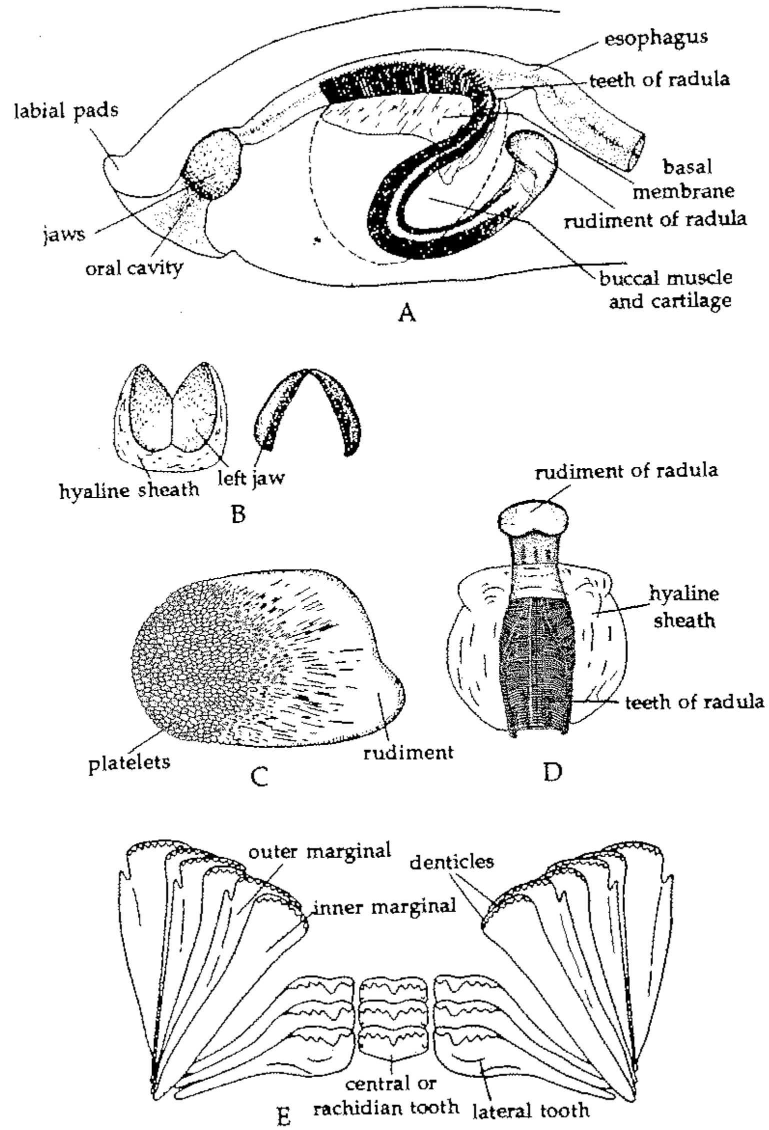

FIG. 18 (cont.). *Thiara granifera* (cont.). **A**, Proboscis, sagittal section; dotted lines indicate limits of buccal muscle and cartilage; **B**, jaws; dorsal (on left) and anterior (on right) views; **C**, outer view of rlght jaw; **D**, radula, dorsal view; **E**, three rows of radular teeth. (From Abbott, 1952).

THIARIDAE

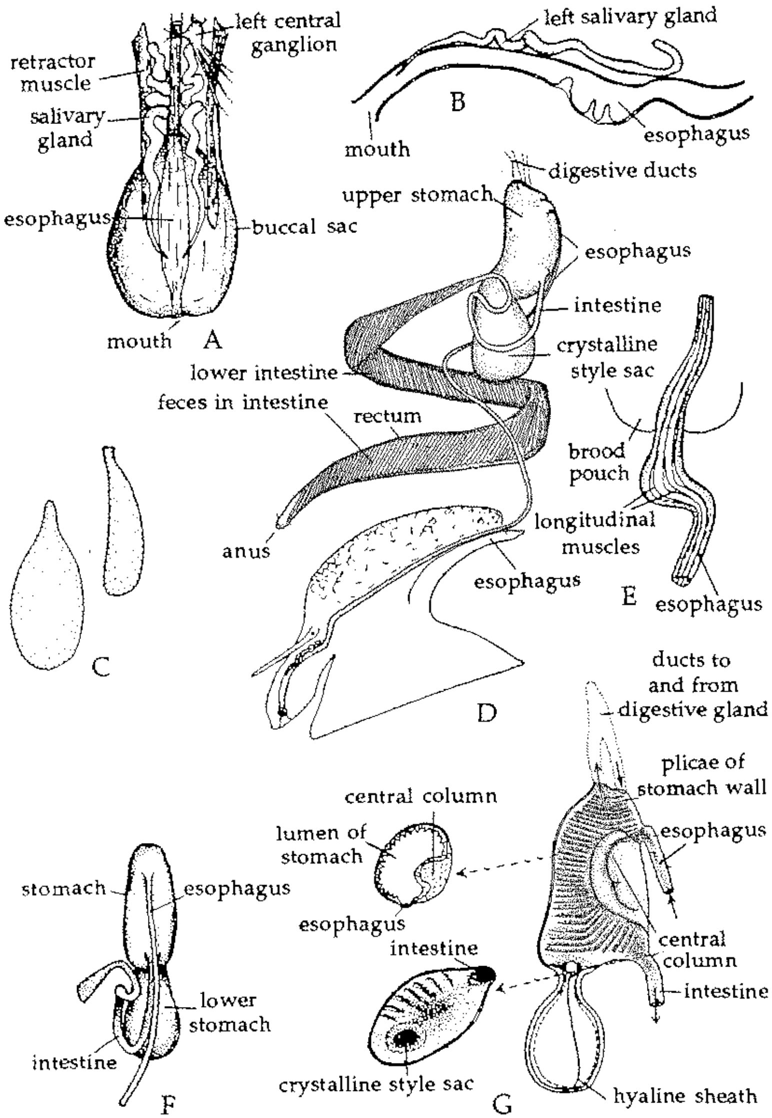

FIG. 18 (cont.). *Thiara granifera* (cont.). **A**, Buccal mass, dorsal view; **B**, esophagus, sagittal section; **C**, crystalline style, preserved (top) and from live specimen (bottom); **D**, alimentary system; **E**, esophagus beneath the brood pouch, dorsal view; **F**, stomach; **G**, interior of stomach. (From Abbott, 1952).

THIARIDAE

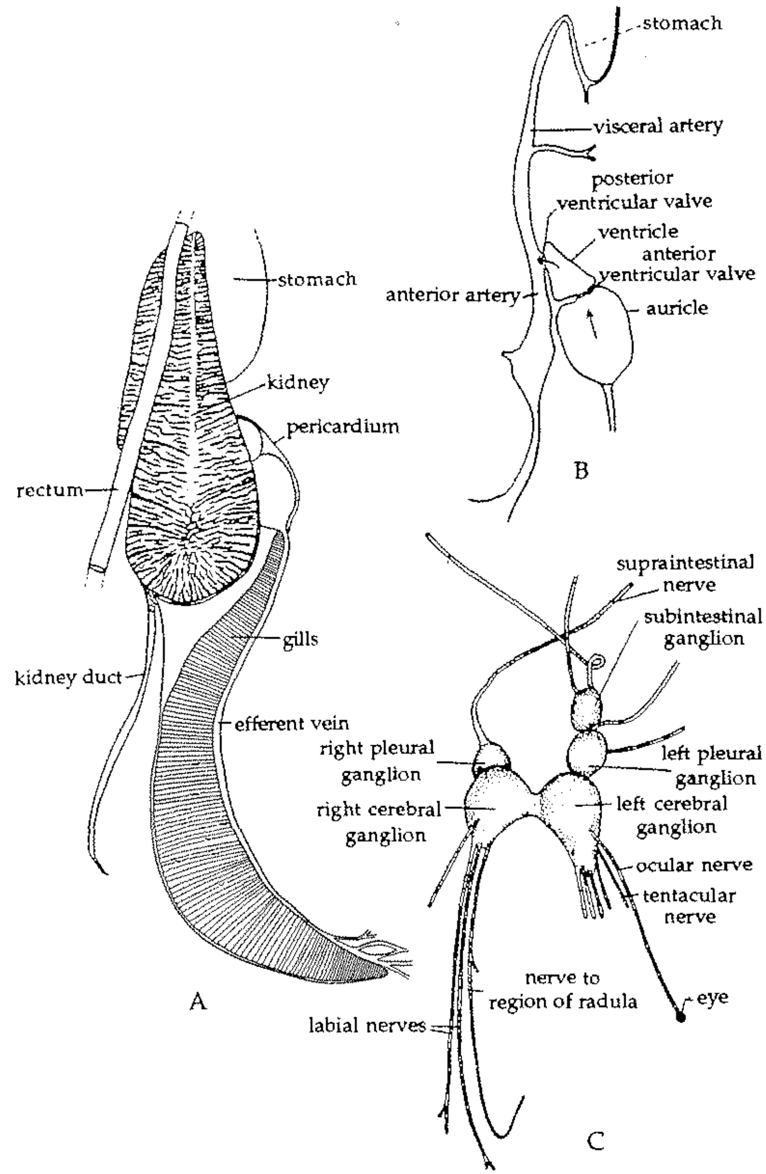

FIG. 18 (cont.). *Thiara granifera* (cont.). **A**, Kidney and gill; **B**, heart and adjacent arteries; **C**, central ganglia and their nerves, dorsal view. (From Abbott, 1952).

THIARIDAE

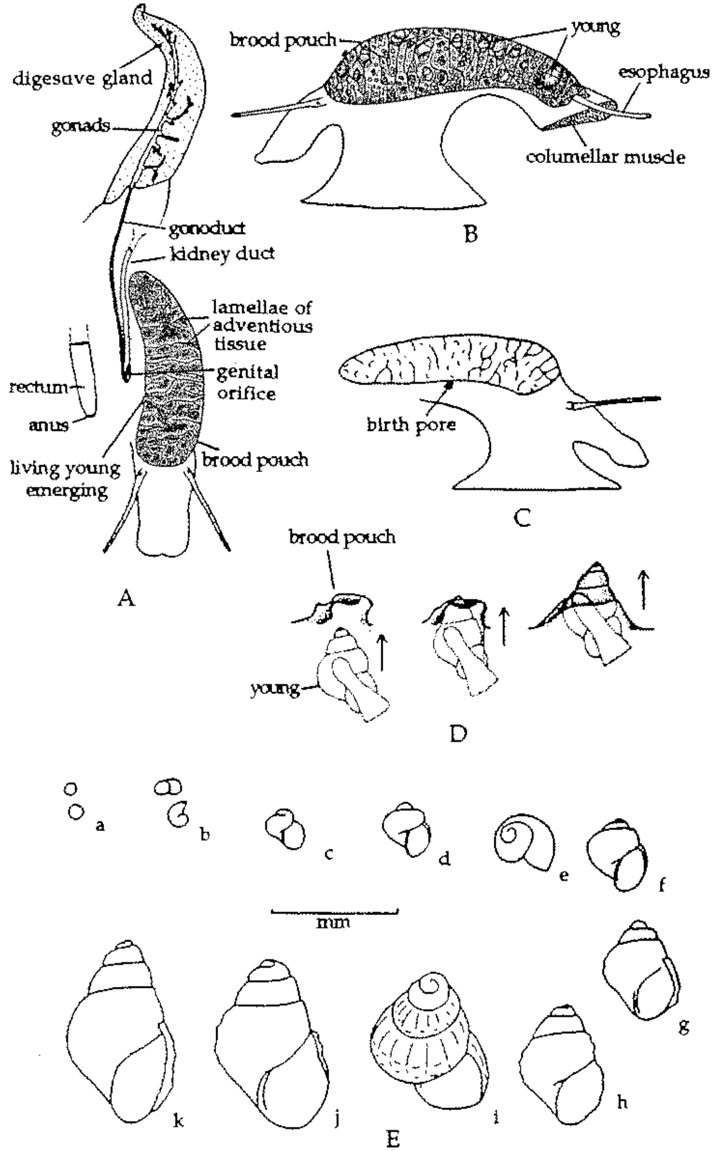

FIG. 18 (cont.). *Thiara granifera* (cont.). **A**, Reproductive system, dorsal view. **B**, **C**, left and right sides of animal, showing young in the brood pouch; **D**, young snails emerging from birth pore; **E**, eggs and young from brood pouch, showing development from fertilized egg (a) to a shell of four whorls (k). (From Abbott, 1952).

PLEUROCERIDAE

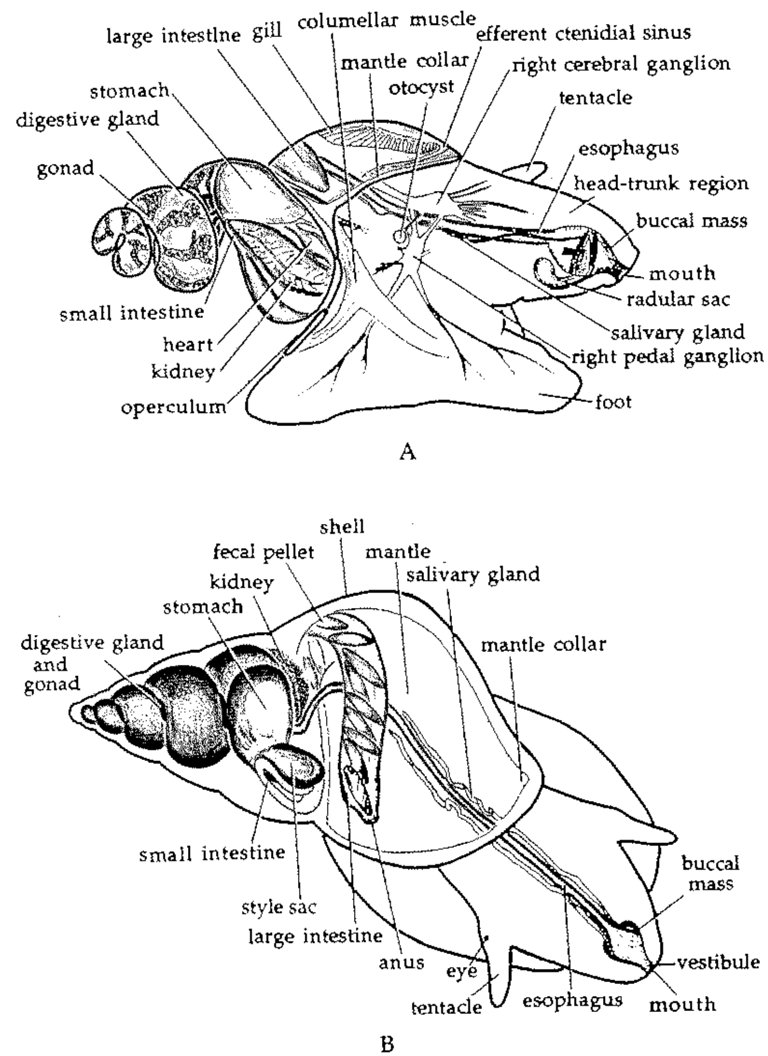

FIG. 18 (cont.). *Elimia livescens*. **A**, Lateral view, right side; **B**, digestive system, dorsal view. (From Dazo, 1965).

The excretory system of mollusks consists of a metanephridium (kidney) and its duct(s). The kidney is closely associated with both the reproductive and circulatory systems. In freshwater gastropods, the

PLEUROCERIDAE

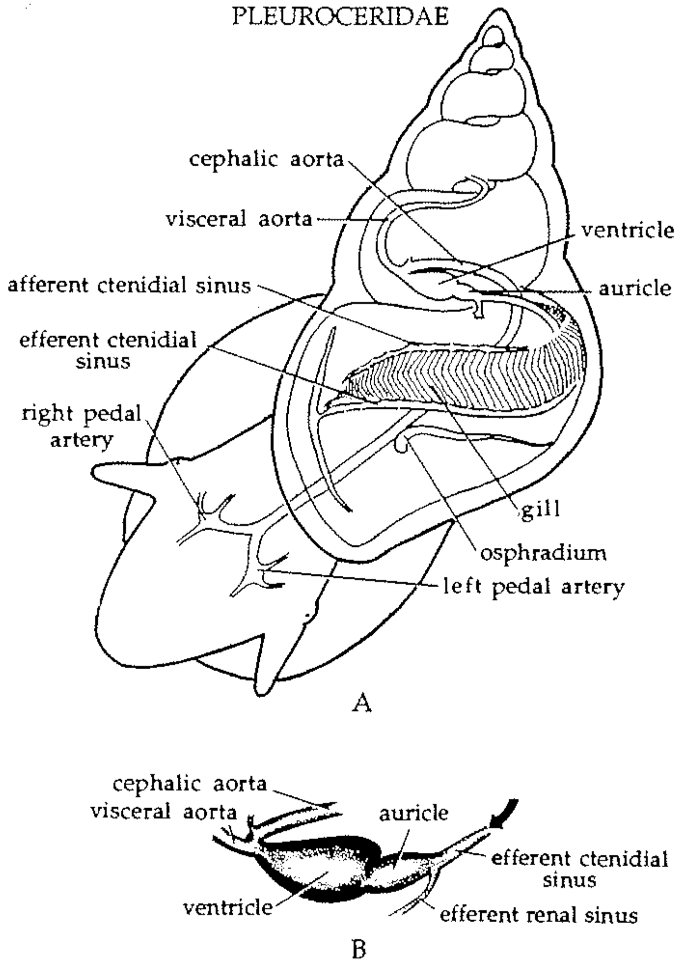

FIG. 18 (cont.). *Elimia livescens* (cont.). **A**, Circulatory system; **B**, heart. (From Dazo, 1965).

kidney lies along side the pericardium, with its contained heart (Fig. 18, pp. 57, 64; Fig. 19, pp. 67, 72). The kidney in the Acroloxidae and Ancylidae differ from the other freshwater pulmonate snails in being serpentine in shape (Fig. 19, pp. 72 (A), 73 (A)).

The nervous system in freshwater gastropods (Fig. 18, p. 57 (C); Fig. 19, pp. 71, 72) has a concentration of paired nerve centers (ganglia) in the anterior hemocoel. The cerebral ganglia receive nerves from the

PLEUROCERIDAE

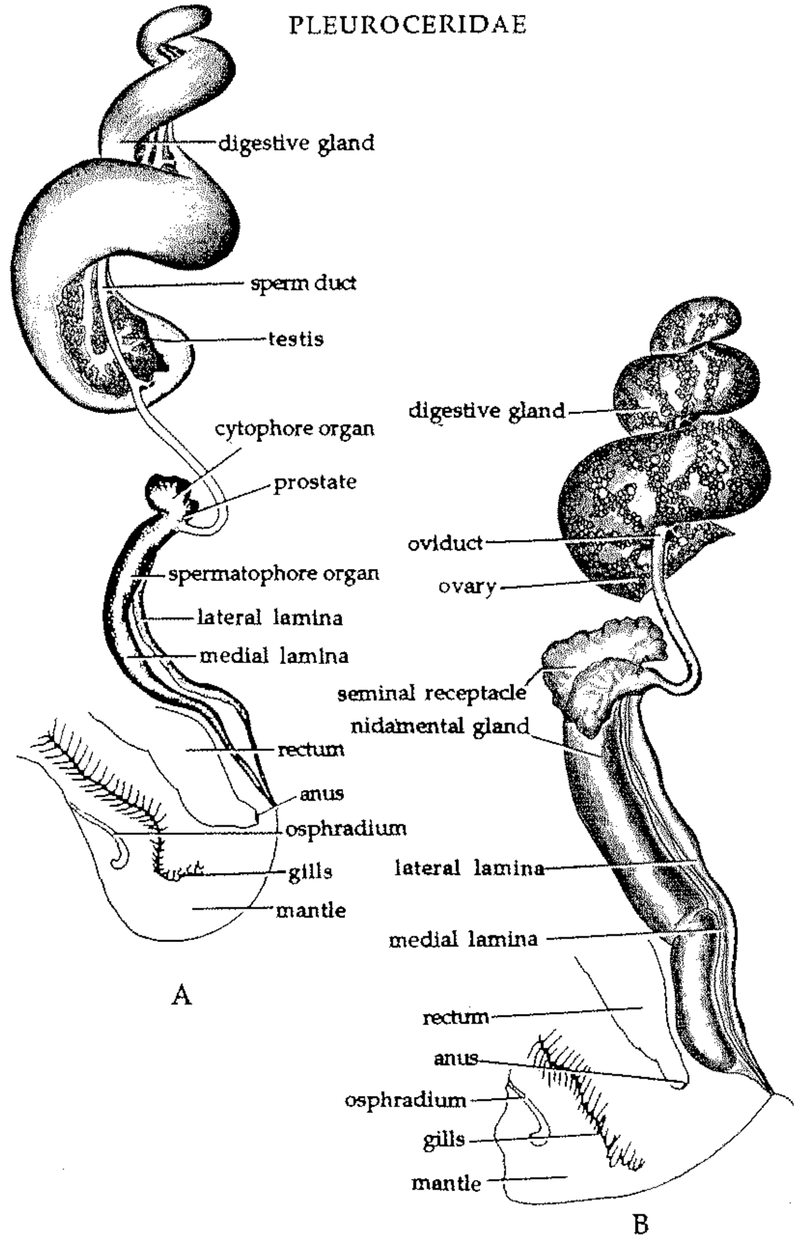

FIG. 18 (cont.). *Elimia livescens* (cont.). Reproductive system. **A**, Male; **B**, female. (From Dazo, 1965).

LYMNAEIDAE

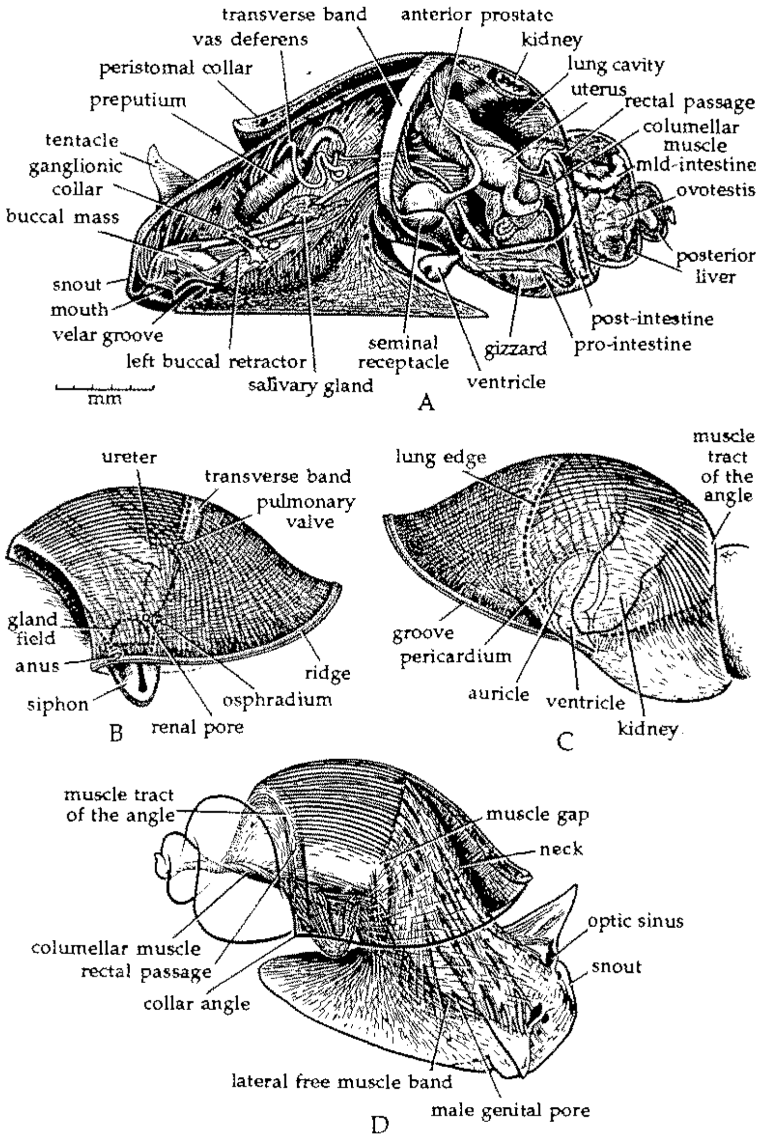

FIG. 18 (cont.). *Stagnicola emarginata*. **A**, Section through left side, showing organs; **B**,**C**, right and left sides of lower mantle and underlying structures; **D**, musculature. (From Walter, 1969).

LYMNAEIDAE

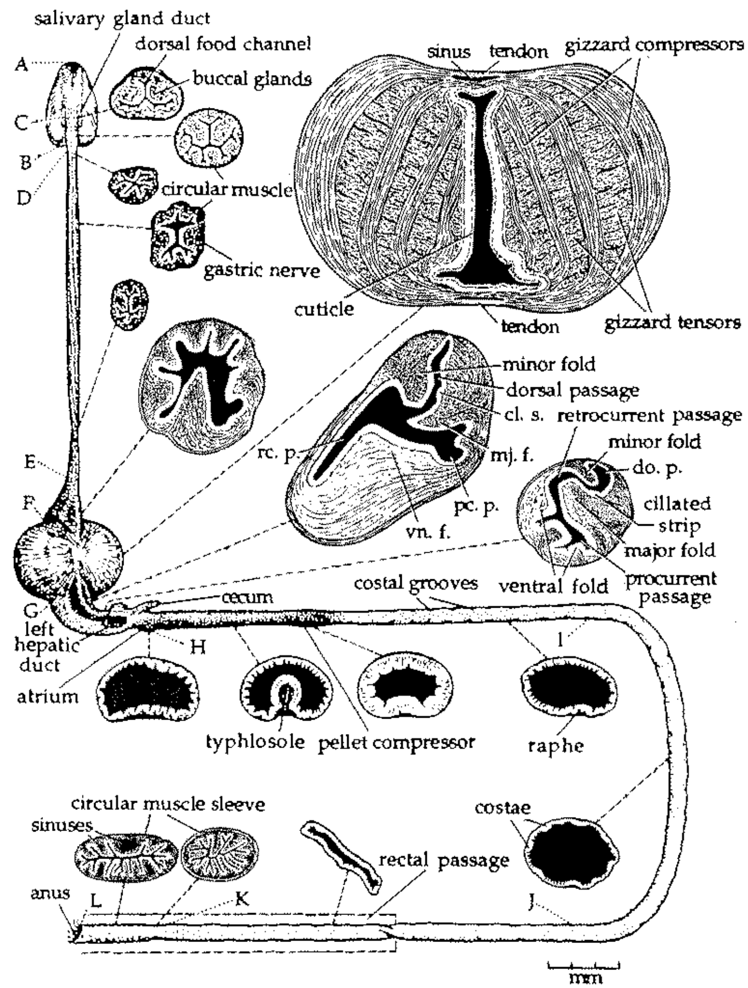

FIG. 18 (cont.). *Stagnicola emarginata* (cont.). Digestive tract. The liver lobes and the salivary glands are omitted. A to B = buccal mass; C to D = proesophagus; D to E = postesophagus; E to F = crop; F to G = gizzard; G to H = pylorus; H to I = prointestine; I to J = midintestine; J to K = postintestine; K to L = rectum. cl.s. = ciliated strip; do.p. = dorsal passage; mj.f. = major fold; pc.p. = procurrent passage; rc.p. = retrocurrent passage; vn.f. = ventral fold. (From Walter, 1969).

eyes and tentacles, the pleural ganglia receive nerves from the body walls, and the pedal ganglia receive nerves from the foot. The cerebral and pleural ganglia are arranged around the anterior

LYMNAEIDAE

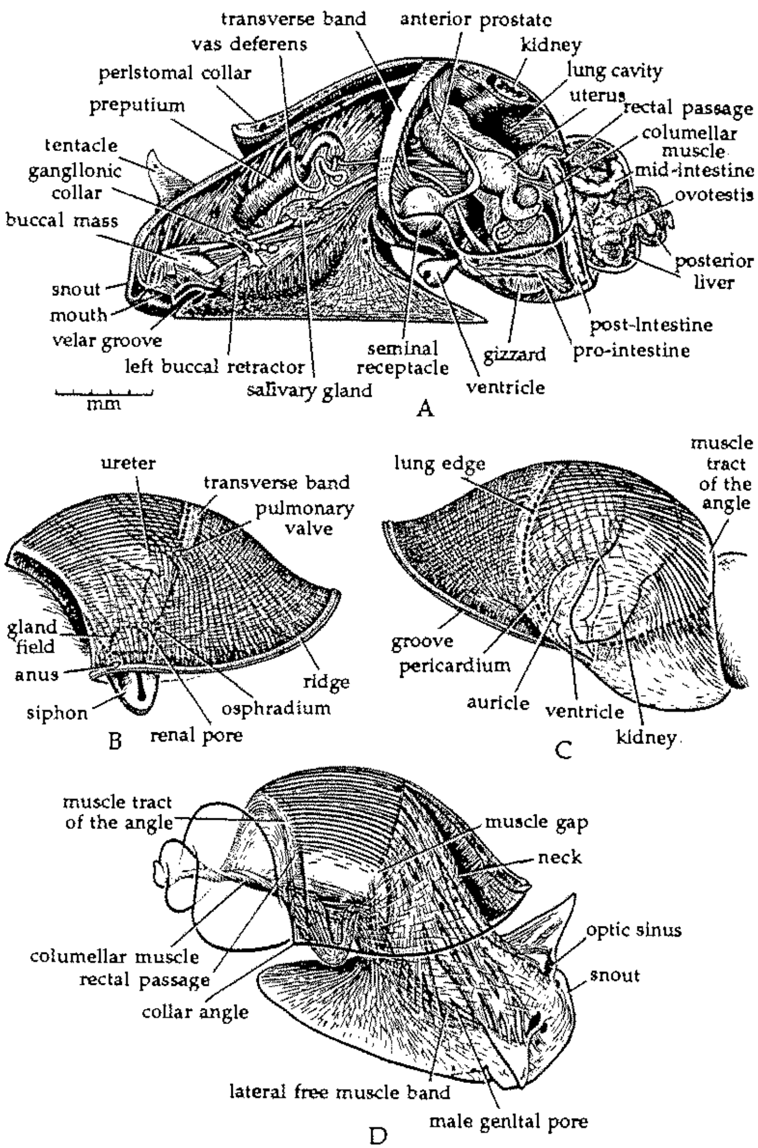

FIG. 18 (cont.). *Stagnicola emarginata*. **A**, Section through left side, showing organs; **B**,**C**, right and left sides of lower mantle and underlying structures; **D**, musculature. (From Walter, 1969).

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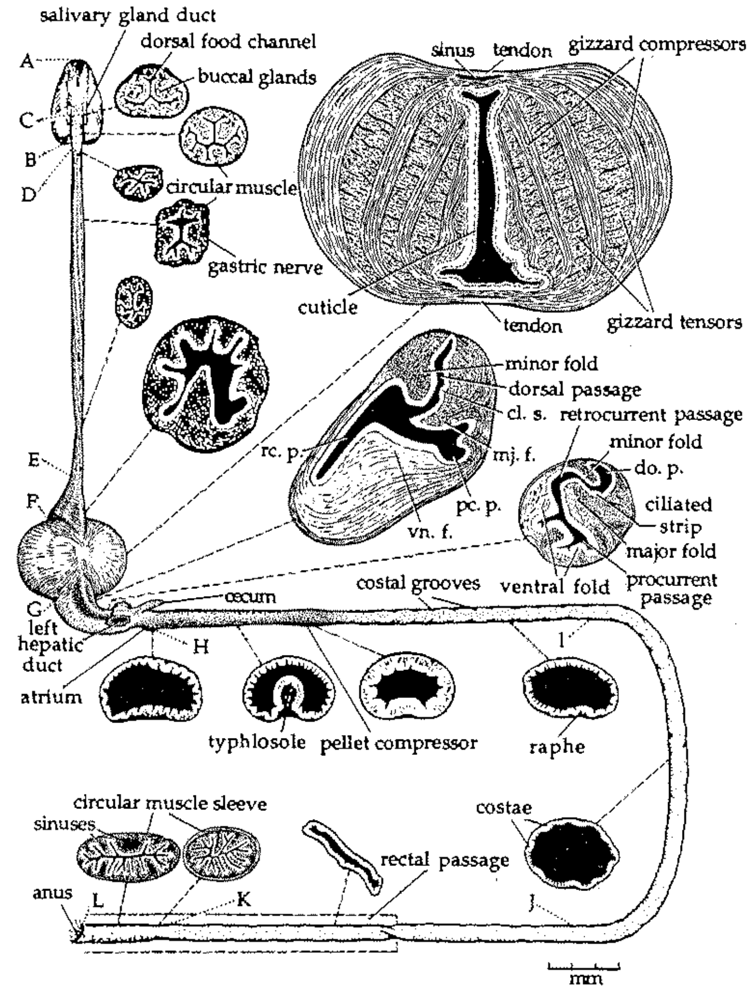

FIG. 18 (cont.). *Stagnicola emarginata* (cont.). Digestive tract. The liver lobes and the salivary glands are omitted. A to B = buccal mass; C to D = proesophagus; D to E = postesophagus; E to F = crop; F to G = gizzard; G to H = pylorus; H to I = prointestine; I to J = midintestine; J to K = postintestine; K to L = rectum. cl.s. = ciliated strip; do.p. = dorsal passage; mj.f. = major fold; pc.p. = procurrent passage; rc.p. = retrocurrent passage; vn.f. = ventral fold. (From Walter, 1969).

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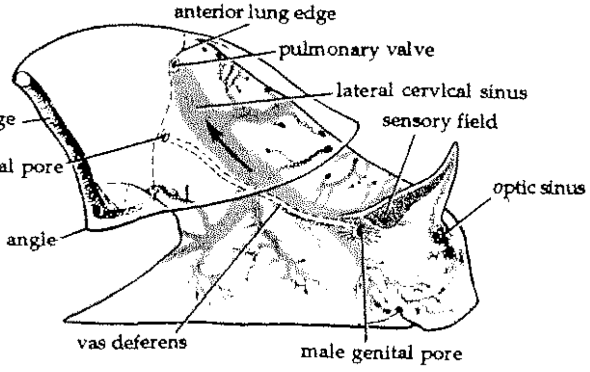
LYMNAEIDAE



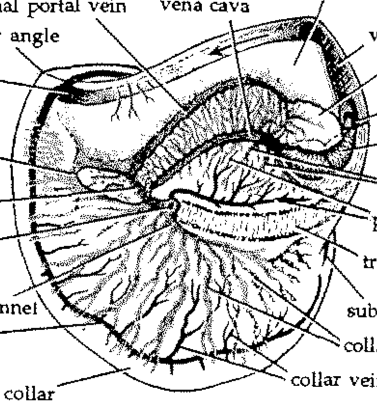
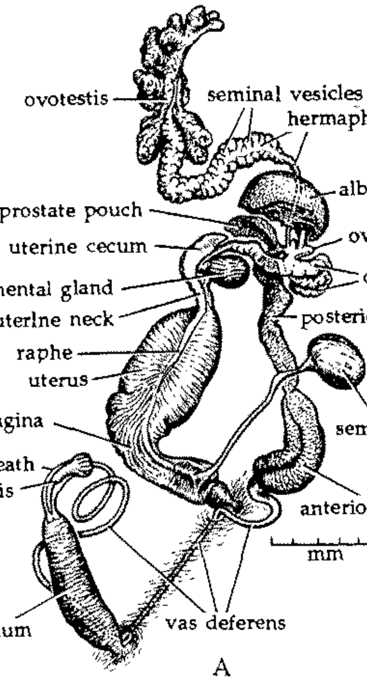


FIG. 18 (cont.). *Stagnicola emarginata* (cont.). **A**, Venous pathways in the wall of the anterior part of the animal; **B**, venous sinuses in the peristomial collar, roof of the lung and kidney. (From Walter, 1969).

esophagus, and the pedal ganglia are beneath the esophagus. The nervous systems of North American freshwater prosobranchs and pulmonates are basically similar.

LYMNAEIDAE



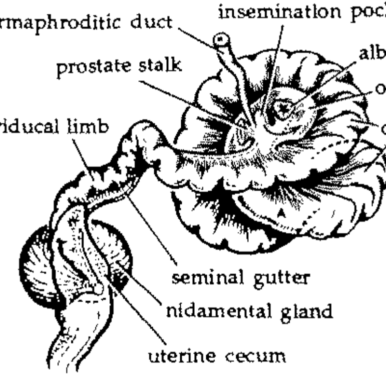


FIG. 18 (cont.). *Stagnicola emarginata* (cont.). **A**, Reproductive system; **B**, the carrefour complex and adjacent portions of the oviducal and uterine divisions of the female tract. (From Walter, 1969).

Freshwater gastropods with cap-shaped shells that have lost their coiled nature would seem certainly to have evolved because of the need to have a more hydrodynamic contour necessary to withstand strong water currents, which would tend to dislodge higher shells with more drag. Once the cap-shaped shells evolved, some of the "limpets" invaded lentic, quiet-water habitats.

Limpet-shaped freshwater mollusks in North America are restricted to four pulmonate snail families, the Acroloxidae, Lymnaeidae, Planorbidae and Ancylidae. [Limpet-like freshwater prosobranchs occur in a few other regions of the world, but not in North America (north of Mexico).] The Acroloxidae and Ancylidae contain *only* limpet-shaped (ancyliform, patelliform) species, while the Lymnaeidae and Planorbidae are families with mainly coiled shells. The Acroloxidae and Lymnaeidae are dextral families (i.e., the external reproductive, pulmonary, renal and terminal alimentary tract openings are on the right side of the animal), while the Planorbidae and Ancylidae are sinistral. In North America, limpet-like lymnaeid snails (genera *Fisherola* and *Lanx*; Figs. 632-634, Sect. IV, pp. 179, 181) are restricted to streams of the Pacific drainage from British Columbia to northern California. Limpet-like Planorbidae (genus *Amphigyra*; Fig. 749, Sect. IV, p. 209) in North America, now extinct due to man-made pollution, were restricted to the Coosa River, Alabama.

The peculiarities in the anatomy of freshwater limpets is mainly the result of the compression of the body into the low, obtuse-conical shape. The mantle cavity is greatly reduced and the nephridium is displaced toward the mantle collar (anteriorly in the Lancinae and to the side in the Acroloxidae and Ancylidae). In the Acroloxidae and Ancylidae, the nephridium additionally takes on a very convoluted shape.

Since there is no longer a columella in the cap-shaped shell, the columellar muscle attachments have moved to the shell surface, and in the more primitive condition (e.g., see genera *Lanx* and *Rhodacmea*) they form a circle near the perimeter of the mantle, open only in the pneumostomal area (Fig. 11a,b,c, p. 38; Fig. 19, p. 67). In more advanced limpets (*Ferrissia, Hebetancylus, Laevapex*), the shell attachment muscle is divided into three major sections, with two main attachment points placed on each side of the mantle anteriorly and one near the posterior left side of the mantle (Fig. 11d (p. 38), Fig. 11e-h (p. 39)).

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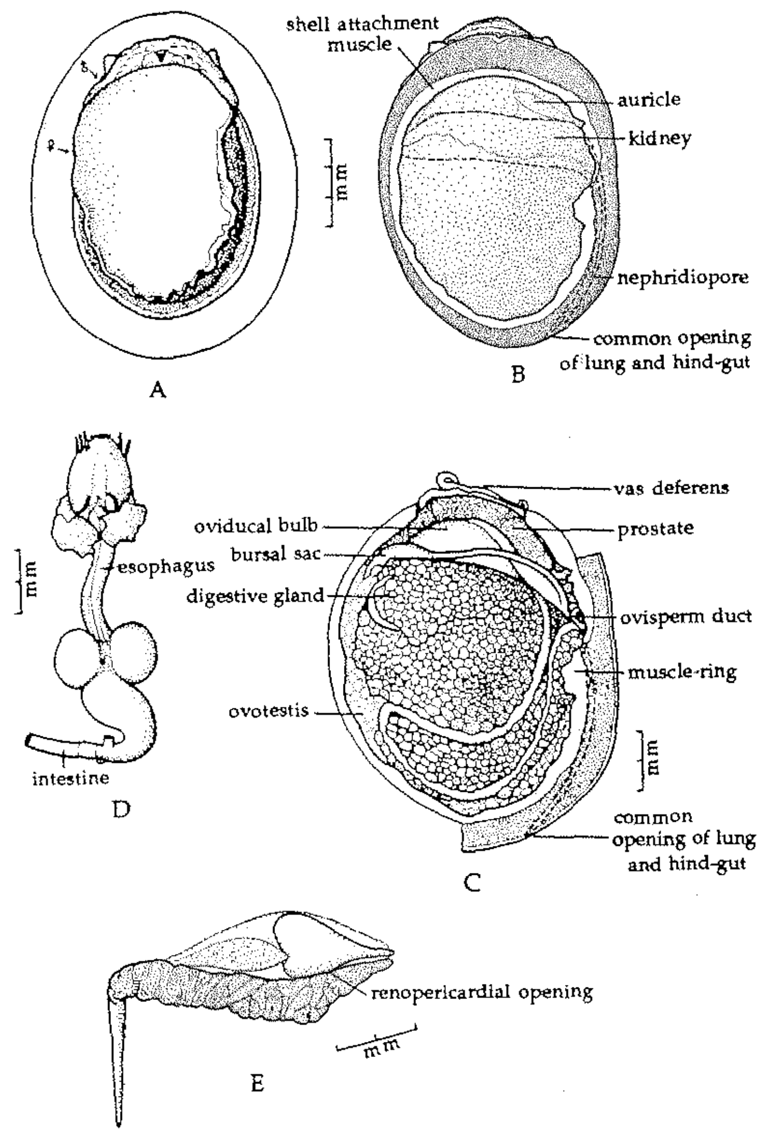

FIG. 19. Freshwater limpets (Lymnaeidae). ***Lanx alta***. **A**, Ventral view; **B**, dorsal view; **C**, dorsal view of visceral mass, with most of the mantle cut away; **D**, anterior portion of the digestive tract; **E**, kidney, pericardium and heart. (From H.B. Baker, 1925).

LYMNAEIDAE (LANCINAE)

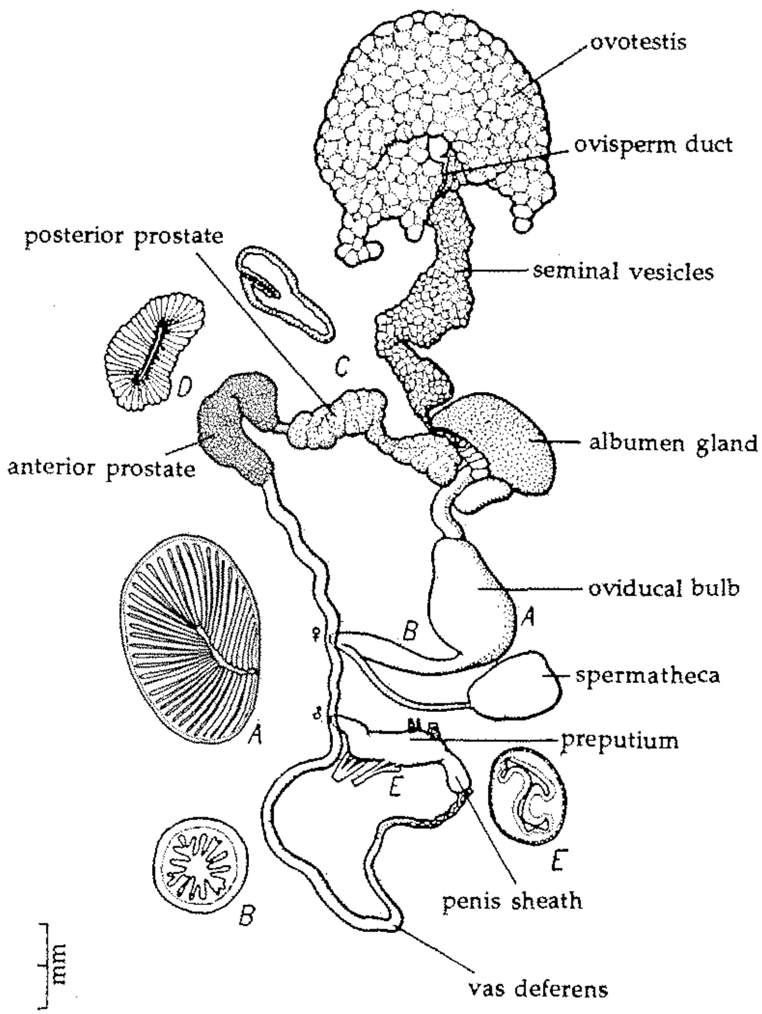

FIG. 19 (cont.). *Lanx alta* (cont.). Reproductive system. Transverse sections through A, the buccal bulb; B, anterior oviduct; C, posterior prostate gland; D, anterior prostate gland; E, preputium. (From H.B. Baker, 1925).

ANCYLIDAE

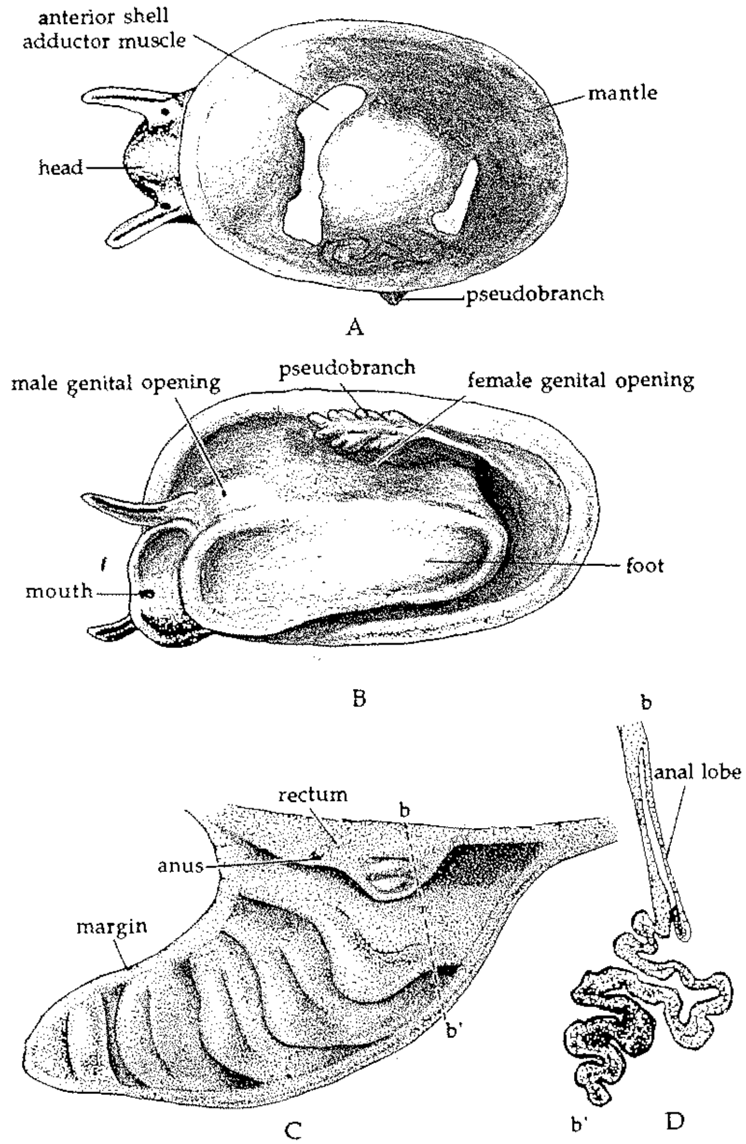

FIG. 19 (cont.). Freshwater limpets (cont.) (Ancylidae). *Laevapex fuscus*. A, Dorsal view; B, right oblique ventral view; C, pseudobranch; D, cross section of pseudobranch at dotted line (b—b') on Fig. C. (From Basch, 1959).

ANCYLIDAE

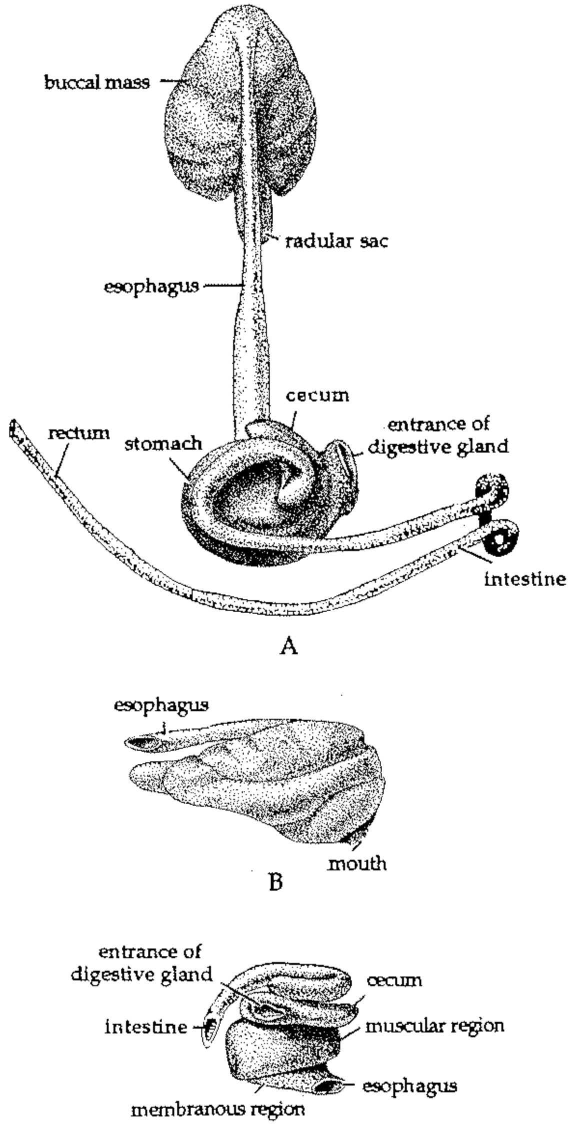

FIG. 19 (cont.). *Laevapex fuscus* (cont.). Digestive system. **A**, Entire system (dorsal view), except for the digestive gland; **B**, buccal mass, right side; **C**, stomach, right side. (From Basch, 1959).

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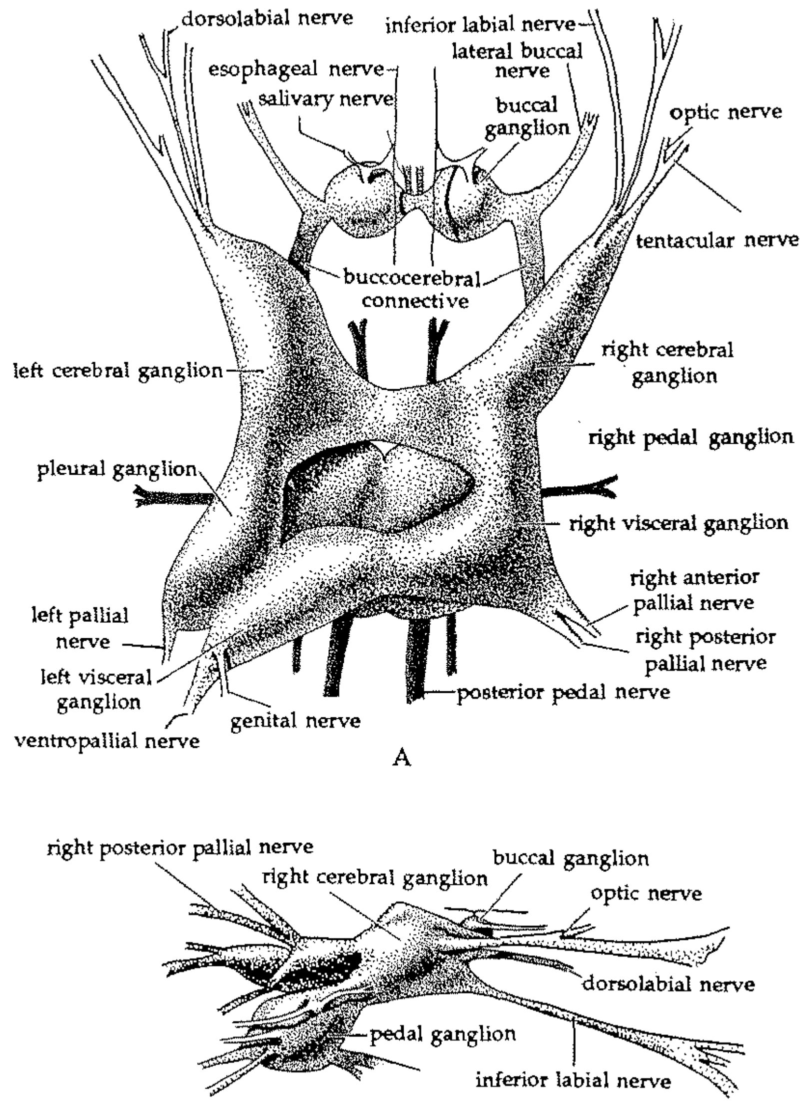

FIG. 19 (cont.). *Laevapex fuscus* (cont.). Brain. **A**, Dorsal view; **B**, right side. (From Basch, 1959).

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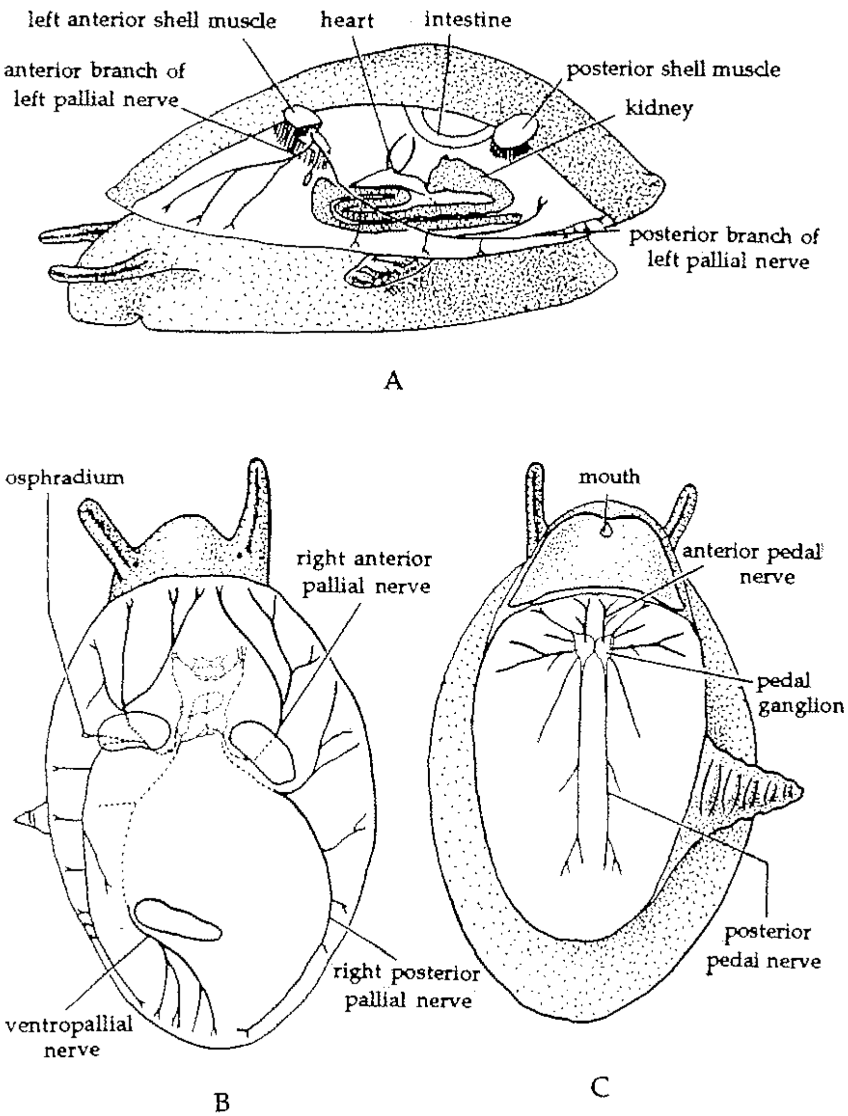

FIG. 19 (cont.). *Laevapex fuscus* (cont.). Nervous system. **A**, Major nerves to left side of mantle; **B**, dorsal superficial nerves; **C**, nerves from pedal ganglia. (From Basch, 1959).

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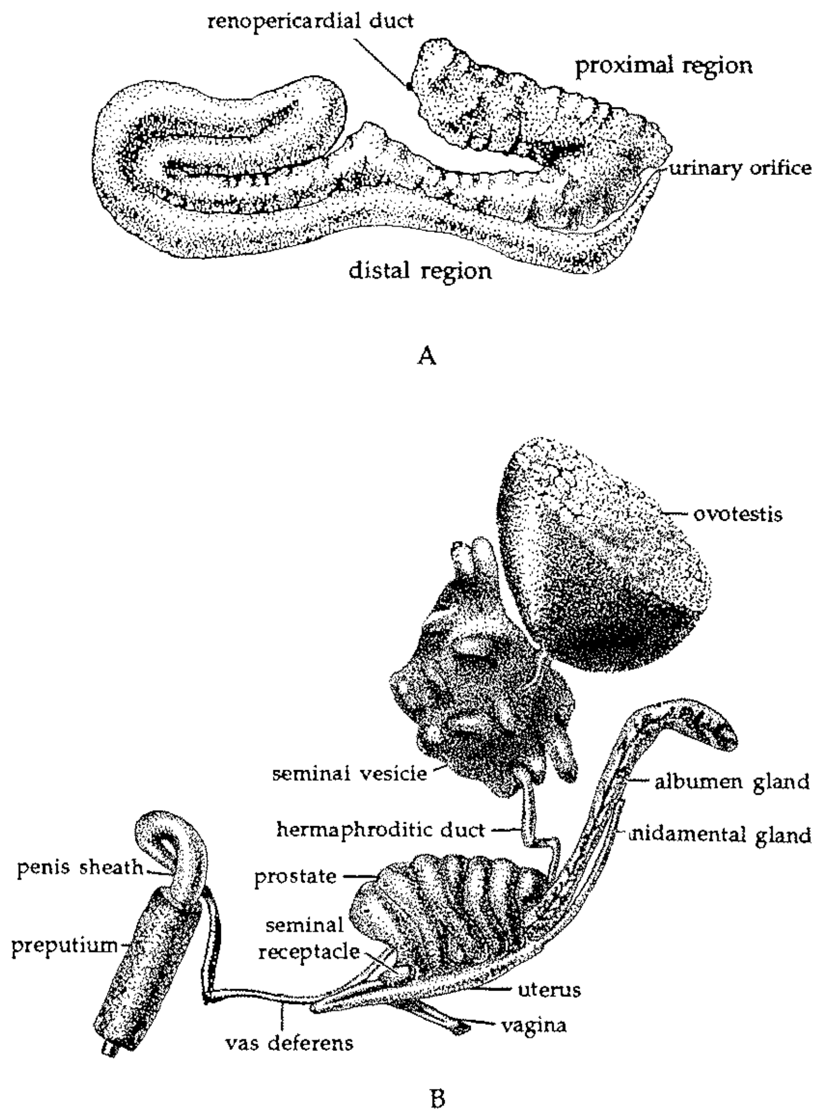

FIG. 19 (cont.). *Laevapex fuscus* (cont.). **A**, Kidney; **B**, reproductive system. (From Basch, 1959).

III. HABITATS AND DISTRIBUTION

HABITATS

North America is a vast region liberally supplied with fresh waters. Living in these fresh waters is a large fauna of aquatic snails, a molluscan fauna which ranks among the richest in the world. Although some snail species are wide-spread and common, other species are very restricted in their distributions, sometimes being known from only a single locality.

The physiography of the North American continent is reflected in the differential makeup of the snail fauna. For example, much of the waters of Canada and the northcentral United States are dominated by lentic environments, and so there is a preponderance of pond and lake species. In the southeastern United States, lakes were very rare before the advent of man-made impoundments, most of the fresh waters in this region being lotic in nature. Similarly, the aquatic habitats of this region are dominated by snails adapted to lotic environments.

Information on the habitats and general ecology of the various North American freshwater snails are scattered through the malacological literature, and, in general, are restricted to statements about the snails' habitats, i.e., whether the snails occur in ponds, lakes, swamps, ditches, creeks, rivers, etc., or whether they are normally found on rocks in swift current, or on a soft mud bottom, or buried in sand, or on submerged vegetation, etc. Literature sources especially useful for this kind of information include the monographs of F.C. Baker (1928), Harmon & Berg (1971) and Clarke (1973), to name only a few. A review of habitats of freshwater snails of the Great Lakes is contained in Burch & Jung (1987). More specific and detailed information about freshwater snail ecology has been given for selected species, and include observations and experiments by Clampitt (1970, 1973, 1974), Dundee & Paine (1977), Horst & Costa (1975), Jokinen (1978) and Wall (1977), to name only several. Reviews on general and other aspects of freshwater snail ecology, as well as extensive bibliographies, can be found in Russell-Hunter (1978), Aldrich (1983) and McMahon (1983).

Freshwater snails have adapted to nearly all natural freshwater habitats in North America, and a few species (e.g., *Physella* spp.) are tolerant enough to live successfully in all but the most heavily polluted waters. In general, however, freshwater snails do not tolerate much pollution, or chemical changes or physical disturbance of their habitats, and there has been a noticeable general decline in the last

several decades in the local distribution and abundance of many species of freshwater snails.

North American aquatic snails have radiated into various kinds of freshwater habitats, with most species being restricted more or less to one or only several types of habitats. There are a few ubiquitous species, of course, but the restriction of species to specific types of habitats is the general rule. Examples of habitat restrictions for freshwater snails in the Great Lakes region are given below.

Deep water lake species: *Birgella subglobosa, Hoyia sheldoni, Valvata sincera sincera, Stagnicola contracta.*

Open shore lake species: *Valvata winnebagoensis, Lymnaea stagnalis sanctaemariae, Stagnicola catascopium, S. emarginata, S. nasoni, S. walkeriana, S. woodruffi, Physella gyrina sayi, P. magnalacustris, P. parkeri, P. vinosa, Planorbella (Pirosoma) corpulenta whiteavesi, P. (Pirosoma) truncata.*

Quiet bay or pond species: *Valvata piscinalis, V. sincera nylanderi, V. winnebagoensis, Viviparus georgianus, Cipangopaludina chinensis malleata, C. japonica, Bythinia tentaculata, Amnicola (Lyogyrus) pilsbryi, Elimia livescens haldemani, Acella haldemani, Bulimnea megasoma, Fossaria cyclostoma, F. galbana, Pseudosuccinea columella, Radix auricularia, Stagnicola elodes, Gyraulus (Torquis) parvus parvus, Helisoma anceps royalense, Menetus (Micromenetus) dilatatus, Planorbella campanulata campanulata, P. campanulata collinsi, P. multivolvis, P. (Pirosoma) corpulenta corpulenta, P. (Pirosoma) pilsbryi, Planorbula armigera, Ferrissia fragilis, F. parallela, F. walkeri, Laevapex fuscus.*

Marsh species: *Stagnicola elodes, Promenetus exacuous.*

Mud-flat species: *Fossaria obrussa, F. exigua.*

Species burrowing in sand or mud in rivers or lakes: *Campeloma crassula, C. decisum, Pleurocera acuta.*

Amphibious species: *Pomatiopsis cincinnatiensis, P. lapidaria, Fossaria parva, Fossaria (Bakerilymnaea) dalli.*

Intermittant pool or stream species: *Stagnicola exilis, S. elodes* (form *reflexa*), *S. (Hinkleyia) caperata, Physella gyrina gyrina, Aplexa elongata, Gyraulus (Armiger) crista, G. (Torquis) circumstriatus.*

Riverine species: *Valvata bicarinata, V. piscinalis, Bythinia tentaculata, Somatogyrus tryoni, Pyrgulopsis letsoni, Fossaria peninsulae, Stagnicola catascopium, S. petoskeyensis, Helisoma anceps royalense, Ferrissia rivularis.*

Species with a general aquatic distribution in both perennial and intermittant waters: *Physa skinneri, P. gyrina gyrina, Gyraulus deflectus.*

Species with a general aquatic distribution, but restricted to perennial waters: *Valvata lewisi, V. tricarinata, Lioplax sulculosa, Amnicola limosa, A. (Lyogyrus) walkeri, Probythinella lacustris, Cincinnatia cincinnatiensis, Marstonia lustrica, Elimia livescens livescens, Fossaria obrussa, Lymnaea stagnalis appressa, Helisoma anceps anceps, Planorbella (Pirosoma) trivolvis.*

Shallow springs species: *Fontigens nickliniana.*

DISTRIBUTION

North America has been divided into various zoogeographical regions in regard to its non-marine molluscan fauna (Binney, 1878, 1885; Henderson, 1931; Pilsbry, 1948). The three primary regions are the Eastern American, Western American and Middle American divisions. On the Continental North American mainland north of Mexico, the Middle American Division includes only the southern tip of Florida and a small portion of southcentral Texas. The largest region, the Eastern American Division, extends westward from the Atlantic coast to the eastern limit of the Rocky mountains - an area encompassing 5/6 of the total North American land mass, and it includes the drainages flowing into the Arctic and Bering seas, the Hudson Bay, the Gulf of Mexico and Atlantic Ocean, the Great Lakes, and the St. Lawrence and Mississippi rivers (Fig. 20). The Eastern Division is characterized by such endemic freshwater snail genera as *Campeloma, Lioplax* and *Tulotoma* (Viviparidae), *Antroselates* (? Micromelanidae), *Antrobia, Aphaostracon, Birgella, Cincinnatia, Clappia, Fontigens, Gillia, Hoyia, Lepyrium, Marstonia, Notogillia, Probythinella, Rhapinema, Somatogyrus, Spilochlamys* and *Stiobia* (Hydrobiidae), *Elimia, Gyrotoma, Io, Leptoxis, Lithasia* and *Pleurocera* (Pleuroceridae), *Acella* and *Bulimnea* (Lymnaeidae), *Amphigyra, Neoplanorbis* and *Planorbula* (Planorbidae) and *Rhodacmea* (Ancylidae). The Western American Division includes about 1/8 of the total North American land mass, and contains the Interior Basin, Colorado River, Columbia River and Pacific Slope drainages. Western freshwater snail genera not found in the Eastern American Division are *Fluminicola, Fontelicella* and *Tryonia* (Hydrobiidae), *Juga* (Pleuroceridae), *Fisherola* and *Lanx* (Lymnaeidae) and *Vorticifex* (Planorbidae). Some genera, of course, occur in both Eastern and Western divisions, e.g., *Valvata* (Valvatidae), *Cipangopaludina* [introduced] (Viviparidae), *Pyrgulopsis, Amnicola* and *Horatia* (Hydrobiidae), *Pomatiopsis* (Pomatiopsidae), *Melanoides* [introduced] (Thiaridae), *Acroloxus* (Acroloxidae), *Fossaria, Stagnicola* and *Radix* [introduced] (Lymnaeidae), *Aplexa* and *Physella* (Physidae), *Gyraulus, Helisoma, Menetus, Planorbella* and *Promenetus* (Planorbidae) and *Ferrissia* (Ancylidae). Genera that occur in either the Eastern or Western divisions, but have species also in the Middle American Division, are *Neritina* (Neritinidae, = Neritidae), *Viviparus* (Viviparidae), *Marisa* [introduced] and *Pomacea* (Ampullariidae), *Pyrgophorus* and *Cochliopina* (Hydrobiidae), *Pseudosuccinea* (Lymnaeidae), *Stenophysa* (Physidae), *Drepanotrema* and *Biomphalaria* (Planorbidae) and *Laevapex* (Ancylidae).

FIG. 20. Major drainages of North America (north of Mexico).

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Corrigenda

p. 90, line 23 - *Lioplax subcarinata* Say dates from 1817 rather than 1816.
p. 144, line 40 - The author of *Elimia virginica* is Gmelin (1791) rather than Say (1817). Say's (1817) "*Lymnaea*" *virginica* is *Elimia livescens* (Menke 1830).
pp. 156, 158, 245 - The subspecific name in the trinominal *Leptoxis* (*Mudalia*) *carinata nickliniata* should be *nickliniana*. The spelling *nickliniata* dates from Goodrich (1942b; see References, p. 310) [*Nitocris carinatus nickliniatus*] and is an error for [*Melania*] *nickliniana Lea* 1841.
p. 176, line 21 - F.C. Baker (1928) restricted the distribution of *Stagnicola apicina* (Lea 1838) "to the region west of the Rocky Mountains, the Pacific drainage." Specimens from Michigan that he previously referred to *S. apicina*, he later (1926) named *S. walkeriana* (type locality: Madeline Island, near Bayfield, Wisconsin).
p. 247, line 11 - Under Lymnaeidae, for "three latter" read "last two."
p. 251, couplet 23 - For "with above five whorls" read "with about five whorls."
p. 288, last line - For "part of beginning" read "part or beginning."

IV. SPECIES LIST, RANGES AND ILLUSTRATIONS*

Family NERITINIDAE[1]

Genus *Neritina* Lamarck 1816

Neritina reclivata reclivata (Say 1822) [Figs. 21, 22][2]
Florida to Mississippi. Also Cuba, northern Mexico and Venezuela (H.B. Baker, 1923).
Neritina reclivata sphaera Pilsbry 1931
Drainage canal draining Lake Okechobee, a few miles from the Atlantic, Ojus, Florida (Pilsbry, 1931).
Neritina reclivoto palmae Dall 1885
Brook near Palma Sola, Florida (Dall, 1885)

Family VALVATIDAE†

Genus *Valvata* Müller 1774

Valvata bicarinata bicarinata Lea 1841 [Fig. 23]
Of discontinuous distribution: New Jersey and Pennsylvania; and Iowa, Illinois, Tennessee, Alabama, Georgia and North Carolina.
Valvata bicarinata morph *normalis* Walker 1902 [Fig. 24]
Distribution nearly as for *V. bicarinata* s.s., but not in Georgia and North Carolina.
Valvata humeralis Say 1829 [Fig. 25]
Known from Montana south to Colorado, and west to British Columbia and California.
Valvata lewisi lewisi Currier 1868 [Fig. 26]
Southern Canada from Quebec west to British Columbia, and northern U.S.A. from New York west to Minnesota.
Valvata lewisi morph *ontarioensis* F.C. Baker 1931 [Fig. 27]
Northwestern Ontario in the region of Lake Superior drained by the headwaters of the Attawapiskat, Albany and Severn river systems (Clarke, 1973).
Valvata mergella Westerlund 1883 [Fig. 28]
Northwestern North America: Alaska to Washington.

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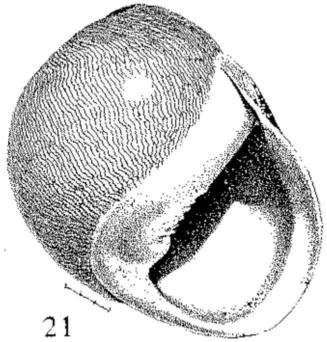
*Additional illustrations of many of the species listed here will also be found in the identification keys, which follow in Section V.

[1] Superscript numbers throughout the text refer to corresponding comments under Supplemental Notes, which appear in Section VII.

†The list of species for the Valvatidae is by William H. Heard (personal communication).



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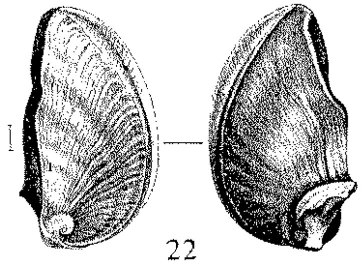

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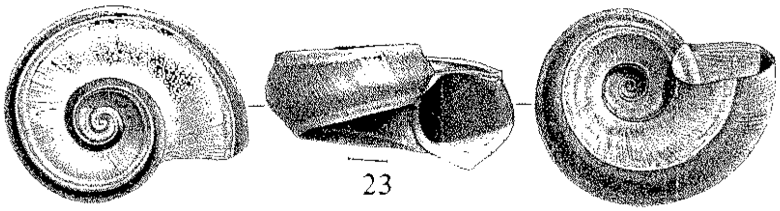

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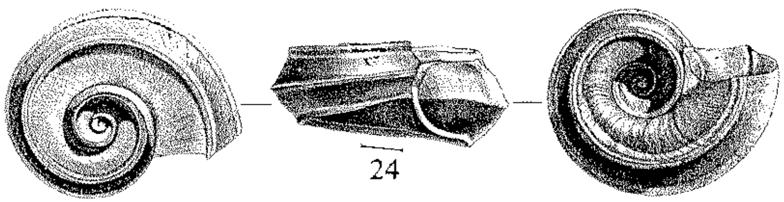

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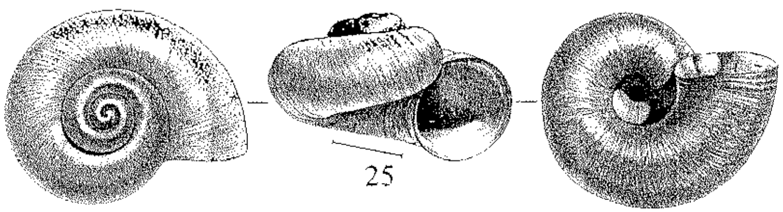

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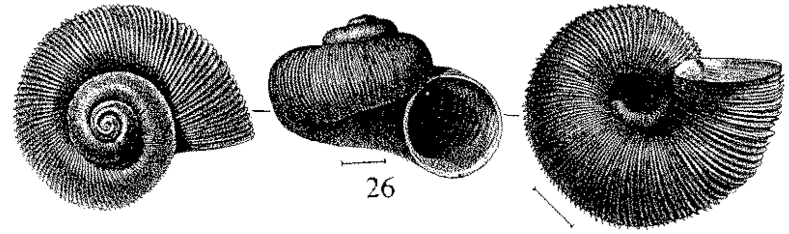
FIGS. 21-25. Shells of Neritinidae (Figs. 21, 22) and Valvatidae (Figs. 23-25). FIG. 21. *Neritina reclivata reclivata*, shell. FIG. 22. *N. reclivata reclivata*, operculum; external view (on left) and internal view (on right). FIG. 23. *Valvata bicarinata*, spire, apertural and umbilical views (left to right). FIG. 24. *V. bicarinata* morph *normalis*. FIG. 25. *V. humeralis*. Measurement lines = 1 mm or are divided into millimeters.



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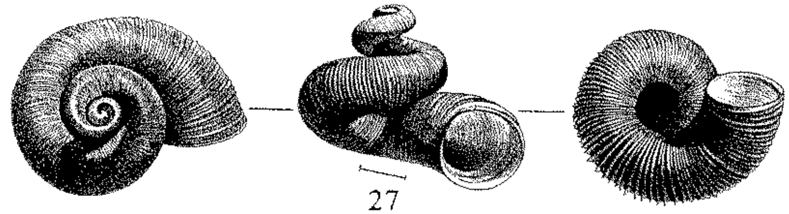

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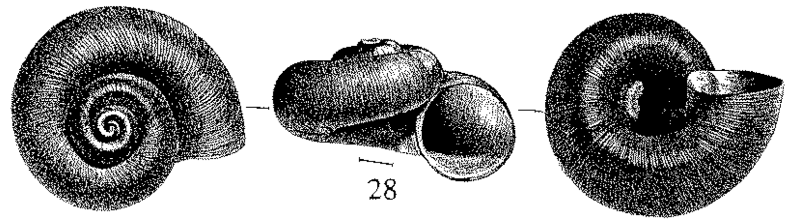

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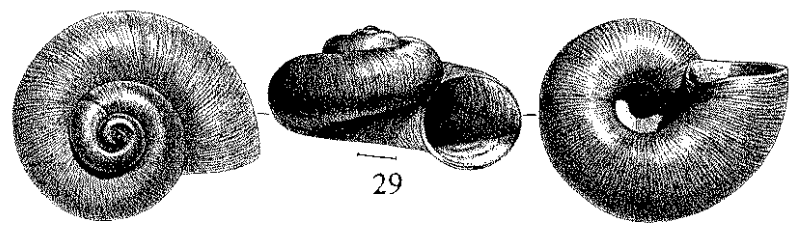

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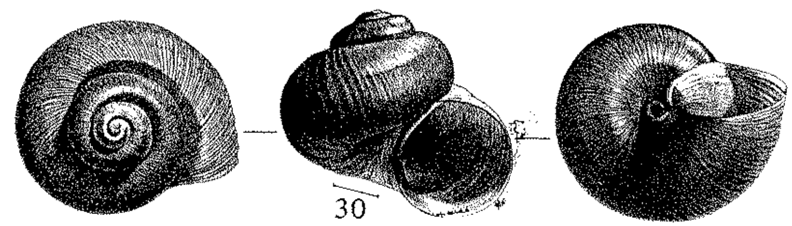

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FIGS. 26-30. Shells of Valvatidae. FIG. 26. *Valvata lewisi*, spire, apertural and umbilical views (left to right). FIG. 27. *V. lewisi* morph *ontarioensis*. FIG. 28. *V. mergella*. FIG. 29. *V. perdepressa*. FIG. 30. *V. piscinalis* ?form *obtusa*. Measurement lines = 1 mm.

Valvata perdepressa Walker 1906 [Fig. 29]
V. perdepressa s.s. and *V. perdepressa* ? form *walkeri* F.C. Baker 1930: the Great Lakes (Lakes Michigan, Huron, Erie and Ontario).
Valvata piscinalis (Müller 1774) (? form *obtusa* Draparnaud 1801) [Fig. 30]
Introduced from Europe into the lower Great Lakes (Lake Ontario, and perhaps tributaries near the lake).
Valvata sincera sincera Say 1824 [Fig. 31]
Maine west to Alberta, and south to South Dakota and Indiana.
Valvata sincera ? form *danielsi* Walker 1906 [Fig. 32]
Of discontinuous distribution: New Brunswick in eastern Canada, and Illinois, Wisconsin and Minnesota in north central U.S.A.
Valvata sincera nylanderi Dall 1905
Quebec and Maine west to Ontario and Minnesota.
Valvata tricarinata (Say 1817) [Fig. 33] and its morphs: *bakeri* Fluck 1932, *basalis* Vanatta 1915, *infracarinata* Vanatta 1915, *mediocarinata* F.C. Baker 1932, *perconfusa* Walker 1917, *simplex* Gould 1841, *tricarinata* s.s., and *unicarinata* DeKay 1843
Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia.
Valvata utahensis Call 1884 [Fig. 34]
V. utahensis s.s. and *V. utahensis* morph *horatii* Baily & Baily 1951 are known only from Idaho and Utah.
Valvata virens Tryon 1863 [Fig. 35]
California, Oregon and Nevada.
Valvata winnebagoensis F.C. Baker 1928 [Fig. 36]
Of sporadic occurrence in Michigan (Ottawa County), Wisconsin (Winnebago and Oshkosh counties) and Minnesota (Rice County).

Family VIVIPARIDAE

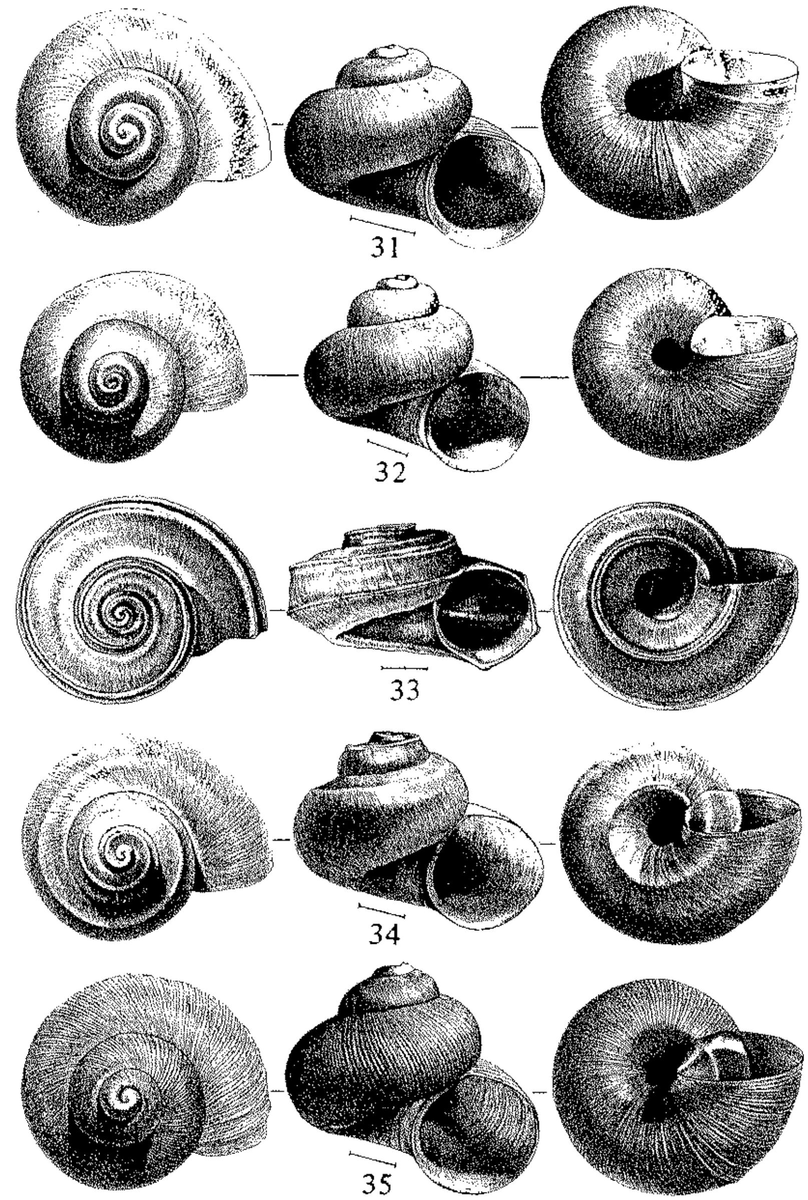
Subfamily Viviparinae

Genus *Tulotoma* Haldeman 1840

Tulotoma magnifica (Conrad 1834)[3] [Figs. 44, 45]
Coosa-Alabama river system in Alabama (Clench, 1962a).

Genus *Viviparus* Montfort 1810

Viviparus georgianus (Lea 1834) [Figs. 46, 47]
South central Florida, Georgia, Alabama and north, mainly in the Mississippi River system, to Illinois and northwestern Indiana; it has invaded Ohio, Michigan, Wisconsin, Virginia, Pennsylvania, New York, New Jersey, New England and Quebec since 1867 (Clench, 1962a; Clench & Fuller, 1965).
Viviparus intertextus (Say 1829) [Fig. 48]
The Houston ship channel system west of Houston, Harris County, and the San Jacinto, Liberty and Neches river systems, Texas; the Bayou Teche system in



FIGS. 31-35. Shells of Valvatidae. FIG. 31. *Valvata sincera sincera*, spire, apertural and umbilical views (left to right). FIG. 32. *V. sincera* ? form *danielsi*. FIG. 33. *V. tricarinata*. FIG. 34. *V. utahensis*. FIG. 35. *V. virens*. Measurement lines = 1 mm or are divided into millimeters.

Louisiana; the Mississippi River system in Louisiana, eastern Arkansas, northwestern Tennessee, Illinois, eastern Iowa, Minneapolis and White Bear Lake, Minnesota; Pearl River system, Mississippi; Coosa-Alabama river system, Alabama; Altamaha River system, Georgia; Edisto and Santee river systems, South Carolina; Rainy Lake, Koochiching County, Minnesota (Clench & Fuller, 1965).

Viviparus subpurpureus (Say 1829) [Figs. 49-51]
Mississippi River system north to southeastern Iowa, northwestern Illinois and northern Kentucky; Neches and Sabine river systems in eastern Texas and Sabine and Atchafalaya river systems in western Louisiana; Pascagoula River system in southeastern Mississippi (Clench & Fuller, 1965).

Subfamily Bellamyinae

Genus *Cipangopaludina* Hannibal 1912

Cipangopaludina chinensis malleatus (Reeve 1863) [Fig. 52]
Widely introduced in the United States. Clench & Fuller (1965) list localities in Arizona, California, Colorado, Delaware, Florida, Indiana, Maine, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Utah, Vermont and Washington.

Cipangopaludina japonicus (Martens 1861) [Fig. 53]
Widely introduced in the United States (some reports may be confused with *C. chinensis malleatus*). Clench & Fuller (1965) list localities in Massachusetts, Michigan and Oklahoma.

Subfamily Lioplacinae

Genus *Campeloma* Rafinesque 1819[4]

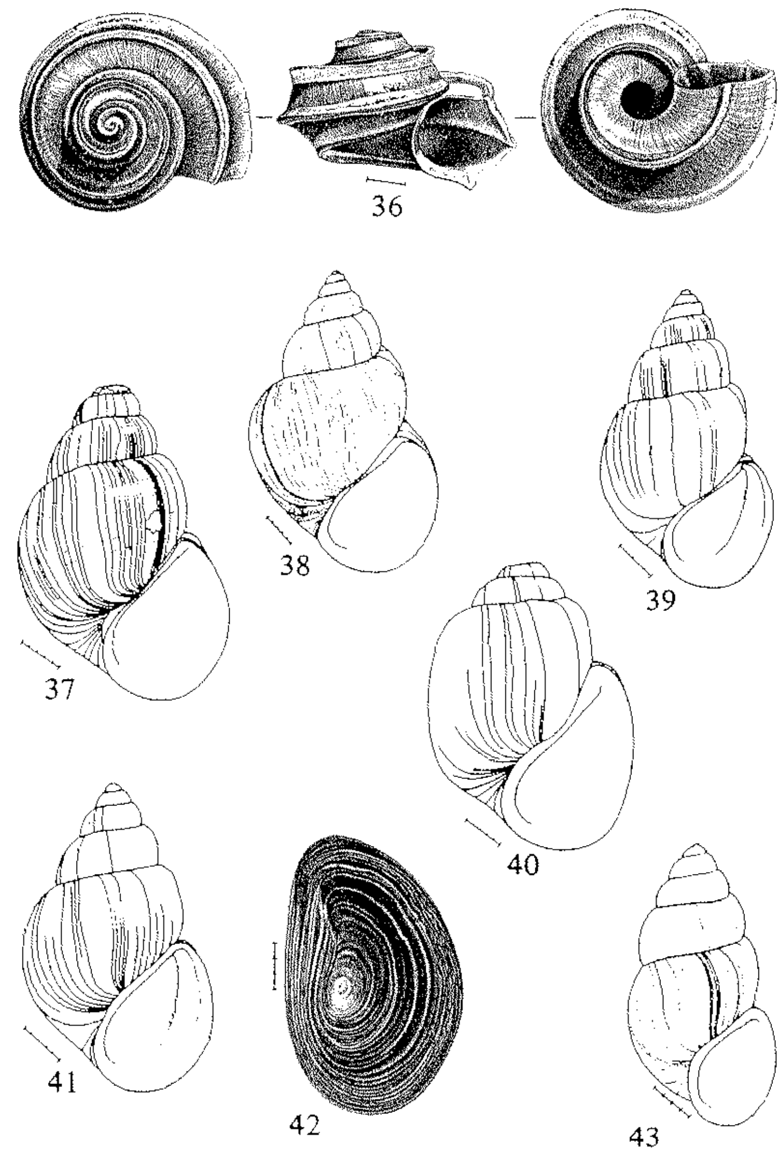
Campeloma coarctatum (Lea 1844) [Figs. 40, 66]
Alabama-Coosa river system, Alabama.

Campeloma crassula Rafinesque 1819 [Figs. 42, 54, 55]
Midwestern United States in the Great Lakes-St. Lawrence and Mississippi drainages as far west as Iowa and south to Tennessee.

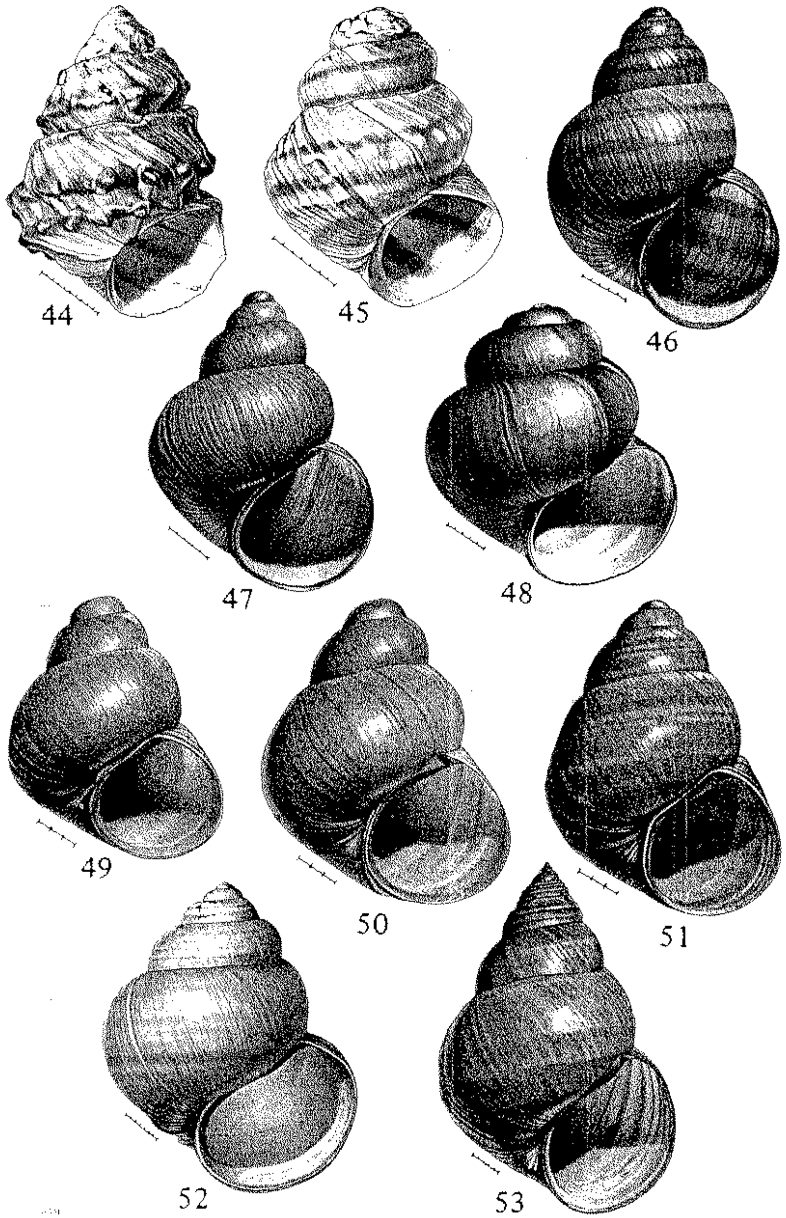
Campeloma decampi ('Currier' Binney 1865) [Fig. 56]
Jackson, Limestone and Madison counties, northern Alabama (Clench & Turner, 1955).

Campeloma decisum (Say 1816) s.l. (includes forms such as *C. brevispirum* [Figs. 58, 59], *C. decisum* s.s. [Fig. 57], *C. exilis*, *C. gibbum* [Fig. 60], *C. integrum*[5] [Fig. 38], *C. leptum*, *C. lewisi* [Fig. 37], *C. milesi* [Fig. 39] and *C. tannum* [Fig. 61]
Eastern North America, from Nova Scotia, southern Ontario and southern Manitoba south to Texas, Louisiana, Mississippi, Alabama, northern Georgia and Virginia.

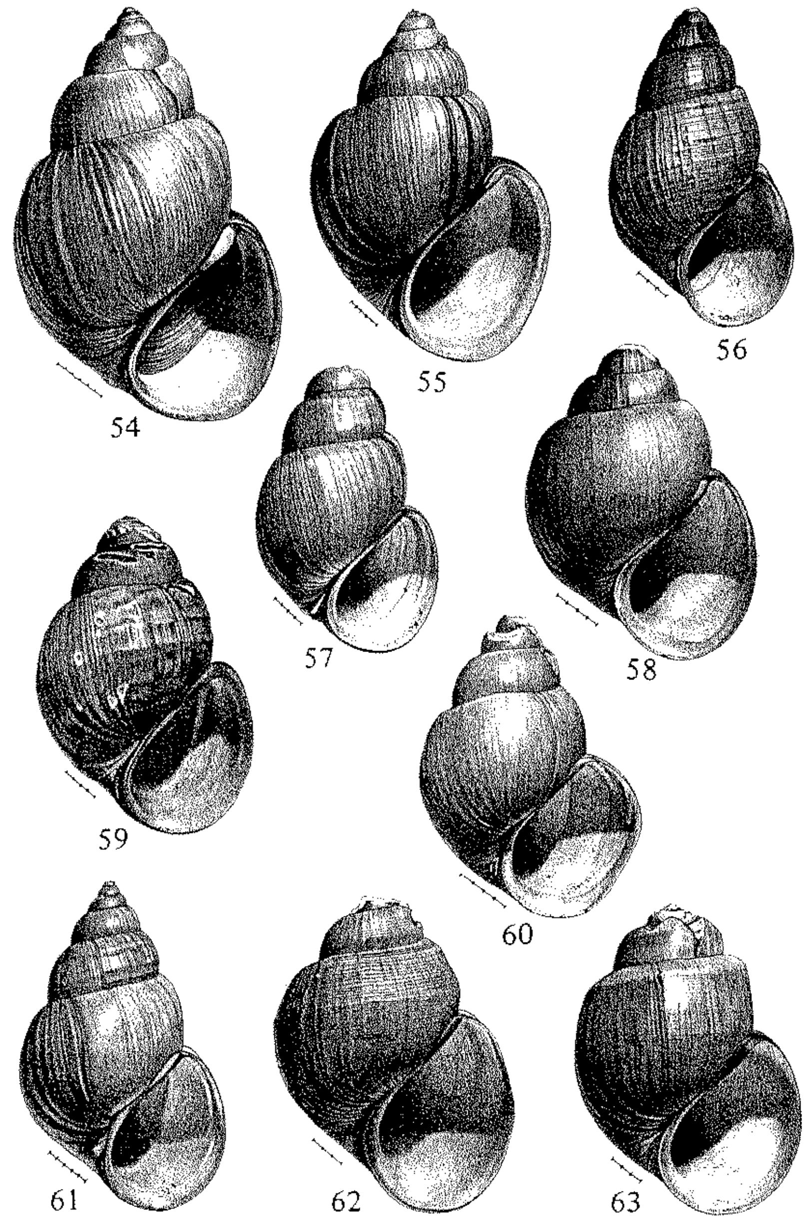
Campeloma floridense Call 1886 [Fig. 62]
Eastern Florida: the upper St. John's River and its tributaries; Lake Jessup;



FIGS. 36-43. Shells of Valvatidae (Fig. 36) and Viviparidae (Lioplacinae) (Figs. 37-43). FIG. 36. *Valvata winnebagoensis*, spire, apertural and umbilical views (left to right). FIG. 37. *Campeloma lewisi* = *C. decisum*. FIG. 38. *C. integrum* = *C. decisum*. FIG. 39. *C. milesi* = *C. decisum*. FIG. 40. *C. coarctatum*. FIG. 41. *C. linum*. FIG. 42. *C. crassula*, operculum. FIG. 43. *Lioplax cyclostomaformis*. Measurement lines = 1 mm or are divided into millimeters.



FIGS. 44-53. Shells of Viviparidae (Viviparinae and Bellamyinae). FIG. 44. *Tulotoma magnifica*. FIG. 45. *T. angulata* ? = *T. magnifica*. FIG. 46. *Viviparus georgianus*. FIG. 47. *V. georgianus*. FIG. 48. *V. intertextus*. FIG. 49. *V. subpurpureus*. FIG. 50. *V. subpurpureus*. FIG. 51. *V. subpurpureus*. FIG. 52. *Cipangopaludina chinensis malleatus*. FIG. 53. *C. japonicus*. Measurement lines are divided into millimeters.



FIGS. 54-63. Shells of Viviparidae (Lioplacinae). FIG. 54. *Campeloma subsolidum* = *C. crassula*. FIG. 55. *C. obesum* = *C. crassula*. FIG. 56. *C. decampi*. FIG. 57. *C. decisum*. FIGS. 58, 59. *C. brevispirum* = *C. decisum*. FIG. 60. *C. gibbum* = *C. decisum*. FIG. 61. *C. tannum* = *C. decisum*. FIG. 62. *C. floridense*. FIG. 63. *C. geniculum*. Measurement lines are divided into millimeters.

Miami (?), Dade County.

Campeloma geniculum (Conrad 1834) [Figs. 63, 64]
Suwannee River, Florida, west to the Escambia River, Alabama (Clench & Turner, 1956).

Campeloma limum (Anthony 1860) [Fig. 41]
Atlantic drainage, from Georgia to North Carolina.

Campeloma parthenum Vail 1979 [Fig. 65]
Ochlockonee River drainage in Florida: Lake Talquin and the Little and Ochlockonee rivers (Vail, 1979a).

Genus *Lioplax* Troschel 1857

Lioplax choctawhatchensis Vanatta 1935[6]
Choctawhatchee River, Florida (Vanatta, 1935).

Lioplax cyclostomaformis (Lea 1841) [Fig. 43]
Coosa-Alabama-Tombigbee river system from northwestern Georgia, south to Selma, Dallas County, on the Alabama River, and Big Prairie Creek, Marengo County, on the Tombigbee River in Alabama (Clench & Turner, 1955); Tensas River, near Delhi, Madison County, Louisiana (Clench, 1962b).

Lioplax pilsbryi Walker 1905 [Fig. 67]
Chattahoochee River east to the Suwannee River, Florida; in the Apalachicola system it extends north as far as Columbus, Georgia, on the Chattahoochee and to the mouth of Gum Creek, Crisp County, Georgia, on the Flint River (Clench & Turner, 1955, in part).

Lioplax subcarinata (Say 1816)[7] [Fig. 68]
Atlantic drainage. Cedar Lake near Litchfield (upper Susquehanna drainage) and Albany (Hudson River drainage), New York, south to South Carolina (Clench & Turner, 1955; Clench, 1965c; Vail, 1979b).

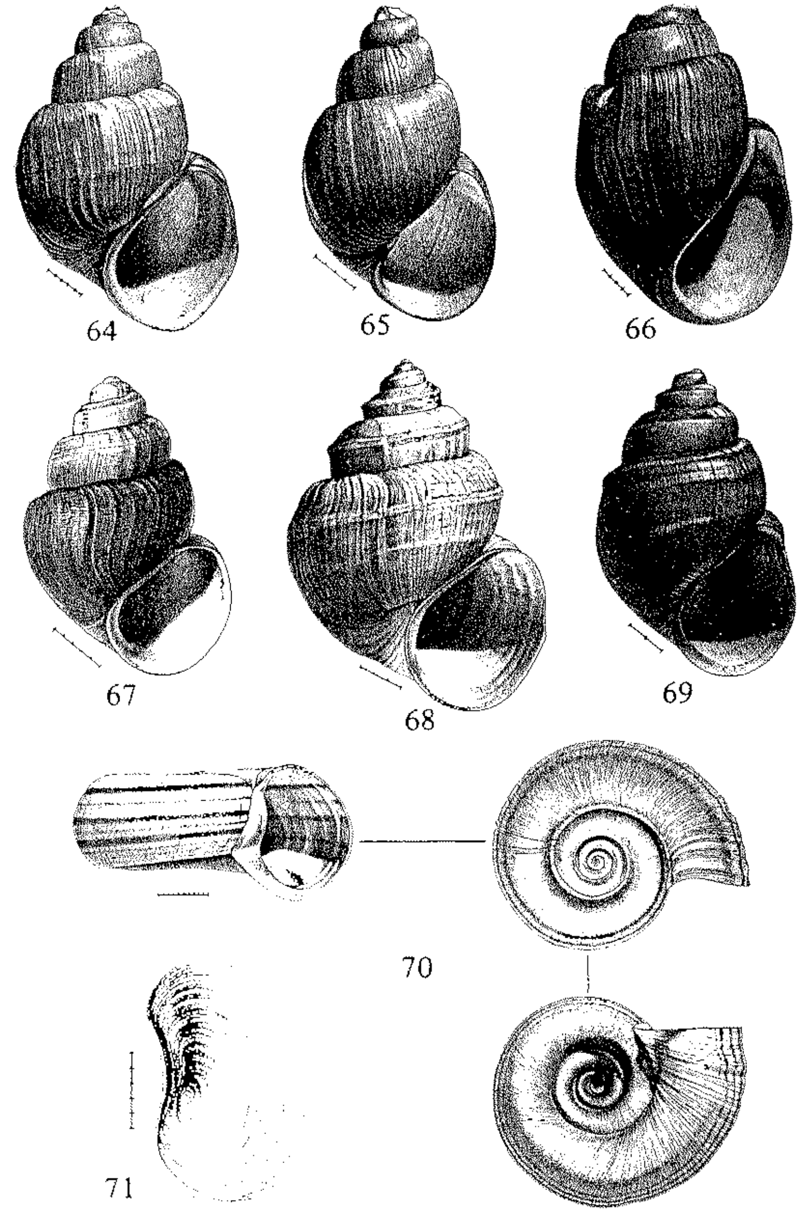
Lioplax sulculosa (Menke 1828)[7]
Mississippi drainage. Northwestern Wisconsin and eastern Minnesota south to northwestern Arkansas and east to southwestern Ohio and northern Kentucky (Clench & Turner, 1955; Vail, 1979b); Paint Rock River of the Tennessee River system, near Paint Rock, Jackson County, Alabama (Clench, 1962b).

Lioplax talquinensis Vail 1979 [Fig. 69]
Ochlockonee River, Florida (Lake Talquin and upstream), and Yellow River (northwestern Florida and southern Alabama) drainages (Vail, 1979b).

Family AMPULLARIIDAE

Genus *Marisa* Gray 1824

Marisa cornuarietis (Linnaeus 1758) [Figs. 70, 71]
Northern South America and southern Central America (H.B. Baker, 1930); introduced into southern Florida (Hunt, 1958; Robins, 1970).



FIGS. 64-71. Shells of Viviparidae (Lioplacinae) (Figs. 64-69) and Ampullariidae (Figs. 70, 71). FIG. 64. *Campeloma geniculum*. FIG. 65. *C. parthenum*. FIG. 66. *C. coarctatum*. FIG. 67. *Lioplax pilsbryi*. FIG. 68. *L. subcarinata*. FIG. 69. *L. talquinensis*. FIG. 70. *Marisa cornuarietis*, apertural (left figure), spire (right top figure) and umbilical (right bottom figure) views. FIG. 71. *M. cornuarietis*, operculum. Measurement lines are divided into millimeters.

Genus *Pomacea* Perry 1810

Pomacea bridgesi (Reeve 1856)
Brazil; introduced into Florida (Clench, 1966).
Pomacea paludosa (Say 1829) [Figs. 72, 73]
Choctawhatchee, Econfina, St. Marks and Suwannee river systems, Florida, and the Apalachicola River system in Georgia and Florida (Clench & Turner, 1956); Gantt, Covington County, Alabama (Hubricht, 1962).

Family BITHYNIIDAE

Genus *Bithynia* Leach (in Abel) 1818

Bithynia tentaculata tentaculata (Linnaeus 1758), introduced, and *Bithynia tentaculata magnalacustris* F.C. Baker 1928, native(?) [Fig. 74]
Great Lakes region from Albany, New York, west to Winnebago Lake, Calumet and Winnebago counties, Wisconsin; recorded from New York, Pennsylvania, Ohio, Indiana, Illinois, Michigan and Wisconsin (F.C. Baker, 1928a,c).

Family MICROMELANIIDAE

Genus *Antroselates* Hubricht 1963

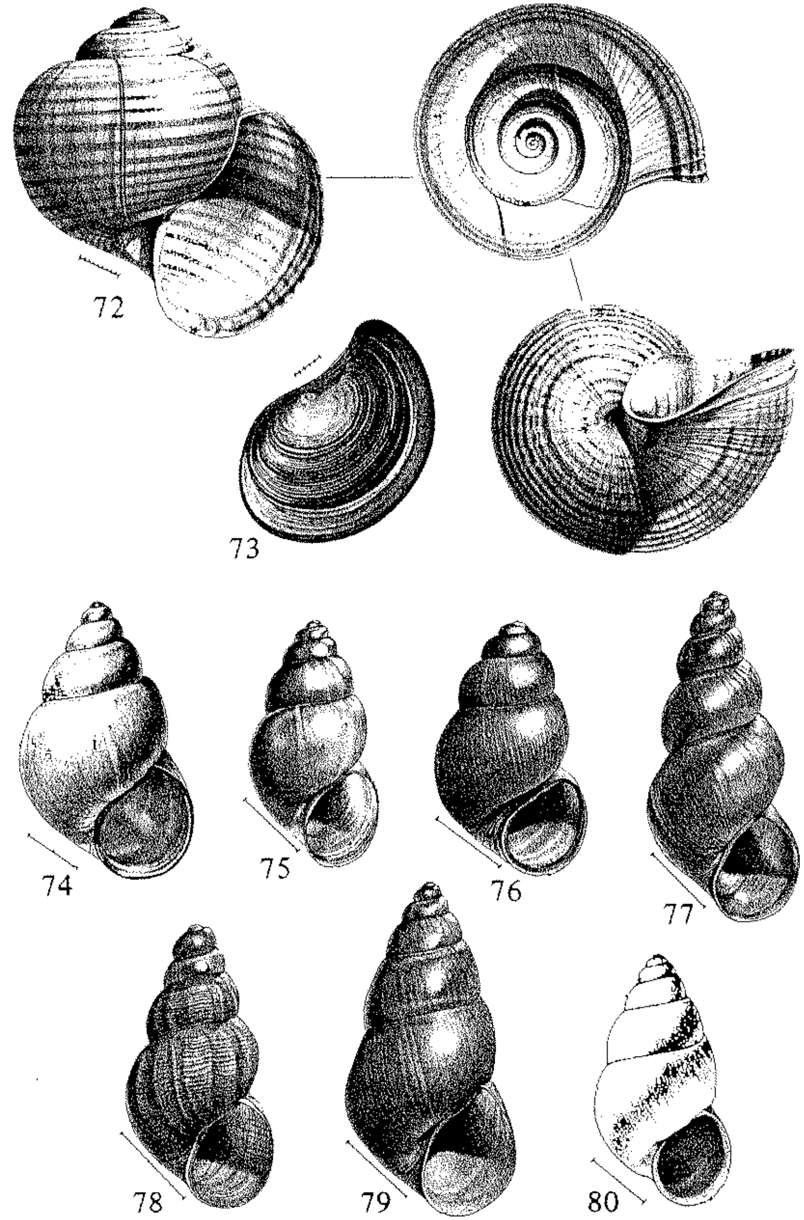
Antroselates spiralis Hubricht 1963 [Fig. 108]
Springs and streams in caves in Crawford County, Indiana, and Edmonson County, Kentucky (Hubricht, 1963b).

Family HYDROBIIDAE

Subfamily Hydrobiinae s.s.

Genus *Aphaostracon* Thompson 1968

Aphaostracon asthenes Thompson 1968 [Figs. 95, 109]
Blue Springs, three miles west of Orange City, Volusia County, Florida (Thompson, 1968).
Aphaostracon chalarogyrus Thompson 1968 [Figs. 96, 110]
Magnesia Springs, 3.7 miles west of Hawthorne, Alachua County, Florida (Thompson, 1968).
Aphaostracon hypohyalina Thompson 1968 [Figs. 97, 111, 112]
North central Florida in springs along the lower half of the Suwannee River and its tributary, the Santa Fe River, and in a nearby landlocked spring (Thompson, 1968).
Aphaostracon monas (Pilsbry 1899) [Figs. 98, 113, 114]
Wekiwa Springs, Florida, and the Wekiva River for about one mile below the springs (Thompson, 1968).



FIGS. 72-80. Shells of Ampullaridae (Figs. 72, 73) and Hydrobiidae (Hydrobiinae) (Figs. 74-80). FIG. 72. *Pomacea paludosa*, apertural (left figure), spire (right top figure) and umbilical (right bottom figure) views. FIG. 73. *P. paludosa*, operculum. FIG. 74. *Bithynia tentaculata magnalacustris*. FIG. 75. *Aphaostracon rhadinus*. FIG. 76. *Hoyia sheldoni*. FIG. 77. *Hyalopyrgus aequicostatus*, female. FIG. 78. *H. aequicostatus*, male. FIG. 79. *Littoridinops tenuipes*. FIG. 80. *L. monroensis*. Measurement lines = 1 mm or are divided into millimeters.

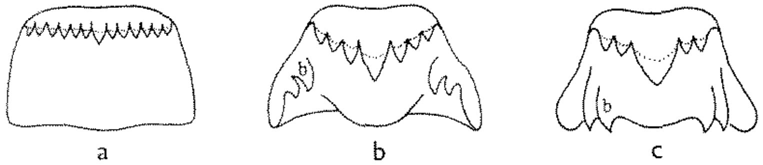


FIG. 81. Central radular tooth of truncatelloid snails. a, A micromelaniid, without basal cusps; b, a hydrobiid, with basal cusps on a thickened ridge along the lateral angle of the tooth; c, a pomatiopsid, with basal cusps on the anterio-posterior ridges. b = basal cusp.

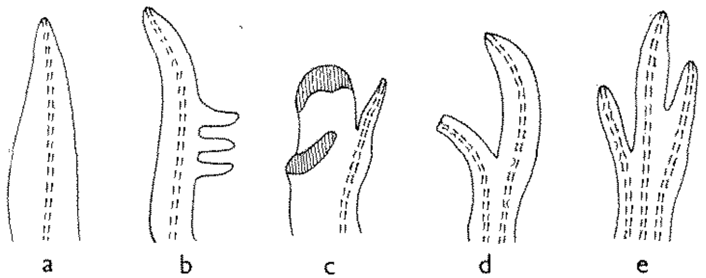
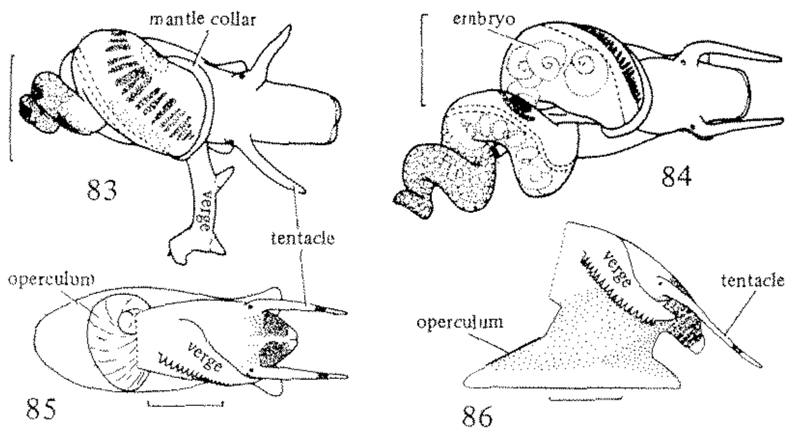
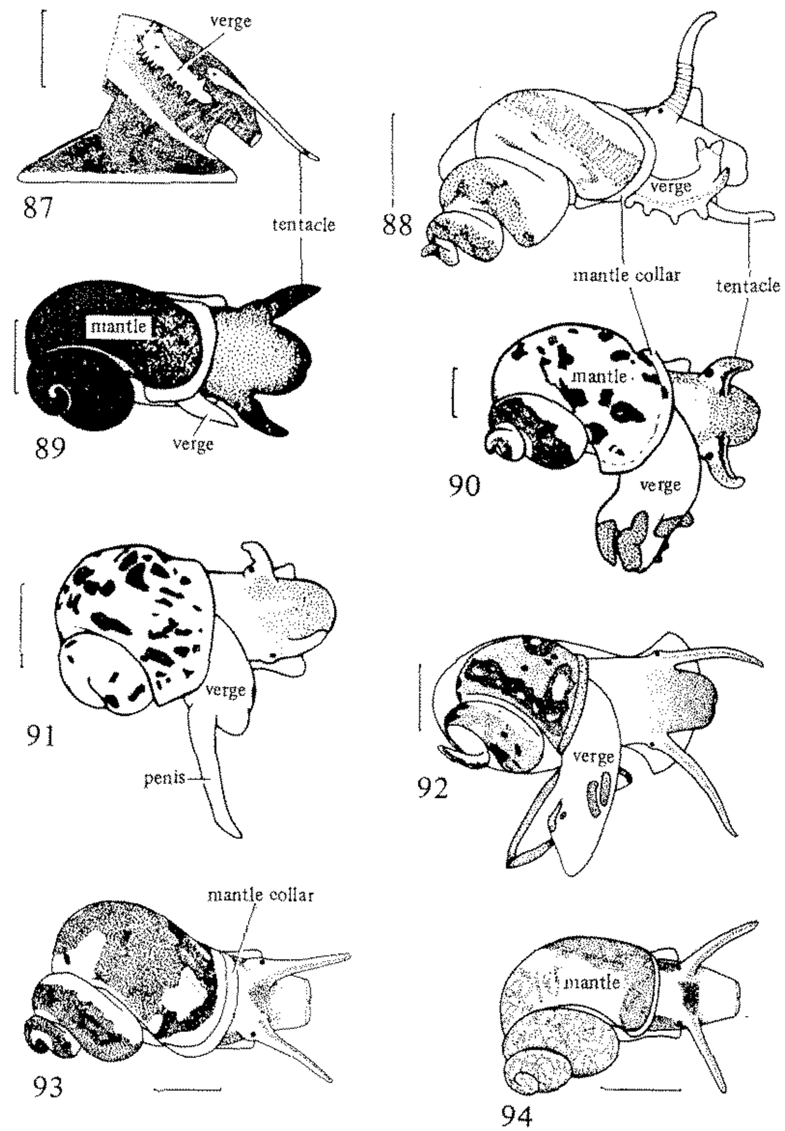


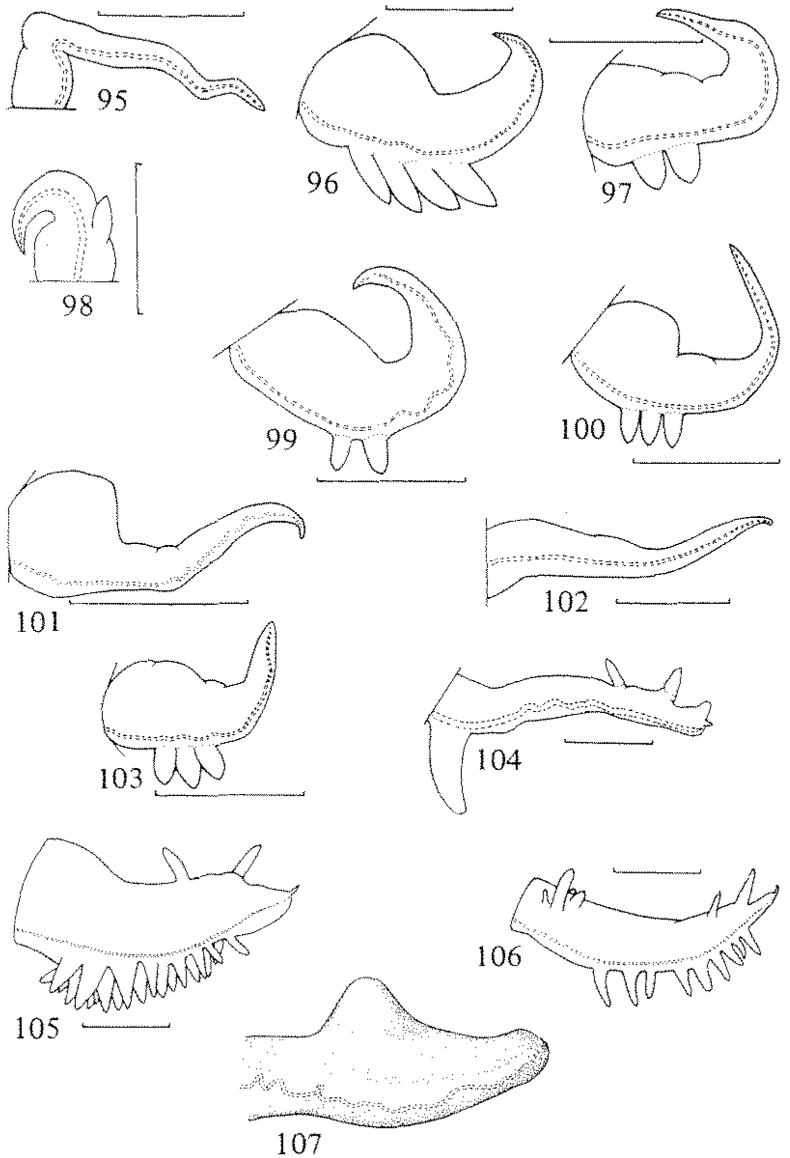
FIG. 82. Basic types of verges of North American hydrobiid snails. a, Simple verge with a single duct (Lithoglyphinae); b, verge with a single duct and accessory lobes (Hydrobiinae); c, verge with a single duct and glandular apical and subapical crests (Nymphophilinae); d, verge with two ducts (Amnicolinae); e, verge with three ducts (Fontigentinae).



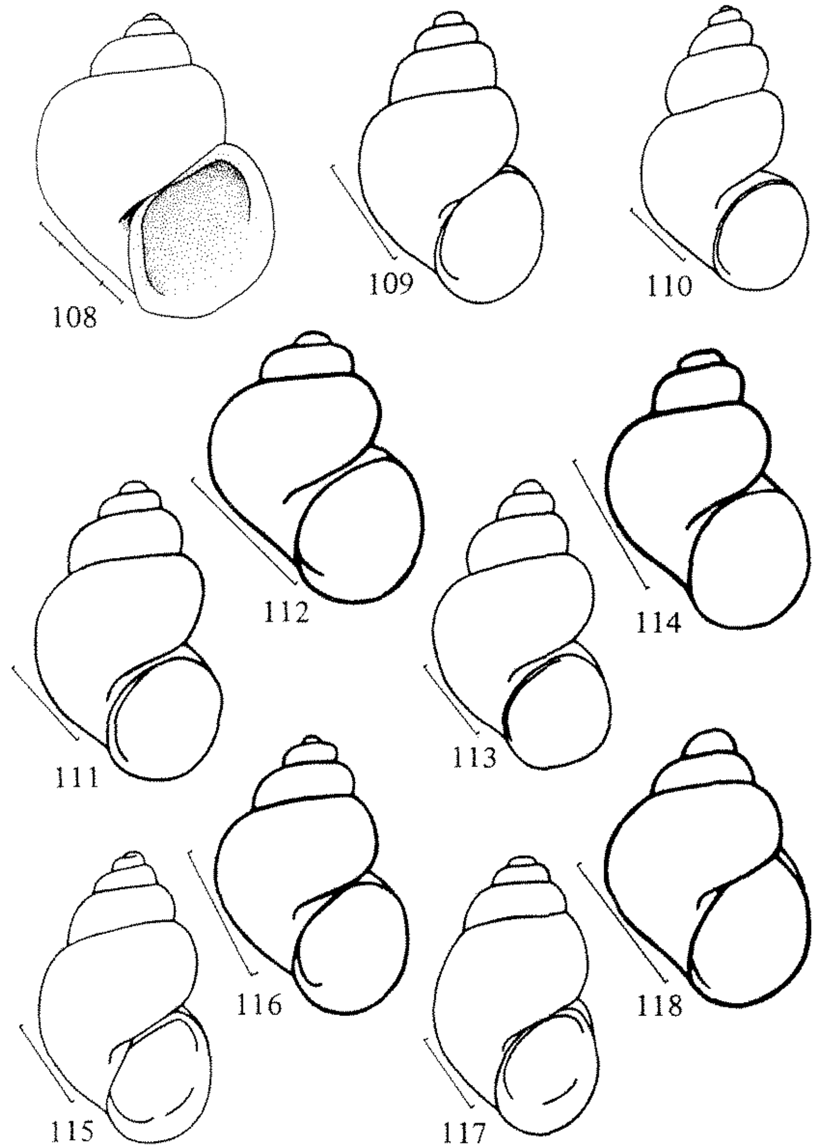
FIGS. 83-86. Animals of hydrobiid snails (Hydrobiinae), with shells removed. FIG. 83. *Hyalopyrgus aequicostatus*, male, dorsal view. FIG. 84. *H. aequicostatus*, female, dorsal view. FIG. 85. *Littoridinops monroensis*, male, dorsal view with mantle and viscera removed. FIG. 86. *L. monroensis*, male, right lateral view. Measurement lines = 1 mm. Figs. 83-86 are from Thompson (1968).



FIGS. 87-94. Animals of hydrobiid snails (Hydrobiinae, Lithoglyphinae, Nymphophilinae and Amnicolinae), with shells removed. FIG. 87. *Littoridinops tenuipes*, male, right lateral view. FIG. 88. *Pyrgophorus platyrachis*, male, dorsal view. FIG. 89. *Somatogyrus (Walkerilla) tenax*, male. FIG. 90. *Notogillia sathon*, male. FIG. 91. *Rhapinema dacryon*, male. FIG. 92. *Spilochlamys conica*, male. FIG. 93. *Amnicola dalli johnsoni*, female. FIG. 94. *Amnicola (Lyogyrus) retromargo*, female. Measurement lines = 1 mm. Figs. 87-94 are from Thompson (1968, 1969).



FIGS. 95-107. Verges of hydrobiid snails (Hydrobiinae). FIG. 95. *Aphaostracon asthenes*. FIG. 96. *A. chalarogyrus*. FIG. 97. *A. hypohyalina*. FIG. 98. *A. monas*. FIG. 99. *A. rhadinus*. FIG. 100. *A. pachynotus*. FIG. 101. *A. pycnus*. FIG. 102. *A. theiocrenetus*. FIG. 103. *A. xynoelictus*. FIG. 104. *Hyalopyrgus aequicostatus*. FIG. 105. *Littoridinops monroensis*. FIG. 106. *L. tenuipes*. FIG. 107. *Probythinella lacustris*. Measurement lines = ½ mm. Figs. 95-106 are from Thompson (1968); Fig. 107 is from E.G. Berry (1943).



FIGS. 108-118. Shells of Micromelaniidae (Fig. 108) and Hydrobiidae (Figs. 109-118). FIG. 108. *Antroselates spiralis*. FIG. 109. *Aphaostracon asthenes*. FIG. 110. *A. chalarogyrus*. FIG. 111. *A. hypohyalina*, female. FIG. 112. *A. hypohyalina*, male. FIG. 113. *A. monas*, female. FIG. 114. *A. monas*, male. FIG. 115. *A. pachynotus*, female. FIG. 116. *A. pachynotus*, male. FIG. 117. *A. pycnus*, female. FIG. 118. *A. pycnus*, male. Measurement lines = ½ mm. Fig. 108 is after Hubricht (1963b); Figs. 109-118 are from Thompson (1968).

Aphaostracon pachynotus Thompson 1968 [Figs. 100, 115, 116]
Eastern Florida, from the upper half of the St. Johns River near Sanford, south to the Miami region (Thompson, 1968).

Aphaostracon pycnus Thompson 1968 [Figs. 101, 117, 118]
Alexander Springs Run, Lake County, Florida (Thompson, 1968).

Aphaostracon rhadinus Thompson 1968 [Figs. 75, 99]
In small streams and sloughs in northeastern Florida draining into the St. Johns River north of Palatka, and in an artificial lake near the coast in St. Johns County (Thompson, 1968).

Aphaostracon theiocrenetus Thompson 1968 [Figs. 102, 119, 120]
Clifton Springs Run, about two miles north of Oviedo, Seminole County, Florida (Thompson, 1968).

Aphaostracon xynoelictus Thompson 1968 [Figs. 103, 121, 122]
Fenney Springs, two miles east of Coleman, Sumter County, Florida (Thompson, 1968).

Genus *Hoyia* F.C. Baker 1926

Hoyia sheldoni (Pilsbry 1890) [Fig. 76]
Lake Michigan, off Racine, Wisconsin (Pilsbry 1890d; F.C. Baker, 1928c).

Genus *Hyalopyrgus* Thompson 1968

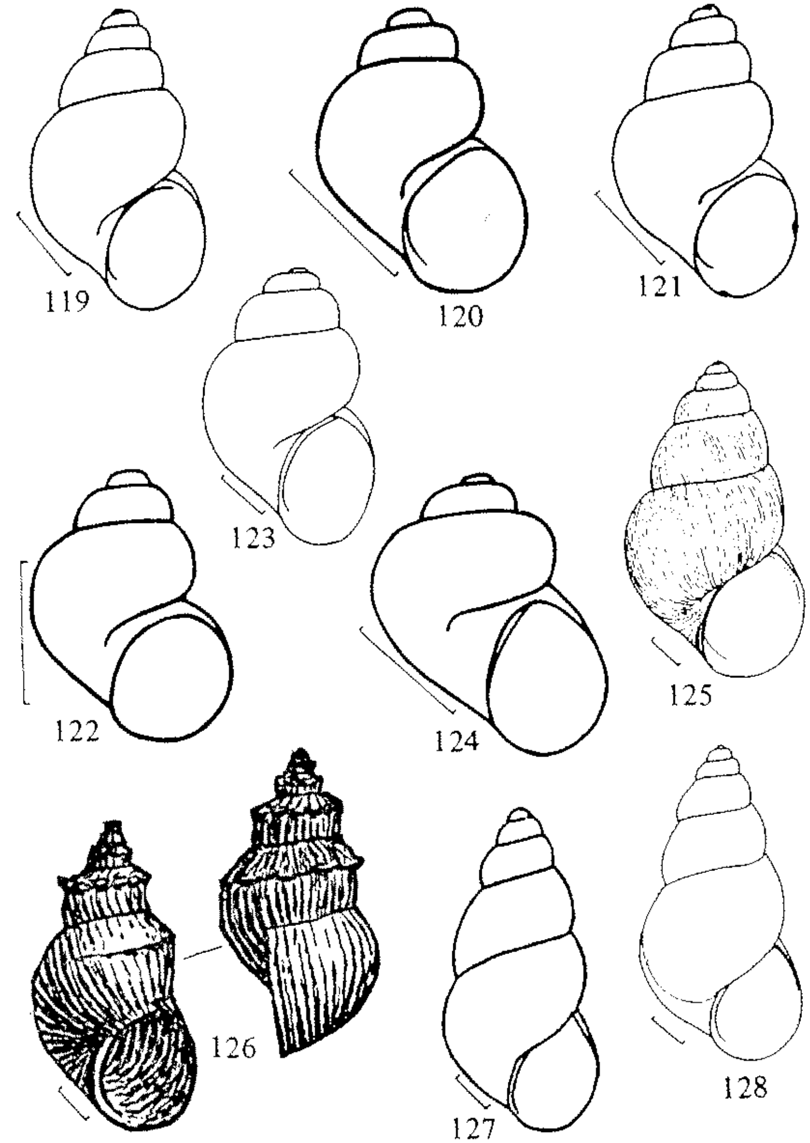
Hyalopyrgus aequicostatus (Pilsbry 1889) [Figs. 77, 78, 83, 84, 104]
Lower half of the St. Johns River system and the Withlacoochee River system, south to Tampa Bay and the Orlando area; also Lake Okeechobee (Thompson, 1968).

Hyalopyrgus brevissima (Pilsbry 1890) [Figs. 123, 124]
Orange, Seminole, Sumter and Volusia counties in central Florida (Thompson, 1968).

Genus *Littoridinops* Pilsbry 1952

Littoridinops monroensis (Frauenfeld 1863) [Figs. 80, 85, 86, 105]
Florida and Bahama Islands; in Florida it is generally distributed along both coasts and the Florida Keys, primarily in brackish water, but it has invaded marginal fresh water, and occurs throughout the St. Johns drainage system (Thompson, 1968).

Littoridinops tenuipes Couper (in Haldeman) 1844 [Figs. 79, 87, 106, 125]
Streams draining into the Atlantic Ocean and the Inland waterway of east Florida and Georgia, from Dade County, Florida, north to at least McIntosh County, Georgia (Thompson, 1968).



FIGS. 119-128. Shells of Hydrobiidae (Hydrobiinae). FIG. 119. *Aphaostracon theiocrenetus*, female. FIG. 120. *A. theiocrenetus*, male. FIG. 121. *A. xynoelictus*, female. FIG. 122. *A. xynoelictus*, male. FIG. 123. *Hyalopyrgus brevissimus*, female. FIG. 124. *H. brevissimus*, male. FIG. 125. *Littoridinops tenuipes*. FIG. 126. *Pyrgophorus spinosus*. FIG. 127. *Tryonia cheatumi*. FIG. 128. *T. cheatumi*. Measurement lines = ½ mm. Figs. 119-124 are from Thompson (1968); Fig. 126 is from Call & Pilsbry (1886); Fig. 127 is from Pilsbry (1935a).

Genus *Probythinella* Thiele 1928

Probythinella lacustris (F.C. Baker 1928)[8] [Figs. 107, 129-131]
Canada: throughout Ontario and Manitoba, northern Saskatchewan, and in the Northwest Territories south of the tree-line (Clarke, 1973); United States: New York west to Iowa, south to Kentucky and Arkansas (F.C. Baker, 1928c); also North Dakota, South Dakota, Nebraska, Missouri and Alabama (Hibbard & Taylor, 1960).

Genus *Pyrgophorus* Ancey 1888

Pyrgophorus platyrachis Thompson 1968 [Figs. 88, 132]
Throughout the southern part of peninsular Florida from Lake Okeechobee south, and along the coast as far north as southern Brevard County (Thompson, 1968).
Pyrgophorus spinosus (Call & Pilsbry 1886) [Fig. 126]
Guadalupe River and its tributary, Comal Creek, Comal County, Texas (Call & Pilsbry, 1886; Pilsbry, 1887b).

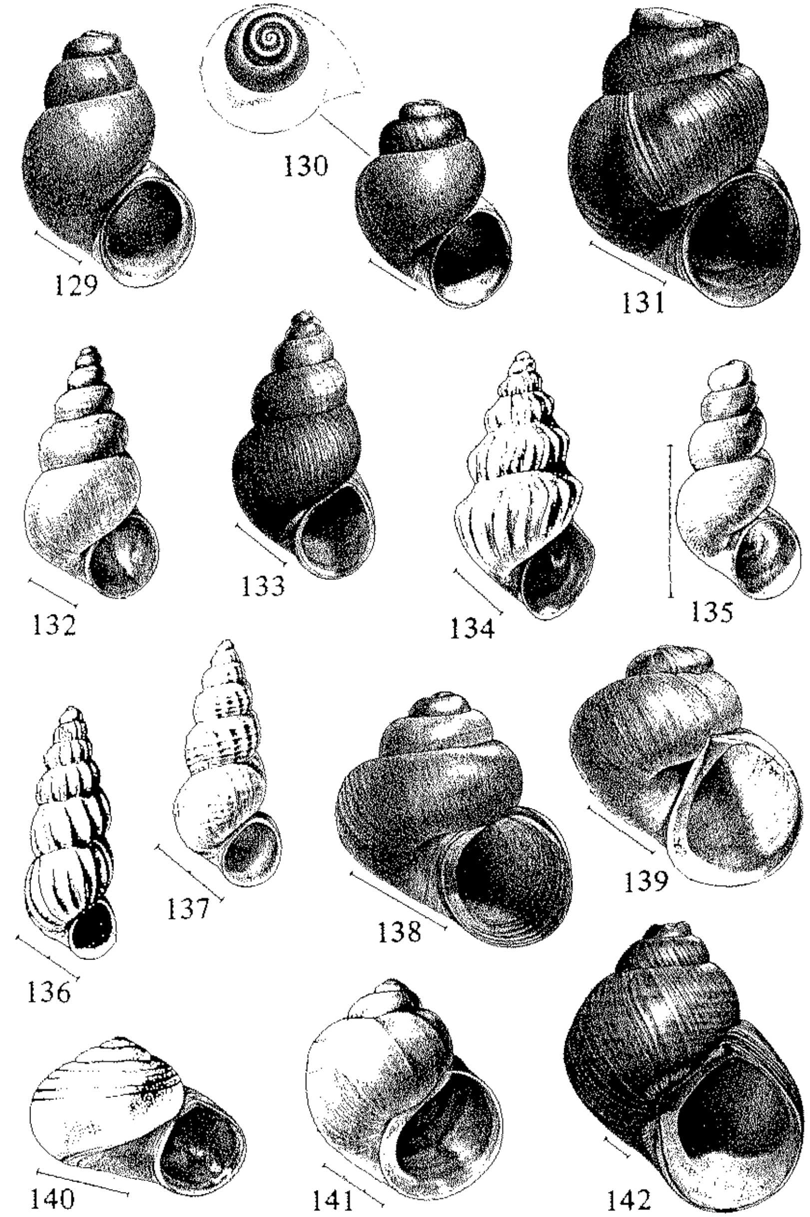
Genus *Tryonia* Stimpson 1865

Tryonia cheatumi (Pilsbry 1935) [Figs. 127, 128, 133]
Phantom Lake, near Toyahvale, Reeves County, Texas (Pilsbry, 1935a).
Tryonia clathrata Stimpson 1865 [Fig. 134]
Pahranagat Valley, southern Nevada (Taylor, 1966b).
Tryonia diaboli (Pilsbry & Ferriss 1906) [Fig. 135]
Devil's River, and Rio San Filipe, Val Verde County, Texas (Pilsbry & Ferriss, 1906).
Tryonia imitator (Pilsbry 1899)
San Francisco Bay to San Diego County, California, in brackish water (Taylor, 1966b); Quitobaquito Springs, Organ Pipe Cactus National Monument, Pima County, Arizona (Bequaert & Miller, 1973).
Tryonia protea (Gould 1855) [Figs. 136, 137]
Colorado Desert and Fish Springs, Imperial County, California (subfossil) (Gould, 1855a; Taylor, 1966b); Santa Cruz River, Tucson, Pima County, Arizona (Pilsbry & Ferriss, 1915); near Buckeye, Maricopa County, Arizona (Bequaert & Miller, 1973).

Subfamily Lithoglyphinae

Genus *Antrobia* Hubricht 1971

Antrobia culveri Hubricht 1972 [Fig. 138]
Stream in Tumbling Creek Cave, near Protem, Taney County, Missouri (Hubricht, 1971).



FIGS. 129-142. Shells of Hydrobiidae (Hydrobiinae and Lithoglyphinae). FIG. 129. *Probythinella lacustris*. FIG. 130. *Pr. lacustris*. FIG. 131. *Pr. lacustris*. FIG. 132. *Pyrgophorus platyrachis*. FIG. 133. *Tryonia cheatumi*. FIG. 134. *T. clathrata*. FIG. 135. *T. diaboli*. FIG. 136. *T. protea*. FIG. 137. *T. protea*. FIG. 138. *Antrobia culveri*. FIG. 139. *Clappia clappi* = *C. umbilicata*. FIG. 140. *Cochliopina riograndensis*. FIG. 141. *Fluminicola fusca*. FIG. 142. *F. nuttalliana*. Measurement lines = 1 mm or are divided into millimeters.

Genus *Clappia* Walker 1909[9]

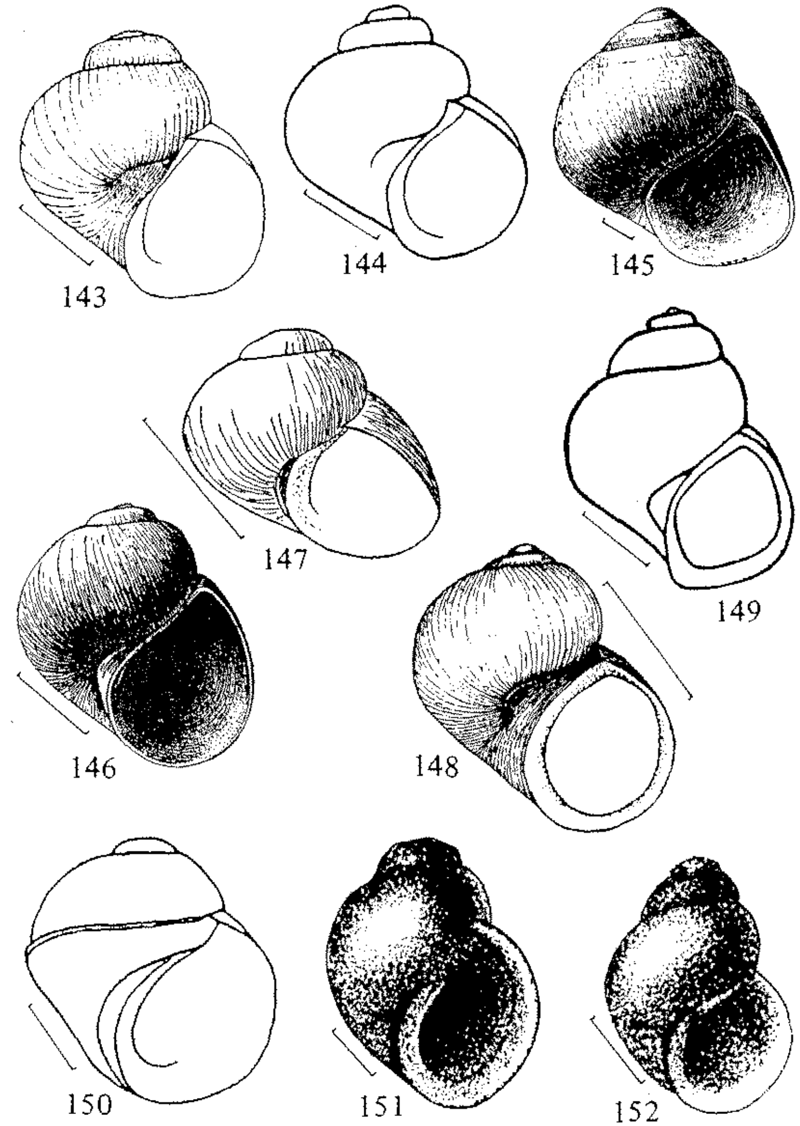
Clappia cahabensis Clench 1965
Cahaba River, Bibb County, Alabama (Clench, 1965b).
Clappia umbilicata (Walker 1904) [Figs. 139, 143, 144]
Coosa River, Alabama (Walker, 1904a, 1909c).

Genus *Cochliopina* Morrison 1946

Cochliopina riograndensis (Pilsbry & Ferriss 1906) [Fig. 140]
Lower Pecos River and Rio Grande valleys, Texas; coastal plain in Tamaulipas, Mexico (Taylor, 1966b).

Genus *Fluminicola* Stimpson 1865[10]

Fluminicola columbiana Hemphill (in Pilsbry) 1899 [Fig. 145]
Middle portions of Columbia River, Washington, and lower Snake River, Washington and Idaho.
Fluminicola erythopoma Pilsbry 1899
Ash Meadows, Nye County, Nevada (Pilsbry, 1899b).
Fluminicola fusca (Haldeman (in Chenu) 1847) [Fig. 141]
"Oregon territory" (Haldeman, 1847).
Fluminicola hindsi (Baird 1863)
Upper Green River and tributaries, Wyoming; tributaries of Great Salt Lake, Utah; upper Snake River and tributaries and Salmon River, Idaho; Spokane, Little Spokane and Grande Ronde rivers, Washington (see Taylor, 1966a).
Fluminicola merriami Pilsbry & Beecher (in Pilsbry) 1892 [Fig. 146]
Pahranagat Valley, Nevada (Pilsbry, 1892a).
Fluminicola minutissima Pilsbry 1907 [Fig. 147]
Price Valley, Weiser Canyon, Washington County, Idaho (Pilsbry, 1907).
Fluminicola modoci Hannibal 1912
California: Fletcher's Spring, south end of Goose Lake; Fritter's Spring, head of Willow Creek, Honey Lake basin; Troxel's Spring, Eagle Lake (Hannibal, 1912b).
Fluminicola nevadensis Walker 1916 [Fig. 148]
Cortez foothills, Humboldt Valley, Elko County, Nevada (Walker, 1916).
Fluminicola nuttalliana (Lea 1838) [Fig. 142]
Probably inhabits the entire Columbia Valley (Pilsbry, 1899b).
Fluminicola seminalis (Hinds 1842)
Sacramento, Pitt and Fall rivers and tributaries, and Surprise Valley, California; Klamath River, Oregon (Pilsbry, 1899b).
Fluminicola turbiniformis (Tryon 1865) [Fig 152]
Upper Sacramento and Pitt rivers and various tributaries in northeastern California, western Nevada and central southern Oregon (see Taylor, 1966a).
Fluminicola virens (Lea 1838)
Willamette, lower Columbia, upper Deschutes and Umpqua rivers, Oregon;



FIGS. 143-152. Shells of Hydrobiidae (Lithoglyphinae). FIG. 143. *Clappia clappi* = *C. umbilicata*. FIG. 144. *C. umbilicata*. FIG. 145. *Fluminicola columbiana*. FIG. 146. *F. merriami*. FIG. 147. *F. minutissima*. FIG. 148. *F. nevadensis*. FIG. 149. *Somatogyrus amnicoloides*. FIG. 150. *S. aldrichi* = *S. (Walkerilla) coosaensis*. FIG. 151. *S. aureus*. FIG. 152. *F. turbiniformis*. Measurement lines = 1 mm. Figs. 143, 144 and 148-150 are from Walker (1904a, 1906a, 1909c, 1915c, 1916); Figs. 145 and 146 are from Stearns (1901b); Fig. 147 is from Pilsbry (1908a); Figs. 151 and 152 are from Tryon (1865i).

Olympia and San Juan County, Washington; Vancouver Island (Pilsbry, 1899b).

Genus *Gillia* Stimpson 1865

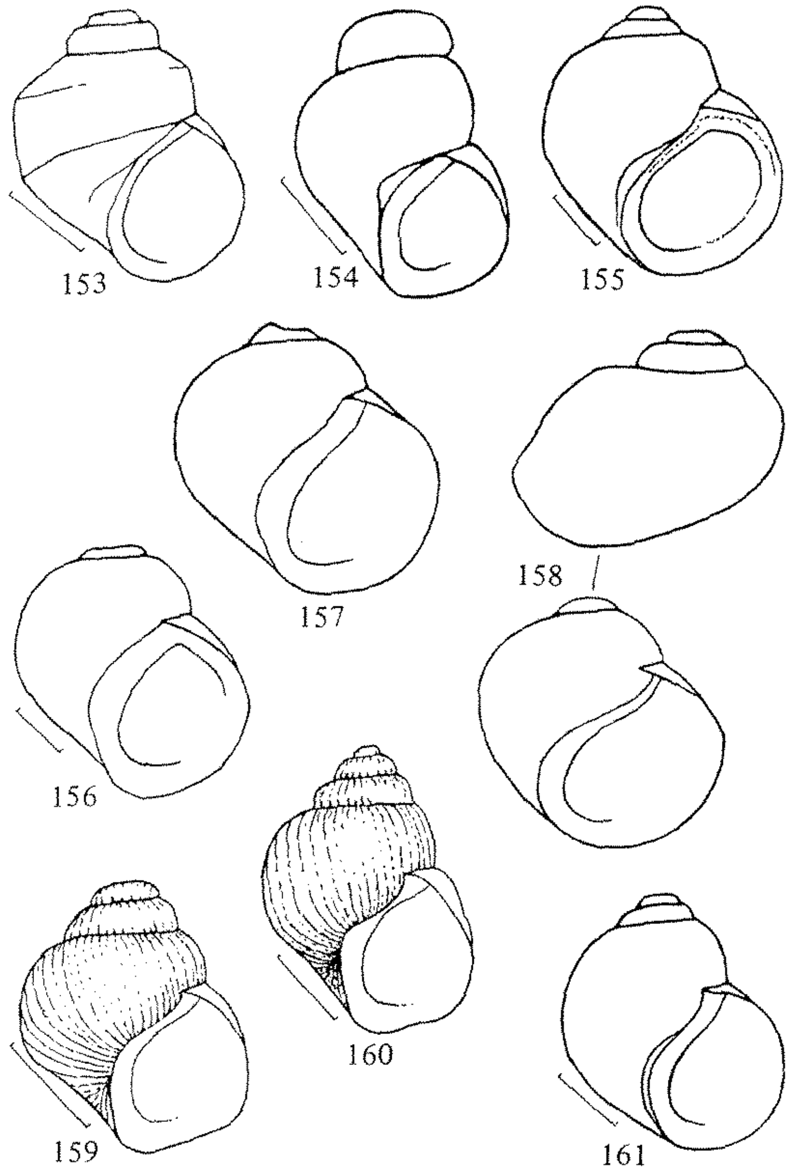
Gillia altilis (Lea 1841) [Fig. 191]
Atlantic drainage from New Jersey to South Carolina (Walker, 1918a).

Genus *Lepyrium* Dall 1896

Lepyrium showalteri (Lea 1861) [Figs. 192, 193]
Cahaba and Coosa rivers, Alabama.

Genus *Somatogyrus* Gill 1863

Somatogyrus alcoviensis Krieger 1972
Alcovy and Yellow rivers, Georgia (Krieger, 1972).
Somatogyrus amnicoloides Walker 1915 [Fig. 149]
Ouachita River, Arkadelphia, Arkansas (Walker, 1915c).
Somatogyrus aureus Tryon 1865 [Figs. 151, 194]
Tennessee River (Tryon, 1865i).
Somatogyrus biangulatus Walker 1906 [Fig. 153]
Tennessee River, Florence, Alabama (Walker, 1906a).
Somatogyrus constrictus Walker 1904 [Fig. 154]
Coosa River, Alabama (Walker, 1904a).
Somatogyrus crassilabris Walker 1915 [Fig. 155]
North Fork of the White River, Norfolk, Arkansas (Hinkley, 1915).
Somatogyrus crassus Walker 1904 [Figs. 156, 157]
Coosa River, Alabama (Walker, 1904a).
Somatogyrus currierianus (Lea 1863) [Fig. 158]
Huntsville, Alabama (Lea, 1863).
Somatogyrus decipiens Walker 1909 [Figs. 159, 160]
Coosa River, Alabama (Walker, 1909c).
Somatogyrus depressus (Tryon 1862) [Fig. 195]
Mississippi River, Davenport, Iowa (Tryon, 1862); Wisconsin, Iowa and Illinois (F.C. Baker, 1928c).
Somatogyrus excavatus Walker 1906 [Figs. 161, 162]
Shoal Creek, Florence, Alabama (Walker, 1906a).
Somatogyrus georgianus Walker 1904 [Fig. 163]
Chattanooga River, Georgia; Tennessee, Cahaba and Alabama rivers, Alabama (Walker, 1904a).
Somatogyrus hendersoni Walker 1909 [Fig. 164]
Coosa River, Alabama (Walker, 1909c).
Somatogyrus hinkleyi Walker 1904 [Figs. 165, 166]
Coosa and Tallapoosa rivers, Alabama (Walker, 1904a).
Somatogyrus humerosus Walker 1906 [Fig. 167]
Tennessee River, Florence, Alabama (Walker, 1906a).

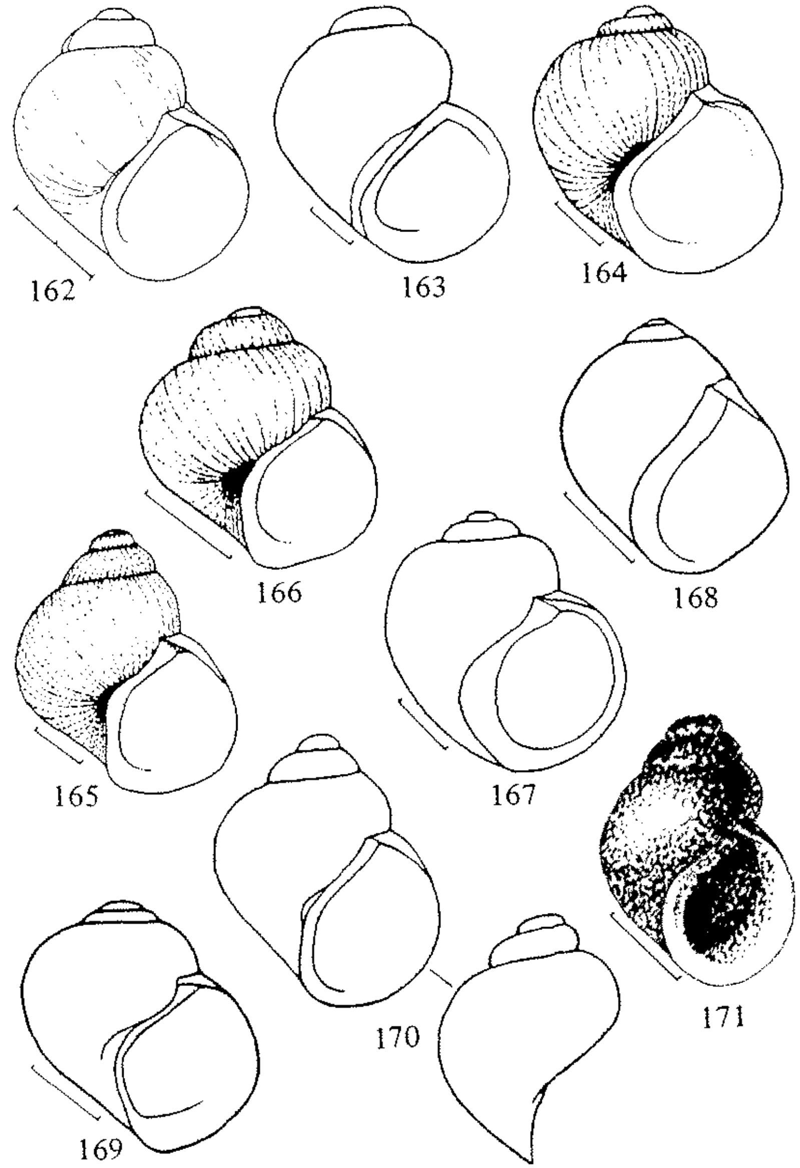


FIGS. 153-161. Shells of Hydrobiidae (Lithoglyphinae). FIG. 153. *Somatogyrus biangulatus.* FIG. 154. *S. constrictus.* FIG. 155. *S. crassilabris.* FIG. 156. *S. crassus.* FIG. 157. *S. crassus*, immature. FIG. 158. *S. currierianus.* FIG. 159. *S. decipiens*, immature. FIG. 160. *S. decipiens.* FIG. 161. *S. excavatus.* Measurement lines = 1 mm. Figs. 153-161 are from Walker (1904a, 1906a, 1909c, 1915c).

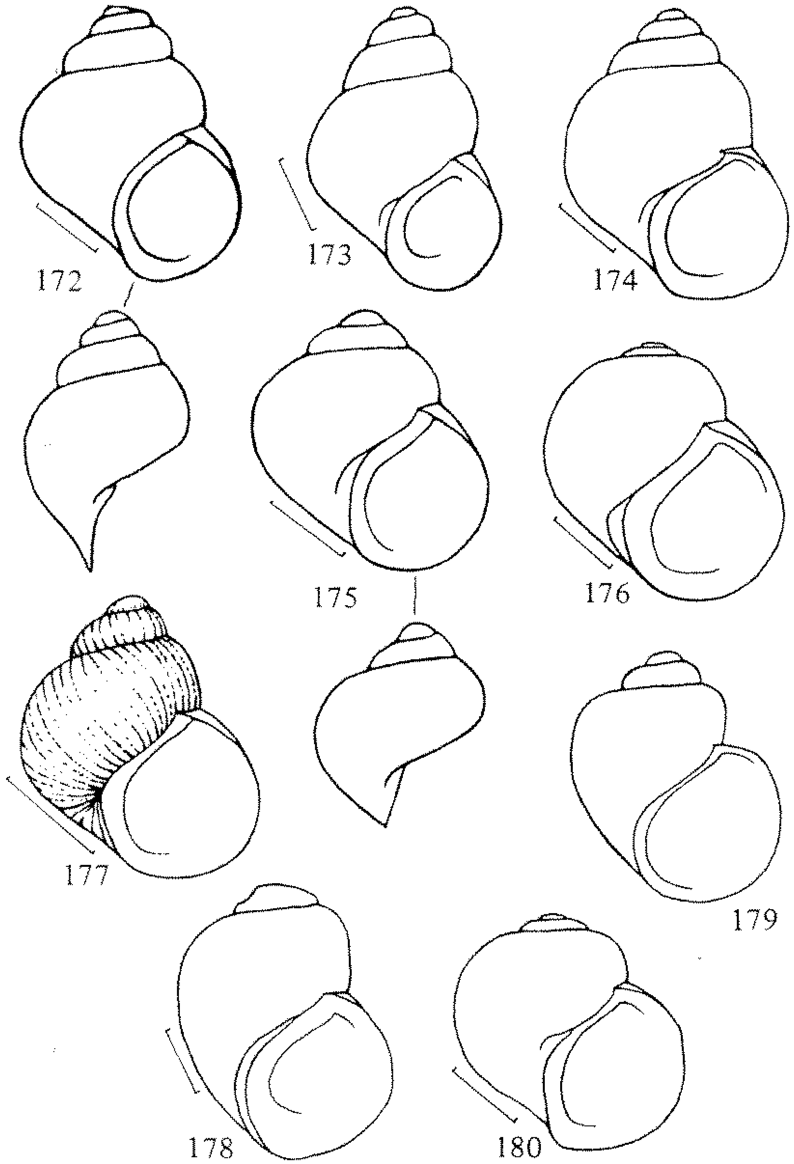
Somatogyrus integra (Say 1829)[11]
Ohio River and tributaries in Ohio, Indiana, Kentucky and eastern Illinois.
Somatogyrus nanus Walker 1904 [Fig. 168]
Coosa River, Alabama (Walker, 1904a).
Somatogyrus obtusus Walker 1904 [Fig. 169]
Coosa River, Alabama (Walker, 1904a).
Somatogyrus parvulus Tryon 1865 [Figs. 170, 171]
Powells River, Tennessee (Tryon, 1865i).
Somatogyrus pennsylvanicus Walker 1904 [Figs. 172-174]
Columbia, Pennsylvania (Walker, 1904a); Potomac River, Harper's Ferry, West Virginia (Walker, 1906a).
Somatogyrus pilsbryanus Walker 1904 [Fig. 175]
Tallapoosa River, Tallassee, Alabama (Walker, 1904a).
Somatogyrus pumilus (Conrad 1834) [Fig. 176]
Black Warrior River and Cahatchee Creek, Shelby, Alabama (Walker, 1906a).
Somatogyrus pygmaeus Walker 1909 [Fig. 177]
Coosa River, Alabama (Walker, 1909c).
Somatogyrus quadratus Walker 1906 [Fig. 178]
Tennessee River and Shoal Creek, Florence, Alabama (Walker, 1906a).
Somatogyrus sargenti Pilsbry 1895 [Fig. 179]
Mud Creek and tributary, tributaries of the Tennessee River, Alabama (Pilsbry, 1895a; Sargent, 1895).
Somatogyrus strengi Pilsbry & Walker 1906 [Fig. 180]
Tennessee River and Shoal Creek, Florence, Alabama; Bridgeport, Alabama (Pilsbry & Walker, 1906a).
Somatogyrus substriatus Walker 1906 [Fig. 181]
Tennessee River, Florence, Alabama; Tombigbee River, Columbus, Mississippi (Walker, 1906a); Uchee Creek, Fort Mitchell, Russell County, and Choctawhatchee River, Dale County, Alabama (Clench & Turner, 1956).
Somatogyrus tennesseensis Walker 1906 [Fig. 182]
Shoal Creek, Florence, Tennessee (Walker, 1906a).
Somatogyrus trothis Doherty 1878
Ohio River, Campbell County, Kentucky (Doherty, 1878).
Somatogyrus tryoni Pilsbry & Baker 1927[9]
Ashippun, Bark and Crawfish rivers, and Lake Michigan drainage, Milwaukee, Wisconsin; Mukwonago River and Creek, Waukesha County, Illinois (Pilsbry & F.C. Baker, 1927).
Somatogyrus walkerianus Aldrich 1905 [Fig. 185]
Conecut River, Escambia County, Alabama (Aldrich, 1905).
Somatogyrus wheeleri Walker 1915 [Figs. 183, 184]
Ouachita River, Arkadelphia, Arkansas (Walker, 1915c).

Subgenus *Walkerilla* Thiele 1928

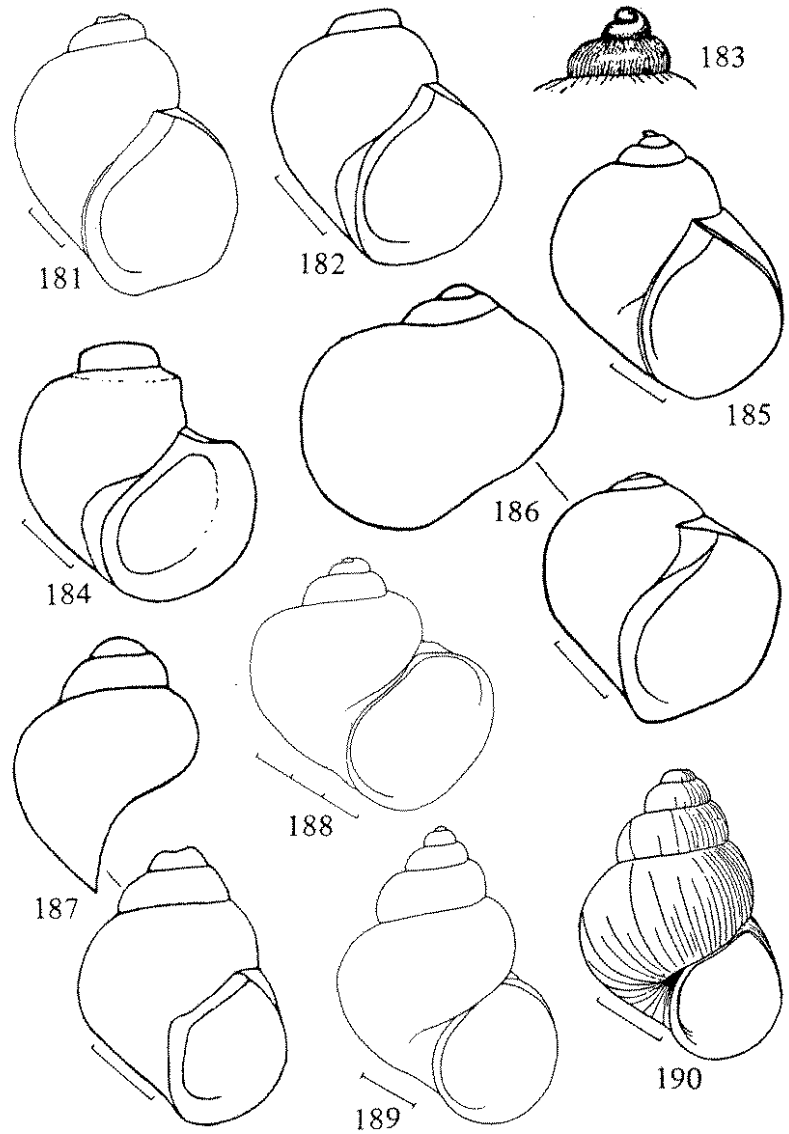
Somatogyrus (Walkerilla) coosaensis Walker 1904 [Figs. 150, 186, 196]
Coosa and Catawba rivers, Alabama (Walker, 1904a, 1906a).
Somatogyrus (Walkerilla) tenax Thompson 1969 [Figs. 89, 197, 201]
Broad River, Elbert County, Georgia (Thompson, 1969).



FIGS. 162-171. Shells of Hydrobiidae (Lithoglyphinae). FIG. 162. *Somatogyrus excavatus*. FIG. 163. *S. georgianus*. FIG. 164. *S. hendersoni*. FIG. 165. *S. hinkleyi*. FIG. 166. *S. hinkleyi*, immature. FIG. 167. *S. humerosa*. FIG. 168. *S. nanus*. FIG. 169. *S. obtusus*. FIG. 170. *S. parvulus*. FIG. 171. *S. parvulus*. Measurement lines = 1 mm. Figs. 163-170 are from Walker (1904a, 1906a, 1909c); Fig. 171 is from Tryon (1865i).



FIGS. 172-180. Shells of Hydrobiidae (Lithoglyphinae). FIG. 172. *Somatogyrus pennsylvanicus*. FIG. 173. *S. pennsylvanicus*. FIG. 174. *S. pennsylvanicus*. FIG. 175. *S. pilsbryanus*. FIG. 176. *S. pumilus*. FIG. 177. *S. pygmaeus*. FIG. 178. *S. quadratus*. FIG. 179. *S. sargenti*. FIG. 180. *S. strengi*. Measurement lines = 1 mm. Figs. 172-180 are from Walker (1904a, 1906a, 1909c).



FIGS. 181-190. Shells of Hydrobiidae (Lithoglyphinae and Nymphophilinae). FIG. 181. *Somatogyrus substriatus*. FIG. 182. *S. tennesseensis*. FIG. 183. *S. wheeleri*, apex. FIG. 184. *S. wheeleri*. FIG. 185. *S. walkerianus*. FIG. 186. *S. (Walkerilla) coosaensis*. FIG. 187. *S. (W.) virginicus*. FIG. 188. *Birgella subglobosa*. FIG. 189. *Cincinnatia judayi* = *C. cincinnatiensis*. FIG. 190. *C. comalensis*. Measurement lines = 1 mm or are divided into millimeters. Figs. 181-184, 186 and 187 are from Walker (1904a, 1906a, 1915c); Fig. 185 is from Aldrich (1905); Fig. 190 is from Pilsbry & Ferriss (1906).

Somatogyrus (Walkerilla) virginicus Walker 1904[9, 12] [Fig. 187]
Barnard's Ford, Rapidan River, Virginia (Walker, 1904a).

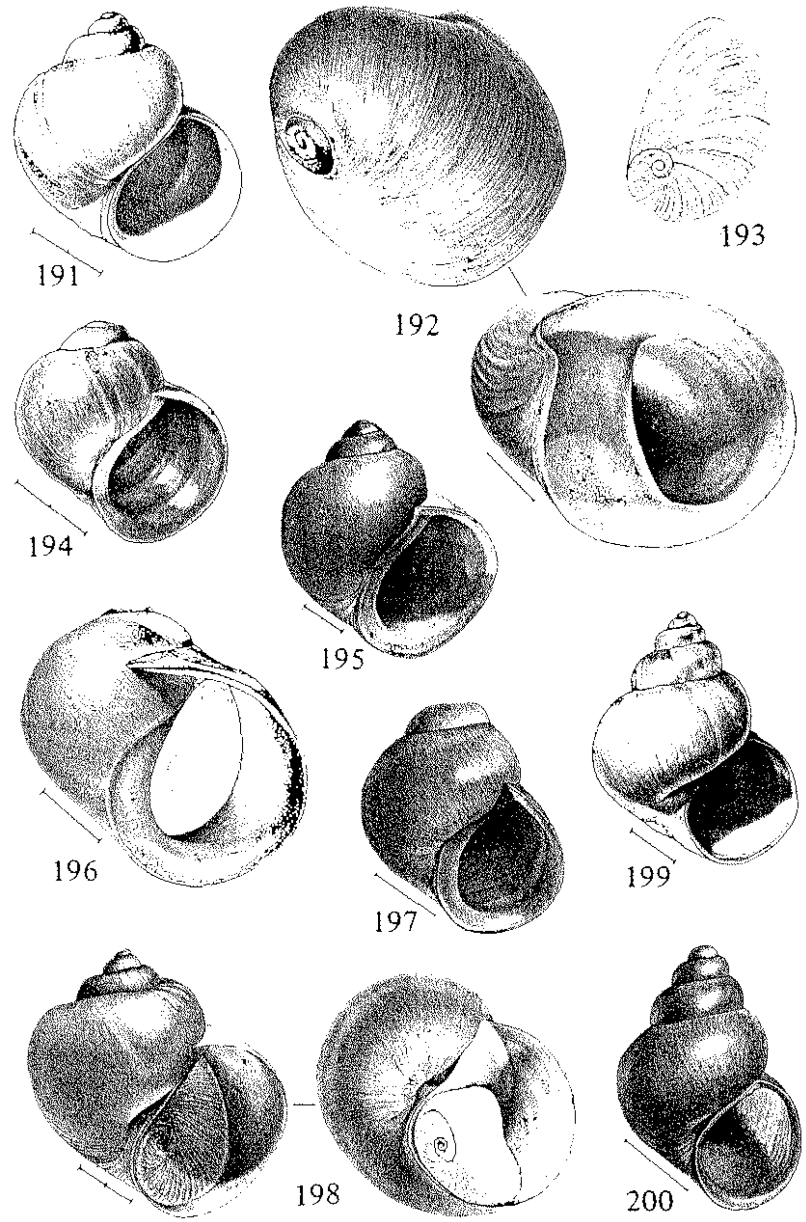
Subfamily Nymphophilinae

Genus *Birgella* F.C. Baker 1926

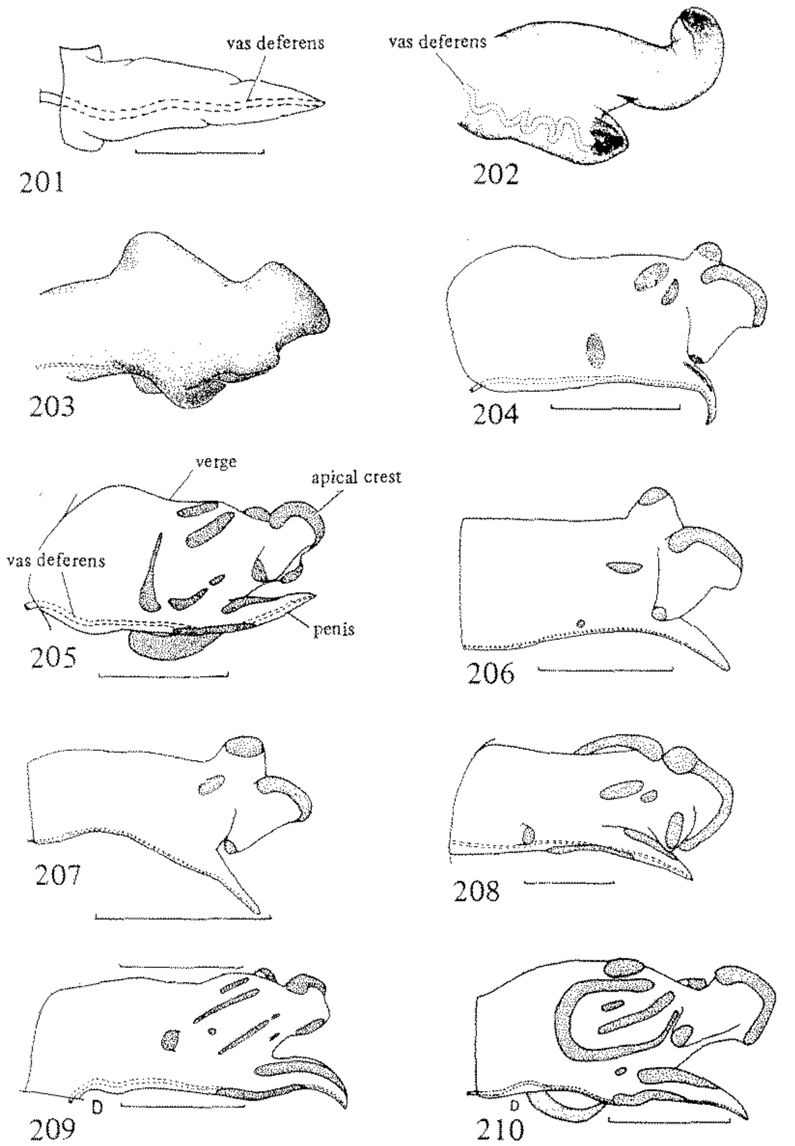
Birgella subglobosa (Say 1825) [Figs. 188, 198, 202]
Great Lakes; the river and creek form (*isogona* Say 1829) ranges from Ohio west to Iowa, and from Michigan south to Alabama and Arkansas (F.C. Baker, 1928c).

Genus *Cincinnatia* Pilsbry 1891

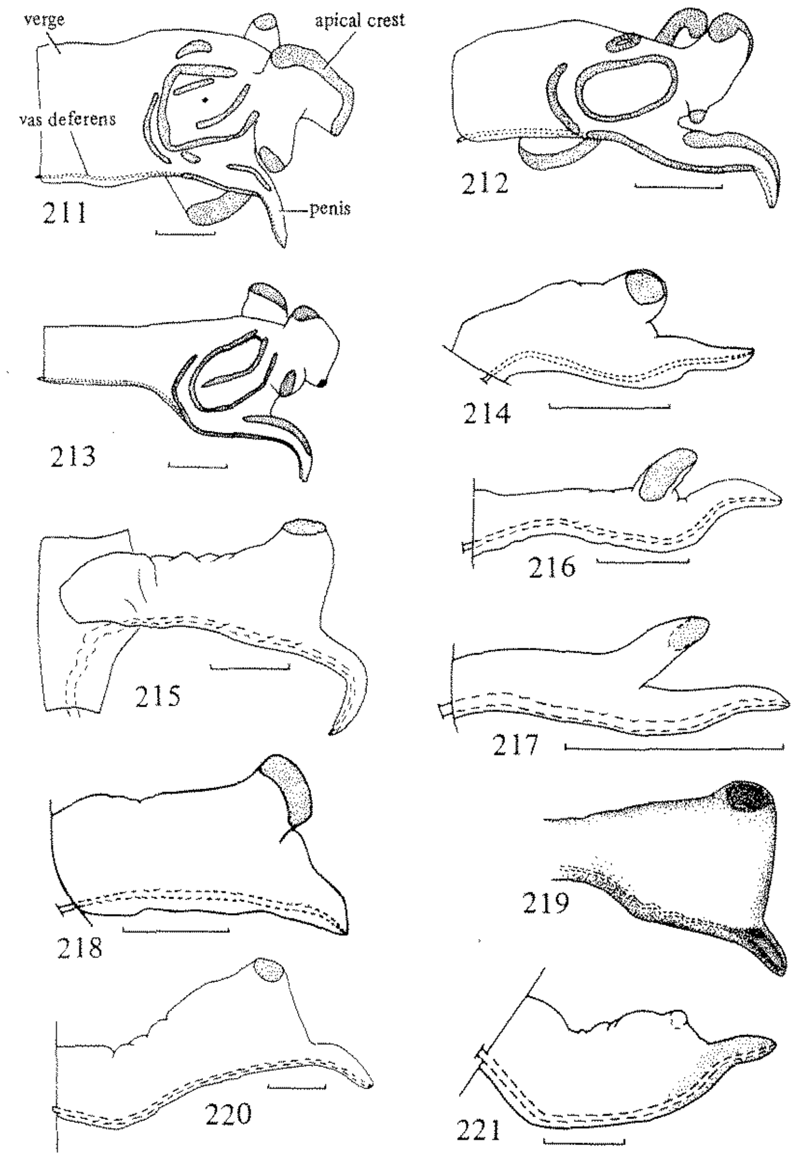
Cincinnatia cincinnatiensis (Anthony 1840)[5] [Figs. 189, 199, 203]
New York and Pennsylvania west to southern Manitoba, southern Saskatchewan, North Dakota, Utah and Texas (Clarke, 1973).
Cincinnatia comalensis (Pilsbry & Ferriss 1906) [Fig. 190]
Comal Creek, near New Braunfels, and the Guadelupe River, about four miles above New Braunfels, Comal County, Texas (Pilsbry & Ferriss, 1906).
Cincinnatia floridana (Frauenfeld 1863) [Figs. 204, 235]
Confined to Florida: from the Suwannee River south to Orlando and Hillsborough County (Thompson, 1968).
Cincinnatia fraterna Thompson 1968 [Figs. 200, 205]
Creeks, small streams and sloughs along the lower third of the St. Johns River, Florida (Thompson, 1968).
Cincinnatia helicogyra Thompson 1968 [Figs. 206, 222]
Spring-fed lagoon on the south side of the head of the Crystal River, Citrus County, Florida (Thompson, 1968).
Cincinnatia integra (Say 1829)
Ohio River and tributaries in Ohio, Indiana, Kentucky and southeastern Illinois.
Cincinnatia mica Thompson 1968 [Figs. 207, 223]
Small spring along the west bank of the Ichetucknee River about one mile northeast of U.S. Highway 27, Suwannee County, Florida (Thompson, 1968).
Cincinnatia monroensis (Dall 1885) [Fig. 208]
Brook flowing from Benson's Mineral Spring, Enterprise, Volusia County, Florida (Dall, 1885; Thompson, 1968).
Cincinnatia parva Thompson 1968 [Figs. 209, 224]
Blue Springs, three miles west of Orange City, Volusia County, Florida (Thompson, 1968).
Cincinnatia peracuta Pilsbry & Walker (in Pilsbry) 1889 [Fig. 225]
Spivey's Lake, Navarro County, Texas (Pilsbry, 1889).
Cincinnatia petrifons Thompson 1968 [Figs. 210, 226]
Rock Springs, 6.5 miles north of Apopka, Orange County, Florida (Thompson, 1968).
Cincinnatia ponderosa Thompson 1968 [Figs. 211, 227]
Sanlando Springs, 3.1 miles west of Longwood, Seminole County, Florida



FIGS. 191-200. Shells of Hydrobiidae (Lithoglyphinae and Nymphophilinae). FIG. 191. *Gillia altilis*. FIG. 192. *Lepyrium showalteri*. FIG. 193. *L. showalteri*, operculum. FIG. 194. *Somatogyrus aureus*. FIG. 195. *S. depressus*. FIG. 196. *S. (Walkerilla) coosaensis*. FIG. 197. *S. (W.) tenax*. FIG. 198. *Birgella subglobosa*. FIG. 199. *Cincinnatia cincinnatiensis*. FIG. 200. *C. fraterna*. Measurement lines = 1 mm.



FIGS. 201-210. Verges of hydrobiid snails (Lithoglyphinae and Nymphophilinae). FIG. 201. *Somatogyrus (Walkerilla) tenax*. FIG. 202. *Birgella subglobosus*. FIG. 203. *Cincinnatia cincinnatiensis*. FIG. 204. *C. floridana*. FIG. 205. *C. fraterna*. FIG. 206. *C. helicogyra*. FIG. 207. *C. mica*. FIG. 208. *C. monroensis*. FIG. 209. *C. parva*. FIG. 210. *C. petrifons*. Measurement lines = 1 mm. Figs. 201 and 204-210 are from Thompson (1968); Figs. 202 and 203 are from E.G. Berry (1943).



FIGS. 211-221. Verges of hydrobiid snails (Nymphophilinae). FIG. 211. *Cincinnatia ponderosa*. FIG. 212. *C. vanhyningi*. FIG. 213. *C. wekiwae*. FIG. 214. *Marstonia agarhecta*. FIG. 215. *M. arga*. FIG. 216. *M. castor*. FIG. 217. *M. halcyon*. FIG. 218. *M. lustrica*. FIG. 219. *M. lustrica*. FIG. 220. *M. ogmorphaphe*. FIG. 221. *M. pachyta*. Measurement lines = ½ mm. Figs. 211-218, 220 and 221 are from Thompson (1968, 1969, 1977); Fig. 219 is from E.G. Berry (1943).

(Thompson, 1968).

Cincinnatia vanhyningi (Vanatta 1934) [Figs. 212, 236]
Seminole Springs, 3.4 miles northeast of Sorrento, Lake County, Florida (Vanatta, 1934; Thompson, 1968).

Cincinnatia wekiwae Thompson 1968 [Figs. 213, 228]
Wekiwa Springs, about five miles northeast of Apopka, Seminole County, Florida (Thompson, 1968).

Genus *Fontelicella* Gregg & Taylor 1965

Subgenus *Fontelicella* s.s.

Fontelicella californiensis Gregg & Taylor 1965 [Fig. 229]
Southern California and northwestern Baja California (Gregg & Taylor, 1965).

Fontelicella deserta (Pilsbry 1916) [Fig. 237]
Washington County, Utah.

Fontelicella intermedia (Tryon 1865) [Fig. 238]
Owyhee River, Malheur County, Oregon (Tryon, 1865i; Gregg & Taylor, 1965).

Fontelicella neomexicana (Pilsbry 1916) [Fig. 239]
In warm springs at Socorro, New Mexico (Pilsbry, 1916a).

Fontelicella pilsbryana (Baily & Baily 1952)
Bear Lake Valley, southeastern Idaho-northeastern Utah (Baily & Baily, 1951; Gregg & Taylor, 1965).

Fontelicella stearnsiana (Pilsbry 1899)
San Francisco Bay region eastward to the Sierra Nevada foothills, California (Gregg & Taylor, 1965).

Subgenus *Natricola* Gregg & Taylor 1965

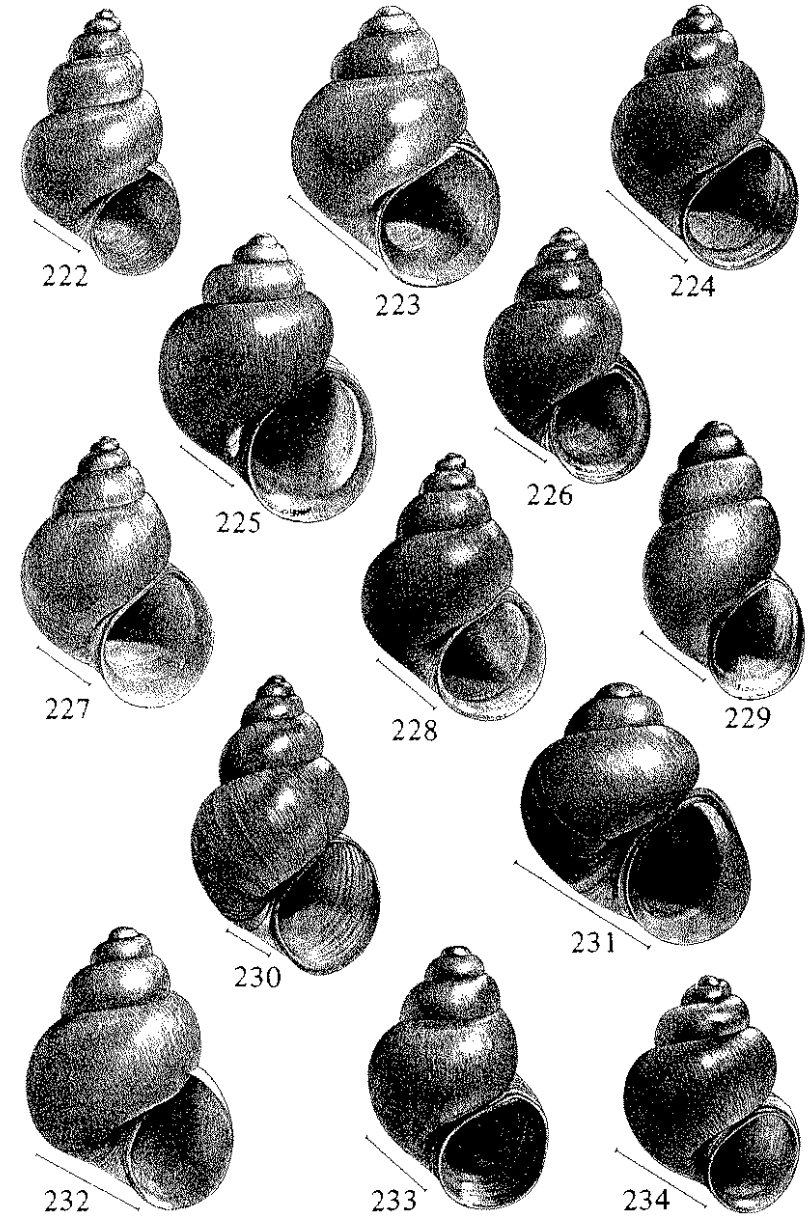
Fontelicella (Natricola) hendersoni (Pilsbry 1933) [Fig. 240]
Harney Lake basin, Harney County, Oregon (Gregg & Taylor, 1965).

Fontelicella (Natricola) idahoensis (Pilsbry 1933) [Figs. 241, 242]
Snake River, southwestern Idaho (Gregg & Taylor, 1965).

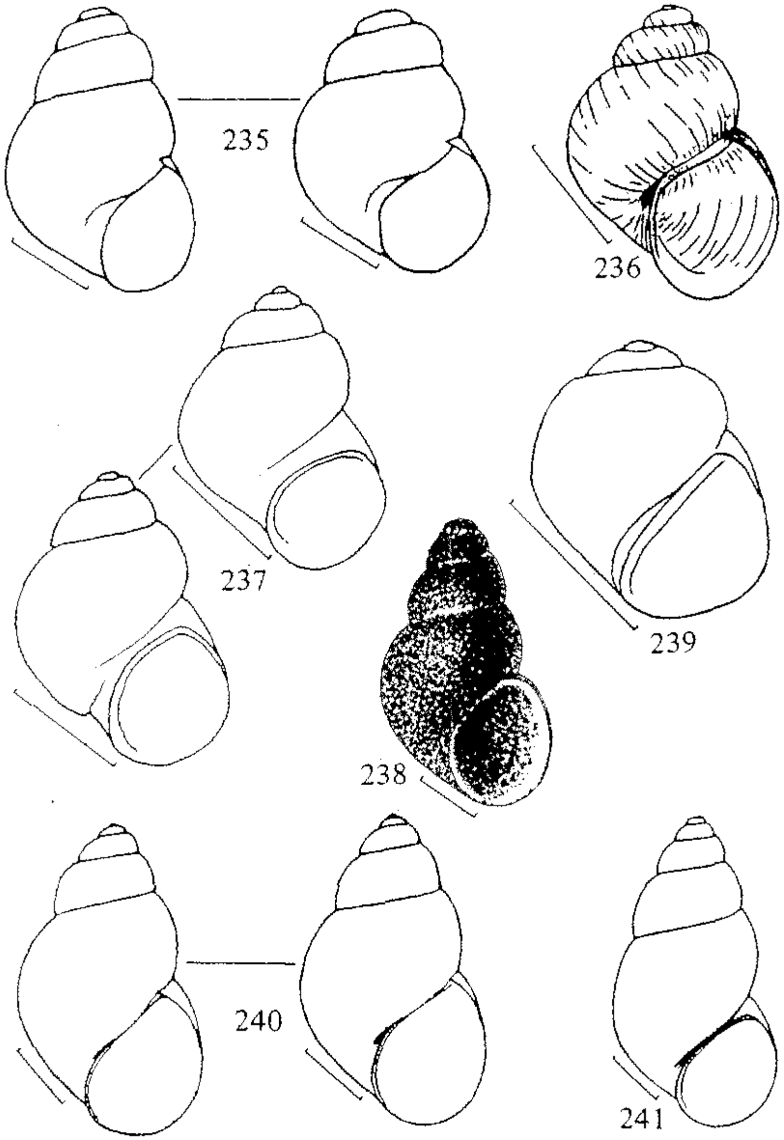
Fontelicella (Natricola) robusta (Walker 1908) [Figs. 230, 243]
Snake River drainage of western Wyoming and southern Idaho; Harney Lake basin, eastern Oregon (Gregg & Taylor, 1965).

Subgenus *Microamnicola* Gregg & Taylor 1965

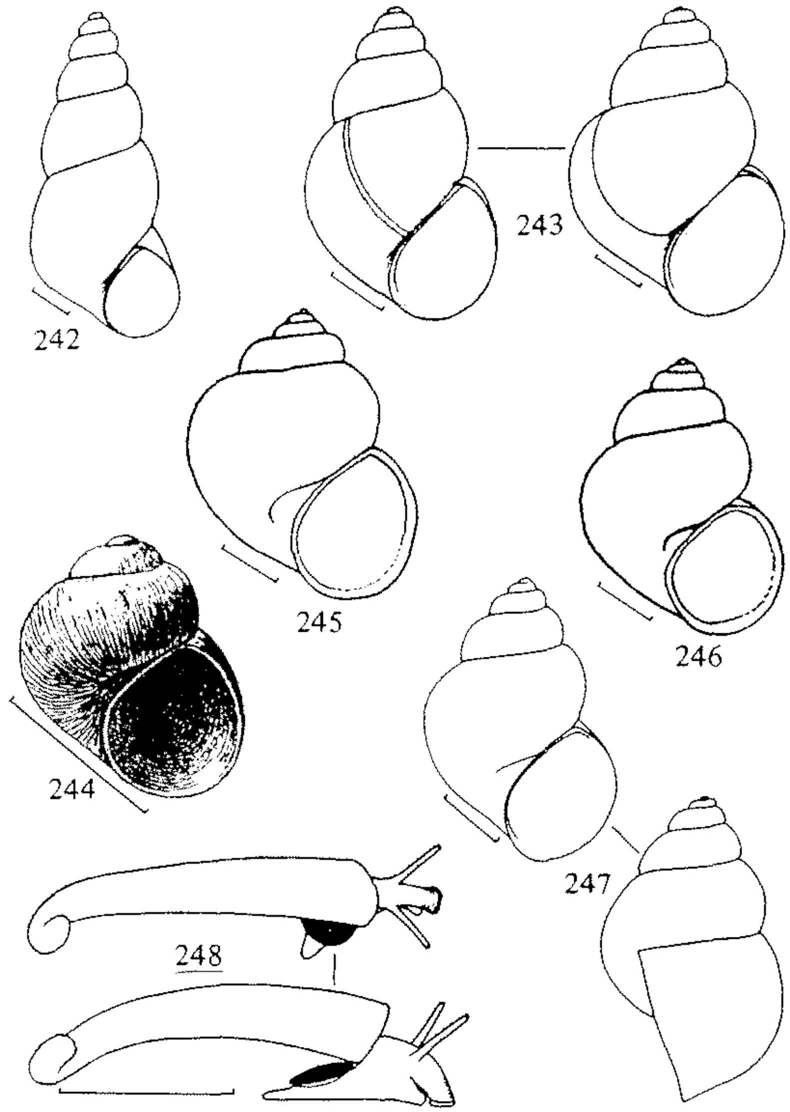
Fontelicella (Microamnicola) micrococcus Pilsbry (in Stearns) 1893 [Figs. 231, 244]
Amargosa River drainage, in southern Nye County, Nevada; eastern Inyo County and northern San Bernardino County, California (Gregg & Taylor, 1965).



FIGS. 222-234. Shells of Hydrobiidae (Nymphophilinae). FIG. 222. *Cincinnatia helicogyra*. FIG. 223. *C. mica*. FIG. 224. *C. parva*. FIG. 225. *C. peracuta*. FIG. 226. *C. petrifons*. FIG. 227. *C. ponderosa*. FIG. 228. *C. wekiwae*. FIG. 229. *Fontelicella californiensis*. FIG. 230. *F. (Natricola) robusta*. FIG. 231. *F. (Microamnicola) micrococcus*. FIG. 232. *Marstonia agarhecta*. FIG. 233. *M. arga*. FIG. 234. *M. castor*. Measurement lines = 1 mm.



FIGS. 235-241. Shells of Hydrobiidae (Nymphophilinae). FIG. 235. *Cincinnatia augustina* = *C. floridana*. FIG. 236. *C. vanhyningi*. FIG. 237. *Fontelicella deserta*. FIG. 238. *F. intermedia*. FIG. 239. *F. neomexicana*. FIG. 240. *F. (Natricola) hendersoni*. FIG. 241. *F. (N.) idahoensis*. Measurement lines = 1 mm. Fig. 235 is from Walker (1906a); Fig. 236 is from Vanatta (1934); Figs. 237 and 239-241 are from Pilsbry (1916a); Fig. 238 is from Tryon (1865i).



FIGS. 242-248. Shells of Hydrobiidae (Nymphophilinae). FIG. 242. *Fontelicella (Natricola) idahoensis*. FIG. 243. *F. (N.) robusta*. FIG. 244. *F. (Microamnicola) micrococcus*. FIG. 245. *Marstonia winkleyi mozleyi* = *M. lustrica*, female. FIG. 246. *M. winkleyi mozleyi* = *M. lustrica*, male. FIG. 247. *M. olivacea*. FIG. 248. *Orygoceras* sp., dorsal and lateral views. Measurement lines = 1 mm. Figs. 242 and 243 are from Pilsbry (1933); Fig. 244 is from Stearns (1893); Figs. 245 and 246 are from Walker (1925a); Fig. 247 is from Thompson (1977); Fig. 248 is after Taylor (1974).

Pyrgulopsis nevadensis nevadensis (Stearns 1883) [Figs. 256, 270-272]
Pyramid Lake and Walker's Lake, Nevada (Stearns, 1883b); Upper Klamath Lake, Oregon (Hanna, 1930).
Pyrgulopsis nevadensis paiutica Baily & Baily 1951
Pyramid Lake, Nevada (Baily & Baily, 1951).
Pyrgulopsis ozarkensis Hinkley 1915[13]
North Fork of the White River, above Norfolk, Arkansas (Hinkley, 1915).
Pyrgulopsis scalariformis (Wolf 1869)[13] [Fig. 273]
Shoal Creek, near Florence, Alabama; Illinois River, Tazewell County, and Rock River, Rock Island County, Illinois, as Pleistocene fossils (Wolf, 1869; F.C. Baker, 1928c).

Genus *Rhapinema* Thompson 1969

Rhapinema dacryon Thompson 1969 [Figs. 91, 257, 262]
Chipola River drainage in Jackson County, Florida (Thompson, 1969).

Genus *Spilochlamys* Thompson 1968

Spilochlamys conica Thompson 1968 [Figs. 92, 258, 263]
River systems draining into the Gulf of Mexico in north central Florida, from Levy County north and west to Jackson County (Thompson, 1968).
Spilochlamys gravis Thompson 1968 [Figs. 264, 275, 276]
North central Florida, in the St. Johns drainage system from Palatka south to the Wekiva River (Thompson, 1968).
Spilochlamys turgida Thompson 1969 [Fig. 259]
Small streams and springs draining into the Ocmulgee River in south central Georgia (Thompson, 1969).

Genus *Stiobia* Thompson 1978

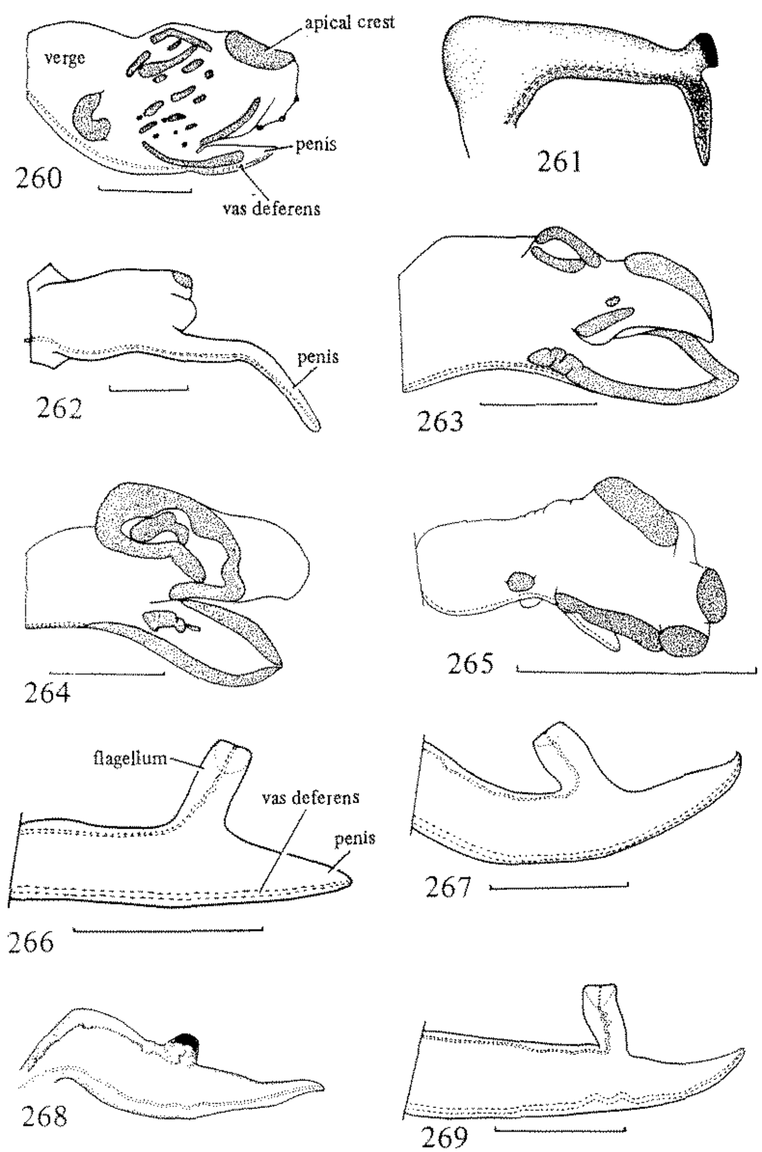
Stiobia nana Thompson 1978 [Figs. 265, 297]
Coldwater Spring Run, west of Oxford, Calhoun County, Alabama (Thompson & McCaleb, 1978).

Subfamily Amnicolinae

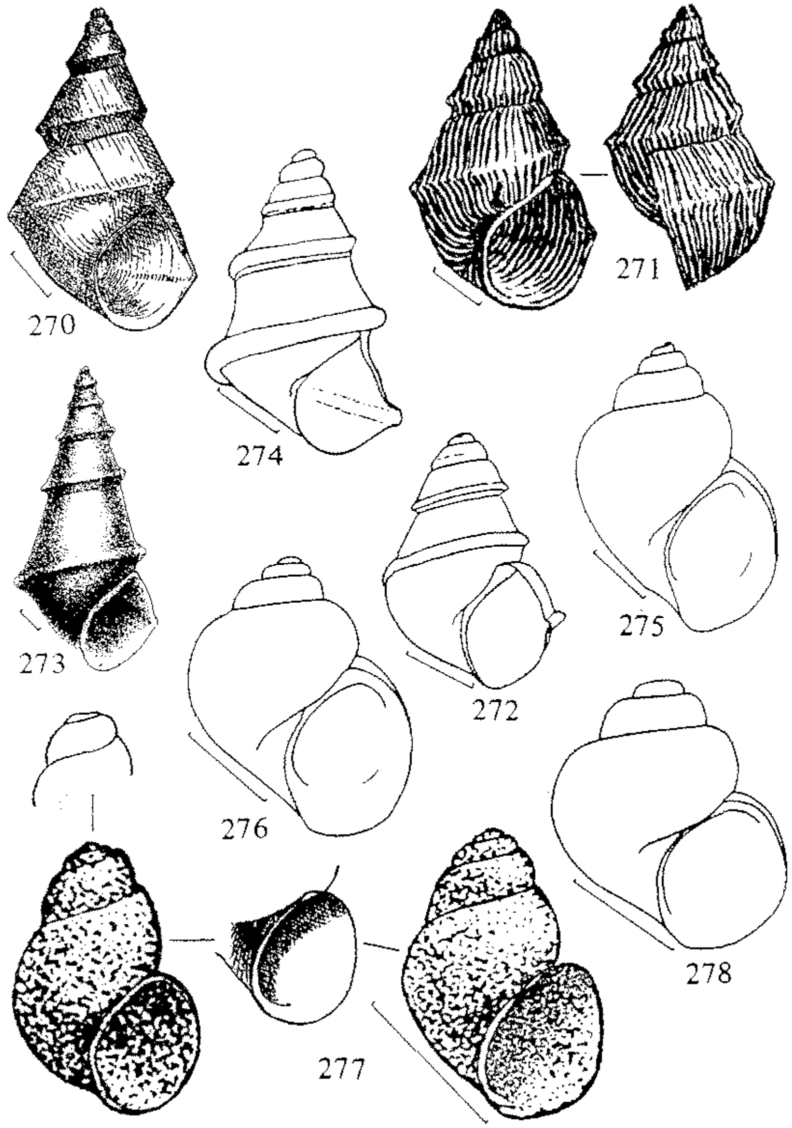
Genus *Amnicola* Gould & Haldeman 1840[15]

Subgenus *Amnicola* s.s.

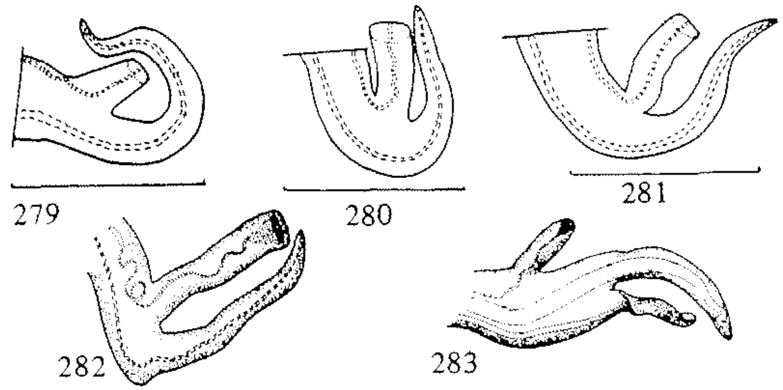
Amnicola aldrichi aldrichi (Call & Beecher 1886)[16] [Fig. 277]
Tributary of Black River, Reynolds County, Missouri (Call & Beecher, 1886).
Amnicola aldrichi antroecetes Hubricht 1940
Caves in southwestern Illinois and in eastern and southeastern Missouri (Hubricht, 1940a).



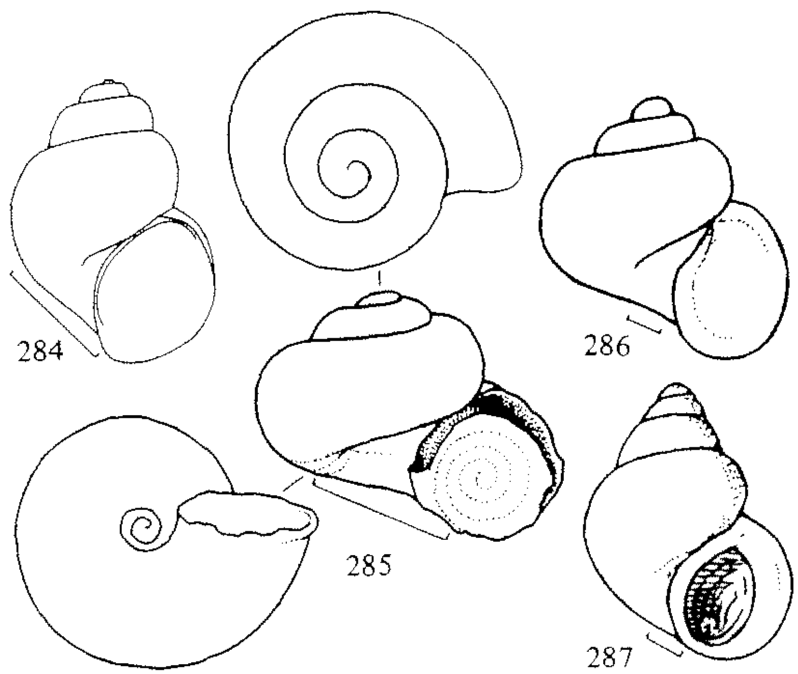
FIGS. 260-269. Verges of hydrobiid snails (Nymphophilinae and Amnicolinae). FIG. 260. *Notogillia wetherbyi*. FIG. 261. *Pyrgulopsis letsoni*. FIG. 262. *Rhapinema dacryon*. FIG. 263. *Spilochlamys conica*. FIG. 264. *Sp. gravis*. FIG. 265. *Stiobia nana*. FIG. 266. *Amnicola dalli dalli*. FIG. 267. *A. dalli johnsoni*. FIG. 268. *A. limosa*. FIG. 269. *A. rhombostoma*. Measurement lines = 1 mm. Figs. 260, 262-267 and 269 are from Thompson (1968, 1969) and Thompson & McCaleb (1978); Figs. 261 and 268 are from E.G. Berry (1943).



FIGS. 270-278. Shells of Hydrobiidae (Nymphophilinae and Amnicolinae). FIG. 270. *Pyrgulopsis nevadensis nevadensis*. FIG. 271. *P. nevadensis nevadensis*. FIG. 272. *P. nevadensis nevadensis*. FIG. 273. *P. scalariformis*. FIG. 274. *P. archimedis*. FIG. 275. *Spilochlamys gravis*. FIG. 276. *S. gravis*. FIG. 277. *Amnicola aldrichi aldrichi*. FIG. 278. *A. dalli johnsoni*. Measurement lines = 1 mm. Fig. 270 is from Stearns (1883b); Fig. 271 is from Call & Pilsbry (1886); Figs. 272 and 274 are from S.S. Berry (1947); Fig. 273 is from Wolf (1869); Figs. 275, 276 and 278 are from Thompson (1968); Fig. 277 is from Call & Beecher (1886).



FIGS. 279-283. Verges of hydrobiid snails (Amnicolinae and Fontigentinae). FIG. 279. *Amnicola (Lyogyrus) grana*. FIG. 280. *A. (L.) pupoidea*. FIG. 281. *A. (L.) retromargo*. FIG. 282. *A. (L.) walkeri*. FIG. 283. *Fontigens nickliniana*. Measurement lines = 1 mm. Figs. 279-281 are from Thompson (1968); Figs. 282 and 283 are from E.G. Berry (1943).

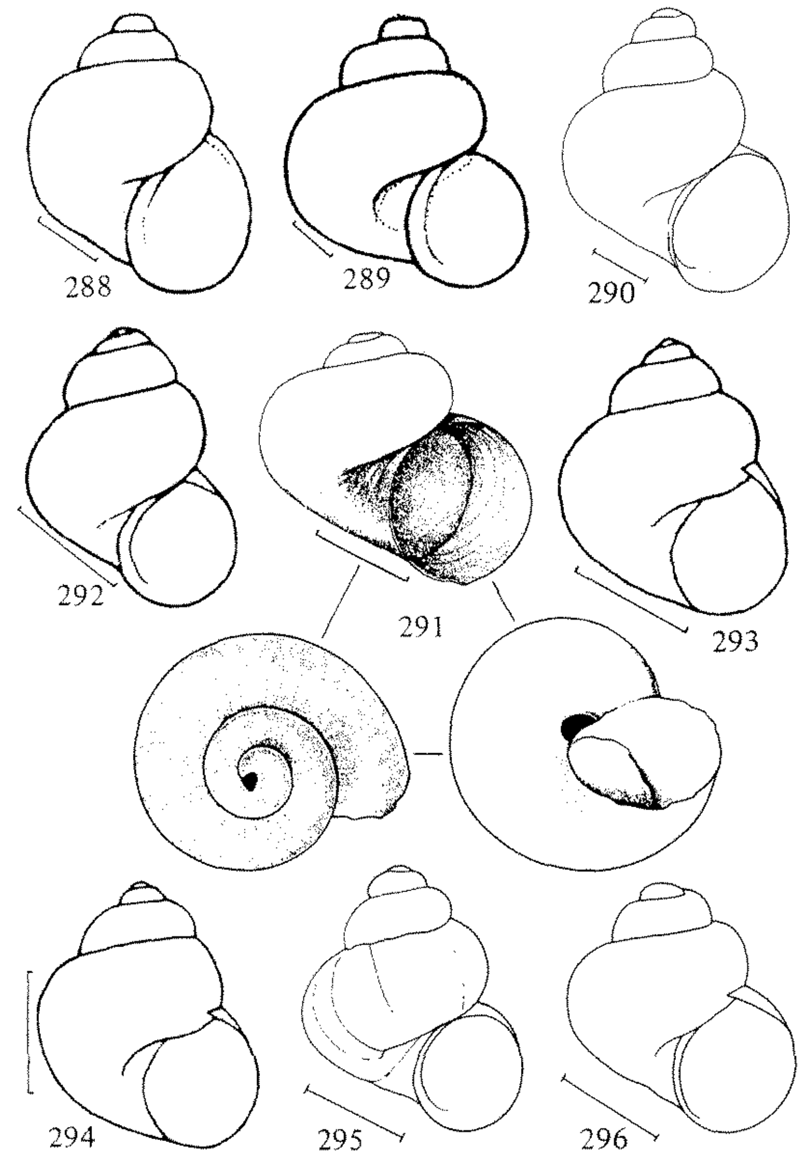


FIGS. 284-287. Shells of Hydrobiidae (Amnicolinae). FIG. 284. *Amnicola dalli johnsoni*. FIG. 285. *A. cora*. FIG. 286. *A. limosa*. FIG. 287. *A. decisa*. Measurement lines = 1 mm. Fig. 284 is from Thompson (1968); Fig. 285 is from Hubricht (1979); Figs. 286 and 287 are from Haldeman (1845).

Amnicola aldrichi insolita Hubricht 1940
Springs in southeastern Missouri (Hubricht, 1940a).
Amnicola bakeriana Pilsbry 1917[16]
Oneida Lake, New York (Pilsbry, 1917c).
Amnicola clarkei Pilsbry 1917[16]
Oneida Lake, New York (Pilsbry, 1917c).
Amnicola cora Hubricht 1979 [Fig. 285]
Stream in Foushee Case, three miles west of Locust Grove, Independence County, Arkansas (Hubricht, 1979).
Amnicola dalli dalli (Pilsbry & Beecher 1892) [Figs. 266, 298]
Throughout the northern half of peninsular Florida and west into the Florida panhandle to Leon County (Thompson, 1968).
Amnicola dalli johnsoni Pilsbry 1899 [Figs. 93, 267, 278, 284]
Throughout the northern two-thirds of peninsular Florida, and near Tallahassee (Thompson, 1968).
Amnicola decisa Haldeman 1845[16] [Fig. 287]
Tributaries of the Susquehanna River and in the Schuylkill River (Haldeman, 1845).
Amnicola limosa limosa (Say 1817) [Fig. 268, 286, 288-290, 299]
From the Atlantic coast to as far west as Utah, and from Labrador to Florida (E.G. Berry, 1943).
Amnicola limosa parva Lea 1841
Atlantic and Middle States, including Ohio, Indiana, Illinois, Iowa and Missouri (F.C. Baker, 1928c).
Amnicola missouriensis Pilsbry 1898[16]
Carter County, Missouri (Pilsbry, 1898a).
Amnicola proserpina Hubricht 1940[16]
Spring in St. Louis County and caves in St. Genevieve and Jefferson counties, eastern Missouri (Hubricht, 1940a, 1942).
Amnicola rhombostoma Thompson 1968 [Figs. 269, 300]
In small sand-bottomed streams and rivers draining into the west side of the St. Johns River in Clay and Putnam counties, Florida (Thompson, 1968).
Amnicola stygia Hubricht 1971 [Fig. 291]
Caves in Perry County, Missouri (Hubricht, 1971).

Subgenus *Lyogyrus* Gill 1863

Amnicola (Lyogyrus) browni Carpenter 1872 [Fig. 301]
Massachusetts and Rhode Island (see E.G. Berry, 1943).
Amnicola (Lyogyrus) grana (Say 1822) [Figs. 279, 302]
Atlantic drainage in southeastern Pennsylvania and New Jersey (Walker, 1918b); headwaters of the Pearl River, Mississippi (Hubricht, 1963a).
Amnicola (Lyogyrus) greggi Pilsbry 1935 [Figs. 292, 303]
Cliff Creek canyon, a fork of Hoback canyon, about 29 miles south of Jackson, Wyoming, in the Snake River drainage (Pilsbry, 1935a); also in western Montana and southeastern Idaho (Taylor, 1966b).
Amnicola (Lyogyrus) pilsbryi Walker 1906 [Figs. 293-296, 304]
Wisconsin east to New Philadelphia, Ohio, and south to northern Illinois (F.C.



FIGS. 288-296. Shells of Hydrobiidae (Amnicolidae). FIG. 288. *Amnicola pallida* = *A. limosa*. FIG. 289. *A. porata* = *A. limosa*. FIG. 290. *A. porata* = *A. limosa*. FIG. 291. *A. stygia*. FIG. 292. *A. (Lyogyrus) greggi*. FIG. 293. *A. (L.) pilsbryi*. FIG. 294. *A. (L.) pilsbryi*. FIG. 295. *A. (L.) pilsbryi*. FIG. 296. *A. (L.) pilsbryi*. Measurement lines = 1 mm. Figs. 288 and 289 are from Haldeman (1845); Fig. 291 is from Hubricht (1971); Fig. 292 is from Pilsbry (1935a); Figs. 293 and 294 are from Walker (1906a).

Baker, 1928c).

Amnicola (Lyogyrus) pupoidea (Gould 1841) [Figs. 280, 305]
Canada, Maine, Connecticut, Massachusetts and the District of Columbia (Binney, 1865d).

Amnicola (Lyogyrus) retromargo Thompson 1968 [Figs. 94, 281, 306]
Occurs in a narrow zone across the neck of the Florida peninsula from the west side of the St. Johns River in Clay and Putnam counties west to Dixie County (Thompson, 1968).

Amnicola (Lyogyrus) walkeri Pilsbry 1898 [Figs. 282, 307, 309]
St. Lawrence River and Great Lake drainages, upper Mississippi drainage, the Canadian Interior basin in the Albany and Winnipeg river systems and in Lake Winnipeg (Clarke, 1973).

Genus *Hauffenia* Pollonera 1898[17]

Hauffenia micra (Pilsbry & Ferriss 1906 [Fig. 308]
Found in drift debris of the Guadalupe River, near New Braunfels, Texas (Pilsbry & Ferriss, 1906).

Genus *Horatia* Bourguignat 1887[17]

Horatia nugax (Pilsbry & Ferriss 1906) [Fig. 316]
Found in drift debris of the Guadalupe River, near New Braunfels, Texas (Pilsbry & Ferriss, 1906).

Subfamily Fontigentinae

Genus *Fontigens* Pilsbry 1933

Fontigens binneyana (Hannibal 1912)[18]
"Ohio" (Lea, 1841, for *"Paludina" obtusa*, preoccupied; renamed *binneyana*).

Fontigens cryptica Hubricht 1963 [Fig. 315]
Small spring in Clarke County, Indiana (Hubricht, 1963b).

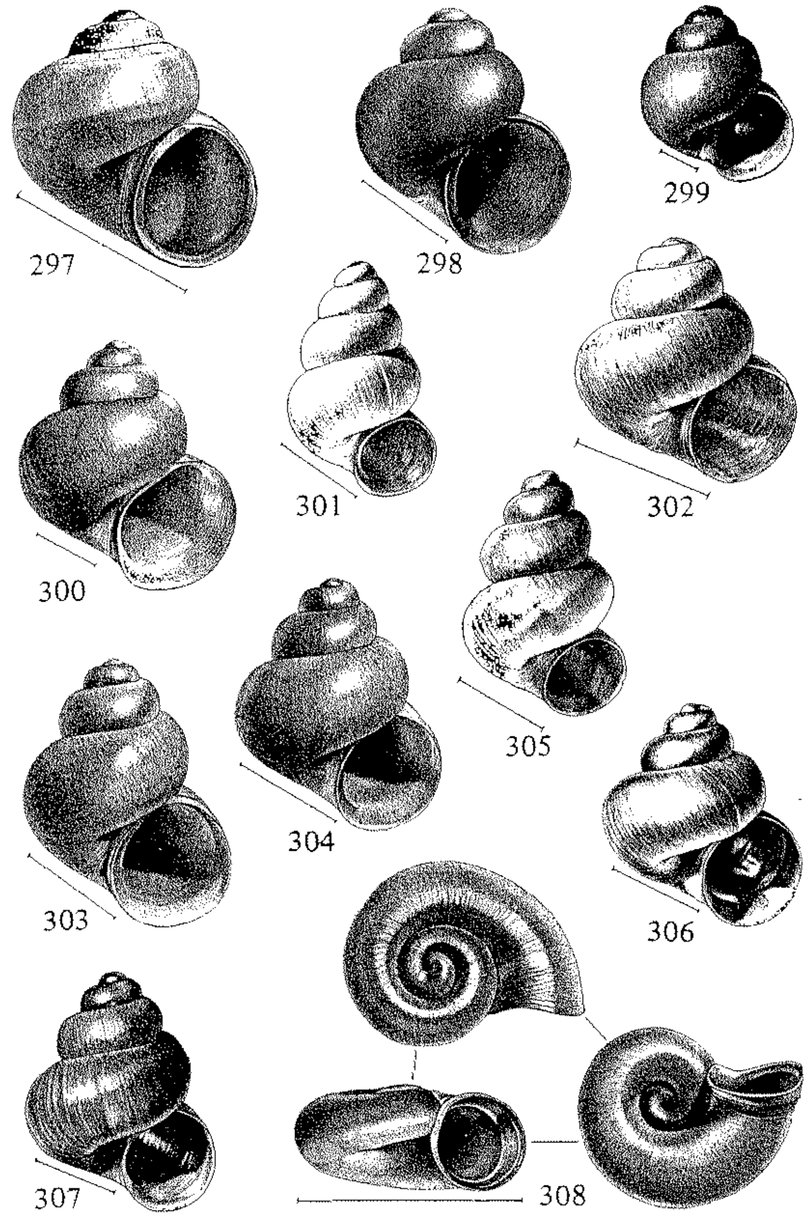
Fontigens holsingeri Hubricht 1976 [Fig. 311]
Streams in caves in Randolph and Pocahontas counties, West Virginia (Hubricht, 1976).

Fontigens nickliniana (Lea 1838) [Figs. 283, 319]
In cool, shallow springs from Pennsylvania to Wisconsin and from Ontario to Alabama (E.G. Berry, 1943).

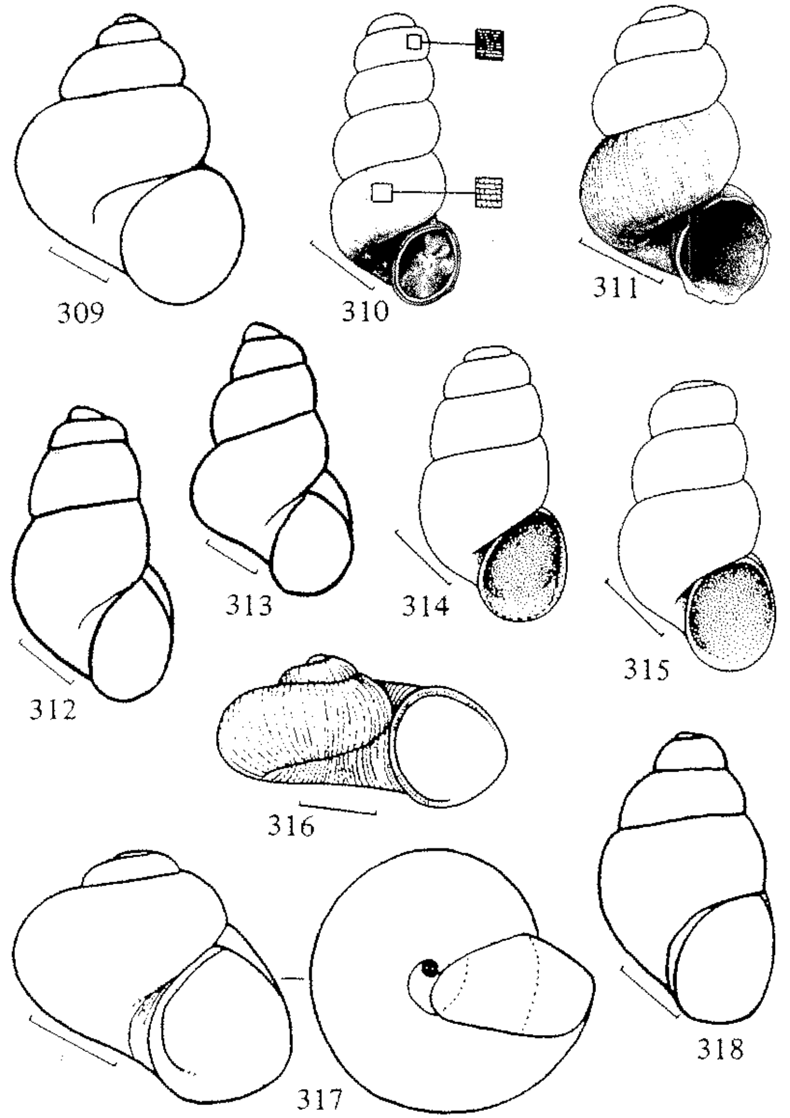
Fontigens orolibas Hubricht 1957 [Figs. 312, 313]
Springs in the Shenandoah National Park and along the Blue Ridge Parkway, Virginia (Hubricht, 1957).

Fontigens tartarea Hubricht 1963 [Fig. 314]
Stream in Organ Cave, Greenbrier County, West Virginia (Hubricht, 1963b).

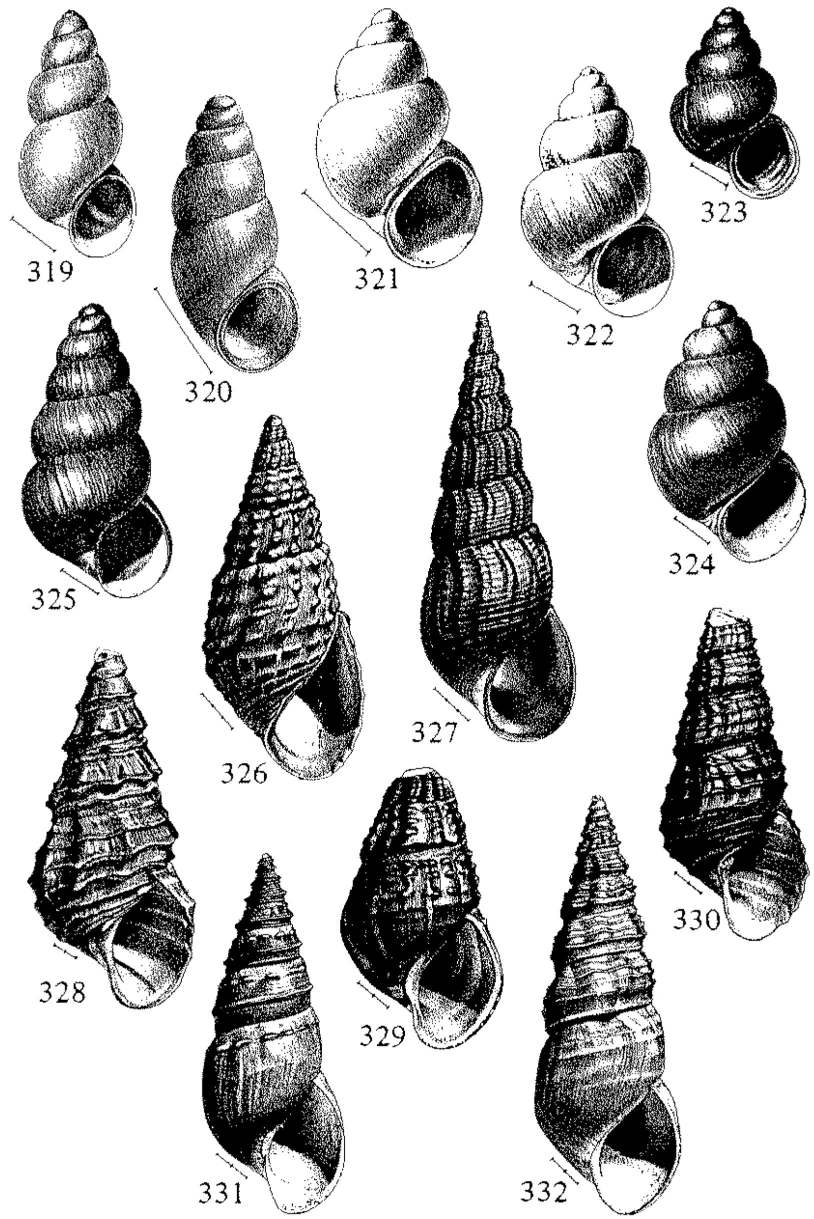
Fontigens turritella Hubricht 1976 [Fig. 310]
Caves in Greenbrier County, West Virginia (Hubricht, 1976).



FIGS. 297-308. Shells of Hydrobiidae (Nymphophilinae and Amnicolinae). FIG. 297. *Stiobia nana*. FIG. 298. *Amnicola dalli dalli*. FIG. 299. *A. limosa limosa*. FIG. 300. *A. rhombostoma*. FIG. 301. *A. (Lyogyrus) browni*. FIG. 302. *A. (L.) grana*. FIG. 303. *A. (L.) greggi*. FIG. 304. *A. (L.) pilsbryi*. FIG. 305. *A. (L.) pupoidea*. FIG. 306. *A. (L.) retromargo*. FIG. 307. *A. (L.) walkeri*. FIG. 308. *Hauffenia micra*. Measurement lines = 1 mm.



FIGS. 309-318. Shells of Hydrobiidae (Nymphophilinae and Amnicolinae). FIG. 309. *Amnicola (Lyogyrus) walkeri*. FIG. 310. *Fontigens turritella*. FIG. 311. *F. holsingeri*. FIG. 312. *F. orolibas*. FIG. 313. *F. orolibas*. FIG. 314. *F. tartarea*. FIG. 315. *F. cryptica*. FIG. 316. *Horatia nugax*. FIG. 317. *"Cochliopa" texana*. FIG. 318. *"Paludestrina" bottimeri*. Measurement lines = ½ mm. Fig. 309 is from Walker (1906a); Figs. 310-315 are from or after Hubricht (1957, 1963b, 1976); Fig. 316 is after Pilsbry & Ferriss (1906); Fig. 317 is from Pilsbry (1935a); Fig. 318 is from Walker (1925a).



FIGS. 319-332. Shells of Hydrobiidae (Figs. 319, 320), Pomatiopsidae (Figs. 321-325), Thiaridae (Figs. 326, 327) and Pleuroceridae (Figs. 328-332). FIG. 319. *Fontigens nickliniana*. FIG. 320. *"Bythinella" hemphilli*. FIG. 321. *Pomatiopsis binneyi*. FIG. 322. *P. californica*. FIG. 323. *P. cincinnatiensis*. FIG. 324. *P. hinkleyi*. FIG. 325. *P. lapidaria*. FIG. 326. *Thiara granifera*. FIG. 327. *Melanoides tuberculata*. FIG. 328. *Elimia boykiniana boykiniana*. FIG. 329. *E. boykiniana viennaensis*. FIG. 330. *E. clenchi*. FIG. 331. *E. carinifera*. FIG. 332. *E. arachnoidea arachnoidea*. Measurement lines = 1 mm or are divided into millimeters.

I

Fontigens weberi Pilsbry 1950[19]
West Lake, Cape Sable, Florida (Pilsbry, 1950a).

Incertae Sedis

"Bythinella" hemphilli Pilsbry 1890 [Fig. 320]
Near Kentucky Ferry, Snake River, Washington (Pilsbry, 1890e)
"Cochliopa" texana Pilsbry 1935 [Fig. 317]
Phantom Lake, near Toyahvale, Reeves County, Texas (Pilsbry, 1935a).
"Paludestrina" battimeri Walker 1925 [Fig. 318]
Glen Echo, Montgomery County, Maryland (Walker, 1925a).

?

Family POMATIOPSIDAE

Genus *Pomatiopsis* Tryon 1862

Pomatiopsis binneyi Tryon 1863 [Fig. 321]
Bolinas, Marin County, California (Tryon, 1863a); Mt. Tamalpais, Marin County (Davis, 1967).
Pomatiopsis californica Pilsbry 1899 [Fig. 322]
San Francisco and Oakland, California (Pilsbry, 1899); Bolinas Bay, Marin County, California (Davis, 1967).
Pomatiopsis chacei Pilsbry 1937
Near Klamath, Humboldt County, California (Pilsbry, 1937a); Crescent City, Del Norte County, and Wilson Creek, California (E.G. Berry, 1947b).
Pomatiopsis cincinnatiensis (Lea 1840) [Fig. 323]
Tennessee and southwest Virginia to southern Michigan, Illinois and Iowa (Burch & Van Devender, 1980).
Pomatiopsis hinkleyi Pilsbry 1896[20] [Fig. 324]
The original localities (near Florence, Alabama) are now covered by the water impounded by Wilson Dam; also found at a spring near Ashland City, Tennessee; and near Eberhardt, South Carolina (Hubricht, 1960).
Pomatiopsis lapidaria (Say 1817) [Fig. 325]
Widely distributed in the eastern United States, with occasional occurrences west to northern Texas and New Mexico (Burch & Van Devender, 1980).

Family THIARIDAE

Genus *Melanoides* Olivier 1904

Melanoides tuberculata (Müller 1774) [Fig. 327]
Much of Africa and the eastern Mediterranean countries, throughout India, Southeast Asia, Malaysia and southern China, north to the Ryukyu Islands of Japan, south and east through many of the Pacific islands to northern Australia and the New Hebrides (Pace, 1973); introduced into Florida, Texas and Arizona (see Dundee, 1974).

Genus *Thiara* Röding 1798

Thiara granifera (Lamarck 1822) [Fig. 326]
Madagascar and India eastward throughout Malaysia and the Philippines to the Society Islands and north to the Ryukyu Islands and Hawaii (Pace, 1973); introduced into Florida (Abbott, 1952) and Texas (Murray, 1964).

Family PLEUROCERIDAE[21,22]

Genus *Elimia* H. & A. Adams 1854[23]

Elimia acuta group

Elimia acuta acuta (Lea 1831)
Tributaries of the Tennessee River in southern Tennessee and northern Alabama (Goodrich, 1930a, 1941b).
Elimia acuta clavula (Lea 1868)
Tributaries of the Tennessee River in Madison County, Tennessee, and Jackson County, Alabama (Goodrich, 1940d).
Elimia comma (Conrad 1834)
Springs and spring branches of the Black Warrior River in Jefferson and Blount counties, Alabama (Goodrich, 1941b).

Elimia boykiniana group

Elimia boykiniana boykiniana (Lea 1840) [Fig. 328]
Chattahoochee and Flint rivers, Georgia (Goodrich, 1942b).
Elimia boykiniana albanyensis (Lea 1864)
Flint River, Georgia, and tributaries; Uchee Creek, Russell County, Alabama (Goodrich, 1942b).
Elimia boykiniana viennaensis (Lea 1862) [Fig. 329]
Flint River and creeks of western Georgia; Uchee Creek, Russell County, Alabama (Goodrich, 1942b).
Elimia clenchi (Goodrich 1924) [Fig. 330]
Tributaries of Choctawhatchee and Chipola rivers, Alabama and Florida; branches of Conecuh River, Covington County, Alabama (Goodrich, 1942b).
Elimia ucheensis (Lea 1862) [Fig. 346]
Uchee and Little Uchee creeks, Russell County, Alabama (Goodrich, 1942b).

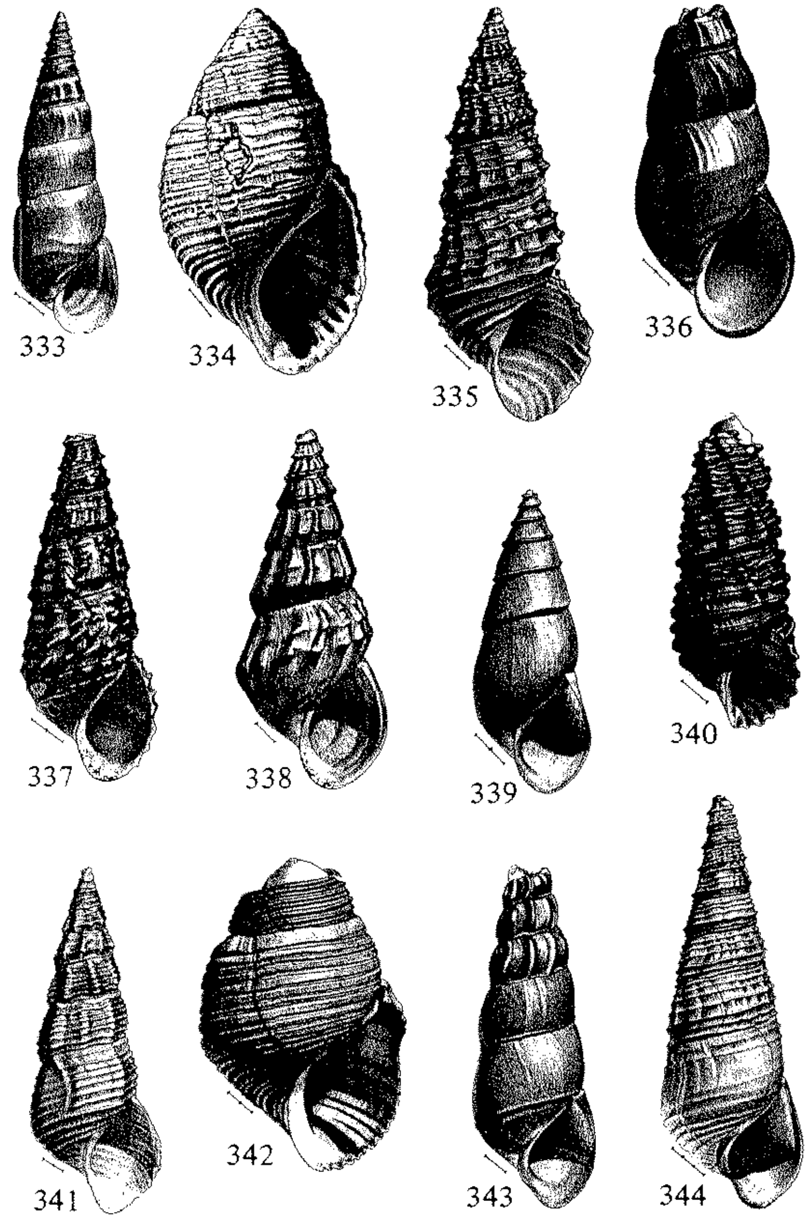
Elimia carinifera group

Elimia bellacrenata (Haldeman 1841) [Fig. 345]
Tributary springs, spring-fed brooks and creeks of the Cahaba River (Goodrich, 1941c).
Elimia carinifera (Lamarck 1822) [Fig. 331]
Springs, brooks, creeks and occasionally rivers of the Alabama River drainage

basin, from north Georgia to Monroe County, Alabama; parts of the Tennessee River system in the vicinity of Chattanooga, Hamilton County, Tennessee (Goodrich, 1941b,c).

Elimia catenaria group

Elimia arachnoidea arachnoidea (Anthony 1854) [Fig. 332]
Small streams of East Tennessee (Goodrich, 1940d).
Elimia arachnoidea spinella (Lea 1862) [Fig. 333]
Small streams of Lee and Scott counties, Virginia, and Claiborne County, Tennessee (Goodrich, 1940d).
Elimia athearni (Clench & Turner 1956)
Central part of the Chipola River system (Clench & Turner, 1956).
Elimia brevis (Reeve 1860) [Figs. 347, 348]
Middle and lower reaches of the Coosa River, Alabama (Goodrich, 1944d).
Elimia capillaris (Lea 1861) [Fig. 334]
Coosa River, Floyd County, Georgia, to shoals of Chilton and Coosa counties, Alabama; in the Etowah River, at Rome, Georgia, and creeks to Talladega County, Alabama (Goodrich, 1944d).
Elimia catenaria catenaria (Say 1822) [Fig. 335]
Springs of eastern South Carolina, possibly in streams southward to the Savannah River (Goodrich, 1942b).
Elimia catenaria dislocata (Reeve 1861) [Figs. 336, 349]
Streams of Durham, Burke, Franklin, Madison and Mecklenburg counties, North Carolina; headstreams in South Carolina; Greenville County, Virginia (Goodrich, 1942b).
Elimia catenaria inclinans (Lea 1862)
Flint River and tributaries, Georgia (Goodrich, 1942b).
Elimia catenaria postelli (Lea 1858) [Fig. 337]
Altamaha, Ogeechee and Canoochee rivers, and possibly Savannah River, Georgia (Goodrich, 1942b).
Elimia catenaria vanhyningiana (Goodrich 1921) [Fig. 338]
Lake, Marion and Orange counties, Florida (Goodrich, 1942b).
Elimia cochilaris (Lea 1868)
Found in springs and spring brooks of the Little Cahaba River in Bibb, Jefferson and Tuscaloosa counties, Alabama (Goodrich, 1941c).
Elimia comalensis comalensis (Pilsbry 1890) [Fig. 339]
Drainage of Guadeloupe River, Texas; ? basin of Brazos River (Goodrich, 1942b).
Elimia comalensis fontinalis (Pilsbry & Ferriss 1906) [Fig. 350]
Comal Creek and its springs, New Braunfels, Comal County, Texas (Goodrich, 1942b).
Elimia crenatella (Lea 1860) [Fig. 340]
Coosa River Basin: in the Coosa River from St. Clair to Chilton County, Alabama, and in creeks of St. Clair, Etowah and Talladega counties (Goodrich, 1944d).
Elimia edgariana (Lea 1841) [Fig. 341]
Streams of Cumberland, Duck and Elk rivers, Tennessee (Goodrich, 1940d).



FIGS. 333-344. Shells of Pleuroceridae. FIG. 333. *Elimia arachnoidea spinella.* FIG. 334. *E. capillaris.* FIG. 335. *E. catenaria catenaria.* FIG. 336. *E. catenaria dislocata.* FIG. 337. *E. catenaria postelli.* FIG. 338. *E. catenaria vanhyningiana.* FIG. 339. *E. comalensis comalensis.* FIG. 340. *E. crenatella.* FIG. 341. *E. edgariana.* FIG. 342. *E. impressa.* FIG. 343. *E. perstriata decampi.* FIG. 344. *E. striatula.* Measurement lines are divided into millimeters.

Elimia floridensis (Reeve 1860)
Upper reaches of the St. Johns and Hillsborough rivers in central Florida, north and west to the Apalachicola River and the upper reaches of Holmes Creek (Clench & Turner, 1956).

Elimia fusiformis (Lea 1841) [Figs. 351, 352]
Coosa River: Weduska Shoals, Shelby County, to Wetumpka, Elmore County, Alabama (Goodrich, 1944d).

Elimia impressa (Lea 1841) [Fig. 342]
Coosa River: Leoto Shoals, St. Clair County, to rapids of Coosa County, Alabama (Goodrich, 1944d).

Elimia nassula (Conrad 1834) [Fig. 353]
Springs and spring branches of Madison and Colbert counties, Alabama (Goodrich, 1940d).

Elimia perstriata perstriata (Lea 1852)
Springs and small streams of north Alabama (Goodrich, 1940d).

Elimia perstriata crispa (Lea 1862)
Lawrence and Madison counties, Alabama (Goodrich, 1940d).

Elimia perstriata decampii (Lea 1863)[24] [Fig. 343]
Madison County, Alabama (Goodrich, 1940d).

Elimia porrecta (Lea 1863) [Figs. 368, 369]
Springs and streams of Claiborne County, Tennessee (Goodrich, 1940d).

Elimia plicatastriata (Wetherby 1876)
Small branches of the Cumberland River, Tennessee and Kentucky; Big Richland Creek of the Tennessee River, Humphreys County, Tennessee (Goodrich, 1940d).

Elimia pupaeformis (Lea 1864) [Fig. 354]
Coosa River, from the vicinity of Riverside, St. Clair County, to Wetumpka, Alabama (Goodrich, 1944d).

Elimia striatula (Lea 1842) [Fig. 344]
In the Tennessee River system at springs in Monroe County and in a reservoir near Cleveland, Bradley County, Tennessee (Goodrich, 1940d); in the Alabama River system at Coahulla Creek, Whitfield County, Georgia (Goodrich, 1941b).

Elimia strigosa (Lea 1841) [Fig. 355]
Small streams near Knoxville, Knox County, Tennessee (Goodrich, 1940d).

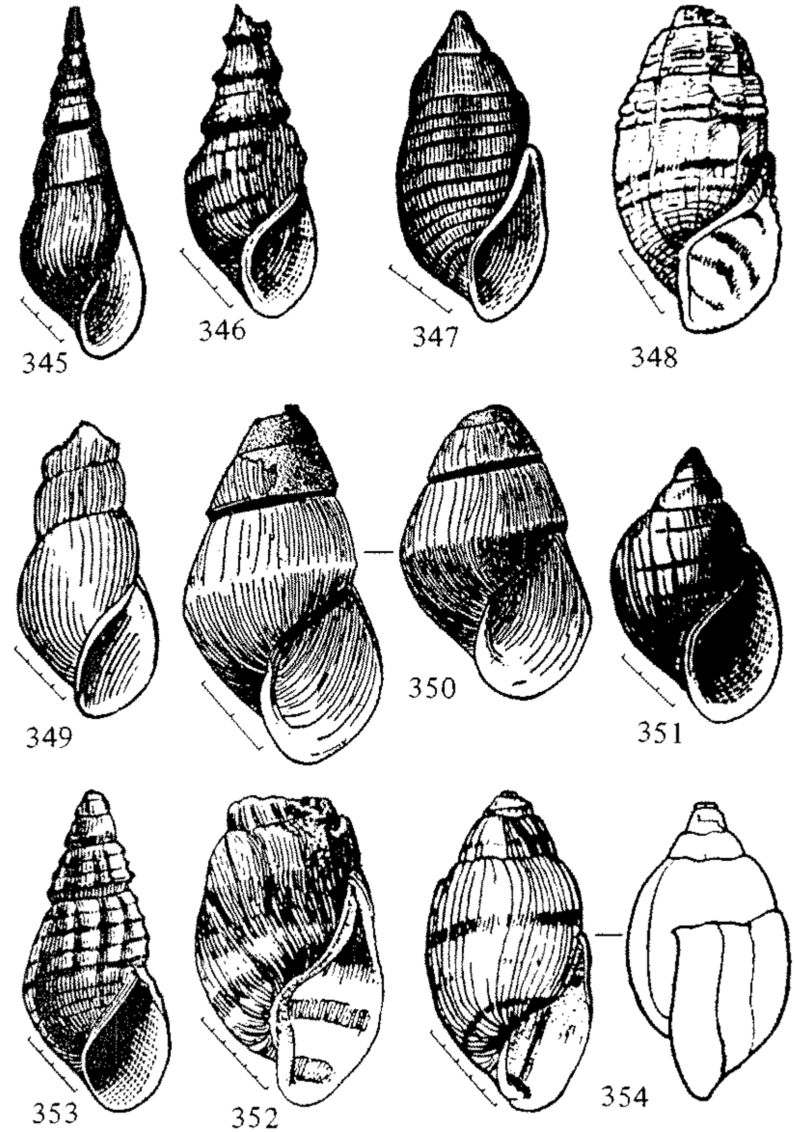
Elimia teres (Lea 1841) [Fig. 356]
Small streams of Walden Ridge, Tennessee, flowing eastward (Goodrich, 1940d).

Elimia troostiana (Lea 1838) [Fig. 357]
Mossy Creek, Jefferson County, Tennessee (Goodrich, 1940d).

Elimia carinocostata group

Elimia bentoniensis (Lea 1862)
Coosa River Basin, in small streams of Calhoun, St. Clair and Talladega counties, Alabama (Goodrich, 1941b, 1944d).

Elimia carinocostata (Lea 1845)
Tributaries of Black Warrior River (Goodrich, 1941b); upper Cahaba River to



FIGS. 345-354. Shells of Pleuroceridae. FIG. 345. *Elimia bellacrenata*. FIG. 346. *E. ucheensis*. FIG. 347. *E. brevis*. FIG. 348. *E. brevis*. FIG. 349. *E. catenaria dislocata*. FIG. 350. *E. comalensis fontinalis*. FIG. 351. *E. fusiformis*. FIG. 352. *E. fusiformis*. FIG. 353. *E. nassula*. FIG. 354. *E. pupaeformis*. Measurement lines are divided into millimeters. Figs. 345-347, 349, 351 and 353 are from Tryon (1865-66, 1873b); Figs. 348, 352 and 354 are from Goodrich (1936); Fig. 350 is from Pilsbry & Ferriss (1906).

Nunley Ford, Shelby County, and upper Little Cahaba River, Alabama (Goodrich, 1941c); Coosa River Basin, in creeks from Whitfield County, Georgia, to Elmore County, Alabama (Goodrich, 1944d).

Elimia curvicostata (Reeve 1861) [Fig. 358]
Streams of western Georgia and Florida; rivers and creeks of southeastern Alabama (Goodrich, 1942b).

Elimia dickinsoni (Clench & Turner 1956) [Fig. 359]
Upper tributaries of the Chipola River in Florida and Alabama, and the tributaries of the Choctawhatchee immediately to the west (Clench & Turner, 1956).

Elimia induta (Lea 1862)
Flint River basin, Crisp and Dooly counties, Georgia (Goodrich, 1942b).

Elimia ebenum group

Elimia ebenum ebenum (Lea 1841) [Fig. 370]
Cumberland River above the Falls; Smith's Shoals, Pulaski County, Kentucky; springs and small streams of the river downstream to Dickson County, Tennessee (Goodrich, 1940d).

Elimia ebenum emeryensis (Lea 1864)
In branches of the Cumberland River in eastern Kentucky and Tennessee (Goodrich, 1940d).

Elimia gerhardtii group

Elimia annettae (Goodrich 1941) [Fig. 360]
Cahaba River, Lily Shoals, Bibb County, Alabama (Goodrich, 1941a).

Elimia cahawbensis cahawbensis (Lea 1861) [Fig. 371]
Headwaters and small streams and creeks of the Cahaba River; in a few tributaries of the Black Warrior River; Waxahatchee Creek and branches of the Coosa River basin (Goodrich, 1941b).

Elimia cahawbensis fraterna (Lea 1864)
A branch of the Cahaba River in Bibb County, and in the Black Warrior River basin at Murphy's Creek, Blount County, Alabama (Goodrich, 1941c).

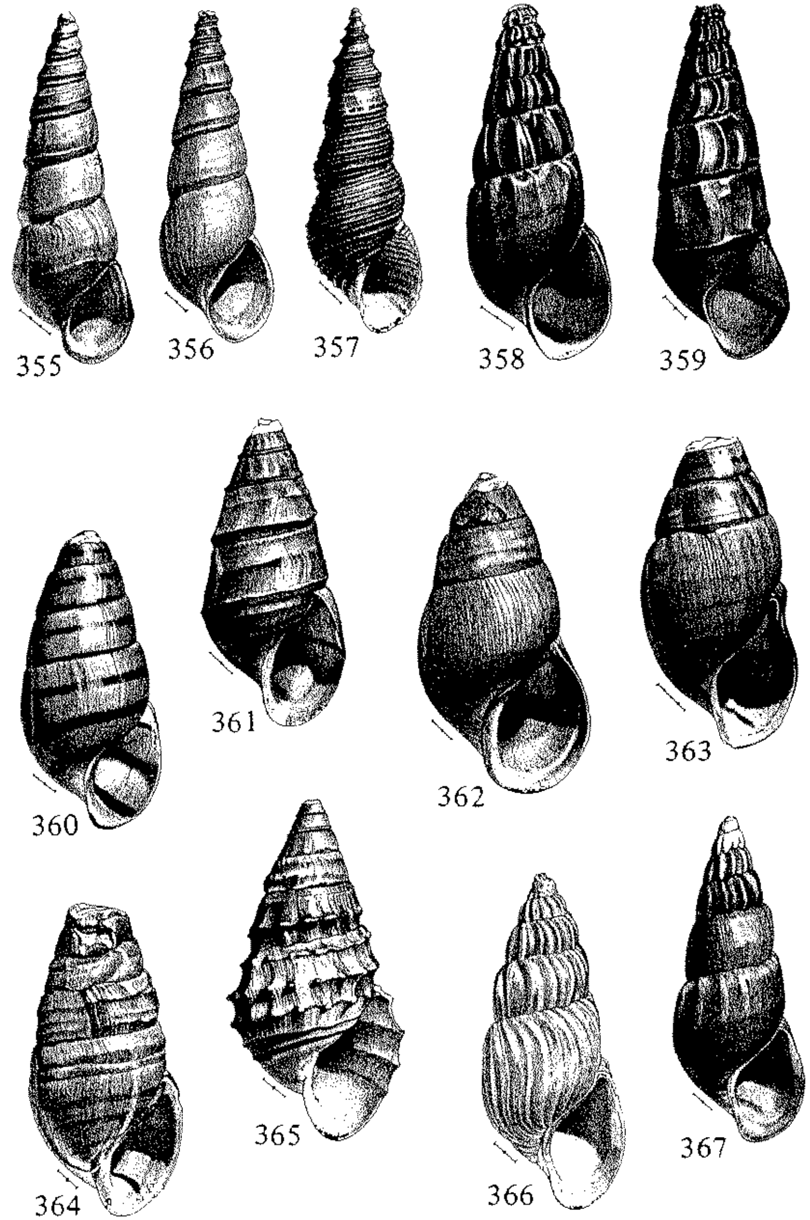
Elimia flava (Lea 1862) [Fig. 372]
Confined to the Tallapoosa River and its tributaries (Goodrich, 1941b).

Elimia gerhardtii (Lea 1862) [Figs. 361, 362, 373]
Coosa River basin, from north Georgia to the lower tributaries of the Coosa River (Goodrich, 1944d).

Elimia varians (Lea 1861)
Cahaba River, Bibb County, Alabama, from Pratt's Ferry to seven miles below Centerville (Goodrich, 1941c).

Elimia hartmaniana group

Elimia hartmaniana (Lea 1861) [Fig. 363]
Coosa River: St. Clair to Elmore County, Alabama (Goodrich, 1944d).



FIGS. 355-367. Shells of Pleuroceridae. FIG. 355. *Elimia strigosa*. FIG. 356. *E. teres*. FIG. 357. *E. troostiana*. FIG. 358. *E. curvicostata*. FIG. 359. *E. dickinsoni*. FIG. 360. *E. annettae*. FIG. 361. *E. gerhardti*. FIG. 362. *E. murrayensis* = *E. gerhardti*. FIG. 363. *E. hartmaniana*. FIG. 364. *E. clausa*. FIG. 365. *E. hydei*. FIG. 366. *E. laqueata laqueata*. FIG. 367. *E. laqueata laqueata*. Measurement lines are divided into millimeters.

Elimia macglameriana (Goodrich 1936) [Fig. 374]
Coosa River: Yancy's Landing, Floyd County, Georgia, to Riddle's Bend, St. Clair County, Alabama (Goodrich, 1944d).
Elimia pygmaea (Smith (in Goodrich) 1936) [Fig. 375]
Three Island Shoals, Coosa River, Talladega County, Alabama (Goodrich, 1944d).

Elimia haysiana group

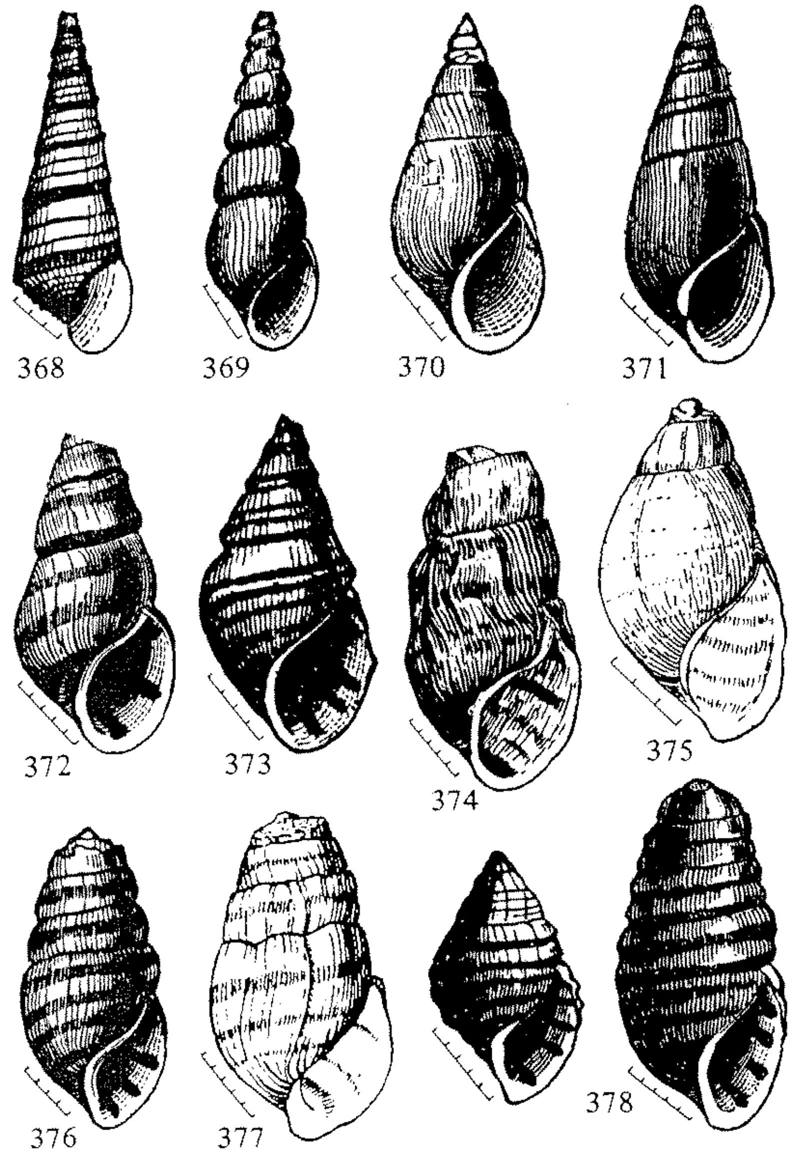
Elimia alabamensis (Lea 1861) [Figs. 376, 377]
In middle sections of the Coosa River, and in creeks of Talladega County, Alabama (Goodrich, 1944d).
Elimia clausa (Lea 1861) [Fig. 364]
Coosa River, in shoals of St. Clair County, Alabama (Goodrich, 1944d).
Elimia haysiana (Lea 1843) [Figs. 378, 379]
Lower part of the Coosa River (Goodrich, 1944d).
Elimia pupoidea (Anthony 1854) [Figs. 380, 381]
Cahaba and Black Warrior rivers, and in the vicinity of Selma, Alabama River, Alabama (Goodrich, 1941c).

Elimia hydei group

Elimia hydei (Conrad 1834) [Fig. 365]
Confined to the Black Warrior River, Alabama, and its branches (Goodrich, 1941b).

Elimia laqueata group

Elimia costifera (Reeve 1861)
Tributaries of the Ohio River in Kentucky and Illinois (Goodrich, 1940d).
Elimia curreyana (Lea 1841)
Green River, Kentucky, and tributaries; streams of Cumberland River, middle Tennessee (Goodrich, 1940d).
Elimia interveniens (Lea 1862)
Tributaries of the Tennessee River in north Alabama (Goodrich, 1940d).
Elimia laqueata laqueata (Say 1829) [Figs. 366, 367, 391]
Green River and tributaries, Kentucky; tributaries of middle parts of Cumberland River, Tennessee; Duck River and branches, Tennessee; tributaries of the Tennessee River, Tennessee and Alabama (Goodrich, 1940d).
Elimia laqueata castanea (Lea 1841) [Fig. 382]
Headwaters of the Duck River, Tennessee (Goodrich, 1940d).
Elimia laqueata costulata (Lea 1841) [Fig. 392]
Green River of Kentucky and branches; branches of the Duck River, Tennessee (Goodrich, 1940d).
Elimia laqueata tortum (Lea 1845)
Elk River drainage in Lynn Creek, Giles County, Tennessee, and Richland



FIGS. 368-378. Shells of Pleuroceridae. FIG. 368. *Elimia porrecta*. FIG. 369. *E. rubella* = ?*E. porrecta*. FIG. 370. *E. ebenum ebenum*. FIG. 371. *E. cahawbensis cahawbensis*. FIG. 372. *E. flava*. FIG. 373. *E. gerhardti*. FIG. 374. *E. macglameriana*. FIG. 375. *E. pygmaea*. FIG. 376. *E. alabamensis*. FIG. 377. *E. alabamensis*. FIG. 378. *E. haysiana*. Measurement lines are divided into millimeters. Figs. 368-373, 376 and 378 are from Tryon (1865-66); Figs. 374, 375 and 377 are from Goodrich (1936).

Creek, Lawrence County, Tennessee; headwaters of Big Creek, Lawrence County, Tennessee (Goodrich, 1930a, 1940d).

Elimia paupercula (Lea 1862) [Fig. 383]
Creeks of northern Alabama (Goodrich, 1940d).

Elimia pybasi (Lea 1862)
Springs and streams of northern Alabama (Goodrich, 1941b).

Elimia livescens group

Elimia livescens livescens (Menke 1830) [Fig. 393]
St. Lawrence River drainage from the Great Lakes to Lake Champlain and Quebec; tributaries of the Ohio River, east of Scioto River in Ohio; Wabash River and branches, west to the Illinois River; through the Erie Canal it has invaded the Hudson River basin (Goodrich, 1940d, 1945).

Elimia livescens gracilior (Lea 1861)
Lakes of Summit and Stark counties, Ohio (Goodrich, 1939d).

Elimia livescens haldemani (Tryon 1865) [Fig. 384]
Lake Erie; ? Lake Champlain (Goodrich, 1939d).

Elimia mutabilis group

Elimia mutabilis mutabilis (Lea 1862) [Fig. 394]
Streams of western Georgia and Florida, and southern Alabama; also a few creeks and springs of Alabama within the Alabama River system (Goodrich, 1942b).

Elimia mutabilis timidus (Goodrich 1942)
Spring two miles northwest of Hawkinsville, Pulaski County, Georgia, in the basin of the Altamaha River (Goodrich, 1942b).

Elimia taitiana (Lea 1841) [Fig. 395]
Branch of Sepulga River, Conecuh County, Alabama; small streams of the Alabama River system, Sumpter, Marengo, Monroe and Wilcox counties, Alabama (Goodrich, 1942b).

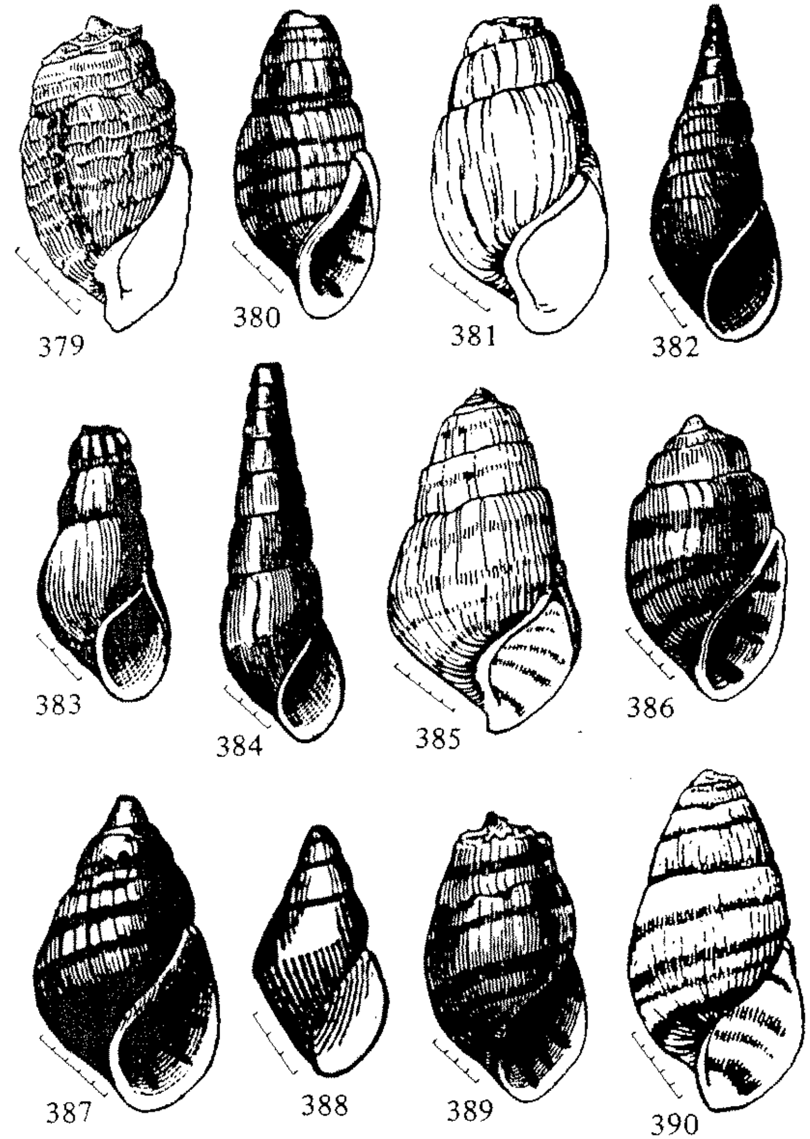
Elimia olivula group

Elimia bellula (Lea 1861) [Fig. 396]
In the middle part of the Coosa River, and in Yellowleaf Creek, Shelby County, and Choccolocco Creek, Talladega County, Alabama (Goodrich, 1944d).

Elimia chiltonensis (Goodrich, 1941) [Fig. 397]
Waxahatchee Creek of Chilton and Shelby counties, Alabama, and three of its tributaries, and in Weguska Creek, Coosa County, Alabama (Goodrich, 1941a).

Elimia cylindracea (Conrad 1834) [Fig. 398]
Tombigbee River from Columbus, Mississippi, to near its mouth, and in the lower part of the Black Warrior River, Alabama (Goodrich, 1936).

Elimia gibbera (Smith 1936) [Fig. 399]
Coosa River, shoals of St. Clair County, Alabama (Goodrich, 1944d).



FIGS. 379-390. Shells of Pleuroceridae. FIG. 379. *Elimia haysiana*. FIG. 380. *E. pupoidea*. FIG. 381. *E. pupoidea*. FIG. 382. *E. laqueata castanea*. FIG. 383. *E. paupercula*. FIG. 384. *E. livescens haldemani*. FIG. 385. *E. pilsbryi*. FIG. 386. *E. showalteri*. FIG. 387. *E. variata*. FIG. 388. *E. aterina*. FIG. 389. *E. bullula*. FIG. 390. *E. bullula*. Measurement lines are divided into millimeters. Figs. 379, 380, 382-384, 386-389 are from Tryon (1865-66, 1873b); Figs. 381, 385 and 390 are from Goodrich (1936).

Elimia lachryma (Reeve 1861) [Fig. 400]
Coosa River: Gilbert's Ferry, Etowah County, to near Childersburg, Talladega County, Alabama (Goodrich, 1944d).

Elimia laeta (Jay 1839) [Fig. 401]
Coosa River, from Cherokee County to Elmore County, Alabama (Goodrich, 1944d).

Elimia olivula (Conrad 1834) [Fig. 402]
Alabama River and the lower Cahaba River (below the Falls Line), Alabama (Goodrich, 1941c).

Elimia pilsbryi (Goodrich 1927)[25] [Fig. 385]
Coosa River: Hall's Island, Talladega County, to mouth of Yellowleaf Creek of Chilton County, Alabama (Goodrich, 1944d).

Elimia showalteri (Lea 1860) [Fig. 386]
Cahaba River, from Lily Shoals to two miles east of Harrisburg, Bibb County, Alabama (Goodrich, 1941c).

Elimia variata (Lea 1861) [Fig. 387]
Cahaba River and tributaries in Shelby and Bibb counties, Alabama; Little Cahaba River, Jefferson County (Goodrich, 1941c).

Elimia semicarinata group

Elimia semicarinata (Say 1829)
Tributaries of Ohio River, Scioto River, Ohio, to Big Blue River, Indiana; Licking River to Salt River in Kentucky; two creeks of Green River of Kentucky (Goodrich, 1940d).

Elimia simplex group

Elimia aterina (Lea 1863) [Fig. 388]
Springs and small streams of Claiborne and Hancock counties, Tennessee (Goodrich, 1940d).

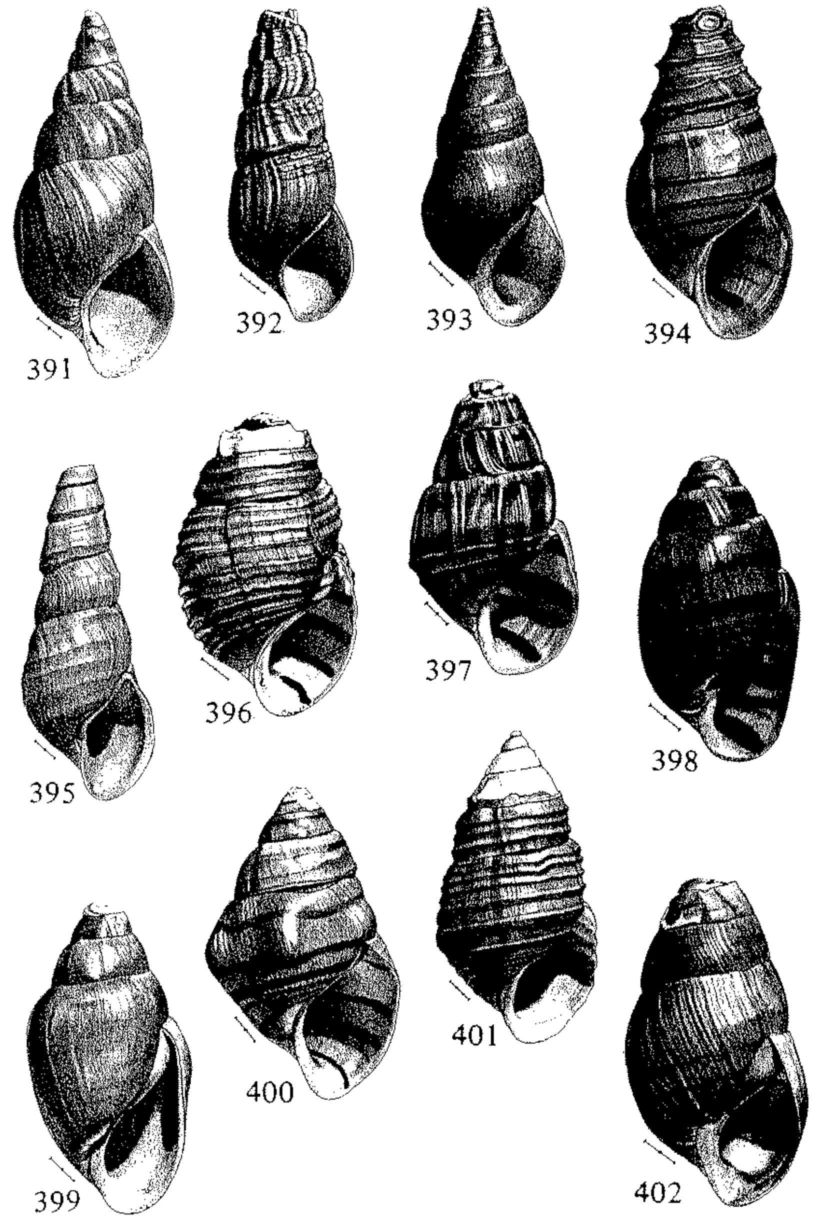
Elimia clavaeformis (Lea 1841) [Figs. 403-405]
Tributaries of the upper Tennessee River in Virginia, Tennessee and North Carolina (Goodrich, 1940d).

Elimia simplex (Say 1825) [Fig. 406]
Headwaters of the Tennessee River system in Virginia, Tennessee and North Carolina; Beaver Fork of the Bluestone River, which is a tributary of the Kanawha River in Mercer County, West Virginia (Goodrich, 1940d).

Elimia vanuxemiana group

Elimia bullula (Lea 1861) [Figs. 389, 390]
Coosa River, Cherokee County, Alabama, to near the Narrows, Coosa County, and in five tributaries between these points (Goodrich, 1944d).

Elimia caelatura caelatura (Reeve 1860) [Fig. 407]
Coosa River Basin, from Georgia headwaters to side streams of Talladega



FIGS. 391-402. Shells of Pleuroceridae. FIG. 391. *Elimia mutata* = *E. laqueata laqueata*. FIG. 392. *E. laqueata costulata*. FIG. 393. *E. livescens livescens*. FIG. 394. *E. mutabilis mutabilis*. FIG. 395. *E. taitiana*. FIG. 396. *E. bellula*. FIG. 397. *E. chiltonensis*. FIG. 398. *E. cylindracea*. FIG. 399. *E. gibbera*. FIG. 400. *E. lachryma*. FIG. 401. *E. laeta*. FIG. 402. *E. olivula*. Measurement lines are divided into millimeters.

County, Alabama (Goodrich, 1944d).

Elimia caelatura excellens (Goodrich, 1935) [Fig. 408]
Known from three streams in the Alabama River system of northwestern Georgia and northeastern Alabama (Goodrich, 1941b).

Elimia caelatura georgiana (Lea 1862) [Fig. 409]
Chattooga River, Georgia (Goodrich, 1941b).

Elimia caelatura infuscata (Lea 1862) [Fig. 415]
Small streams of the Alabama River system in Bartow, Floyd, Gordon and Murray counties, Georgia, and Cherokee, Etowah and St. Clair counties, Alabama (Goodrich, 1941b).

Elimia caelatura lecontiana (Lea 1841)
Creeks of the Alabama River system in northwestern Georgia to northeastern Alabama (Goodrich, 1941b).

Elimia caelatura luteocella (Lea 1868) [Fig. 410]
Small streams of the Alabama River system in northwestern Georgia, northeastern Alabama and Talladega County, Alabama (Goodrich, 1941b).

Elimia caelatura stearnsiana (Call 1886) [Figs. 411, 416]
Small streams of the Alabama River from north Georgia to Calhoun, Shelby and Talladega counties, Alabama (Goodrich, 1941b).

Elimia fascinans (Lea 1861) [Fig. 417]
Coosa River Basin, in creeks from Calhoun to Coosa County, and occasionally in the Coosa River (Goodrich, 1944d).

Elimia jonesi (Goodrich 1936) [Fig. 418]
Coosa River: Ten Island Shoals, St. Clair County, to the Bar, Chilton County, Alabama (Goodrich, 1944d).

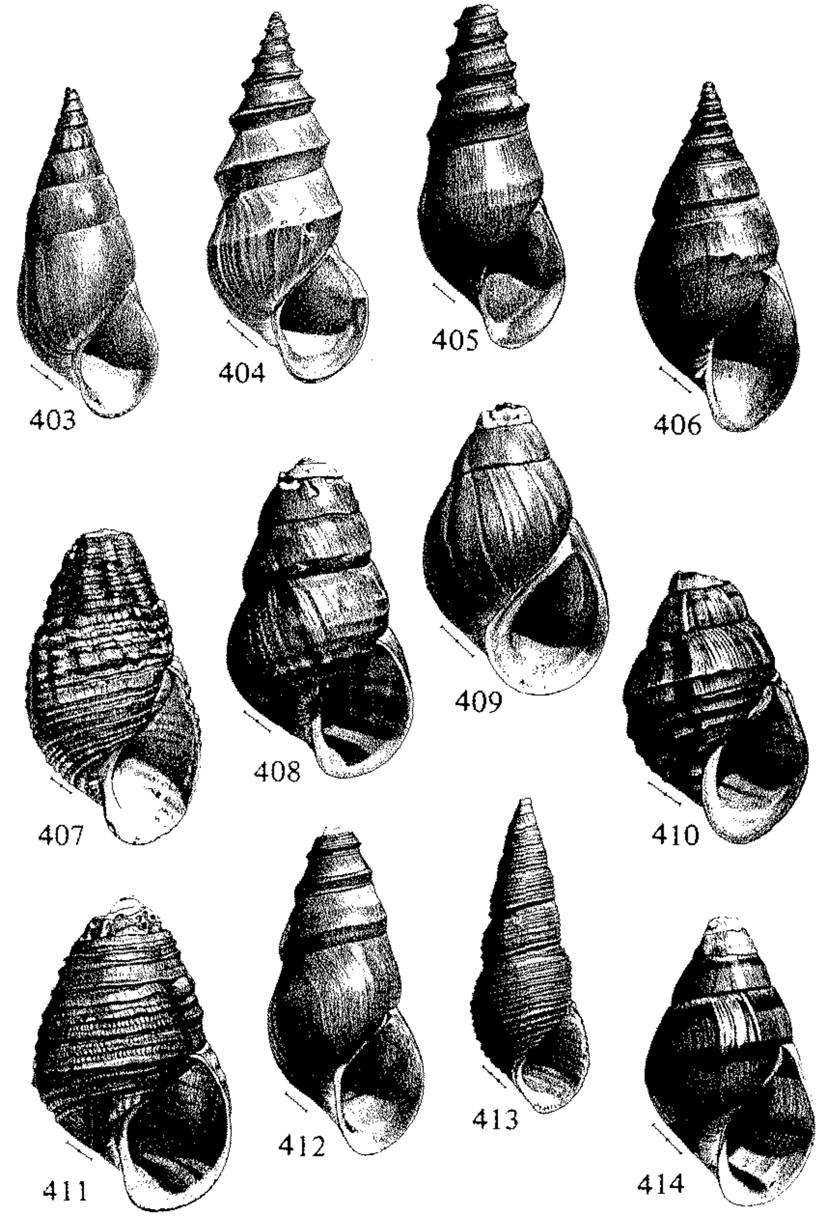
Elimia vanuxemiana (Lea 1843) [Figs. 419-422]
Coosa River Basin: in the Coosa River at Etowah County and downstream, and in the mouths of a few tributaries of the same range (Goodrich, 1944d).

Elimia virginica group

Elimia proxima (Say 1825) [Fig. 412]
Highlands of North and South Carolina. *Elimia proxima* may be a composite group, those in the Atlantic drainage having been derived from *E. symmetrica* and those in the Tennessee drainage from *E. simplex* (Goodrich, 1942b, 1950). Say (1825) originally described *E. proxima* from specimens from three localities: a small brook which discharges into the Catawba River near Landsford, South Carolina [Atlantic drainage], and in the warm springs and in the French Broad River, both in Buncombe County, North Carolina [Tennessee drainage].

Elimia symmetrica (Haldeman 1841) [Figs. 423-425]
Southern Virginia; North Carolina (Goodrich, 1942b).

Elimia virginica (Say 1817) [Fig. 413]
Connecticut River, Massachusetts and Connecticut, to Virginia; ? also North Carolina; westward through the Erie Canal to Monroe County, New York, in the Great Lakes basin (Goodrich, 1942b).



FIGS. 403-414. Shells of Pleuroceridae. FIG. 403. *Elimia clavaeformis*. FIG. 404. *E. acutocarinata* = ? *E. clavaeformis*. FIG. 405. *E. acutocarinata* = ? *E. clavaeformis*. FIG. 406. *E. simplex*. FIG. 407. *E. caelatura caelatura*. FIG. 408. *E. caelatura excellens*. FIG. 409. *E. caelatura georgiana*. FIG. 410. *E. caelatura luteocella*. FIG. 411. *E. stearnsiana*. FIG. 412. *E. proxima*. FIG. 413. *E. virginica*. FIG. 414. *E. clara*. Measurement lines are divided into millimeters.

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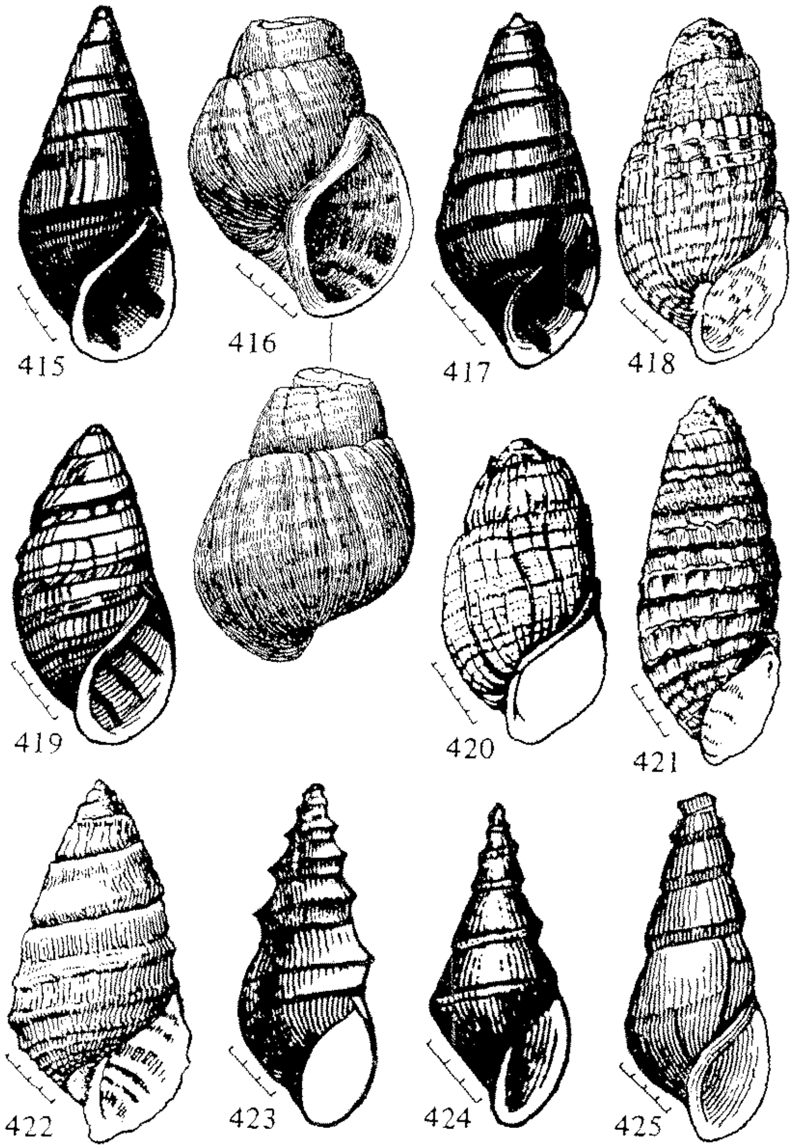
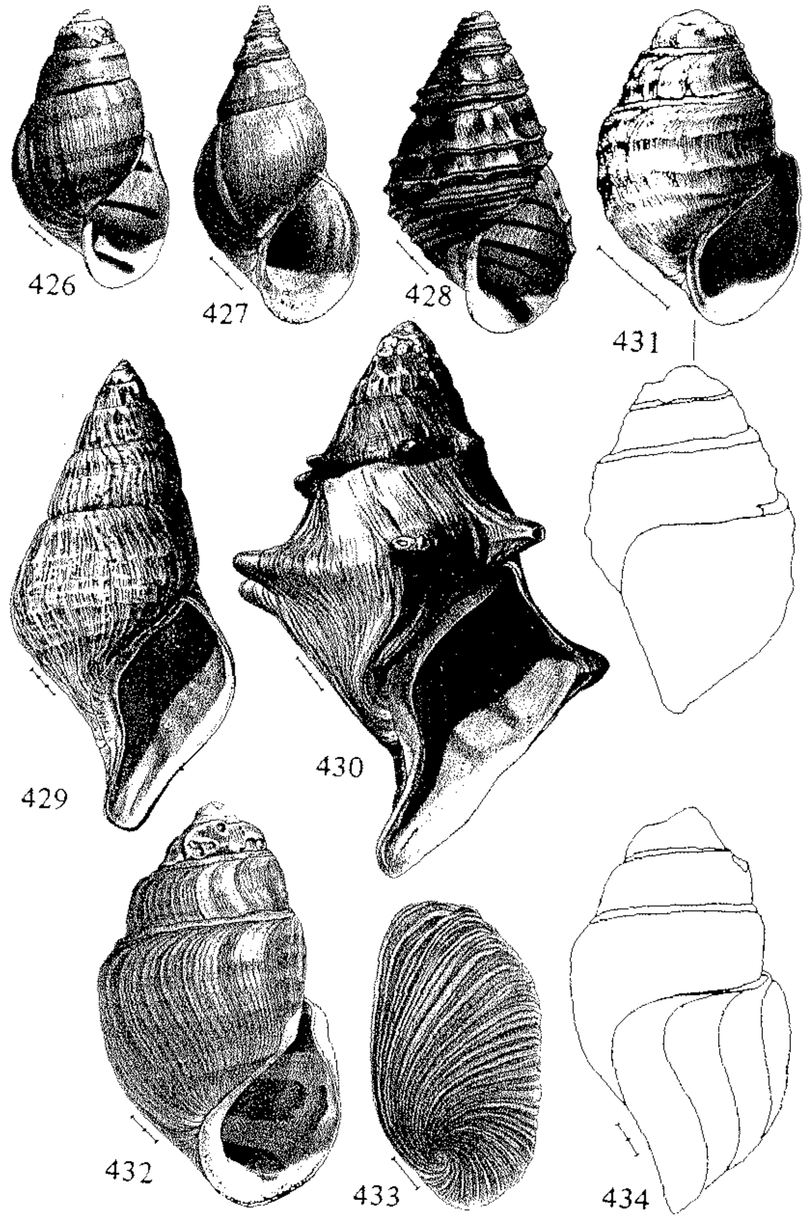


FIGS. 415-425. Shells of Pleuroceridae. FIG. 415. *Elimia caelatura infuscata*. FIG. 416. *E. caelatura stearnsiana*. FIG. 417. *E. fascinans*. FIG. 418. *E. jonesi*. FIG. 419. *E. vanuxemiana*. FIG. 420. *E. vanuxemiana*. FIG. 421. *E. vanuxemiana*. FIG. 422. *E. vanuxemiana*. FIG. 423. *E. symmetrica*. FIG. 424. *E. symmetrica*. FIG. 425. *E. symmetrica*. Measurement lines are divided into millimeters. Figs. 415, 417, 419, 423-425 are from Tryon (1865-66, 1873b); Fig. 416 is from Call (1886c); Figs. 418 and 420-422 are from Goodrich (1936).



FIGS. 426-434. Shells of Pleuroceridae. FIG. 426. *Elimia ampla*. FIG. 427. *E. potosiensis potosiensis*. FIG. 428. *E. interrupta*. FIG. 429. *Io fluvialis*. FIG. 430. *I. fluvialis* form *angitremoides*. FIG. 431. *Gyrotoma excisum*, apertural and right lateral views. FIG. 432. *G. excisum*. FIG. 433. *G. excisum*, operculum. FIG. 434. *G. excisum*, right lateral view of the shell in Fig. 432. Measurement lines = 1 mm or are divided into millimeters.

Elimia clara (group ?)

Elimia clara (Anthony 1854) [Fig. 414]
Cahaba River, Alabama, and its tributaries (Goodrich, 1941c).
Elimia ampla (Anthony 1854)[26] [Fig. 426]
Cahaba River, Alabama, at Centerville and Lily Shoals (Goodrich, 1941c).

Elimia potosiensis (group ?)

Elimia potosiensis potosiensis (Lea 1841) [Fig. 427]
Upland streams of a few Missouri counties (Goodrich, 1939e).
Elimia potosiensis crandalli (Pilsbry 1890)
Known only from Mammoth Springs, Fulton County, Arkansas (Goodrich, 1939e).
Elimia potosiensis ozarkensis (Call 1886) [Fig. 458]
In springs of Shannon, Carter, Washington; Dent and Camden counties, Missouri (Goodrich, 1939e).
Elimia potosiensis plebius (Gould 1850) [Figs. 459, 460]
Common in rivers and creeks of the Ozarkian area of Missouri and Arkansas, and in Oklahoma counties bordering Missouri (Goodrich, 1939e).

group ?

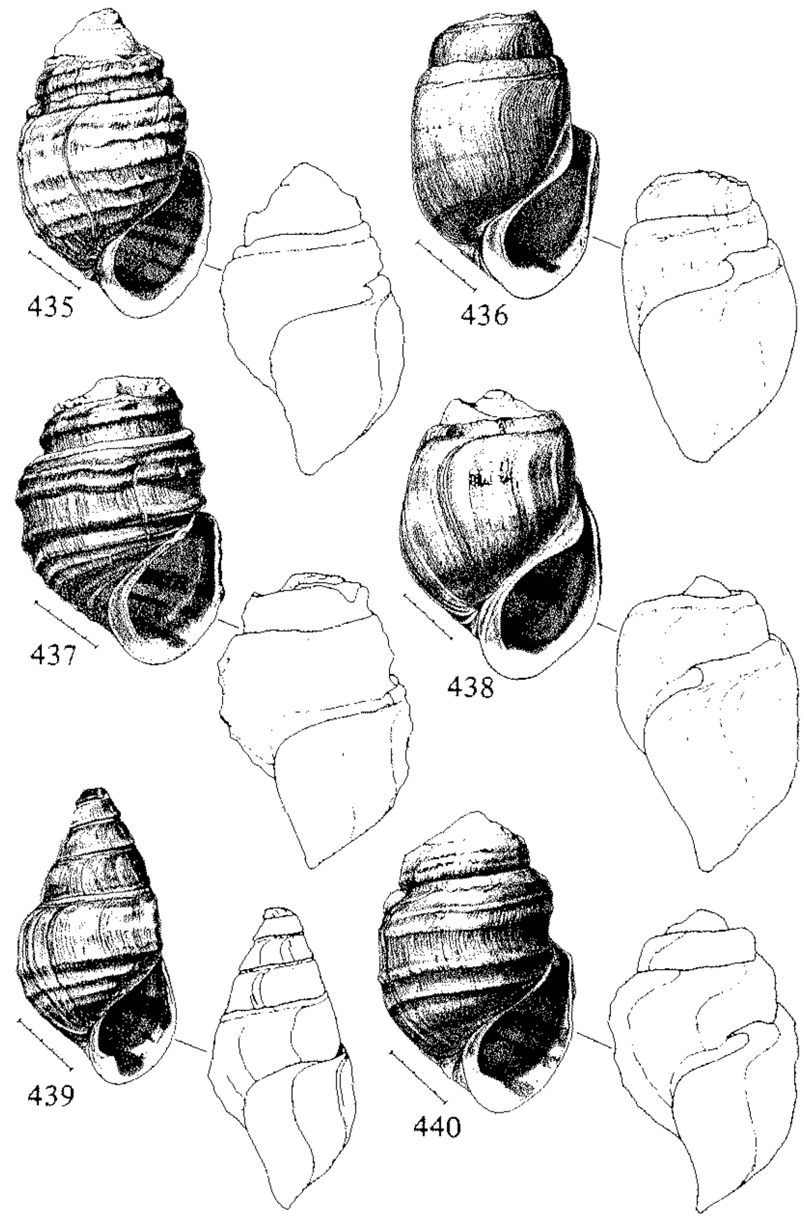
Elimia interrupta (Haldeman 1840) [Fig. 428]
Hiwassee River and its streams, North Carolina and eastern Tennessee (Goodrich, 1940d).

(? hybrid)

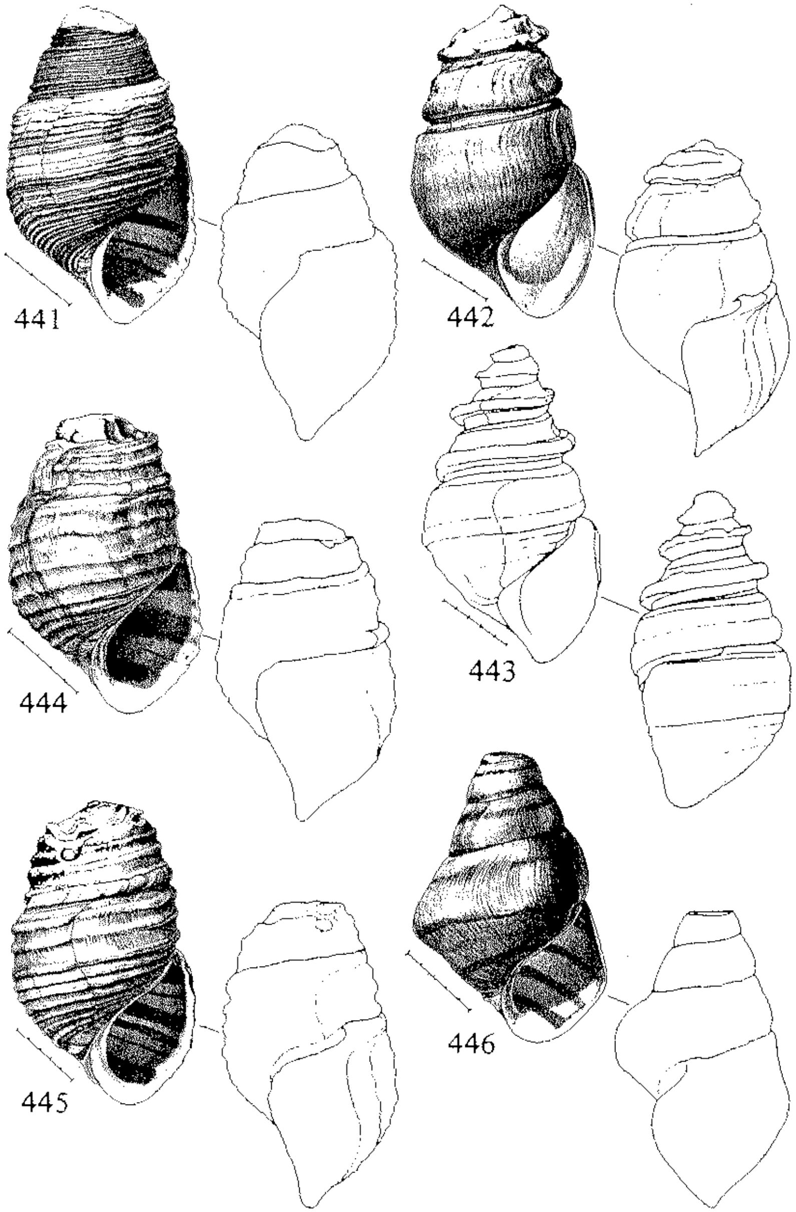
Elimia ornata (Lea 1868)[27]
Coosa River Basin, confined to a few miles of the Connesauga River, Georgia, and nearby tributaries (Goodrich, 1944d).

Genus *Gyrotoma* Shuttleworth 1845[28, 29]

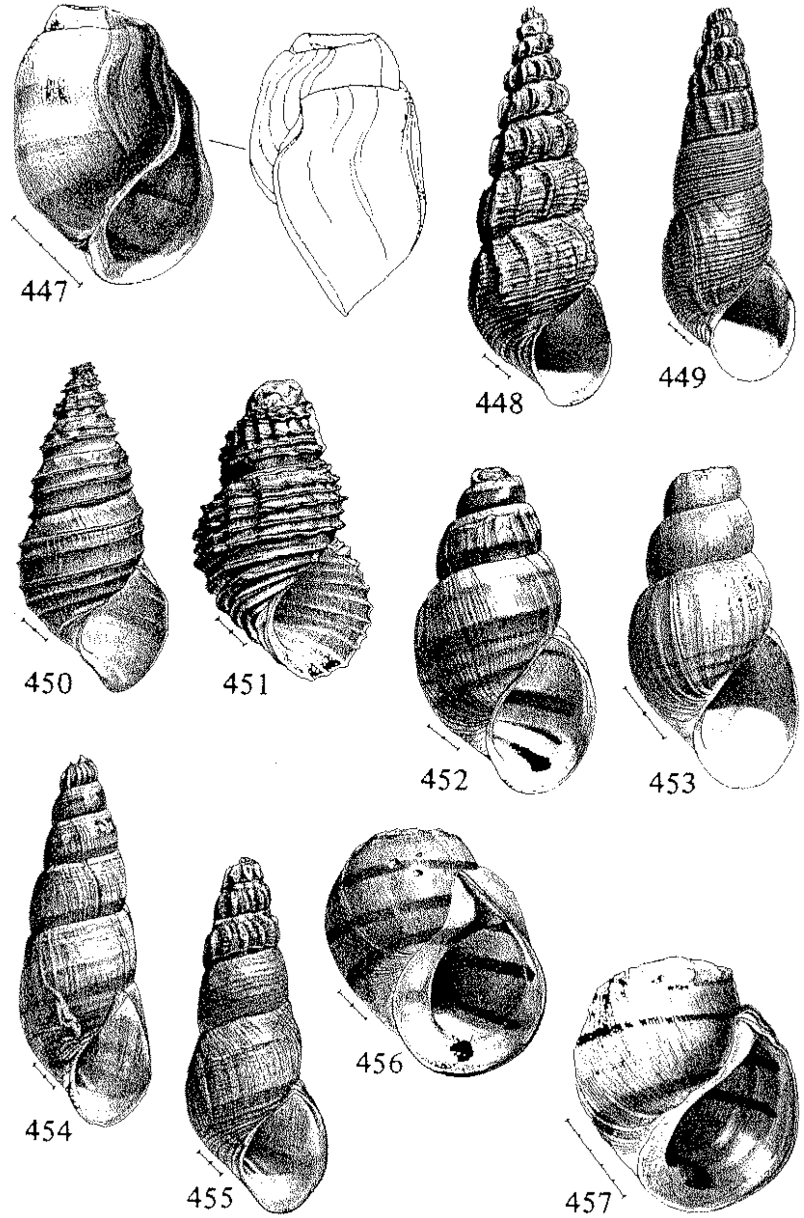
Gyrotoma excisum (Lea 1843) [Figs. 431-440]
Coosa River, Alabama, in Chilton, Coosa, Elmore, Shelby, St. Clair and Talladega counties.
Gyrotoma lewisi (Lea 1869) [Fig. 441]
Coosa River, Alabama: Fort William Shoals, Talladega County, and Three Island Shoals, Wilsonville, Shelby County (Goodrich, 1924a, 1944d).
Gyrotoma pagodum (Lea 1845) [Figs. 442, 443]
Coosa River, Alabama: The Bar, Chilton County, to Wetumpka, Elmore County (Goodrich, 1944d).



FIGS. 435-440. Shells of Pleuroceridae, apertural and right lateral views. FIG. 435. *Gyrotoma alabamensis* = ? *G. excisum*. FIG. 436. *G. ampla* = ? *G. excisum*. FIG. 437. *G. carinifera* = ? *G. excisum*. FIG. 438. *G. incisa* = ? *G. excisum*. FIG. 439. *G. laciniatum* = ? *G. excisum*. FIG. 440. *G. spillmani* = ? *G. excisum*. Measurement lines are divided into millimeters.



FIGS. 441-446. Shells of Pleuroceridae, apertural and right lateral views. FIG. 441. *Gyrotoma lewisi*. FIG. 442. *G. pagodum*. FIG. 443. *G. pagodum*. FIG. 444. *G. pumilum*. FIG. 445. *G. hendersoni* = ? *G. pumilum*. FIG. 446. *G. pyramidatum*. Measurement lines are divided into millimeters.



FIGS. 447-457. Shells of Pleuroceridae. FIG. 447. *Gyrotoma walkeri*, apertural and right lateral views. FIG. 448. *Juga plicifera*. FIG. 449. *J. silicula*. FIG. 450. *J. (Calibasis) acutifilosa*. FIG. 451. *J. (C.) occata*. FIG. 452. *J. (Oreobasis) bulbosa*. FIG. 453. *J. (O.) nigrina*. FIG. 454. *J. hemphilli hemphilli*. FIG. 455. *J. hemphilli dallesensis*. FIG. 456. *Leptoxis ampla*. FIG. 457. *L. ampla*. Measurement lines are divided into millimeters.

Gyrotoma pumilum (Lea 1860) [Figs. 444, 445]
Coosa River, Alabama: Fort William Shoals, Talladega County, and Weduska Shoals, Shelby County, to Wetumpka (Goodrich, 1924a, 1944d).

Gyrotoma pyramidatum Shuttleworth 1845 [Fig. 446]
Coosa River, Alabama: Ten Island Shoals, St. Clair County, to the mouth of Yellowleaf Creek, Shelby County (Goodrich, 1944d).

Gyrotoma walkeri Smith (in Goodrich) 1924 [Fig. 447]
Coosa River, Alabama: Weduska Shoals, Shelby County, to Butting Ram Shoals, Coosa County (Goodrich, 1944d).

Genus *Io* Lea 1831

Io fluvialis (Say 1825)[30] [Figs. 429, 430, 461-465]
Tennessee River and several of its main tributaries in western Virginia and eastern Tennessee (Clinch, French Broad, Holston, Nolichucky and Powell rivers).

Genus *Juga* H. & A. Adams 1854

Subgenus *Juga* s.s.

Juga hemphilli hemphilli (Henderson 1935) [Fig. 454]
Near Portland, Oregon (Henderson, 1935a).

Juga hemphilli dallesensis (Henderson 1935) [Fig. 455]
Mill Creek, The Dalles, Oregon (Henderson, 1935a).

Juga plicifera (Lea 1838) [Fig. 448]
Larger streams of Oregon and Washington (Goodrich, 1942d).

Juga silicula (Gould 1847) [Fig. 449]
Streams of Oregon and Washington (Goodrich, 1942d).

Subgenus *Calibasis* Taylor 1966

Juga (Calibasis) acutifilosa acutifilosa (Stearns 1890) [Fig. 450]
Shasta and Lassen counties, California (Goodrich, 1942d).

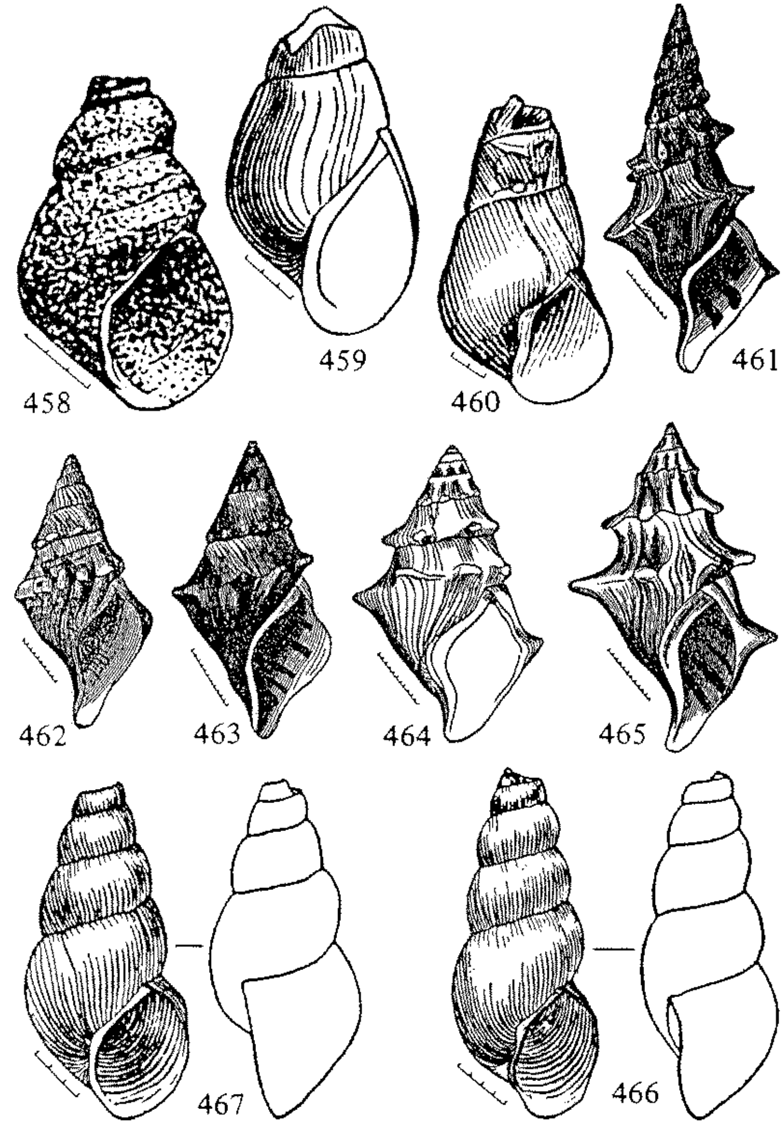
Juga (Calibasis) acutifilosa pittensis (Henderson 1935)
Fall River, Shasta County, California (Henderson, 1935a).

Juga (Calibasis) acutifilosa siskiyouensis (Pilsbry 1899)
Siskiyou County, California (Goodrich, 1942d).

Juga (Calibasis) occata (Hinds 1844) [Fig. 451]
Sacramento and San Joaquin rivers, California (Goodrich, 1942d).

Subgenus *Oreobasis* Taylor 1966

Juga (Oreobasis) bulbosa (Gould 1847) [Fig. 452]
Lower Columbia River in Oregon and Washington and several of its tributaries



FIGS. 458-467. Shells of Pleuroceridae. FIG. 458. *Elimia potosiensis ozarkensis*. FIG. 459. *E. potosiensis plebius*. FIG. 460. *E. potosiensis plebius*. FIG. 461. *Io fluvialis* form *turrita*. FIG. 462. *I. fluvialis* form *verrucosa*. FIG. 463. *I. fluvialis* form *recta*. FIG. 464. *I. fluvialis* form *brevis*. FIG. 465. *I. fluvialis* form *spinosa*. FIG. 466. *Juga (Oreobasis) interioris*. FIG. 467. *J. (O.) laurae*. Measurement lines are divided into millimeters. Fig. 458 is from Call (1886b); Figs. 459-465 are from Tryon (1873b); Figs. 466 and 467 are from Goodrich (1944a).

(Deschutes and Owyhee rivers) (Pilsbry, 1899f).

Juga (Oreobasis) interioris (Goodrich 1944) [Fig. 466]
Badger Creek, Bitner Ranch, Washoe County, and in the outlet of artesian wells, nine miles west of Gerlach, Washoe County, Nevada (Goodrich, 1944a).

Juga (Oreobasis) laurae (Goodrich 1944) [Fig. 467]
Found in a spring west of Home Camp and in Boulder Springs, both in Long Valley, Nevada, and in springs of Grasshopper Valley, Lassen County, California (Goodrich, 1944a).

Juga (Oreobasis) nigrina (Lea 1856) [Fig. 453]
Head streams and river tributaries of Oregon and northern California (Goodrich, 1942d).

Genus *Leptoxis* Rafinesque 1819

Subgenus *Leptoxis* s.s.[32]

Leptoxis ampla (Anthony 1855) [Figs. 456, 457]
Cahaba River, Alabama, and some of its tributaries (Goodrich, 1941b).

Leptoxis clipeata (Smith (in Goodrich) 1922) [Fig. 468]
Coosa River, Alabama, from near Riverside, St. Clair County, to Butting Ram Shoals (Goodrich, 1944d).

Leptoxis compacta (Anthony 1854) [Figs. 469, 470]
Mostly confined to the middle parts of the Cahaba River, but taken at two upstream localities and in Buck Creek, Shelby County, Alabama (Goodrich, 1941b).

Leptoxis foremani (Lea 1843) [Figs. 471, 472]
Coosa River, Alabama, from Three Island Shoals, Talladega County, to Butting Ram Shoals (Goodrich, 1944d).

Leptoxis formosa (Lea 1860)
Coosa River, from the head streams in northwestern Georgia to Coosa County, Alabama; Terrapin Creek, Cherokee County, Alabama (Goodrich, 1941b, 1944d).

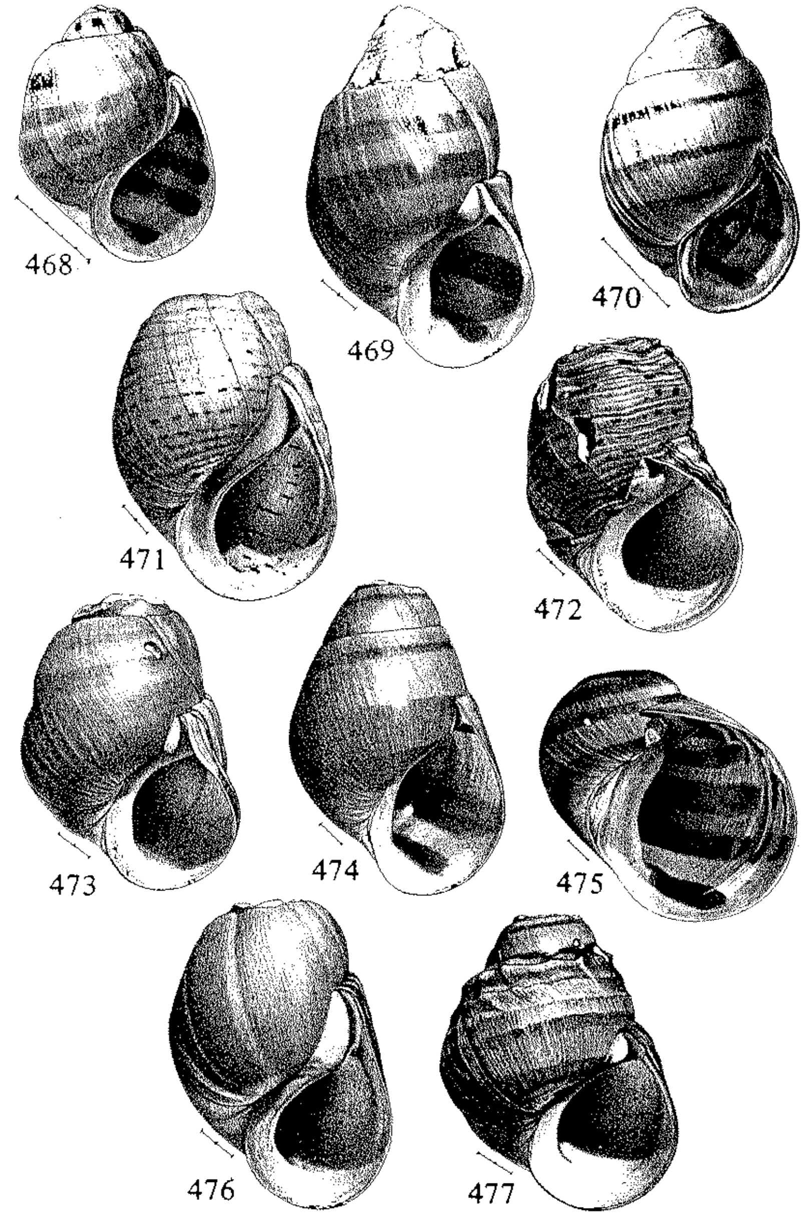
Leptoxis ligata (Anthony 1860) [Fig. 473]
Coosa River, Alabama, from Weduska Shoals, Shelby County, to Wetumpka (Goodrich, 1944d).

Leptoxis lirata (Smith (in Goodrich) 1922)[33]
Three Island and Fort William shoals, Coosa River, Talladega County, Alabama (Goodrich, 1922).

Leptoxis melanoides (Conrad 1834) [Fig. 474]
Black Warrior River (Goodrich, 1922).

Leptoxis occultata (Smith (in Goodrich) 1922) [Fig. 475]
Coosa River, Alabama, confined to the shoals bordering Chilton and Coosa counties (Goodrich, 1944d).

Leptoxis picta (Conrad 1834) [Fig. 476]
Alabama River from the Coosa River to Clairborne, Monroe County, Alabama; in the Coosa River only as far up as the gravel bars below the last series of rapids below Wetumpka (Goodrich, 1922, 1944d).

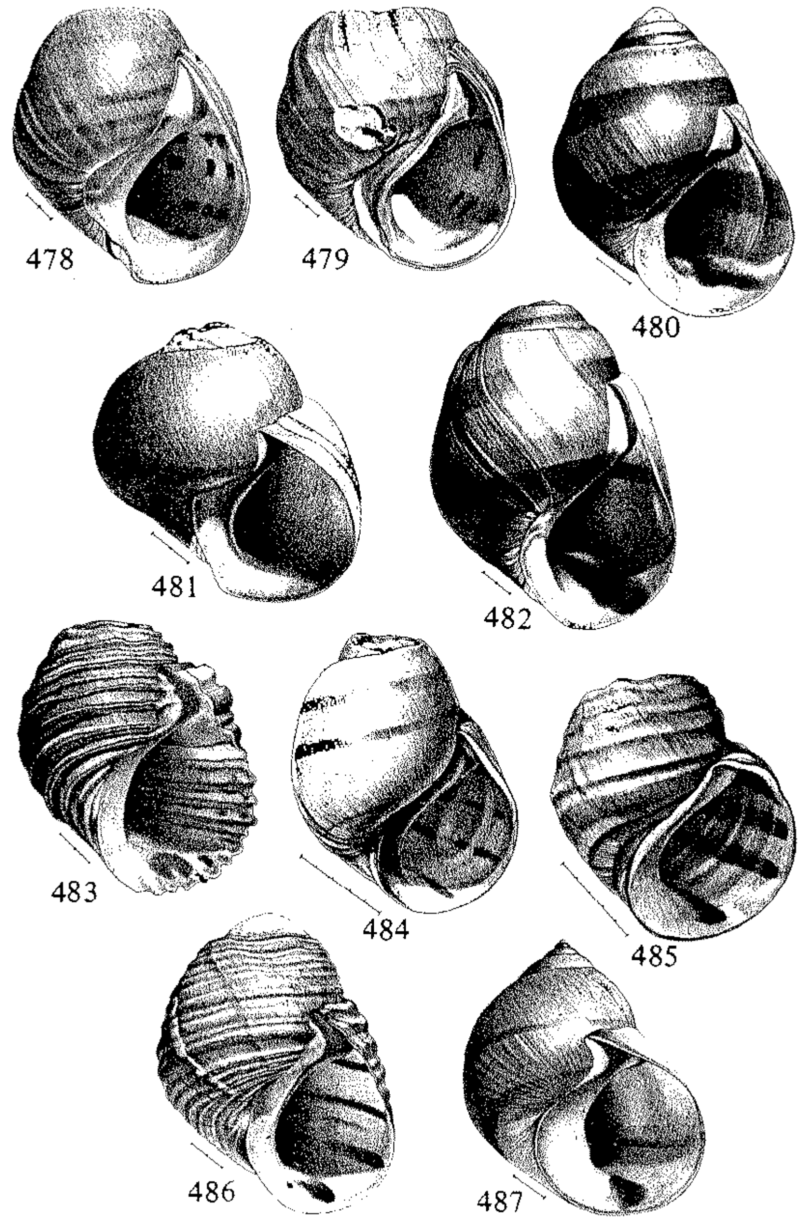


FIGS. 468-477. Shells of Pleuroceridae. FIG. 468. *Leptoxis clipeata*. FIG. 469. *L. compacta*. FIG. 470. *L. compacta*. FIG. 471. *L. foremani*. FIG. 472. *L. downiei* = *L. foremani*. FIG. 473. *L. ligata*. FIG. 474. *L. melanoides*. FIG. 475. *L. occultata*. FIG. 476. *L. picta*. FIG. 477. *L. plicata*. Measurement lines = 1 mm or are divided into millimeters.

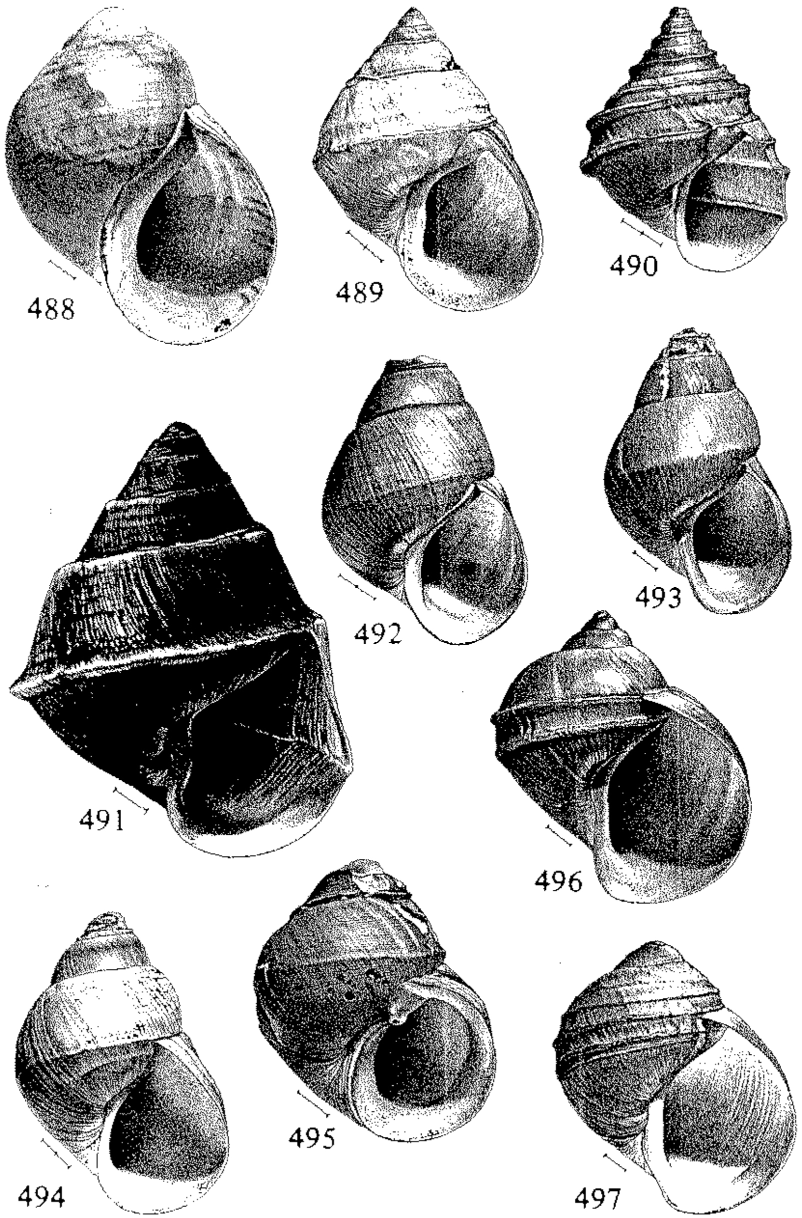
Leptoxis plicata (Conrad 1834) [Fig. 477]
Headwaters of the Black Warrior River, and Valley Creek, Jefferson County, Alabama (Goodrich, 1922, 1941b).
Leptoxis praerosa (Say 1821) [Figs. 478-482]
Ohio River, below Cincinnati, Ohio, to Elizabethtown, Illinois, together with a few tributaries; Cumberland River and branches; Duck River, Coffee County, Tennessee, to its mouth; Tennessee River and the lower parts of its tributaries (Goodrich, 1940d).
Leptoxis showalteri (Lea 1860) [Fig. 483]
Coosa River, Alabama, from Ten Island Shoals, St. Clair County, to Fort William and Peckerwood Shoals, Talladega County (Goodrich, 1944d).
Leptoxis taeniata (Conrad 1834) [Figs. 484-486]
Alabama River and the Coosa River and its tributaries, Alabama, and into the Cahaba River for a short distance (Goodrich, 1922, 1944d).
Leptoxis umbilicata (Wetherby 1876) [Fig. 528]
Stone's River, Red River, and Ringgold Creek of the Cumberland River, all in Tennessee; Elk River, Franklin County, Tennessee (Goodrich, 1940d).
Leptoxis vittata (Lea 1860) [Fig. 487]
Coosa River, Alabama, from The Bar, Chilton County, to Wetumpka (Goodrich, 1922).

Subgenus *Mudalia* Haldeman 1840

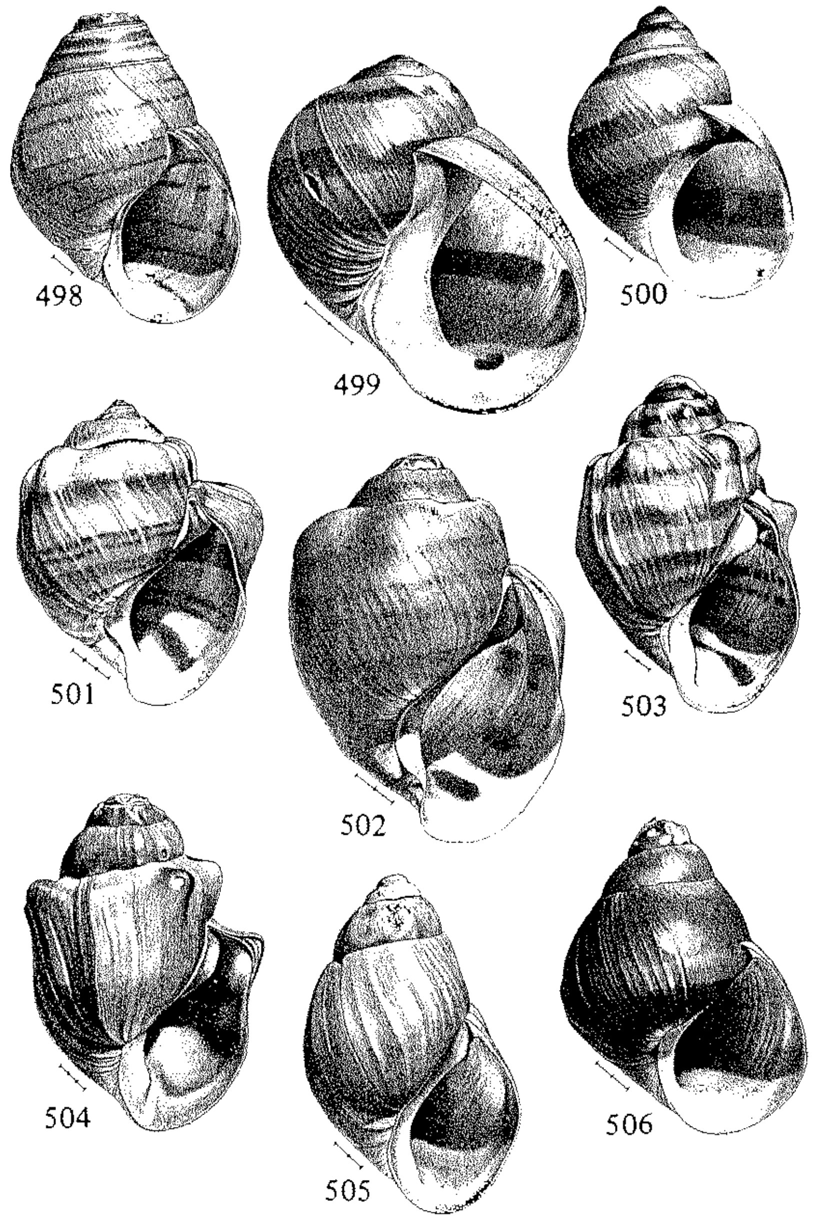
Leptoxis (Mudalia) arkansensis (Hinkley 1915) [Fig. 488]
White River, Baxter County, Arkansas, and North Fork of the White River, east of Richville, Douglas County, Missouri (Goodrich, 1939e).
Leptoxis (Mudalia) carinata carinata (Bruguière 1792) [Figs. 489-492]
New York to North Carolina; ? also South Carolina (Goodrich, 1942b).
Leptoxis (Mudalia) carinata nickliniata (Lea 1841) [Fig. 493]
Hot Springs, Bath County, Virginia (Goodrich, 1942b).
Leptoxis (Mudalia) dilatata (Conrad 1835) [Fig. 494]
Kanawha River, West Virginia; its head streams and branches (Goodrich, 1940d).
Leptoxis (Mudalia) minor (Hinkley 1912) [Fig. 495]
Tennessee River at Muscle Shoals, Lauderdale County, Alabama (Goodrich, 1940d).
Leptoxis (Mudalia) trilineata (Say 1829) [Figs. 496, 497]
Ohio River, Cincinnati, Ohio, to Louisville, Kentucky; Little Miami River, Ohio, near its mouth; Five-mile Creek, Campbell County, Kentucky (Goodrich, 1940d).
Leptoxis (Mudalia) virgata (Lea 1841) [Figs. 498-500]
Holston River and its forks, Sullivan County to Knox County, Tennessee; Tennessee River, Knox County, Tennessee, to Jackson County, Alabama; Hiwassee River, North Carolina (Goodrich, 1940d).



FIGS. 478-487. Shells of Pleuroceridae. FIG. 478. *Leptoxis praerosa*. FIG. 479. *L. praerosa*. FIG. 480. *L. subglobosa* = *L. praerosa*. FIG. 481. *L. gibbosa* = *L. praerosa*. FIG. 482. *L. tintinabulum* = *L. praerosa*. FIG. 483. *L. showalteri*. FIG. 484. *L. coosaensis* = *L. taeniata*. FIG. 485. *L. brevispira* = *L. taeniata*. FIG. 486. *L. taeniata*. FIG. 487. *L. vittata*. Measurement lines = 1 mm or are divided into millimeters.



FIGS. 488-497. Shells of Pleuroceridae. FIG. 488. *Leptoxis (Mudalia) arkansensis*. FIG. 489. *L. (M.) carinata carinata*. FIG. 490. *L. (M.) carinata carinata*. FIG. 491. *L. (M.) carinata carinata*. FIG. 492. *L. (M.) corpulenta* = *L. (M.) carinata*. FIG. 493. *L. (M.) carinata nickliniata*. FIG. 494. *L. (M.) dilatata*. FIG. 495. *L. (M.) minor*. FIG. 496. *L. (M.) trilineata*. FIG. 497. *L. (M.) trilineata*. Measurement lines = 1 mm or are divided into millimeters.



FIGS. 498-506. Shells of Pleuroceridae. FIG. 498. *Leptoxis (Mudalia) virgata*. FIG. 499. *Le. (M.) virgata*. FIG. 500. *Le. (M.) virgata*. FIG. 501. *Le. (Athearnia) crassa crassa*. FIG. 502. *Le. (A.) crassa anthonyi*. FIG. 503. *Lithasia geniculata geniculata*. FIG. 504. *Li. geniculata geniculata*. FIG. 505. *Li. geniculata fuliginosa*. FIG. 506. *Li. geniculata pinguis*. Measurement lines = 1 mm or are divided into millimeters.

Subgenus *Athearnia* Morrison 1971

Leptoxis (Athearnia) crassa crassa (Haldeman 1841)[34] [Fig. 501]
Eastern Tennessee: Powell River, near its mouth, and the Clinch River in Anderson, Knox and Roane counties (Goodrich, 1940d).

Leptoxis (Athearnia) crassa anthonyi (Redfield 1854) [Fig. 502]
Tennessee River, Knox County, Tennessee, to Lauderdale County, Alabama; lower French Broad and Clinch rivers, eastern Tennessee; Elk River, Alabama; smaller tributaries of the Tennessee River from the Little Tennessee River, Tennessee, to Limestone County, Alabama (Goodrich, 1940d).

Genus *Lithasia* Haldeman 1840

Subgenus *Lithasia* s.s.

Lithasia geniculata geniculata (Haldeman 1840) [Figs. 503, 504]
Cumberland River, above Burnside, Pulaski County, Kentucky, to points below Nashville, Davidson County, Tennessee; branches in Tennessee; Duck River, Maury County to its mouth (Goodrich, 1940d).

Lithasia geniculata fuliginosa (Lea 1841) [Fig. 505]
Tennessee: Duck River, Bedford County, to below Maury County; Buffalo River; Harpeth River; Red River, Robertson County (Goodrich, 1940d).

Lithasia geniculata pinguis (Lea 1852) [Fig. 506]
Tennessee: Caney Fork and branches; Duck River, Coffee County (Goodrich, 1940d).

Lithasia obovata (Say 1829)[35] [Figs. 507-510]
Ohio River and tributaries, in Pennsylvania, Ohio, Indiana, Illinois, Kentucky and Tennessee.

Lithasia salebrosa salebrosa (Conrad 1834)[36] [Fig. 511]
Tennessee River and Cypress Creek, Lauderdale County, Alabama; lower Cumberland River, Montgomery County, Tennessee, to Trigg County, Kentucky (Goodrich, 1940d).

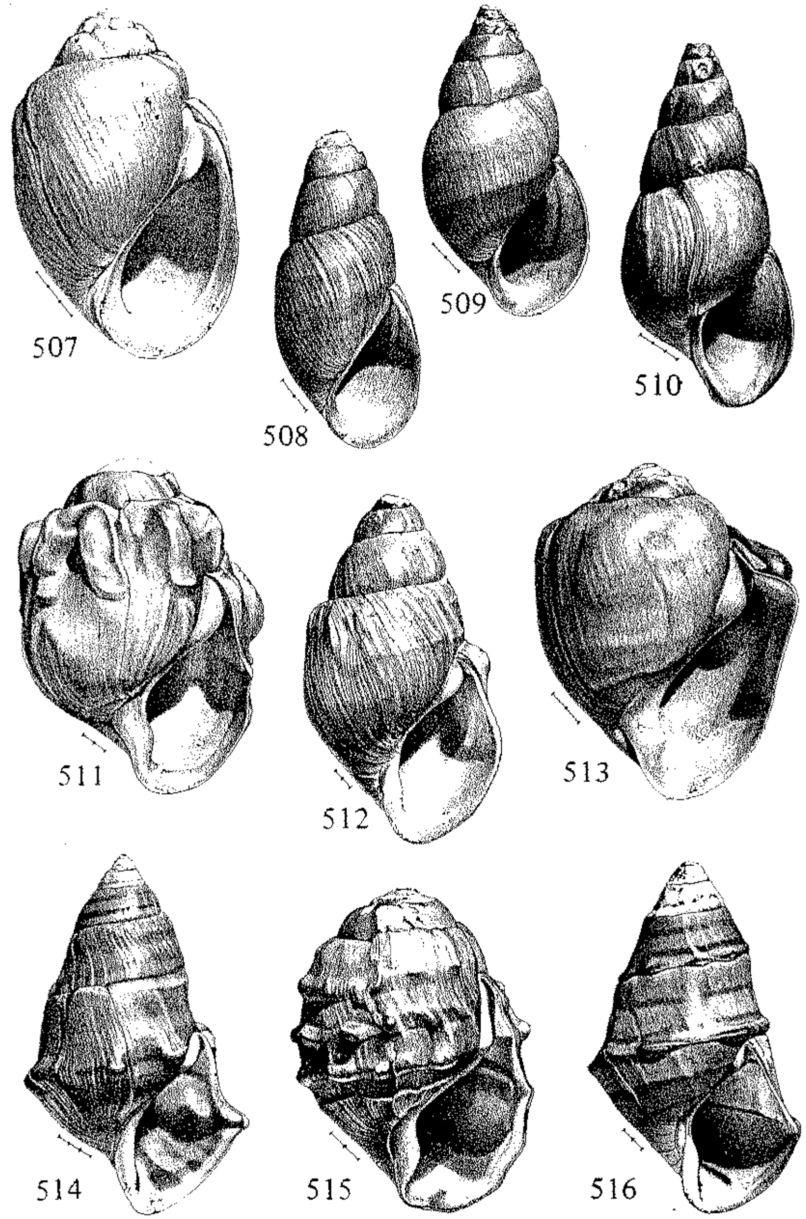
Lithasia salebrosa florentiana (Lea 1841) [Fig. 512]
Tennessee River, Muscle Shoals, Alabama, and a near-by tributary; Elk River, Tennessee and Alabama (Goodrich, 1940d).

Lithasia salebrosa subglobosa (Lea 1861) [Fig. 513]
Tennessee River, Muscle Shoals, Alabama (Goodrich, 1940d).

Subgenus *Angitrema* Haldeman 1841

Lithasia (Angitrema) armigera (Say 1821) [Fig. 514]
Lower Ohio River, lower Wabash River; Cumberland River from above Burnside, Pulaski County, Kentucky, to branches in Trigg County, Kentucky; Tennessee River in the vicinity of Florence, Lauderdale County, Alabama (Goodrich, 1940d).

Lithasia (Angitrema) curta Lea 1868 [Fig. 515]
Tennessee River, Muscle Shoals; Shoals Creek, Lauderdale County, Alabama



FIGS. 507-516. Shells of Pleuroceridae. FIG. 507. *Lithasia obovata*. FIG. 508. *L. obovata* form *depygis*. FIG. 509. *L. obovata* form *pennsylvanica*. FIG. 510. *L. obovata* form *sordida*. FIG. 511. *L. salebrosa salebrosa*. FIG. 512. *L. salebrosa florentiana*. FIG. 513. *L. salebrosa subglobosa*. FIG. 514. *L. (Angitrema) armigera*. FIG. 515. *L. (A.) curta*. FIG. 516. *L. (A.) duttoniana*. Measurement lines are divided into millimeters.

(Goodrich, 1940d).

Lithasia (Angitrema) duttoniana (Lea 1841) [Fig. 516[
Tennessee: Duck River, Bedford County to Humphreys County; two tributaries in Bedford County (Goodrich, 1940d).

Lithasia (Angitrema) hubrichti Clench 1956
Big Black River, Mississippi (Clench, 1965a).

Lithasia (Angitrema) jayana (Lea 1841) [Fig. 517]
Forks of Cumberland River; Caney Fork, Tennessee, near mouth.

Lithasia (Angitrema) lima (Conrad 1834) [Figs. 518, 519]
Elk River, Tennessee and Alabama; branch of Elk River in Franklin County, Tennessee: Tennessee River, Alabama, Muscle Shoals and three near-by creeks (Goodrich, 1940d).

Lithasia (Angitrema) verrucosa (Rafinesque 1820) [Fig. 520]
Branch of Ohio River near Cincinnati to lower part of river; lower Wabash River; lower parts of East Tennessee head streams of Tennessee River to Marshall County, Kentucky; Black and Spring rivers, Arkansas (Goodrich, 1940d).

Genus *Pleurocera* Rafinesque 1818[37]

Pleurocera acuta group

Pleurocera acuta acuta Rafinesque 1831 [Fig. 521]
Ohio River head streams and tributaries; Great Lakes and tributaries; Mississippi River and westward to Nebraska and Kansas; through the Erie Canal into the basin of the Hudson River; Cumberland and Duck rivers, Tennessee (Goodrich, 1940d).

Pleurocera acuta hinkleyi Goodrich 1921
Little Muddy River, Dubois, Washington County, Illinois (Goodrich, 1939e).

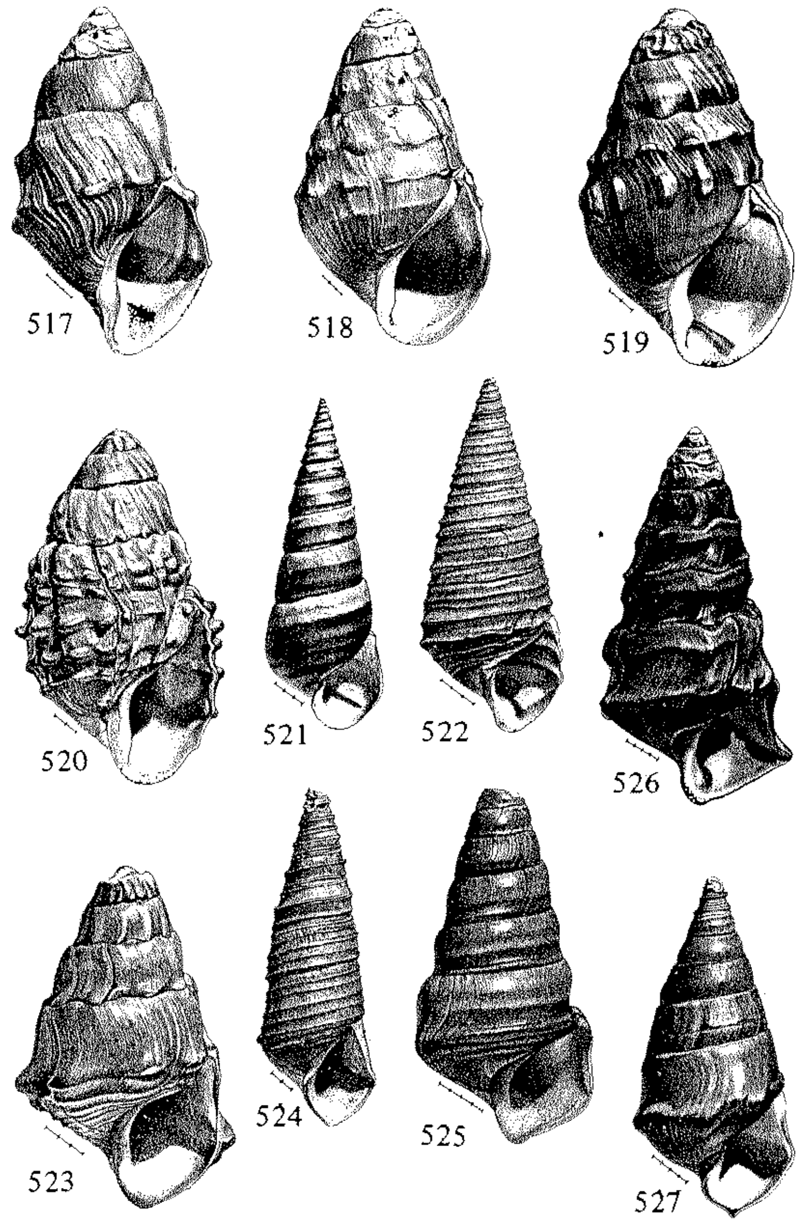
Pleurocera acuta lewisi (Lea 1862) [Fig. 522]
Illinois and Kankakee rivers, Illinois (Goodrich, 1939e, 1940d).

Pleurocera alveare group

Pleurocera alveare (Conrad 1834) [Figs. 523, 529]
Lower parts of Ohio, Wabash and Green rivers, together with a few tributaries; Cumberland River, above Burnside, Pulaski County, Kentucky, to tributaries of the river in Trigg County, Kentucky; Tennessee River, Muscle Shoals, and near-by creeks, Alabama; streams of northern Arkansas and southern Missouri (Goodrich, 1940d).

Pleurocera canaliculatum group

Pleurocera canaliculatum canaliculatum (Say 1821)
Ohio River from vicinity of Pittsburgh, Pennsylvania, to Illinois; Wabash River and its tributaries; aberrantly in the Tennessee River system; Omaha, Nebraska (Goodrich, 1940d).

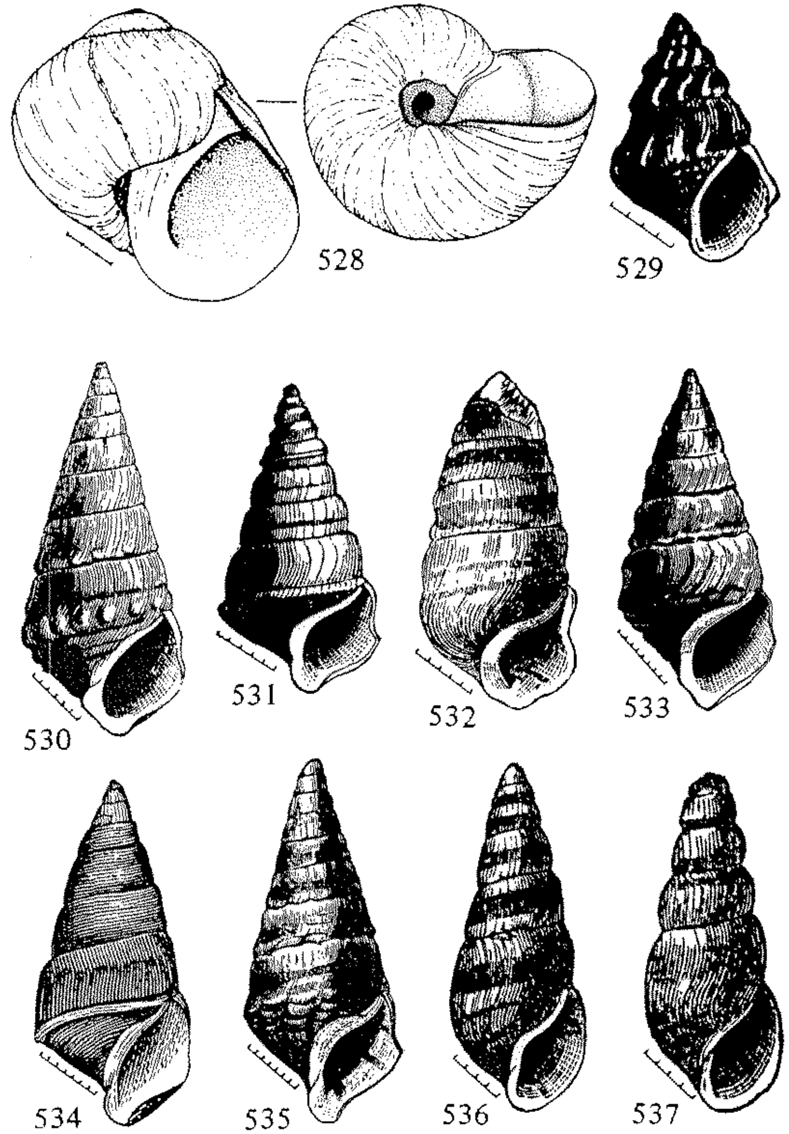


FIGS. 517-527. Shells of Pleuroceridae. FIG. 517. *Lithasia (Angitrema) jayana*. FIG. 518. *L. (A.) lima*. FIG. 519. *L. (A.) lima* form. FIG. 520. *L. (A.) verrucosa*. FIG. 521. *Pleurocera acuta acuta*. FIG. 522. *P. acuta lewisi*. FIG. 523. *P. alveare*. FIG. 524. *P. striatum* = *P. canaliculatum alabamense*. FIG. 525. *P. canaliculatum filum*. FIG. 526. *P. canaliculatum undulatum*. FIG. 527. *P. canaliculatum undulatum*. Measurement lines are divided into millimeters.

Pleurocera canaliculatum alabamense (Lea 1862) [Fig. 524]
Tributaries of the Tennessee River in northern Alabama (Goodrich, 1940d).
Pleurocera canaliculatum excuratum (Conrad 1834) [Fig. 530]
Tennessee River at Muscle Shoals, Alabama, and lower parts of a few near-by tributaries; Cumberland River, Nashville, Tennessee, to parts of the river in Kentucky; aberrant in Clinch and Wabash rivers (Goodrich, 1940d).
Pleurocera canaliculatum filum (Lea 1845) [Figs. 525, 531]
Upper Cumberland River to a point above Nashville, Davidson County, Tennessee; Duck River, Coffee County, to near the mouth, Tennessee; aberrant in Tennessee River (Goodrich, 1940d).
Pleurocera canaliculatum moriforme (Lea 1862) [Fig. 532]
Muscle Shoals, Tennessee River, Alabama (Goodrich, 1940d).
Pleurocera canaliculatum undulatum (Say 1829) [Figs. 526, 527, 533, 534]
Kentucky River, Kentucky (typical form); Ohio River and tributaries and Cumberland and Tennessee rivers and branches (carinate or angled forms); Rock River, Illinois (Goodrich, 1940d).
Pleurocera gradatum (Anthony 1854) [Fig. 538]
Holston River, Washington County, southwestern Virginia (Tryon, 1873b).
Pleurocera nobile nobile (Lea 1845) [Fig. 550]
Tennessee River, Jackson County, to Marion County, Alabama; Sequatchie River, Tennessee, near mouth; Flint Creek, Morgan County, Alabama (Goodrich, 1940d).
Pleurocera nobile nodosa (Lea 1861) [Fig. 535]
Tennessee River above Chattanooga, Hamilton County, Tennessee (Goodrich, 1940d).
Pleurocera parvum (Lea 1862) [Figs. 536, 537]
Tributaries of the Tennessee River, East Tennessee; apparently extending into South Carolina (Goodrich, 1940d).
Pleurocera postelli (Lea 1862) [Fig. 539]
Small streams of northern Alabama in the vicinity of Muscle Shoals (Goodrich, 1940d).

Pleurocera pyrenellum group

Pleurocera brumbyi (Lea 1852) [Fig. 551]
Springs and streams of the Tennessee River in Madison, Limestone and Courtland counties, Alabama (Goodrich, 1940d).
Pleurocera currierianum (Lea 1863)[38] [Fig. 552]
Alabama: Florence, Lauderdale County; Swan Lake, near Decatur, Limestone County; discharge of a spring in Madison County (Goodrich, 1940d).
Pleurocera pyrenellum (Conrad 1834) [Figs. 540, 541, 553]
Tributaries of the Tennessee River in Morgan and Limestone counties, Alabama, and Walker County, Georgia (Goodrich, 1940d).
Pleurocera trochiformis (Conrad 1834) [Fig. 554]
Tennessee River, Bridgeport, Jackson County, to Florence, Lauderdale County, Alabama; tributaries in Walker County, Georgia, to those near Muscle Shoals, Alabama (Goodrich, 1940d).



FIGS. 528-537. Shells of Pleuroceridae. FIG. 528. *Leptoxis umbilicata*. FIG. 529. *Pleurocera alveare*. FIG. 530. *P. canaliculatum excuratum*. FIG. 531. *P. canaliculatum filum*. FIG. 532. *P. canaliculatum moriforme*. FIG. 533. *P. canaliculatum undulatum*. FIG. 534. *P. ponderosum* = *P. canaliculatum undulatum*. FIG. 535. *P. moniliferum* = *P. nobile nodosa*. FIG. 536. *P. parvum*. FIG. 537. *P. modestum* = *P. parvum*. Measurement lines are divided into millimeters. Figs. 529-537 are from Tryon (1865-66).

Pleurocera viridulum (Anthony 1854)[39] [Fig. 556]
Chickamauga Creek, Walker County, Georgia (Goodrich, 1940d).

Pleurocera unciale group

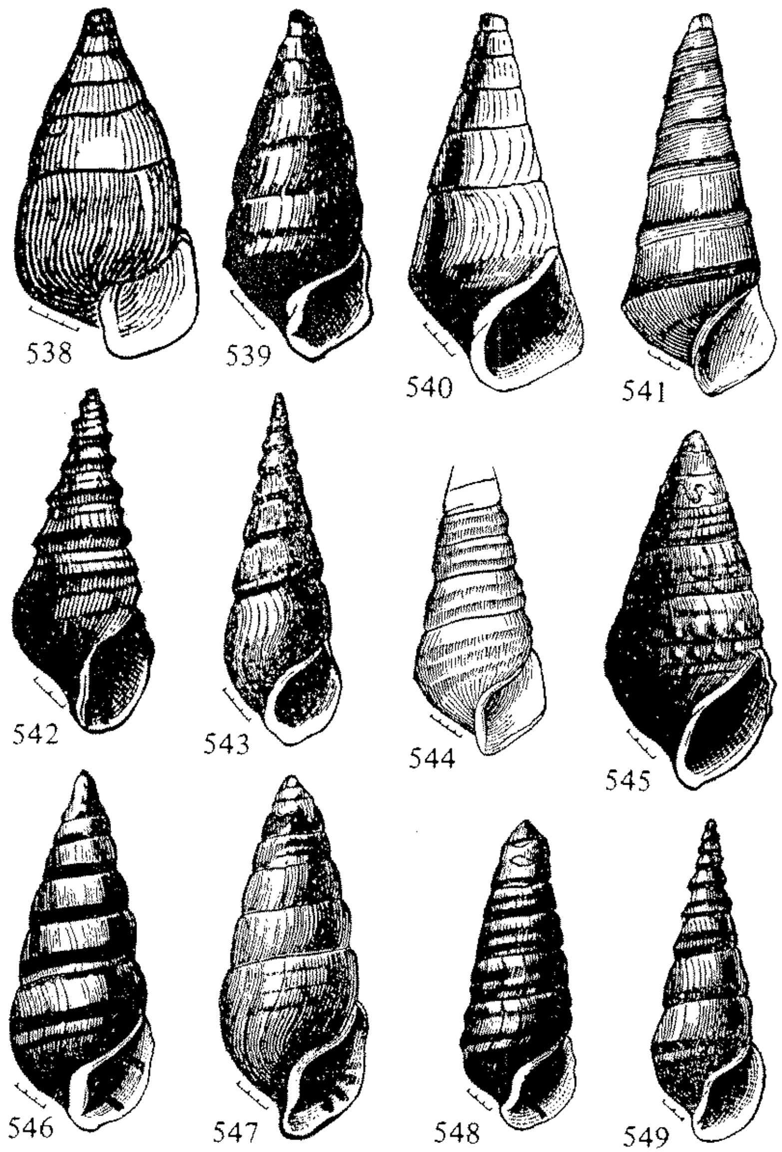
Pleurocera unciale unciale (Reeve 1861) [Figs. 542, 543, 555]
Upper tributaries of the Tennessee River in Virginia and eastern Tennessee (Goodrich, 1940d).
Pleurocera unciale hastatum (Anthony 1854) [Fig. 557]
North and South Fork of the Holston River, Sullivan County, Tennessee (Goodrich, 1940d).

Pleurocera prasinatum group

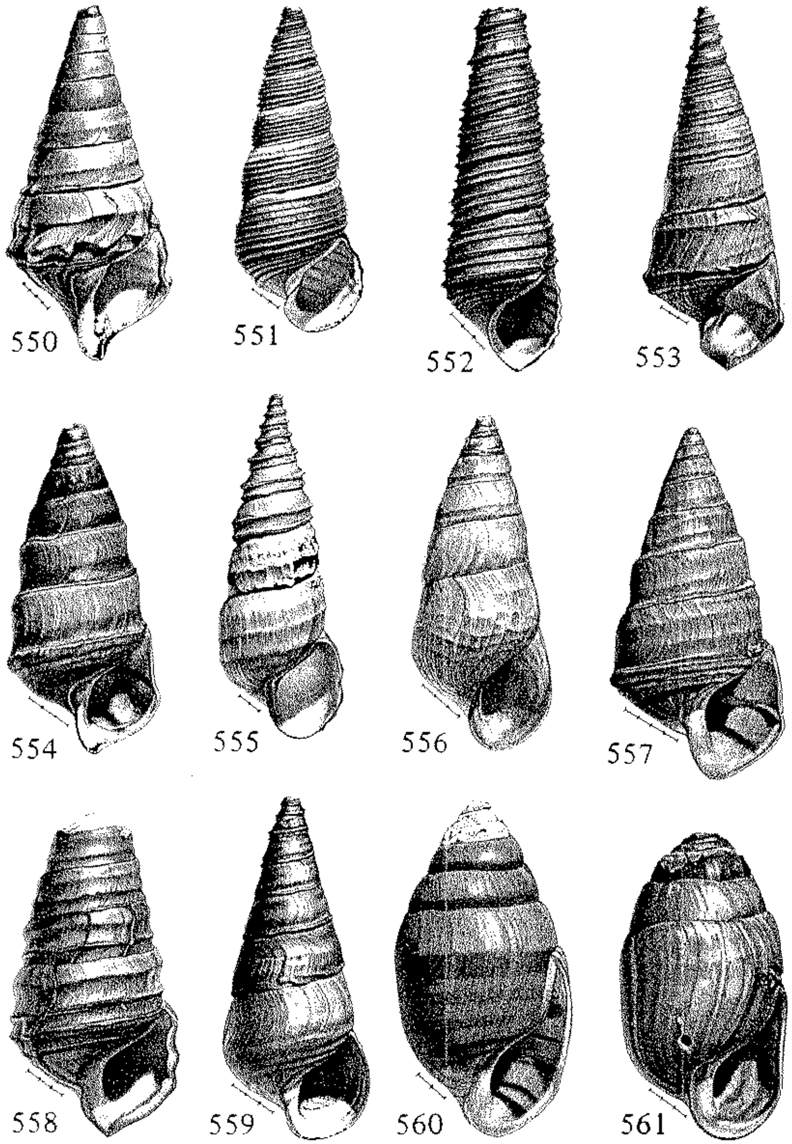
Pleurocera annuliferum (Conrad 1834) [Figs. 544, 558]
Upper and middle parts of the Black Warrior River; also known from Village Creek, Jefferson County, Alabama (Goodrich, 1941b).
Pleurocera foremani (Lea 1843) [Fig. 545]
Cahaba River and Coosa River basin from the Etowah River of Georgia downstream, and at the mouths of a few side streams (Goodrich, 1944d).
Pleurocera prasinatum (Conrad 1834) [Figs. 546, 547]
In quiet stretches in the middle and lower Cahaba and Coosa rivers and in the Alabama River (Goodrich, 1941b,c, 1944d).
Pleurocera showalteri (Lea 1862) [Fig. 548]
Lower part of the main Coosa River headwaters and that part of the river which is in Georgia (Goodrich, 1944d).
Pleurocera vestitum (Conrad 1834) [Figs. 549, 559]
Headwaters, creeks and springs from northern Georgia and Alabama to small streams as far south as the first county above Mobile (Goodrich, 1941b).

Subgenus *Strephobasis* Lea 1861

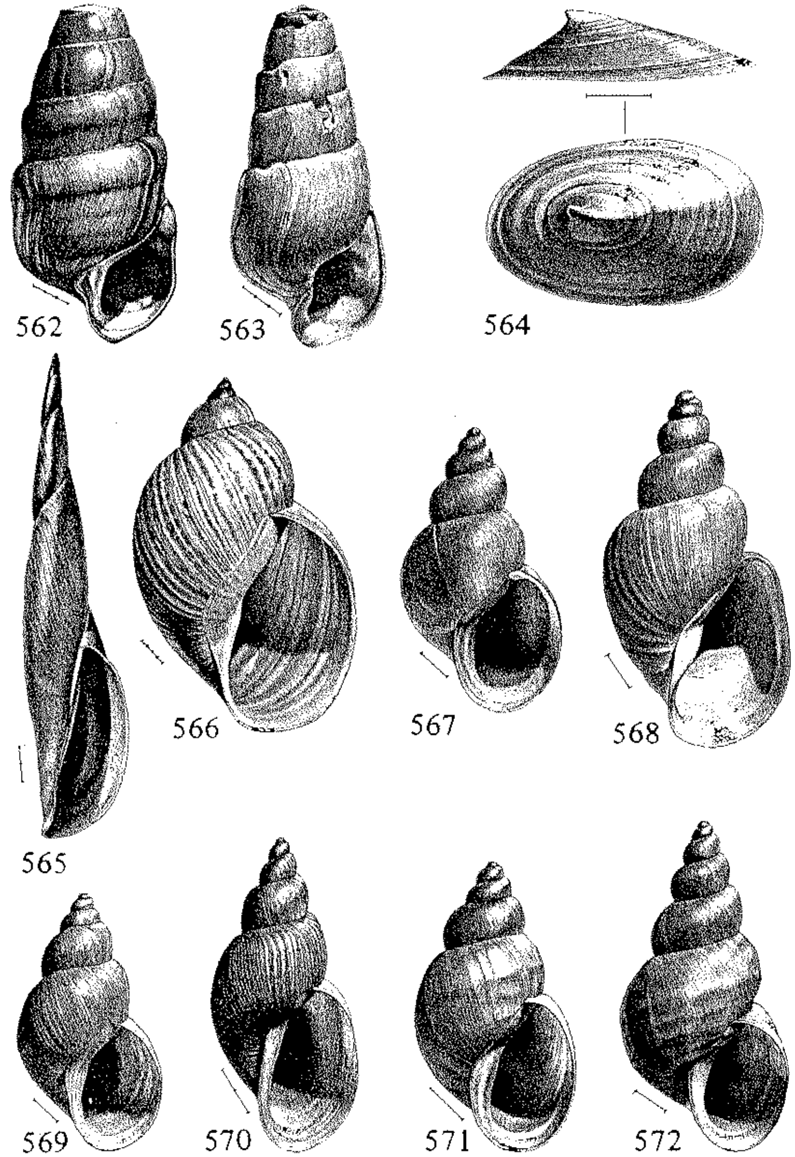
Pleurocera (Strephobasis) corpulentum (Anthony 1854) [Fig. 560]
Tennessee River between Bridgeport and Florence, Alabama; Battle Creek at Ketchall, Marion County, Tennessee (Goodrich, 1928a).
Pleurocera (Strephobasis) curtum curtum (Haldeman 1841) [Fig. 561]
Holston and Tennessee rivers from McMillan, Knox County, Tennessee, to the Muscle Shoals area in Alabama, and probably below it; Cumberland River in the vicinity of Nashville, Tennessee, and Caney Fork near Carthage, Tennessee; Clinch, Little and Little Tennessee rivers a few miles above their mouths; Paint Rock and Flint rivers, Alabama (Goodrich, 1928a).
Pleurocera (Strephobasis) curtum roanense (Lea 1864) [Fig. 562]
Emory River, Roane and Morgan counties, and the Little River, Blount County, Tennessee (Goodrich, 1928a).
Pleurocera (Strephobasis) walkeri Goodrich 1928 [Fig. 563]
Sequatchie and Little Sequatchie rivers, Marion County, Tennessee; Cumber-



FIGS. 538-549. Shells of Pleuroceridae. FIG. 538. *Pleurocera gradatum*. FIG. 539. *P. postelli*. FIG. 540. *P. pyrenellum*. FIG. 541. *P. planogyrum* = *P. pyrenellum*. FIG. 542. *P. unciale unciale*. FIG. 543. *P. esterbrooki* = *P. unciale*. FIG. 544. *P. annuliferum*. FIG. 545. *P. foremani*. FIG. 546. *P. prasinatum*. FIG. 547. *P. prasinatum*. FIG. 548. *P. showalteri*. FIG. 549. *P. vestitum*. Measurement lines are divided into millimeters. Figs. 538-549 are from Tryon (1865-66).



FIGS. 550-561. Shells of Pleuroceridae. FIG. 550. *Pleurocera nobile nobile.* FIG. 551. *P. brumbyi.* FIG. 552. *P. currierianum.* FIG. 553. *P. pyrenellum.* FIG. 554. *P. trochiformis.* FIG. 555. *P. unciale unciale.* FIG. 556. *P. viridulum.* FIG. 557. *P. unciale hastatum.* FIG. 558. *P. annuliferum.* FIG. 559. *P. vestitum.* FIG. 560. *P. (Strephobasis) corpulentum.* FIG. 561. *P. (S.) curtum curtum.* Measurement lines are divided into millimeters.



FIGS. 562-572. Shells of Pleuroceridae (Figs. 562, 563), Acroloxidae (Fig. 564) and Lymnaeidae (Lymnaeinae) (Figs. 565-572). FIG. 562. *Pleurocera (Strephobasis) curtum roanense.* FIG. 563. *P. (S.) walkeri.* FIG. 564. *Acroloxus coloradensis.* FIG. 565. *Acella haldemani.* FIG. 566. *Bulimnea megasoma.* FIG. 567. *Fossaria cyclostoma.* FIG. 568. *F. galbana.* FIG. 569. *F. humilis.* FIG. 570. *F. obrussa.* FIG. 571. *F. parva.* FIG. 572. *F. tazewelliana.* Measurement lines = 1 mm or are divided into millimeters.

land River, Jackson County, the Tennessee River at Muscle Shoals and Shoals Creek, Lauderdale County, Alabama (Goodrich, 1928a).

Family ACROLOXIDAE

Genus *Acroloxus* Beck 1837

Acroloxus coloradensis (Henderson 1930) [Fig. 564]
Isolated lakes high in the Rocky Mountains in Colorado, Montana and Alberta, and a few pond and lake localities in northern Quebec and eastern Ontario (Clarke, 1973).

Family LYMNAEIDAE

Subfamily Lymnaeinae[40]

Genus *Acella* Haldeman 1841

Acella haldemani ('Deshayes' W.G. Binney 1867) [Fig. 565]
Vermont and eastern Ontario west to northern Minnesota, south to northern Illinois and Ohio (F.C. Baker, 1928c).

Genus *Bulimnea* Haldeman 1841

Bulimnea megasoma (Say 1824) [Fig. 566]
Great Lakes and St. Lawrence River drainage area, upper tributaries of the Mississippi drainage area, parts of the Albany, Winnipeg and Nelson river systems in the Canadian Interior Basin (see Clarke, 1973).

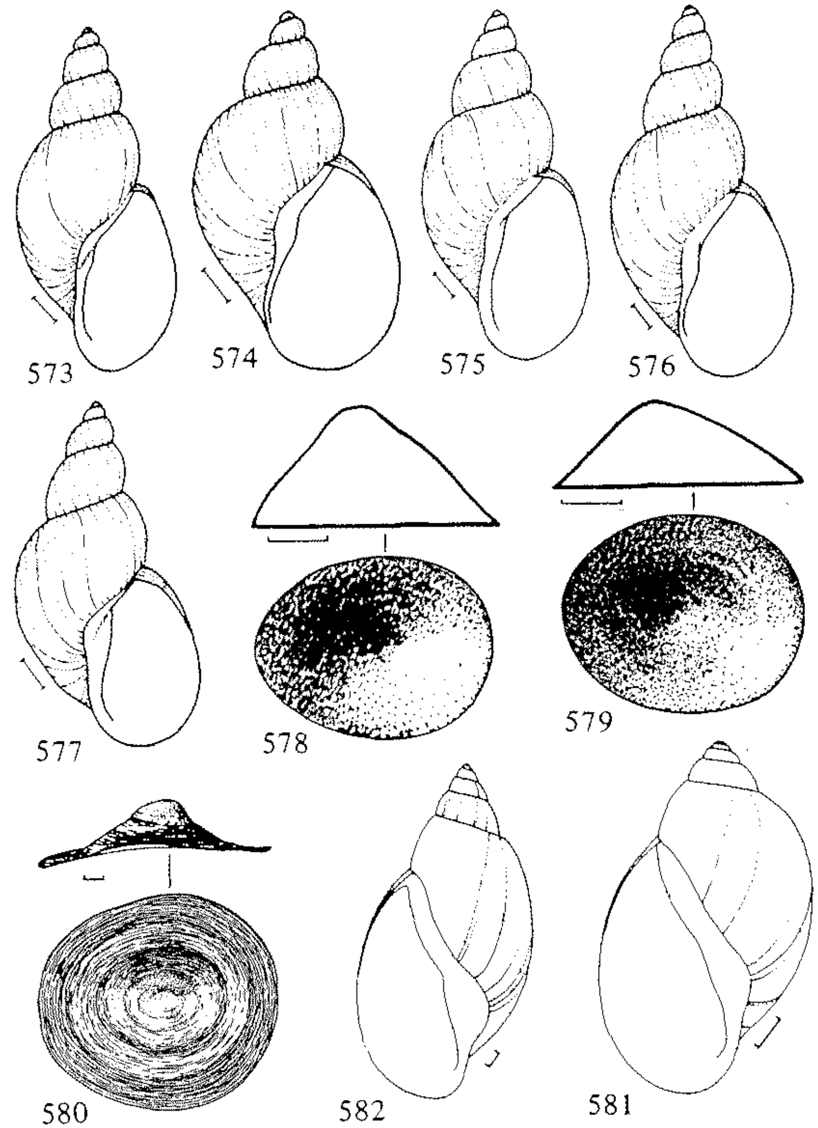
Genus *Fossaria* Westerlund 1885[41]

Subgenus *Fossaria* s.s.

Fossaria cyclostoma (Walker 1908) [Fig. 567]
New York to Michigan; a species of the Canadian region and of the Transition life zone (F.C. Baker, 1911a); Great Lakes region; Ontario (F.C. Baker, 1928c).

Fossaria galbana (Say 1825) [Fig. 568]
Great Lakes-St. Lawrence River basin northward in the region west of James Bay to the Attawapiskat and Severn river systems, and northwestward in the boreal forest region to the vicinity of Great Slave Lake (Clarke, 1973, as given for *F. decampi*, here considered a synonym of *F. galbana*).

Fossaria humilis (Say 1822) [Fig. 569]
Atlantic drainage area from southern New Jersey south to South Carolina (see F.C. Baker, 1911a).

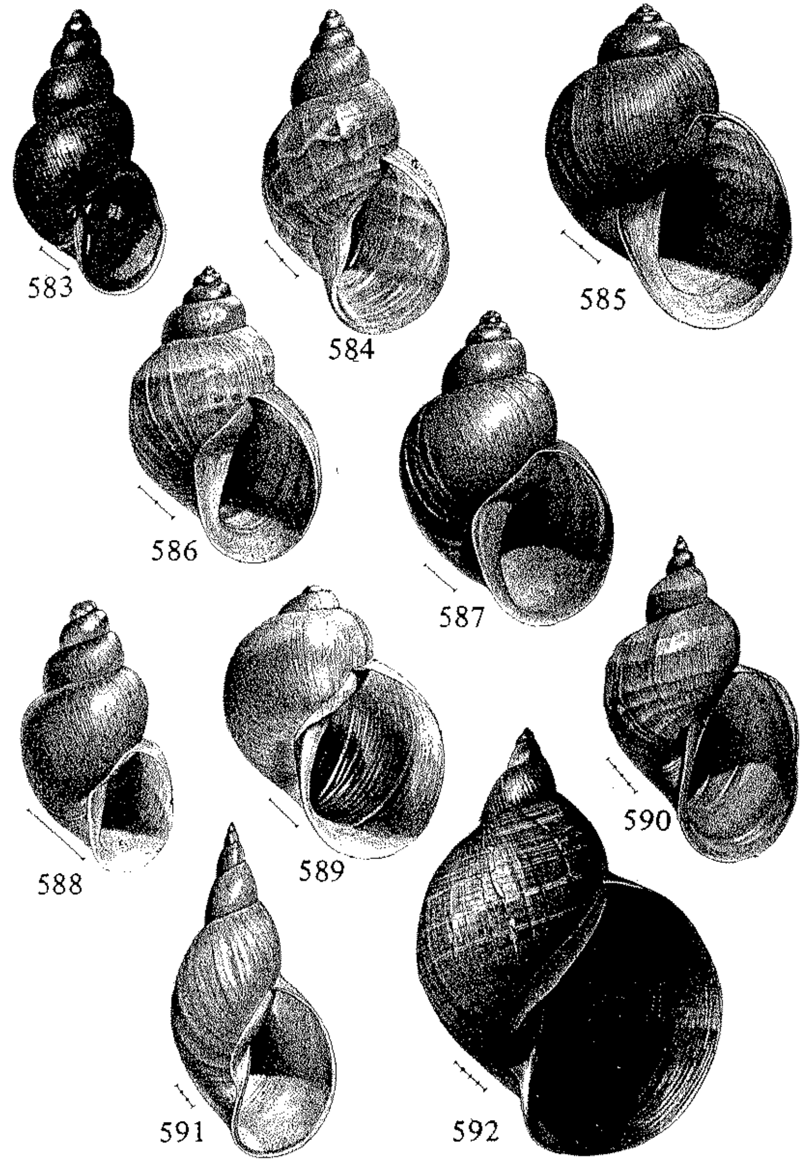


FIGS. 573-582. Shells of Lymnaeidae (Lymnaeinae and Lancinae) (Figs. 573-580) and Physidae (Figs. 581, 582). FIG. 573. *Fossaria exigua*. FIG. 574. *F. modicella*. FIG. 575. *F. obrussa*. FIG. 576. *F. peninsulae*. FIG. 577. *F. rustica*. FIG. 578. *Lanx alta*. FIG. 579. *L. subrotunda*. FIG. 580. *Lanx hanni* = ? *L. patelloides*. FIG. 581. *Physella boucardi*. FIG. 582. *P. (Costatella) conoidea*. Measurement lines = 1 mm. Figs. 578 and 579 are from Tryon (1865i). Fig. 580 is from Walker (1925b).

Fossaria obrussa (Say 1825) group [Figs. 570, 573-577]
North America generally, except for the Atlantic drainage from southern Virginia south.
exigua Lea 1841 [Fig. 573]
Throughout the St. Lawrence River system, south to Alabama in the Mississippi-Missouri river basin, north to the Hudson Bay lowlands in northern Ontario, and west to the Red River and Lake Winnipeg region in Minnesota and Manitoba (Clarke, 1973).
modicella Say 1825 [Fig. 574]
Eastern Quebec, Nova Scotia and New Jersey west to Vancouver Island, Manitoba south to southern California, Arizona, Texas and Alabama (F.C. Baker, 1928c); also Saskatchewan, Alberta and Northwest Territories (Clarke, 1973).
obrussa Say 1825 [Figs. 570, 575]
From the Atlantic to the Pacific oceans, and from Mackenzie Territory, Canada, south to Arizona and northern Mexico (F.C. Baker, 1928c).
peninsulae Walker 1908 [Fig. 576]
Northern Maine west to Wisconsin; in Wisconsin and Michigan found in streams flowing into Lake Superior (F.C. Baker, 1928c).
rustica Lea 1841 [Fig. 577]
New York west to Utah, Nebraska south to New Mexico (F.C. Baker, 1928c); Ontario, Manitoba, Saskatchewan, Alberta and Northwest Territories (Clarke, 1973).
Fossaria parva (Lea 1841) [Fig. 571]
Connecticut west to Idaho, James Bay and Montana south to Maryland, Kentucky, Oklahoma, southern New Mexico and Arizona (F.C. Baker, 1928c); in Canada, from eastern James Bay drainage to Alberta and north to the region of Great Slave Lake (Clarke, 1973).
Fossaria tazewelliana (Wolf 1869) [Fig. 572]
Northeastern Illinois (Pleistocene); Iowa.
Fossaria truncatula (Müller 1774) [Fig. 583]
Europe, northern Asia and portions of Alaska and Yukon Territory (F.C. Baker, 1911a).

Subgenus *Bakerilymnaea* Weyrauch 1964

Fossaria (Bakerilymnaea) bulimoides (Lea 1841) group [Figs. 584-586]
United States west of the vicinity of the Mississippi River; also southern Saskatchewan and Alberta (chiefly in the prairie and Rocky foothill regions) and southern British Columbia (Clarke, 1973).
alberta F.C. Baker 1919
Brazean Lake, Alberta, Canada (F.C. Baker, 1919e).
bulimoides Lea 1841 [Fig. 584]
Pacific Coast, from Vancouver Island south to southern California (F.C. Baker, 1911a).
cockerelli Pilsbry & Ferriss 1906 [Fig. 585]
Sporadic over most of the United States west of the Mississippi River (Hibbard & Taylor, 1960).



FIGS. 583-592. Shells of Lymnaeidae (Lymnaeinae). FIG. 583. *Fossaria truncatula*. FIG. 584. *F. (Bakerilymnaea) bulimoides*. FIG. 585. *F. (B.) cockerelli*. FIG. 586. *F. (B.) techella*. FIG. 587. *F. (B.) cubensis*. FIG. 588. *F. (B.) dalli*. FIG. 589. *F. (B.) sonomaensis*. FIG. 590. *Lymnaea atkaensis*. FIG. 591. *L. stagnalis appressa*. FIG. 592. *L. stagnalis sanctaemariae*. Measurement lines = 1 mm or are divided into millimeters.

hendersoni F.C. Baker 1909
West of Fort Collins, Larimer County, Colorado (F.C. Baker, 1909a).
perplexa F.C. Baker & Henderson 1929
Park Lake, Grand Coulee, Washington (F.C. Baker & Henderson, 1929).
techella Haldeman 1867 [Fig. 586]
Southwestern and south central United States to central Mexico; from southern California through Utah, Colorado, southernmost Nebraska and Kansas to Missouri and Alabama (Hibbard & Taylor, 1960).
vancouverensis F.C. Baker 1939
Southern part of Vancouver Island, British Columbia, Canada (F.C. Baker, 1939a).

Fossaria (Bakerilymnaea) cubensis (Pfeiffer 1839) [Fig. 587]
Southern United States, from Florida to southern Texas (see F.C. Baker, 1911a).

Fossaria (Bakerilymnaea) dalli (F.C. Baker 1907) [Fig. 588]
Ohio to northern Michigan and Montana, south to Kansas and Arizona (F.C. Baker, 1928c); in the Canadian Interior Basin from southern Manitoba to Alberta (Clarke, 1973).

Fossaria (Bakerilymnaea) perpolita (Dall 1905)
Nushagak, Bristol Bay, Alaska (Dall, 1905).

Fossaria (Bakerilymnaea) sonomaensis Hemphill (in Pilsbry & Ferriss) 1906 [Fig. 589]
Sonoma County, California (Pilsbry & Ferriss, 1906).

Genus *Lymnaea* Lamarck 1799[40]

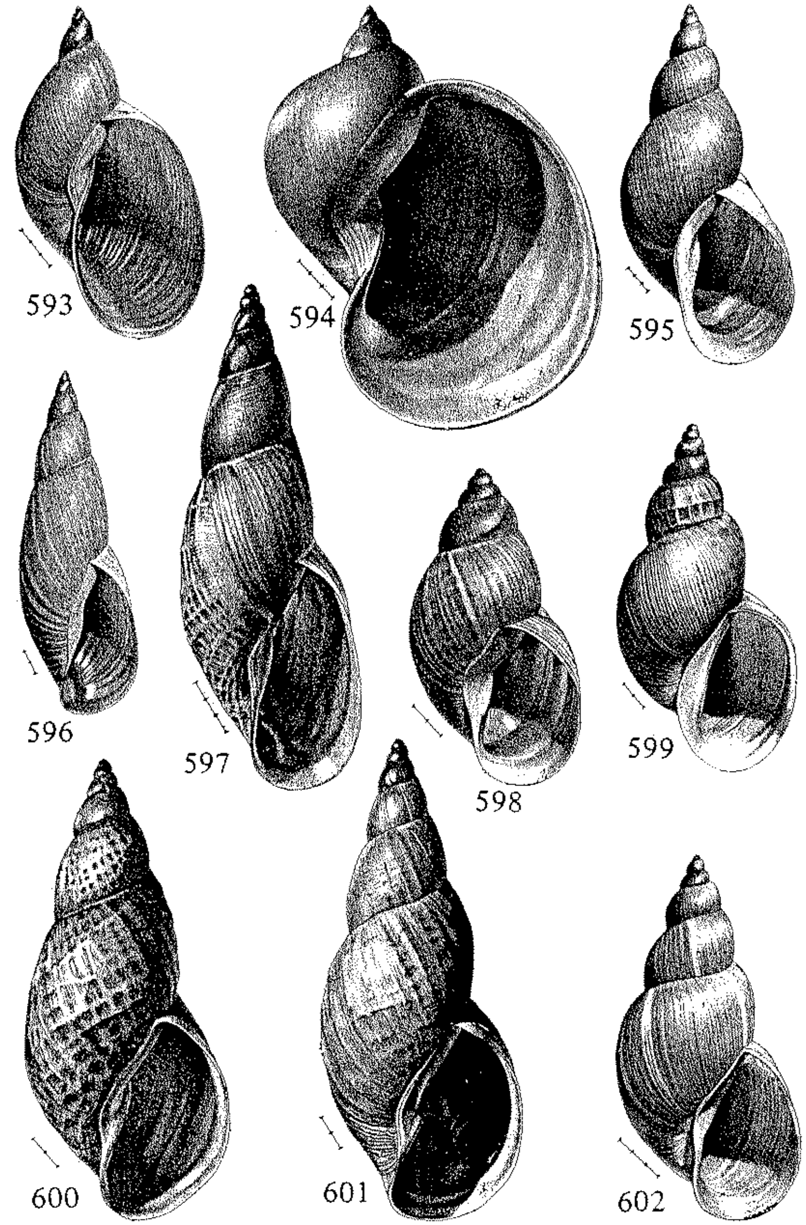
Lymnaea atkaensis Dall 1884 [Fig. 590]
Throughout most of Alaska and the Yukon Territory, in northern British Columbia in the Liard and Yukon river systems, and along the Arctic Coast to Cape Perry, Northwest Territory (Clarke, 1973).

Lymnaea stagnalis appressa Say 1821 [Fig. 591]
Great Lakes-St. Lawrence River drainage area, northwest to the Mackenzie and Yukon river drainage areas, west to the Rocky Mountains, south in the Rocky Mountains to Colorado, and in Illinois and Ohio in the Mississippi drainage (Clarke, 1973).

Lymnaea stagnalis sanctaemariae Walker 1892 [Fig. 592]
Lake Superior drainage area and adjacent parts of the Lake Huron, Wisconsin River and Winnipeg River drainage areas (Clarke, 1973).

Genus *Pseudosuccinea* F.C. Baker 1908

Pseudosuccinea columella (Say 1817) [Fig. 593]
Eastern North America generally. Nova Scotia and Quebec west to Manitoba, Minnesota and eastern Kansas, south to central Texas and Florida (F.C. Baker, 1911a).



FIGS. 593-602. Shells of Lymnaeidae (Lymnaeinae). FIG. 593. *Pseudosuccinea columella*. FIG. 594. *Radix auricularia*. FIG. 595. *Stagnicola elrodiana*. FIG. 596. *S. exilis*. FIG. 597. *S. exilis*. FIG. 598. *S. neopalustris*. FIG. 599. *S. traski*. FIG. 600. *S. elodes*. FIG. 601. *S. jolietensis* = *S. elodes*. FIG. 602. *S. alpenensis* = *S. elodes*. Measurement lines are divided into millimeters.

Genus *Radix* Montfort 1810

Radix auricularia (Linnaeus 1758) [Fig. 594]
Europe and northern Asia; widely introduced but of spotty occurrence in North America.

Genus *Stagnicola* Leach (in Jeffreys) 1830[42,43]

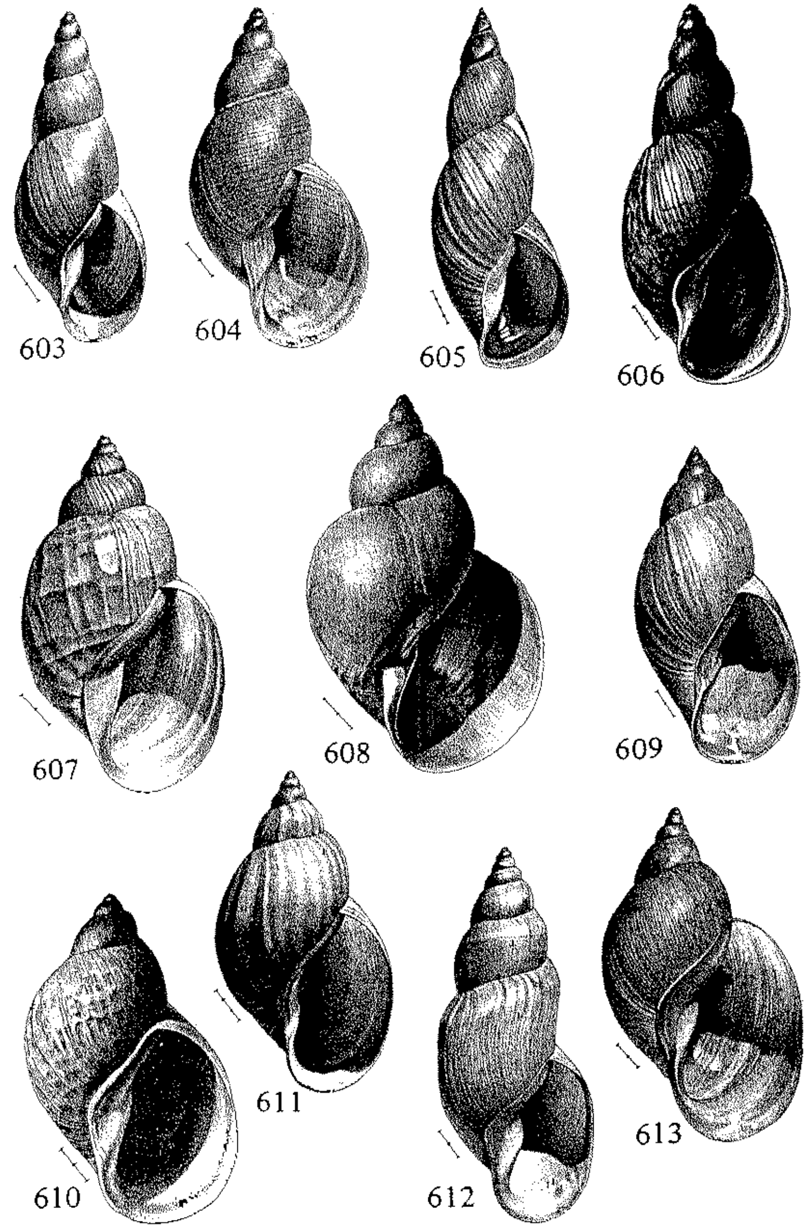
Subgenus *Stagnicola* s.s.

Stagnicola elodes group

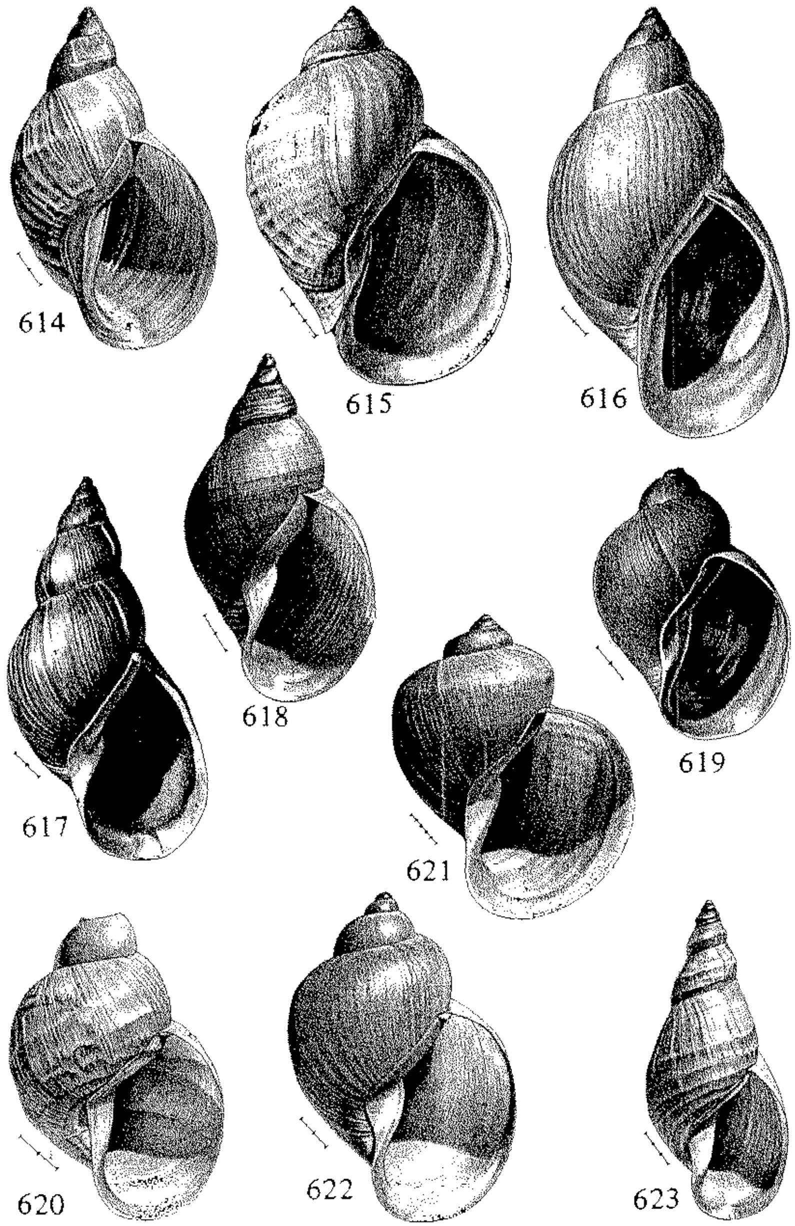
Stagnicola elodes (Say 1821)[42] [Figs. 600-606, 611]
New England west to Oregon and California, south to New Mexico; widely distributed in the Canadian Interior Basin (see Clarke, 1973).
Stagnicola elrodiana F.C. Baker 1935 [Fig. 595]
Western Montana (Lakes Sin-yale-a-min and McDonald) (Elrod, 1902).
Stagnicola exilis (Lea 1834) [Figs. 596, 597]
Ohio to Kansas, northward to northern Minnesota and Michigan (F.C. Baker, 1928c).
Stagnicola neopalustris (F.C. Baker 1911) [Fig. 598]
Orange County, Virginia (F.C. Baker, 1911a).
Stagnicola traski (Tryon 1863) [Fig. 599]
California to Wyoming, north to southern Alberta (F.C. Baker, 1911a).

Stagnicola emarginata/catascopium group

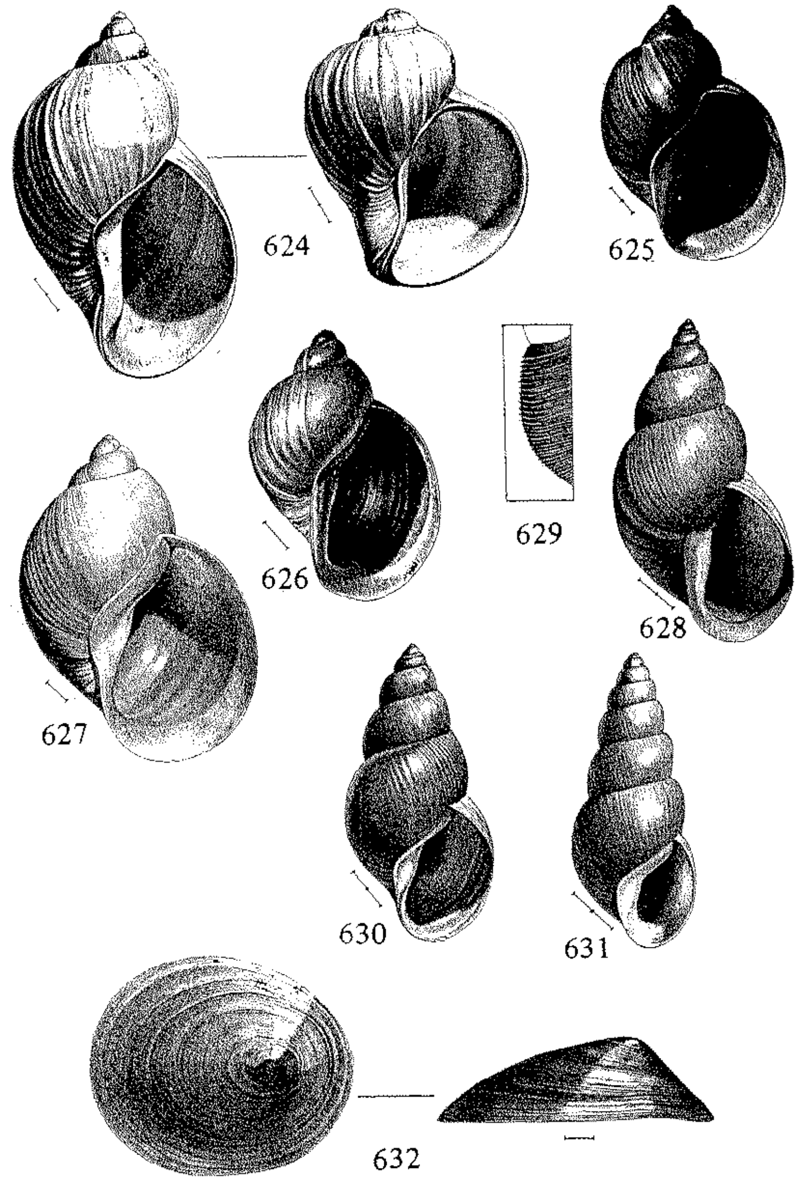
Stagnicola apicina (Lea 1838)
Northern part of the lower peninsula of Michigan west to western Washington; Ontario south to southern Wyoming and South Dakota (F.C. Baker, 1911a).
Stagnicola arctica (Lea 1864) [Fig. 607]
Newfoundland to the vicinity of Hudson Bay, north and northwest in subarctic and arctic Canada to Ungava, southern Victoria Island, the Mackenzie River Delta and the vicinity of Point Barrow, Alaska (Clarke, 1973).
Stagnicola bonnevillensis (Call 1884) [Fig. 608]
Wyoming (D.W. Taylor!).
Stagnicola catascopium (Say 1817) [Figs. 609, 610]
Eastern Canada and Nova Scotia west to North Dakota, Great Slave Lake south to northern Iowa, northern Ohio and Maryland (F.C. Baker, 1928c).
Stagnicola contracta (Currier (in DeCamp) 1881) [Fig. 612]
Higgins Lake, Roscommon County, Michigan (DeCamp, 1881).
Stagnicola elrodi (F.C. Baker & Henderson 1933) [Fig. 613]
Flathead Lake, Montana (F.C. Baker & Henderson, 1933).
Stagnicola emarginata (Say 1821) [Figs. 614-617]
Maine west to Minnesota and Wisconsin, Canadian Interior Basin south to Michigan, Pennsylvania and New York (F.C. Baker, 1928c).



FIGS. 603-613. Shells of Lymnaeidae (Lymnaeinae). FIG. 603. *Stagnicola impedita* = ? *S. elodes*. FIG. 604. *S. newfoundlandensis* = ? *S. elodes*. FIG. 605. *S. elodes* form *reflexa*. FIG. 606. *S. wyomingensis* = ? *S. elodes*. FIG. 607. *S. arctica*. FIG. 608. *S. bonnevillensis*. FIG. 609. *S. catascopium*. FIG. 610. *S. ? catascopium*. FIG. 611. *S. laurentiana* = ? *S. elodes*. FIG. 612. *S. contracta*. FIG. 613. *S. elrodi*. Measurement lines are divided into millimeters.



FIGS. 614-623. Shells of Lymnaeidae (Lymnaeinae). FIG. 614. *Stagnicola emarginata*. FIG. 615. *S. emarginata* form *serrata*. FIG. 616. *S. emarginata* form *canadensis*. FIG. 617. *S. emarginata* form *nashotahensis*. FIG. 618. *S. gabbi*. FIG. 619. *S. idahoense*. FIG. 620. *S. hinkleyi*. FIG. 621. *S. mighelsi*. FIG. 622. *S. oronoensis*. FIG. 623. *S. petoskeyensis*. Measurement lines are divided into millimeters.



FIGS. 624-632. Shells of Lymnaeidae (Lymnaeinae and Lancinae). FIG. 624. *Stagnicola kingi* = *S. utahensis*. FIG. 625. *S. walkeriana*. FIG. 626. *S. woodruffi*. FIG. 627. *S. nasoni* = ? *S. woodruffi*. FIG. 628. *S. (Hinkleyia) caperata*. FIG. 629. *S. (H.) caperata*, periostracal ridges on body whorl. FIG. 630. *S. (H.) montanensis*. FIG. 631. *S. (H.) pilsbryi*. FIG. 632. *Fisherola nuttalli lancides*, top (left figure) and right lateral (right figure) views. Measurement lines = 1 mm or are divided into millimeters.

Stagnicola gabbi (Tryon 1865) [Fig. 618]
California (see F.C. Baker, 1911a).
Stagnicola hinkleyi (F.C. Baker 1906) [Fig. 620]
Columbia River drainage, Idaho and Oregon (F.C. Baker, 1911a).
Stagnicola idahoense (Henderson 1931) [Fig. 619]
Little Salmon River, Idaho (Henderson, 1931a).
Stagnicola mighelsi (Binney 1865) [Fig. 621]
Lakes in Maine (see F.C. Baker, 1911a).
Stagnicola oronoensis (F.C. Baker 1904) [Fig. 622]
Maine to eastern Ontario (F.C. Baker, 1911a).
Stagnicola petoskeyensis (Walker 1908) [Fig. 623]
Small spring-brook flowing into Little Traverse Bay, near Petoskey, Michigan (Walker, 1908e).
Stagnicola utahensis (Call 1884) [Fig. 624]
Lake Utah, Utah (Call, 1884).
Stagnicola walkeriana F.C. Baker 1926 [Fig. 625]
Great Lakes (Michigan and Superior) (F.C. Baker, 1928c).
Stagnicola woodruffi (F.C. Baker 1901) [Figs. 626, 627]
Great Lakes (Huron, Michigan, Ontario); Lake Geneva, Wisconsin; Rainy River system; Lake of the Woods (Clarke, 1973).

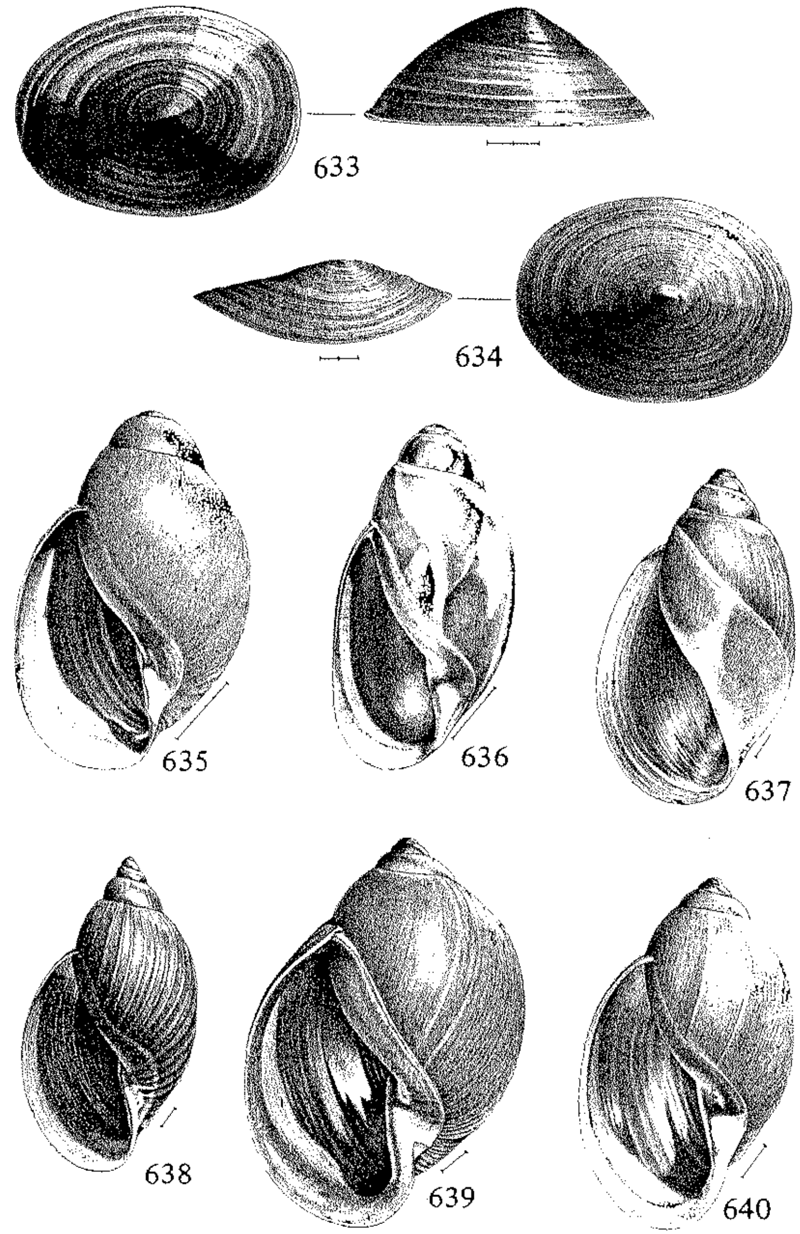
Subgenus *Hinkleyia* F.C. Baker 1928

Stagnicola (Hinkleyia) caperata (Say 1829) [Figs. 628, 629]
Quebec and Massachusetts west to California; Yukon Territory and James Bay south to Maryland, Indiana, Colorado and California (F.C. Baker, 1928c).
Stagnicola (Hinkleyia) montanensis (F.C. Baker 1913) [Fig. 630]
Hays Creek near Ward, Montana; upper Snake River drainage in Idaho and Wyoming; Beaver, Cache and Summit counties, Utah; Nye County, Nevada (Taylor, Walter & Burch, 1963).
Stagnicola (Hinkleyia) pilsbryi (Hemphill 1890) [Fig. 631]
Fish Springs, Juab County, Utah (Russell, 1971b).

Subfamily Lancinae[44]

Genus *Fisherola* Hannibal 1912

Fisherola nuttalli nuttalli (Haldeman 1841)[45]
Columbia River drainage (Pilsbry, 1925a); Snake River drainage, Idaho, and Deschutes River and The Dalles, Oregon (Henderson, 1936c).
Fisherola nuttalli kootaniensis (Baird 1863)
Spokane River [eastern Washington] and Kootenai River, British Columbia (Baird, 1863).
Fisherola nuttalli lancides Hannibal 1912 [Fig. 632]
Snake River basin (Hannibal, 1912b), = ? Spokane River (Henderson, 1936c).



FIGS. 633-640. Shells of Lymnaeidae (Lancinae) (Figs. 633, 634) and Physidae (Physinae) (Figs. 635-640). FIG. 633. *Lanx patelloides*. FIG. 634. *L. (Walkerola) klamathensis*. FIG. 635. *Physa jennessi*. FIG. 636. *Physa skinneri*. FIG. 637. *Physa skinneri*, large unnamed morph. FIG. 638. *Physella boucardi*. FIG. 639. *Physella columbiana*. FIG. 640. *Physella cooperi*. Measurement lines = 1 mm or are divided into millimeters.

Genus *Lanx* Clessin 1882

Subgenus *Lanx* s.s.

Lanx alta (Tryon 1865) [Fig. 578]
Klamath River, California (Tryon, 1865j).
Lanx patelloides (Lea 1856) [Figs. 580, 633]
Sacramento River, California (Lea, 1856).
Lanx subrotundata (Tryon 1865) [Fig. 579]
Umpqua River, Oregon (Tryon, 1865j); Umpqua River system, Oregon (Henderson, 1929c, 1936c).

Subgenus *Walkerola* Hannibal 1912

Lanx (Walkerola) klamathensis Hannibal 1912 [Fig. 634]
Klamath system in basin of Klamath River, Oregon (Hannibal, 1912b).

Family PHYSIDAE[46]

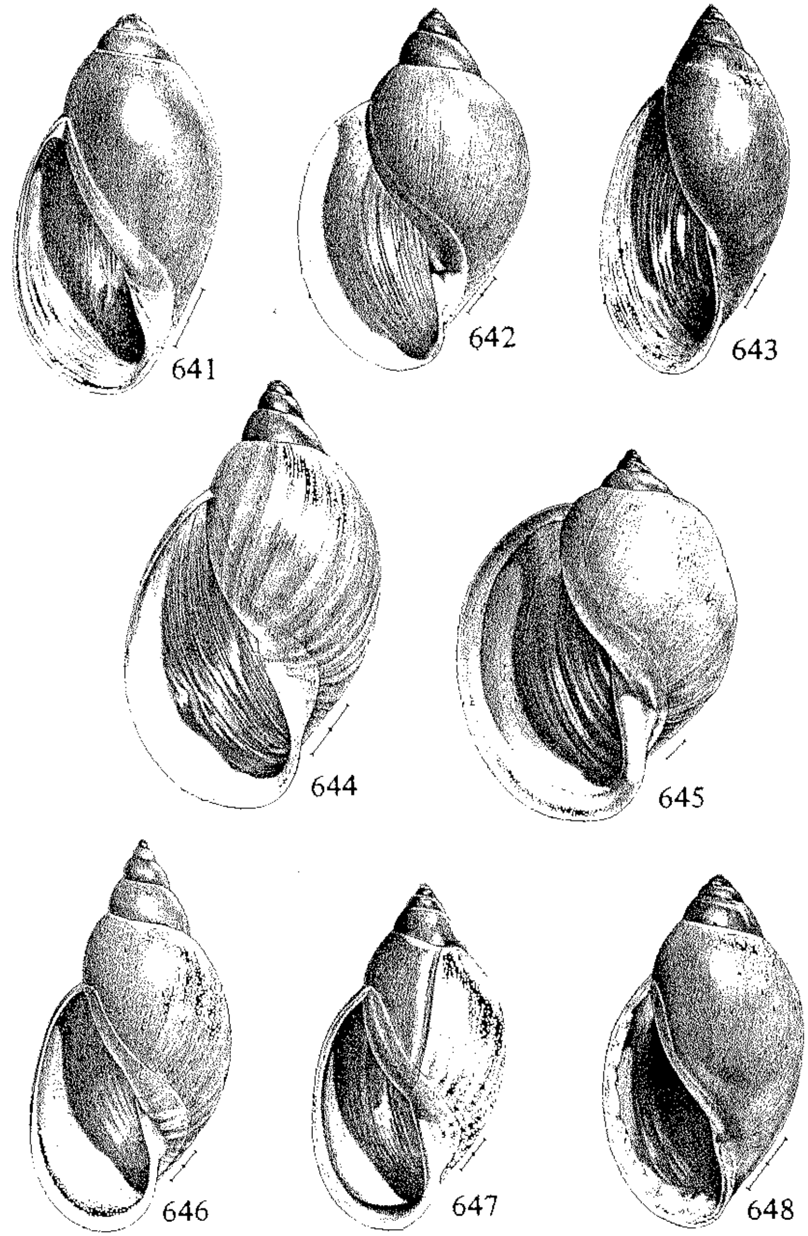
Subfamily Physinae

Genus *Physa* Draparnaud 1801

Physa jennessi Dall 1919 [Fig. 635]
Alaska, Northwest Territories and British Columbia.
Physa skinneri Taylor 1954 [Fig. 636]
Canada from Quebec to Northwest Territories and British Columbia; south to Washington, Montana, Wyoming, Nebraska, Iowa, Ohio, Pennsylvania and New England.
Physa skinneri, large unnamed morph [Fig. 637]
Canada from Ontario west to Saskatchewan; Massachusetts and Pennsylvania west to Michigan.

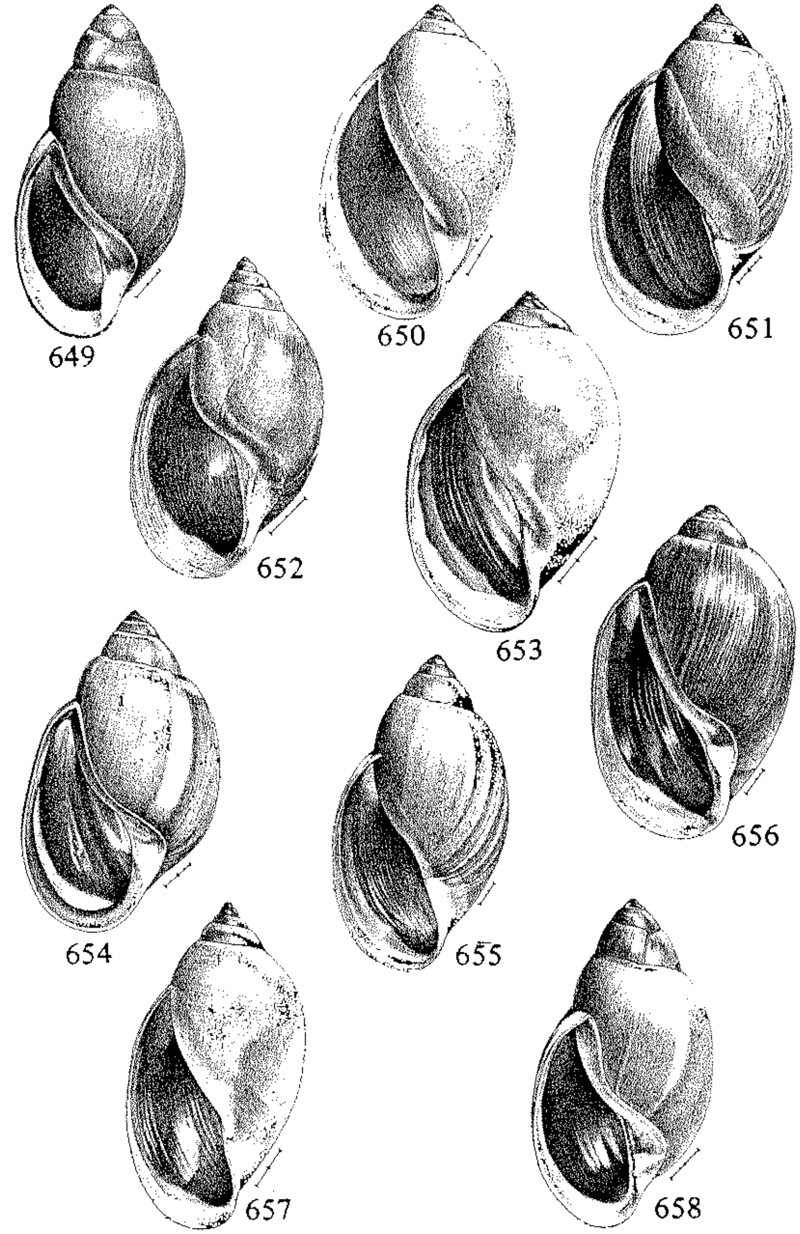
Genus *Physella* Haldeman 1843

Physella ancillaria (Say 1825) [Fig. 666]
New Brunswick to Ontario, Canada, and New York and Pennsylvania east into New England.
Physella boucardi (Crosse & Fischer 1881) [Figs. 581, 638]
Nevada and California south into Mexico.
Physella columbiana (Hemphill 1890) [Fig. 639]
Wyoming and Montana west to Washington.
Physella cooperi (Tryon 1865) [Fig. 640]
Wyoming west to California and east to Colorado.
Physella globosa (Haldeman 1841) [Fig. 667]
Kentucky, Ohio and Tennessee.

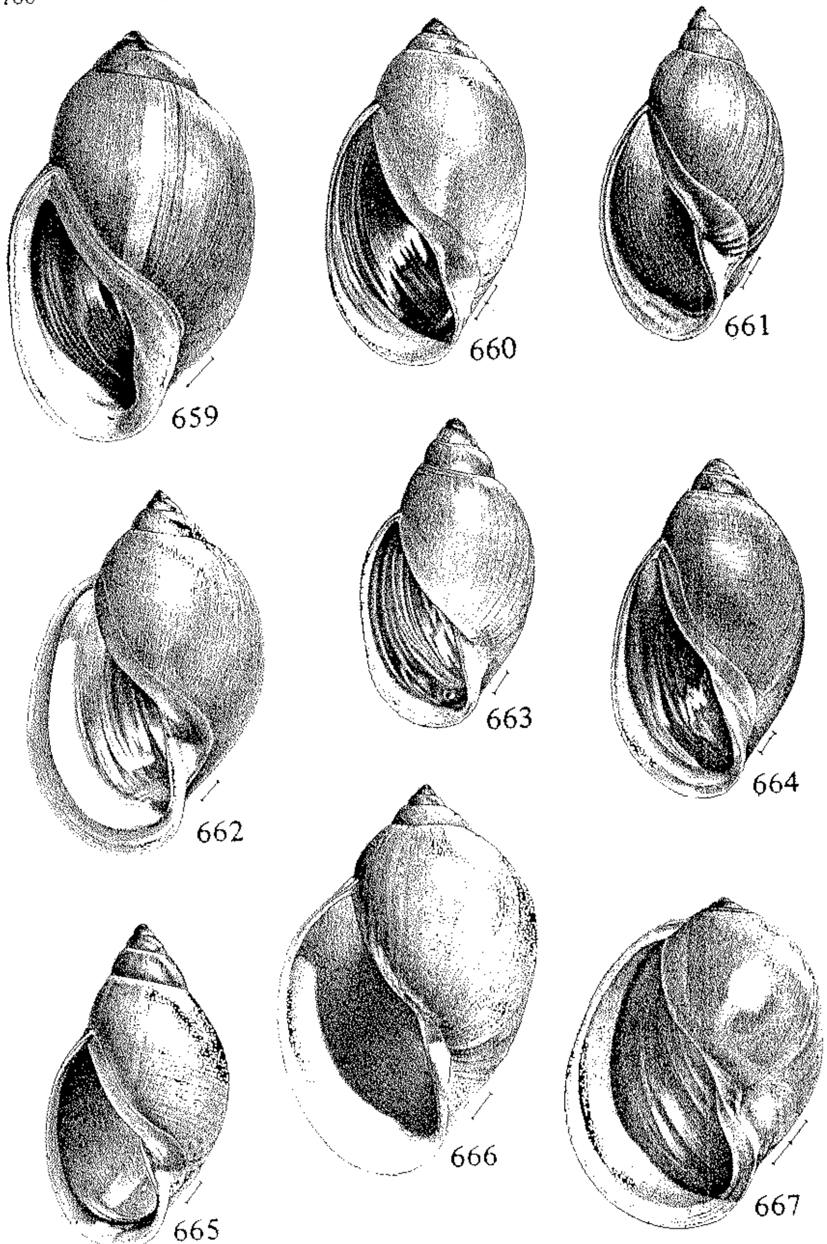


FIGS. 641-648. Shells of Physidae (Physinae). FIG. 641. *Physella hordacea*. FIG. 642. *P. lordi*. FIG. 643. *P. microstriata*. FIG. 644. *P. traski*. FIG. 645. *P. utahensis*. FIG. 646. *P. virginea*. FIG. 647. *P. gyrina gyrina*. FIG. 648. *P. gyrina gyrina* morph *elliptica*. Measurement lines = 1 mm or are divided into millimeters.

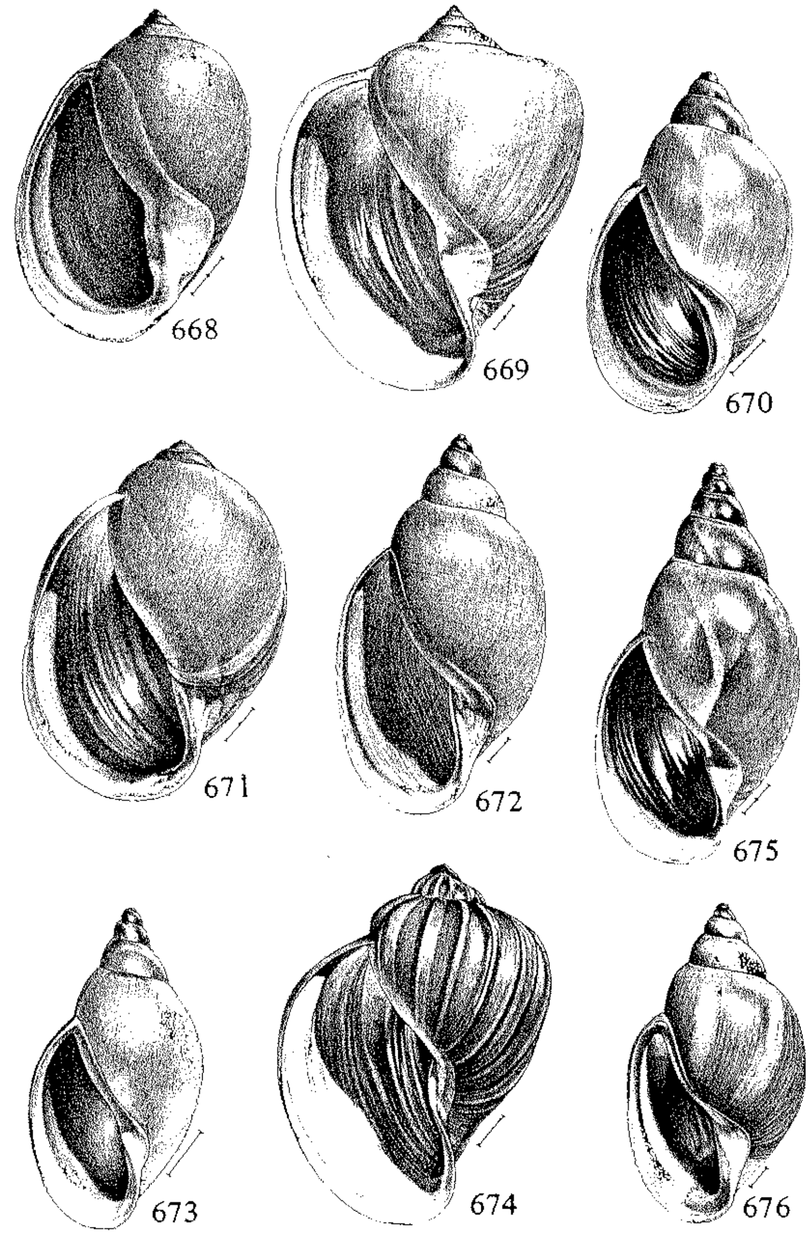
Physella gyrina gyrina (Say 1821) [Fig. 647]
In Canada, Quebec to Ontario; south to Nebraska and east to New York.
Physella gyrina gyrina morph *elliptica* (Lea 1834) [Fig. 648]
Ontario south to Iowa and Missouri and east to New York.
Physella gyrina gyrina morph *hildrethiana* (Lea 1841) [Fig. 649]
Ontario south to Iowa and Missouri and east to New York.
Physella gyrina alba (Crandall 1901) [Fig. 650]
Eastern Canada to Ontario and northeastern United States.
Physella gyrina ampullacea Gould 1855 [Fig. 651]
In Canada from Manitoba west to British Columbia; south to California, east to Arizona and north to Minnesota.
Physella gyrina athearni (Clarke 1973) [Fig. 652]
Alberta, Canada.
Physella gyrina aurea (Lea 1838) [Fig. 653]
New Jersey to Kansas, south to Arkansas and Florida.
Physella gyrina aurea morph *albofilata* ('Ancey' Sampson 1893) [Fig. 654]
Pennsylvania west to Kansas, south to Oklahoma and Alabama.
Physella gyrina bayfieldensis (Baker 1928) [Fig. 655]
Northwest Territories of Canada south to Kansas.
Physella gyrina cylindrica (Newcomb 1843) [Fig. 656]
Ontario and New York south to Virginia.
Physella gyrina gouldi (Clench 1935) [Fig. 657[
Northwest Territories south to Wisconsin and Colorado.
Physella gyrina hawni (Lea 1864) [Fig. 658]
Ohio west to Kansas and south to Texas and Alabama.
Physella gyrina microstoma (Haldeman 1840) [Fig. 659]
Virginia to Missouri and south to Arkansas and Alabama.
Physella gyrina sayi (Tappan 1838) [Fig. 660]
Quebec to Northwest Territories, south to Saskatchewan, the Dakotas and New York.
Physella gyrina smithiana (Baker 1920) [Fig. 661]
Kansas to Texas, Wyoming and California.
Physella hordacea (Lea 1864) [Fig. 641]
British Columbia, Washington and Oregon.
Physella lordi (Baird 1863) [Fig. 642]
British Columbia south to Montana, Nevada and California.
Physella magnalacustris (Walker 1901) [Fig. 668]
Ontario south to the Great Lakes states and Indiana, east to Vermont and Maine.
Physella microstriata (Chamberlain & E.G. Berry 1930) [Fig. 643]
Utah.
Physella parkeri parkeri (Currier (in DeCamp) 1881) [Fig. 669]
Michigan and Wisconsin.
Physella parkeri latchfordi (Baker 1928) [Fig. 670]
Quebec, Ontario, Wisconsin, Michigan and Maine.
Physella propinqua propinqua (Tryon 1865) [Fig. 662]
Montana and Washington south to Wyoming and California.



FIGS. 649-658. Shells of Physidae (Physinae). FIG. 649. *Physella gyrina gyrina* morph *hildrethiana*. FIG. 650. *P. gyrina alba*. FIG. 651. *P. gyrina ampullacea*. FIG. 652. *P. gyrina athearni*. FIG. 653. *P. gyrina aurea*. FIG. 654. *P. gyrina aurea* morph *albofilata*. FIG. 655. *P. gyrina bayfieldensis*. FIG. 656. *P. gyrina cylindrica*. FIG. 657. *P. gyrina gouldi*. FIG. 658. *P. gyrina hawnii*. Measurement lines = 1 mm or are divided into millimeters.



FIGS. 659-667. Shells of Physidae (Physinae). FIG. 659. *Physella gyrina microstoma*. FIG. 660. *P. gyrina sayi*. FIG. 661. *P. gyrina smithiana*. FIG. 662. *P. propinqua propinqua*. FIG. 663. *P. propinqua nuttalli*. FIG. 664. *P. propinqua nuttalli* morph *triticea*. FIG. 665. *P. propinqua nuttalli* morph *venusta*. FIG. 666. *P. ancillaria*. FIG. 667. *P. globosa*. Measurement lines = 1 mm or are divided into millimeters.

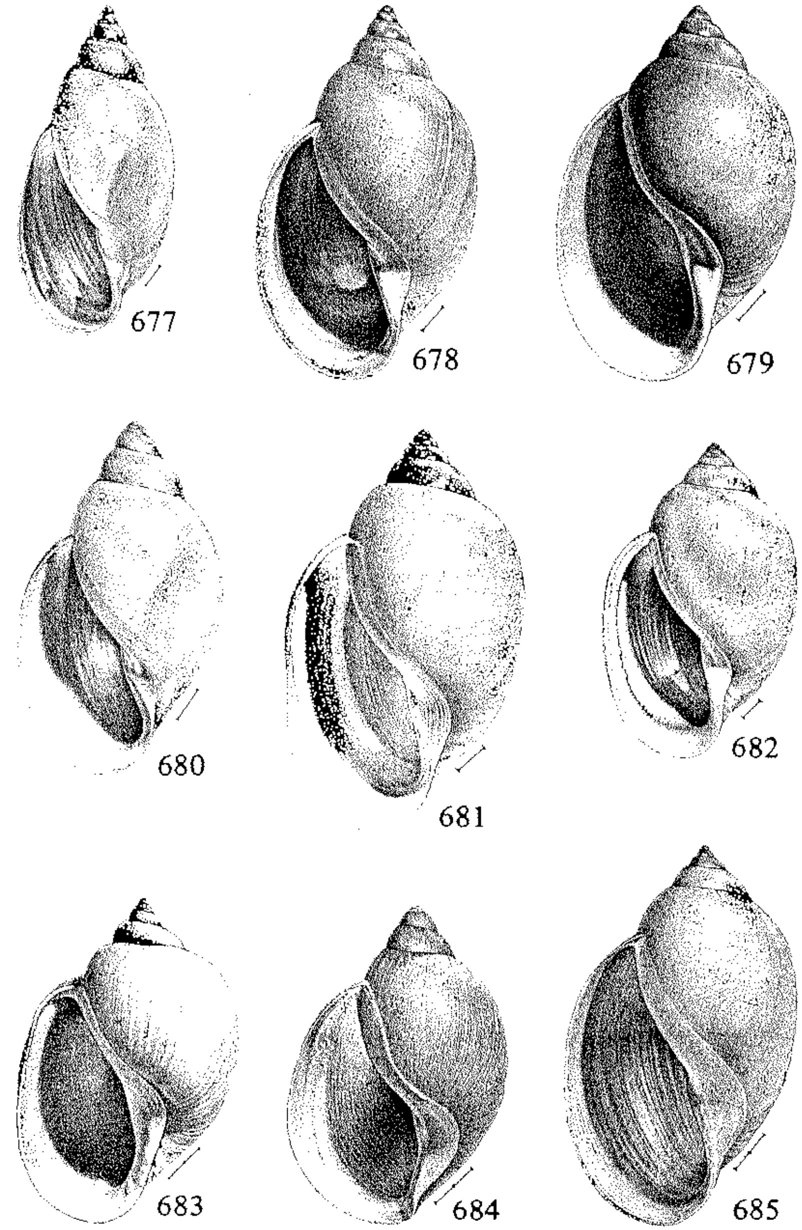


FIGS. 668-676. Shells of Physidae (Physinae). FIG. 668. *Physella magnalacustris*. FIG. 669. *P. parkeri parkeri*. FIG. 670. *P. parkeri latchfordi*. FIG. 671. *P. vinosa*. FIG. 672. *P. (Costatella) cubensis cubensis*. FIG. 673. *P. (C.) cubensis peninsularis*. FIG. 674. *P. (C.) costata*. FIG. 675. *P. (C.) hendersoni hendersoni*. FIG. 676. *P. (C.) hendersoni hendersoni* morph *ariomus*. Measurement lines = 1 mm or are divided into millimeters.

Physella propinqua nuttalli (Lea 1864) [Fig. 663]
British Columbia south to Montana, Wyoming and California.
Physella propinqua nuttalli morph *triticea* (Lea 1856) [Fig. 664]
Idaho and Washington, south to California and Nevada.
Physella propinqua nuttalli morph *venusta* (Lea 1864) [Fig. 665]
Montana to Washington, south to California and northeast to Utah and Wyoming.
Physella traski (Lea 1864) [Fig. 644]
Oregon and California.
Physella utahensis (Clench 1925) [Fig. 645]
Wyoming, Colorado and Utah.
Physella vinosa (Gould 1847) [Fig. 671]
Ontario, Canada, and the Great Lakes states.
Physella virginea (Gould 1847) [Fig. 646]
British Columbia south to California.

Subgenus *Costatella* Dall 1870

Physella (Costatella) acuta Draparnaud 1805) [Fig. 678]
Europe, Mediterranean regions, and Africa; introduced into Australia, Hawaii and perhaps parts of continental United States.
Physella (Costatella) bottimeri (Clench 1924) [Fig. 679]
New Mexico, Oklahoma and Texas.
Physella (Costatella) conoidea (Fischer & Crosse 1886) [Fig. 582]
Texas.
Physella (Costatella) costata (Newcomb 1861) [Fig. 674]
California.
Physella (Costatella) cubensis cubensis (Pfeiffer 1839) [Fig. 672]
Bahamas, Cuba, Jamaica, Puerto Rico, West Indies, Honduras and Florida.
Physella (Costatella) cubensis peninsularis (Pilsbry 1889) [Fig. 673]
Florida.
Physella (Costatella) hendersoni hendersoni (Clench 1925) [Fig. 675]
West Virginia, Tennessee and Missouri, south to the Carolinas, Mississippi, and Florida.
Physella (Costatella) hendersoni hendersoni morph *ariomus* (Clench 1925) [Fig. 676]
Virginia, South Carolina, Georgia, Florida and Alabama.
Physella (Costatella) hendersoni ssp.]Fig. 677]
Virginia, North Carolina, Florida and Alabama.
Physella (Costatella) heterostropha heterostropha (Say 1817) [Fig. 680]
Nova Scotia to Ontario; New England to Ohio, Tennessee and the Virginias; the Bahamas.
Physella (Costatella) heterostropha halei (Lea 1864) [Fig. 682]
Illinois, Missouri, Kansas, Arkansas and Texas.
Physella (Costatella) heterostropha pomila (Conrad 1834) [Fig. 681]
Eastern United States to the Ohio and Mississippi rivers and in Iowa.
Physella (Costatella) humerosa (Gould 1855) [Fig. 683]
California, Arizona and Colorado.



FIGS. 677-685. Shells of Physidae (Physinae). FIG. 677. *Physella (Costatella) hendersoni* ssp. FIG. 678. *P. (C.) acuta*. FIG. 679. *P. (C.) bottimeri*. FIG. 680. *P. (C.) heterostropha heterostropha*. FIG. 681. *P. (C.) heterostropha pomila*. FIG. 682. *P. (C.) heterostropha halei*. FIG. 683. *P. (C.) humerosa*. FIG. 684. *P. (C.) johnsoni*. FIG. 685. *P. (C.) osculans*. Measurement lines = 1 mm or are divided into millimeters.

Physella (Costatella) integra integra (Haldeman 1841) [Fig. 695]
Quebec to Manitoba, Canada, and the Great Lakes states, Iowa, South Dakota, Tennessee, Kentucky and West Virginia.
Physella (Costatella) integra integra morph *walkeri* (Crandall 1901) [Fig. 696]
Quebec, Ontario and the Great Lakes states.
Physella (Costatella) integra brevispira (Lea 1864) [Fig. 697]
New York, Ohio, Wisconsin and Minnesota.
Physella (Costatella) johnsoni (Clench 1926) [Fig. 684]
Alberta, Canada, and Montana, Wyoming and Colorado.
Physella (Costatella) osculans (Haldeman 1841) [Fig. 685]
Colorado west to California and southeast to Arizona and into Mexico.
Physella (Costatella) spelunca (Turner & Clench 1974) [Fig. 686]
Wyoming.
Physella (Costatella) squalida (Morelet 1851) [Fig. 687]
Texas into Mexico, Central and South America, and in Costa Rica.
Physella (Costatella) virgata virgata (Gould 1855) [Fig. 688]
Nebraska west to California, east to Texas and into Mexico.
Physella (Costatella) virgata virgata morph *parva* (Lea 1864) [Fig. 689]
Iowa west to California, east to Texas and north to Kansas.
Physella (Costatella) virgata anatina (Lea 1864) [Fig. 690]
Wisconsin and South Dakota southwest to Colorado and Nevada; Texas and Arkansas north to Illinois and Nebraska.
Physella (Costatella) virgata berendti (Fischer & Crosse 1886) [Fig. 691]
Wyoming to California, southeast to Texas and Mexico and north to Kansas.
Physella (Costatella) virgata concolor (Haldeman 1841) [Fig. 692]
Manitoba and Wisconsin to Idaho.
Physella (Costatella) virgata concolor morph [Fig. 693]
Wyoming.
Physella (Costatella) virgata rhyssa (Pilsbry 1899) [Fig. 694]
California, New Mexico and Texas into Mexico.

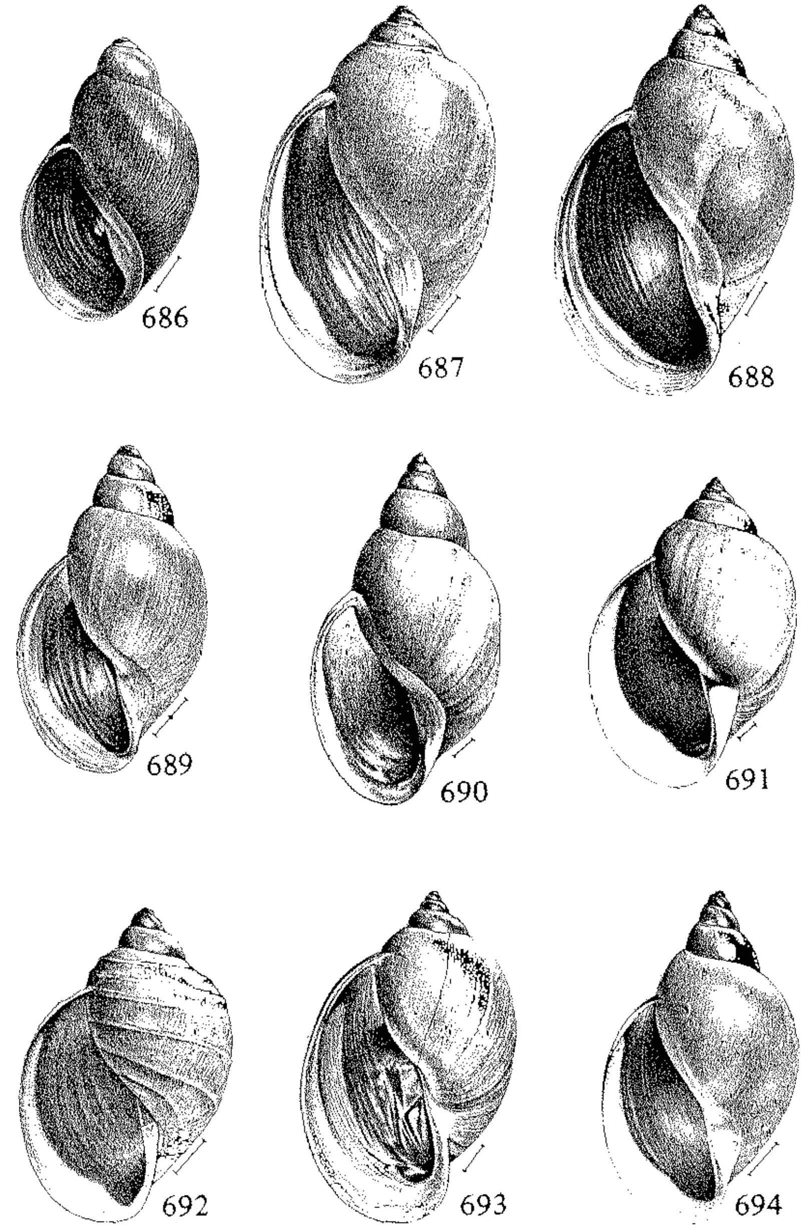
Subgenus *Petrophysa* Pilsbry 1926

Physella (Petrophysa) zionis (Pilsbry 1926) [Fig. 698]
Utah.

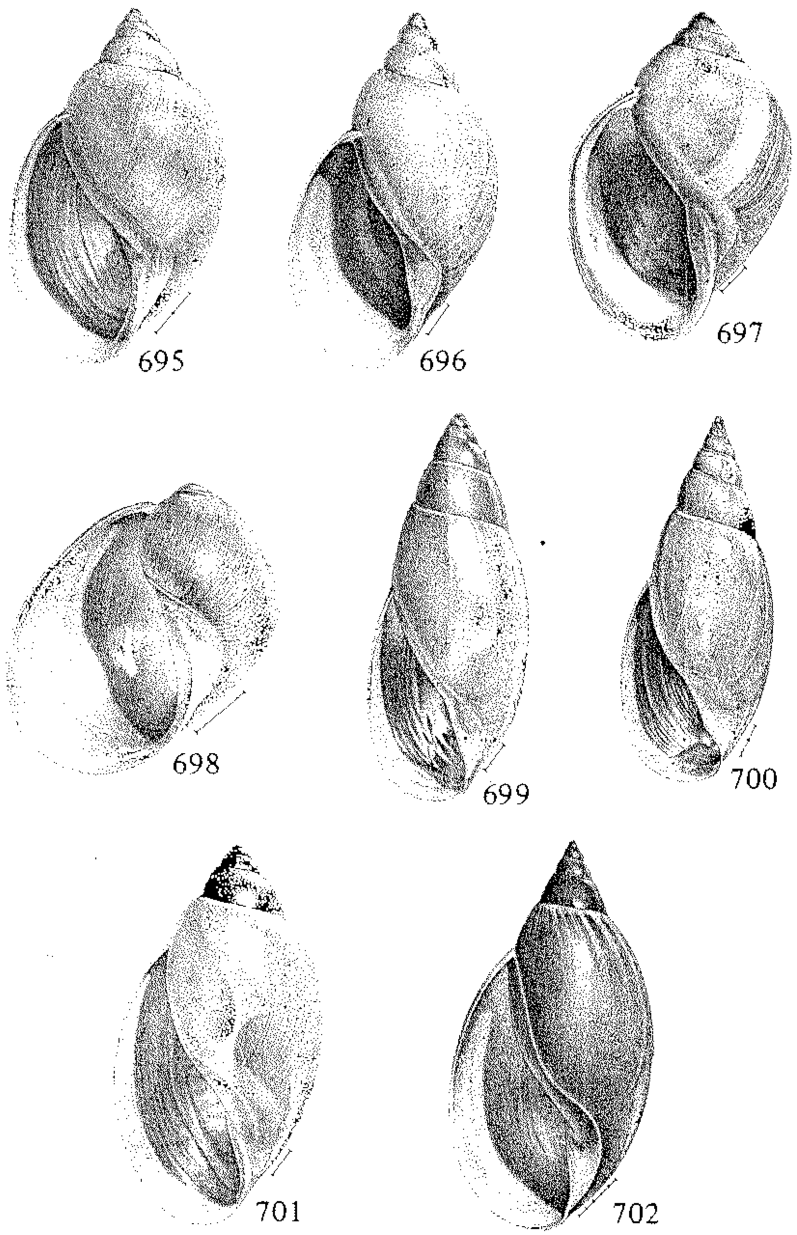
Subfamily Aplexinae

Genus *Aplexa* Fleming 1820

Aplexa elongata (Say 1821) [Fig. 699]
Ontario to Saskatchewan, Canada, and Alaska; New England through the Great Lakes states to Washington; south to Idaho, Utah and Wyoming.
Aplexa elongata morph *tryoni* (Currier 1867) [Fig. 700]
Ontario and Alberta, Canada; Michigan and Minnesota west to Washington; also in Utah, Illinois and Indiana.



FIGS. 686-694. Shells of Physidae (Physinae). FIG. 686. *Physella (Costatella) spelunca*. FIG. 687. *P. (C.) squalida*. FIG. 688. *P. (C.) virgata virgata*. FIG. 689. *P. (C.) virgata virgata* morph *parva*. FIG. 690. *P. (C.) virgata anatina*. FIG. 691. *P. (C.) virgata berendti*. FIG. 692. *P. (C.) virgata concolor*. FIG. 693. *P. (C.) virgata concolor* morph. FIG. 694. *P. (C.) virgata rhyssa*. Measurement lines = 1 mm or are divided into millimeters.



FIGS. 695-702. Shells of Physidae (Physinae and Aplexinae). FIG. 695. *Physella (Costatella) integra integra*. FIG. 696. *P. (C.) integra integra* morph *walkeri*. FIG. 697. *P. (C.) integra brevispira*. FIG. 698. *P. (Petrophysa) zionis*. FIG. 699. *Aplexa elongata*. FIG. 700. *A. elongata* morph *tryoni*. FIG. 701. *Stenophysa marmorata*. FIG. 702. *S. maugeriae*. Measurement lines = 1 mm or are divided into millimeters.

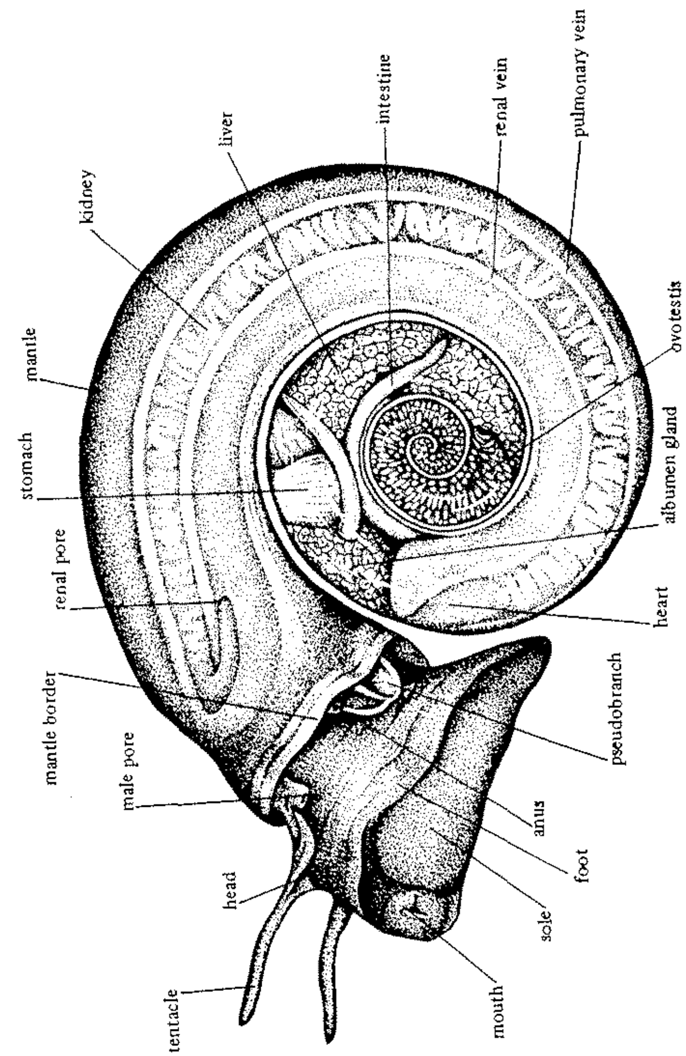


FIG. 703. Planorbid (*Biomphalaria*) with shell removed to show aspects of anatomy (left side) (from Barbosa et al., 1968, after Demian).

M

Genus *Stenophysa* Martens 1898[47]

Stenophysa marmorata (Guilding 1828) [Fig. 701]
Brazil, Guatemala, Uruguay, Venezuela and the West Indies. Introduced into Texas (*teste* Te, 1978).

Stenophysa maugeriae (Gray 1837) [Fig. 702]
Mexico. Introduced into Texas (*teste* Te, 1978).

Family PLANORBIDAE

Subfamily Planorbinae

Tribe Planorbini

Genus *Gyraulus* 'Agassiz' Charpentier 1837

Subgenus *Gyraulus* s.s.

Gyraulus deflectus (Say 1824) [Fig. 705]
Along the Atlantic Coast from Prince Edward Island south to Virginia, west to Ohio, Illinois, Alberta and Idaho (Miller, 1966); north to near the Arctic Coast in the Ungava, Coppermine River and Mackenzie River districts (Clarke, 1973).

Subgenus *Armiger* Hartmann 1840

Gyraulus (Armiger) crista (Linnaeus 1758) [Fig. 706]
Holarctic. In North America from Ontario and Maine to Minnesota, northwestern Northwest Territories and Alaska (Clarke, 1973).

Subgenus *Torquis* Dall 1905

Gyraulus (Torquis) circumstriatus (Tryon 1866) [Fig. 707]
Connecticut north to Quebec, west to Alberta and south in the Rocky Mountains to New Mexico (Clarke, 1973).

Gyraulus (Torquis) hornensis F.C. Baker 1934[48] [Fig. 708]
Mackenzie River region west of Great Slave Lake; western Ontario, Wisconsin and North Dakota (F.C. Baker, 1934).

Gyraulus (Torquis) parvus (Say 1817) [Fig. 709]
North America, from Alaska and northern Canada to Cuba and from the Atlantic to the Pacific Coast (Taylor, 1960).

Tribe Drepanotremini[49]

Genus *Drepanotrema* Fischer & Crosse 1880

Subgenus *Antillorbis* Harry & Hubendick 1964

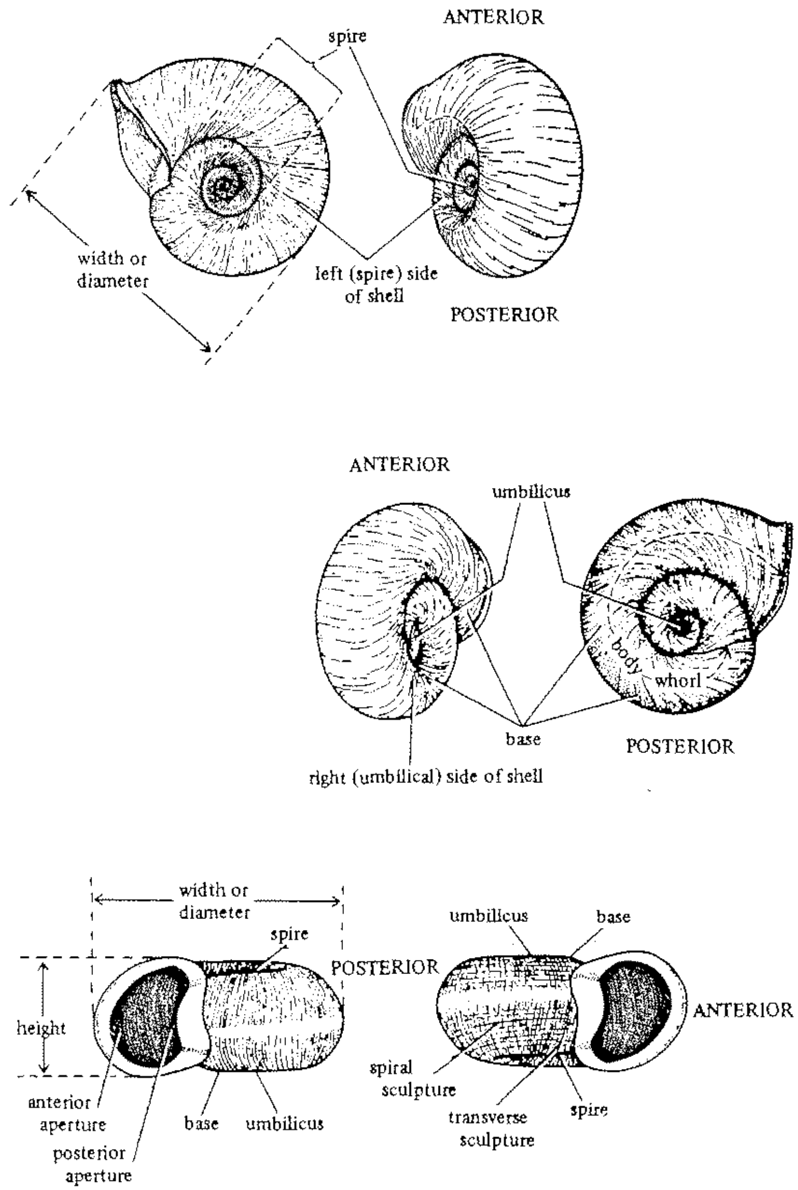
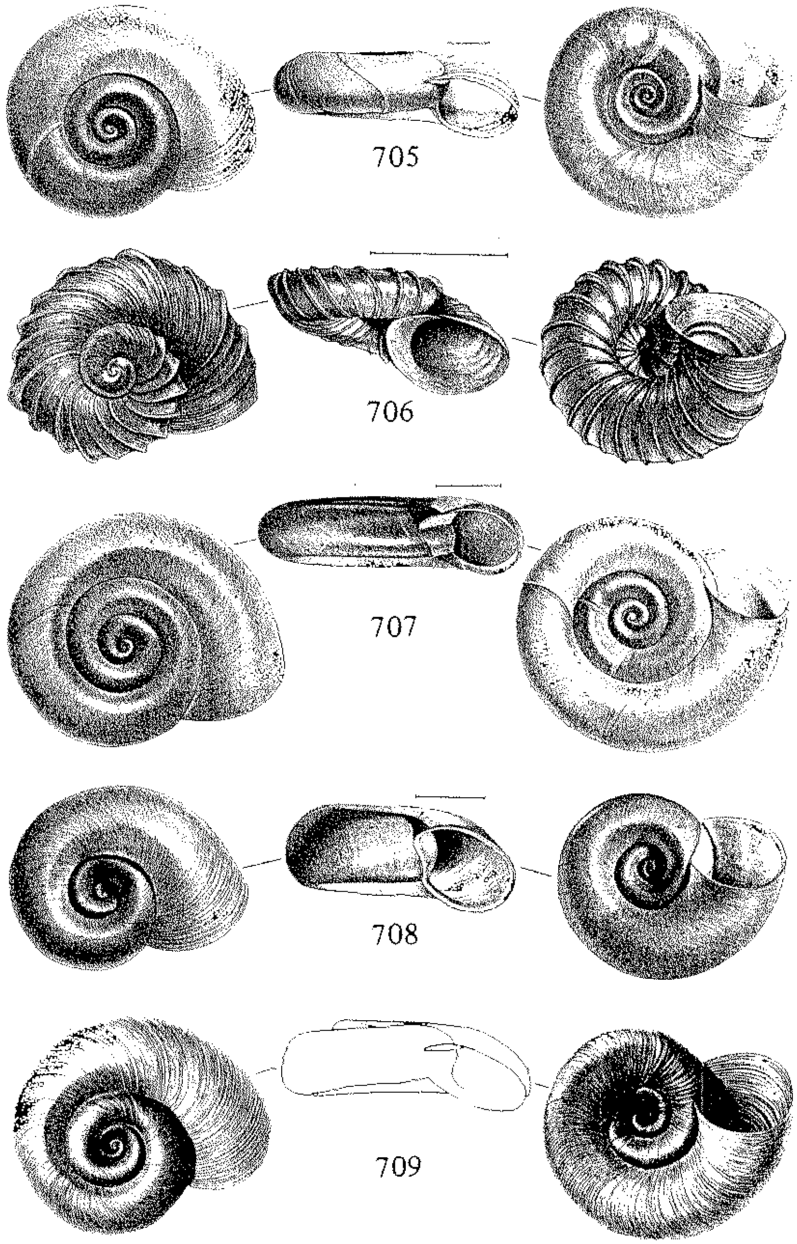
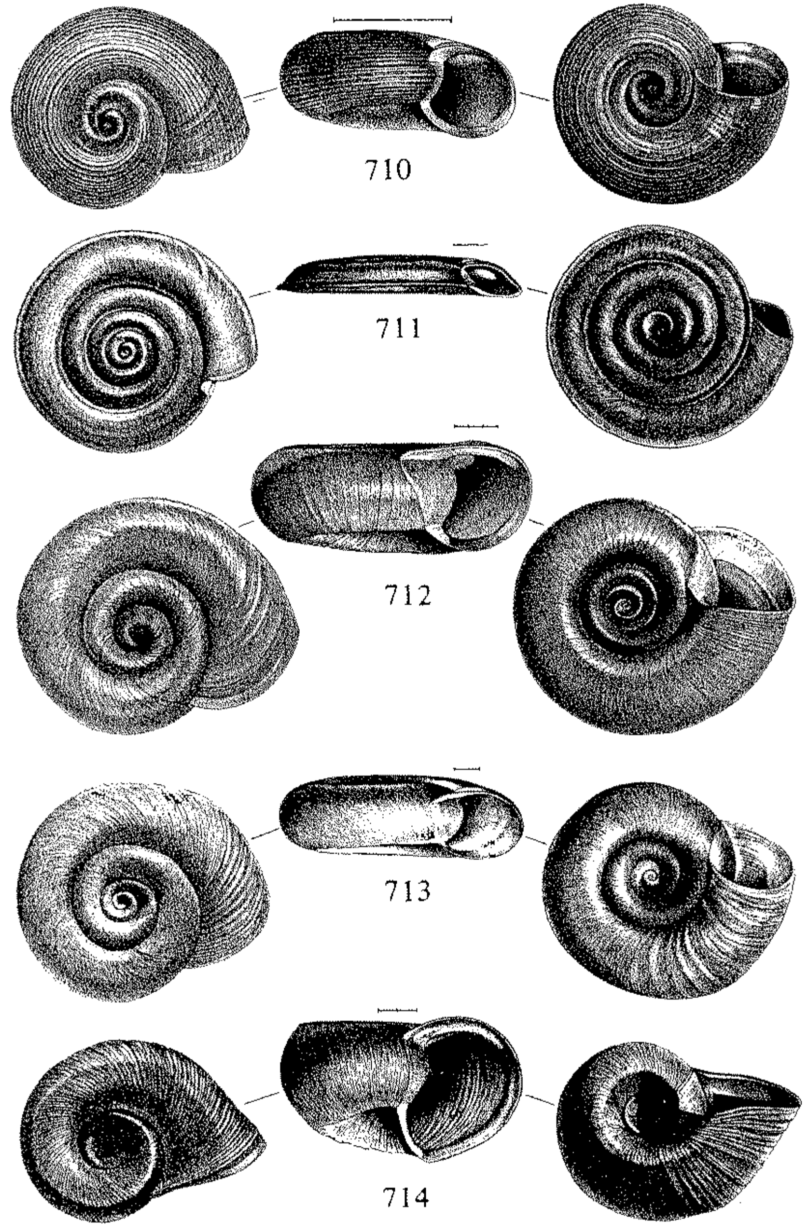


FIG. 704. Terminology of a planorbid shell.



FIGS. 705-709. Shells of Planorbidae (Planorbinae, Planorbini). FIG. 705. *Gyraulus deflectus*, umbilical, apertural and spire views (left to right). FIG. 706. *G. (Armiger) crista*. FIG. 707. *G. (Torquis) circumstriatus*. FIG. 708. *G. (T.) hornensis*. FIG. 709. *G. (T.) parvus*. Measurement lines = 1 mm.



FIGS. 710-714. Shells of Planorbidae (Planorbinae, Drepanotremini, Biomphalariini and Helisomini). FIG. 710. *Drepanotrema (Antillorbis) aeruginosum*, umbilical, apertural and spire views (left to right). FIG. 711. *D. (Fossulorbis) kermatoides*. FIG. 712. *Biomphalaria glabrata*. FIG. 713. *B. havanensis*. FIG. 714. *Helisoma anceps anceps*. Measurement lines = 1 mm or are divided into millimeters.

Drepanotrema (Antillorbis) aeruginosum (Morelet 1851) [Fig. 710]
Southern Texas and southern Arizona, Mexico, Guatemala and Antilles (Bequaert & Miller, 1973).

Subgenus *Fossulorbis* Pilsbry 1934

Drepanotrema (Fossulorbis) cimex (Moricand 1839) [Fig. 715]
Southern Texas, Mexico, Central America, Venezuela, Brazil and the Greater Antilles (Harry & Hubendick, 1964).
Drepanotrema (Fossulorbis) kermatoides (d'Orbigny 1835) [Fig. 711]
Florida, Texas, Mexico, Central America, Venezuela, Peru, Brazil and the Lesser Antilles (Harry & Hubendick, 1964).

Tribe Biomphalariini

Genus *Biomphalaria* Preston 1910

Biomphalaria glabrata (Say 1818) [Fig. 712]
West Indies, Venezuela, Surinam, French Guiana and Brazil (Barbosa et al., 1968); introduced to Florida.
Biomphalaria havanensis (Pfeiffer 1839) [Fig. 713]
Florida, Louisiana and Texas (Malek, 1969); Arizona, Mexico, Central America (Bequaert & Miller, 1973); also Puerto Rico and Cuba.

Tribe Helisomini

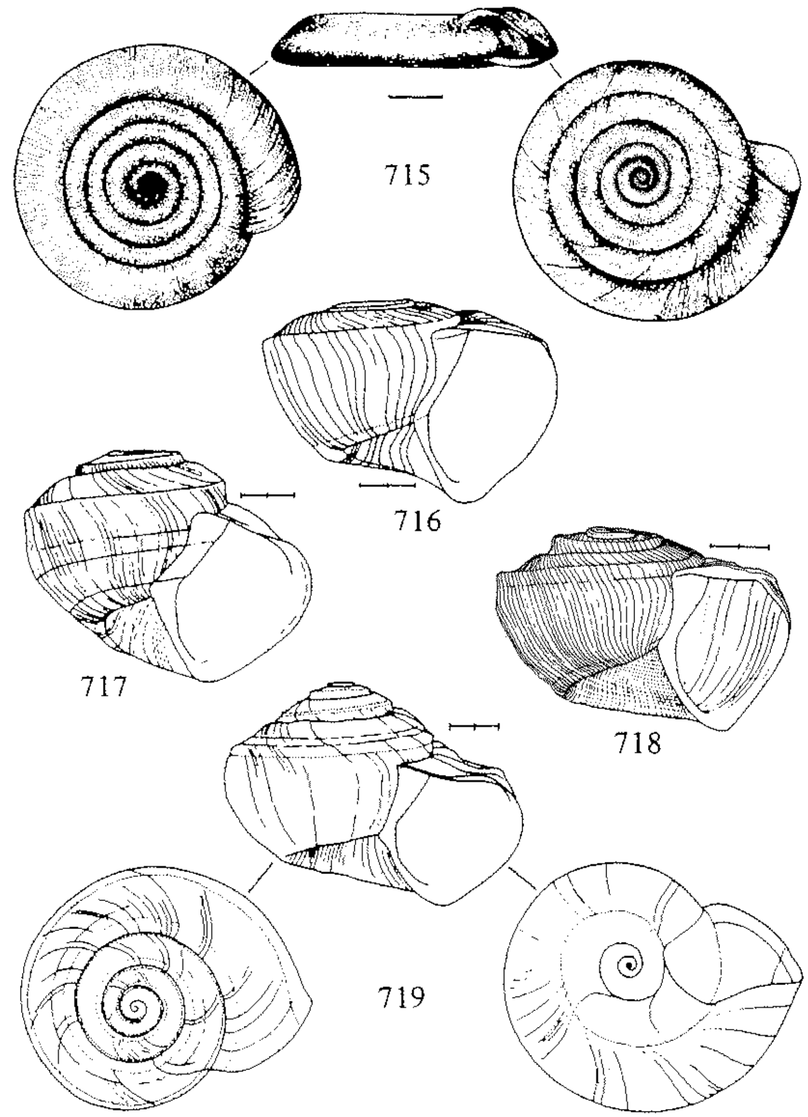
Genus *Helisoma* Swainson 1840

Subgenus *Helisoma* s.s.

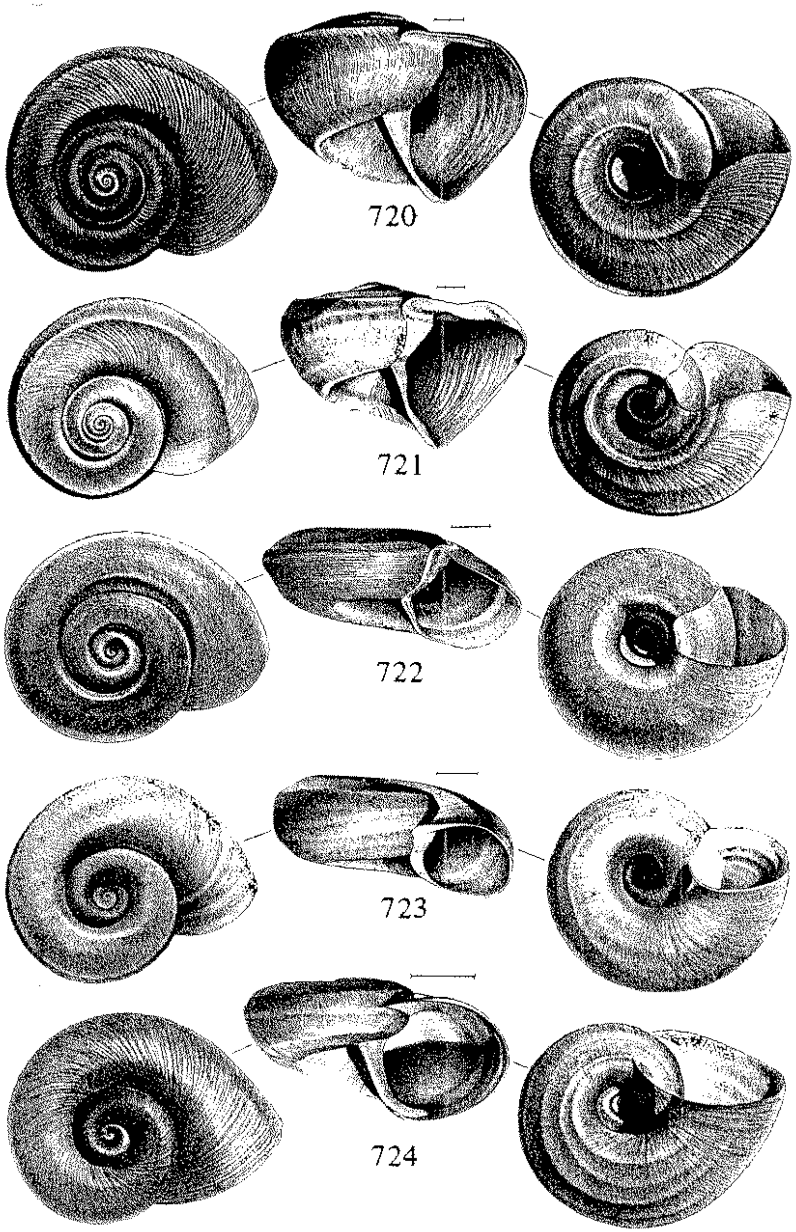
Helisoma anceps anceps (Menke 1830)[50] [Fig. 714]
Throughout North America from James and Hudson bays south to Georgia, Alabama, Texas and northwestern Mexico, west to southwestern Northwest Territories, Alberta and Oregon (see Walker, 1909e; Clarke, 1973).
Helisoma anceps royalense (Walker 1909)
Isle Royale, Lake Superior, and the adjacent portion of Ontario north and west of Lake Superior in parts of the Albany, Attawapiskat and Winnipeg river systems (Clarke, 1973).

Subgenus *Carinifex* W.G. Binney 1865[51]

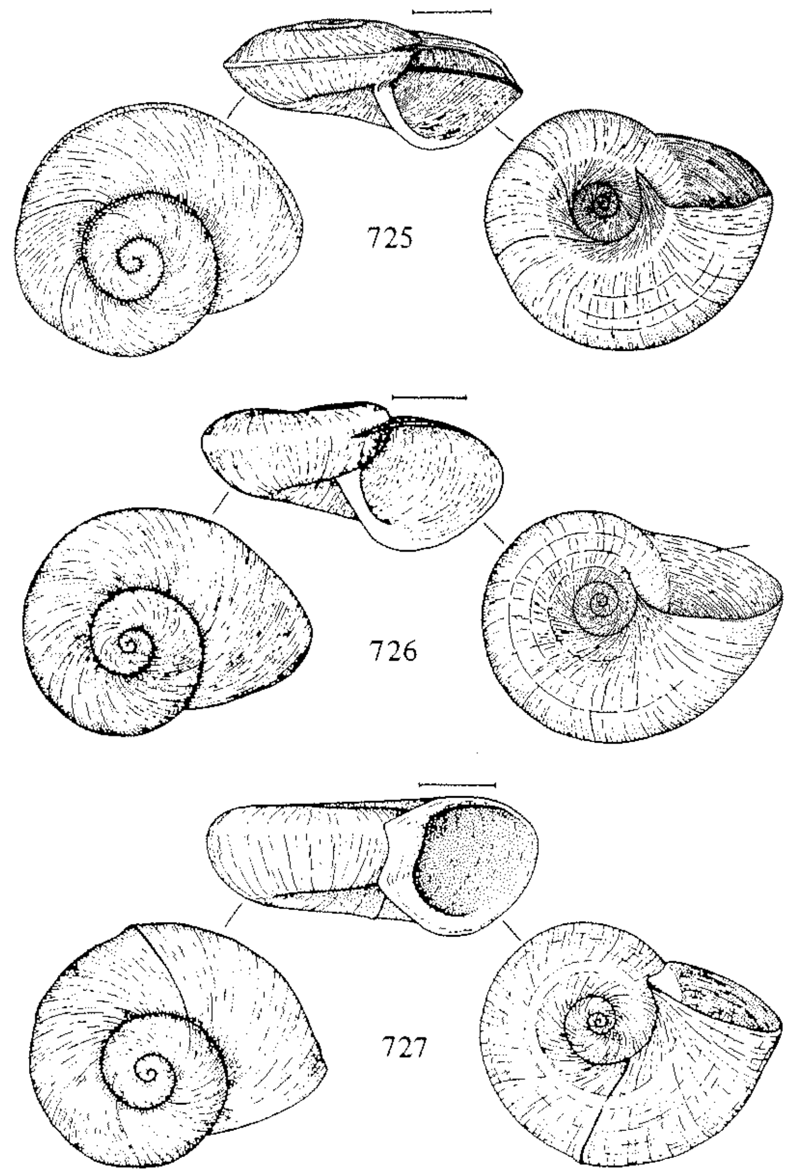
Helisoma (Carinifex) newberryi newberryi (Lea 1858) [Figs. 720, 721]
Idaho, Utah, Nevada, Oregon and California.
Helisoma (Carinifex) newberryi jacksonensis Henderson 1932 [Figs. 716, 717]
Jackson Lake, Wyoming (Henderson, 1932a).



FIGS. 715-719. Shells of Planorbidae (Planorbinae, Drepanotremini and Helisomini). FIG. 715. *Drepanotrema (Antillorbis) cimex*, umbilical, apertural and spire views (left to right). FIG. 716. *Helisoma (Carinifex) newberryi jacksonensis*. FIG. 717. *H. (C.) newberryi jacksonensis*. FIG. 718. *H. (C.) newberryi occidentalis*. FIG. 719. *H. (C.) newberryi occidentalis*. Measurement lines = 1 mm or are divided into millimeters. FIG. 715 is from Barbosa et al. (1968).



FIGS. 720-724. Shells of Planorbidae (Planorbinae, Helisomini). FIG. 720. *Helisoma (Carinifex) newberryi newberryi*, umbilical, apertural and spire views (left to right). FIG. 721. *H. (C.) newberryi newberryi* form *ponsonbyi*. FIG. 722. *Menetus opercularis*. FIG. 723. *M. opercularis* ? form *callioglyptus*. FIG. 724. *M. (Micromenetus) dilatatus*. Measurement lines = 1 mm or are divided into millimeters.



FIGS. 725-727. Shells of Planorbidae (Planorbinae, Helisomini). FIG. 725. *Menetus (Micromenetus) brogniartiana*, umbilical, apertural and spire views (left to right). FIG. 726. *Me. (Mi.) dilatatus*. FIG. 727. *Me. (Mi.) sampsoni*. Measurement lines = 1 mm.

Helisoma (Carinifex) newberryi occidentalis Hanna 1924 [Figs. 718, 719]
Eagle Lake, Lassen County, California (Hanna, 1924).

Genus *Menetus* H. & A. Adams 1855

Subgenus *Menetus* s.s.[52]

Menetus opercularis (Gould 1847) [Figs. 722, 723]
Alaska south to Alberta and southern California.

Subgenus *Micromenetus* F.C. Baker 1945[53, 54, 55]

Menetus (Micromenetus) brogniartiana (Lea 1842) [Fig. 725]
Near Cincinnati, Ohio (Lea, 1842b); Woodville, Alabama (Pilsbry, 1895b; for *alabamensis*).
Menetus (Micromenetus) dilatatus (Gould 1841 [Figs. 724, 726]
Eastern United States, from Maine west to Iowa, south to Texas and Florida.
Menetus (Micromenetus) sampsoni 'Ancey' Sampson 1885 [Fig. 727]
Illinois, Missouri and Arkansas (Sampson, 1913).

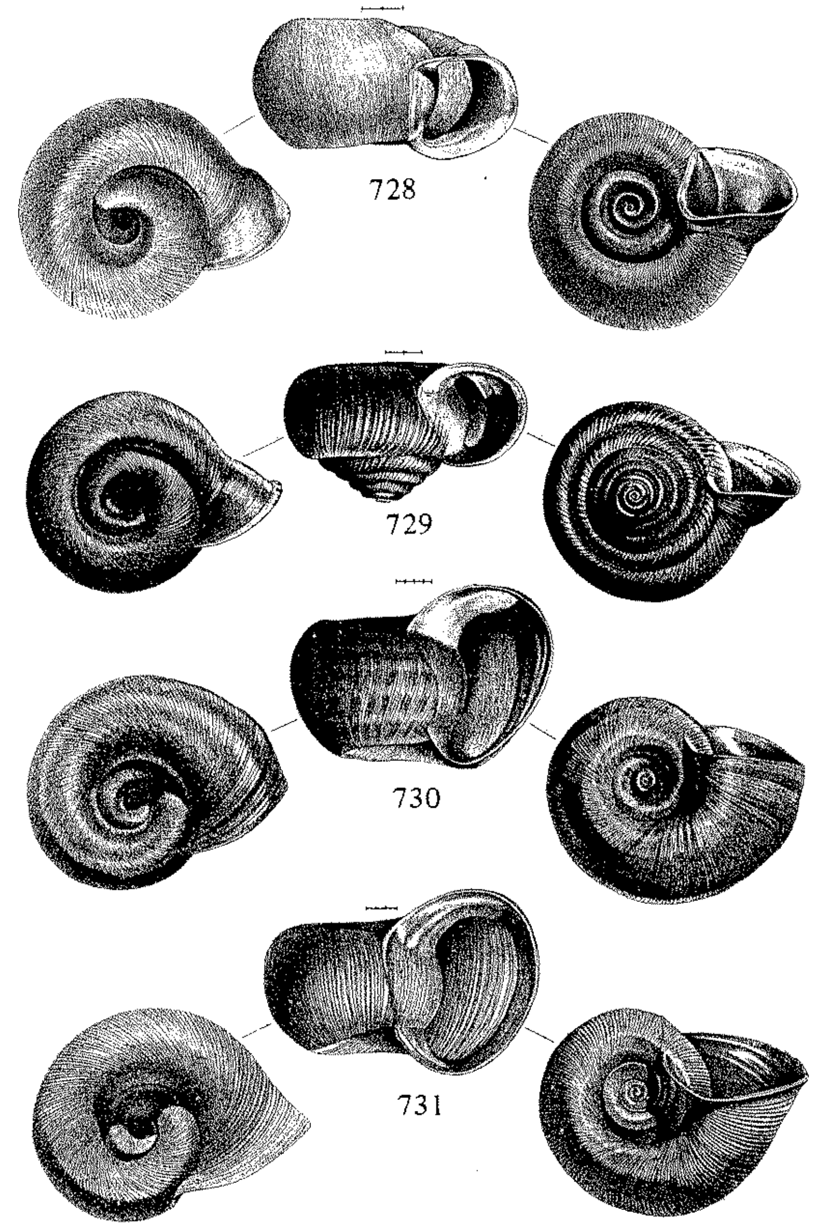
Genus *Planorbella* Haldeman 1842

Subgenus *Planorbella* s.s.[56]

Planorbella campanulata campanulata (Say 1821) [Fig. 728]
Vermont west to North Dakota, south to Ohio and Illinois, northward to Great Slave Lake (F.C. Baker, 1928c).
Planorbella campanulata collinsi (F.C. Baker 1939)
Northwestern Ontario in the headwaters of the Albany, Winnipeg and Severn river systems (Clarke, 1973).
Planorbella multivolvis (Case 1847) [Fig. 729]
Howe Lake, Marquette County, Michigan (Walker, 1907d).

Subgenus *Pierosoma* Dall 1905

Planorbella (Pierosoma) ammon (Gould 1855) [Fig. 730]
Cienaga Grande, or Colorado Low Desert (Gould, 1855a).
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) columbiense (F.C. Baker 1945)
Lac La Hache, Cariboo District, British Columbia (F.C. Baker, 1945).
Planorbella (Pierosoma) corpulentum corpulentum (Say 1824)
Western Ontario, eastern Manitoba and northern Minnesota in the Winnipeg



FIGS. 728-731. Shells of Planorbidae (Planorbinae, Helisomini). FIG. 728. *Planorbella campanulata campanulata*, umbilical apertural and spire views (left to right). FIG. 729. *P. multivolvis*. FIG. 730. *Pl. (Pierosoma) ammon*. FIG. 731. *Pl. (Pi.) pilsbryi infracarinatum*. Measurement lines are divided into millimeters.

River system; upper Mississippi River system in northern Minnesota (Clarke, 1973).

Planorbella (Pierosoma) corpulentum vermilionense (F.C. Baker 1929)
Vermilion Lake, St. Louis County, Minnesota (F.C. Baker, 1929b).

Planorbella (Pierosoma) corpulentum whiteavesi (F.C. Baker 1932)
Greenwater Lake and Lac des Mille Lacs, Thunder Bay District, Ontario (Clarke, 1973).

Planorbella (Pierosoma) magnificum (Pilsbry 1903) [Fig. 732]
Lower Cape Fear River in the vicinity of Wilmington, North Carolina (Pilsbry, 1903b).

Planorbella (Pierosoma) occidentale (Cooper 1870) [Fig. 733]
Lakes, rivers, creeks, ditches, sloughs and swamps in California, Oregon and Washington (see Henderson, 1936c).

Planorbella (Pierosoma) pilsbryi pilsbryi (F.C. Baker 1926)
Massachusetts west to Minnesota, northern New York and central Wisconsin northward (F.C. Baker, 1928c).

Planorbella (Pierosoma) pilsbryi infracarinatum (F.C. Baker 1932) [Fig. 731]
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).

Planorbella (Pierosoma) pseudotrivolvis (F.C. Baker 1920)
South Dakota, Wisconsin, Illinois, Indiana, Michigan and New York (F.C. Baker, 1928c).

Planorbella (Pierosoma) subcrenatum (Carpenter 1857) [Fig. 734]
California to British Columbia and Yukon Territory and east to Utah, Colorado, Minnesota and Manitoba (Clarke, 1973).

Planorbella (Pierosoma) tenue (Dunker 1850) [Fig. 735]
Texas, Arizona, New Mexico, southern California and Mexico (Bequaert & Miller, 1973).

Planorbella (Pierosoma) trivolvis trivolvis (Say 1817) [Fig. 736]
Atlantic Coast and Mississippi River drainages, northward to Arctic Canada and Alaska, and southward to Tennessee and Missouri (F.C. Baker, 1928c).

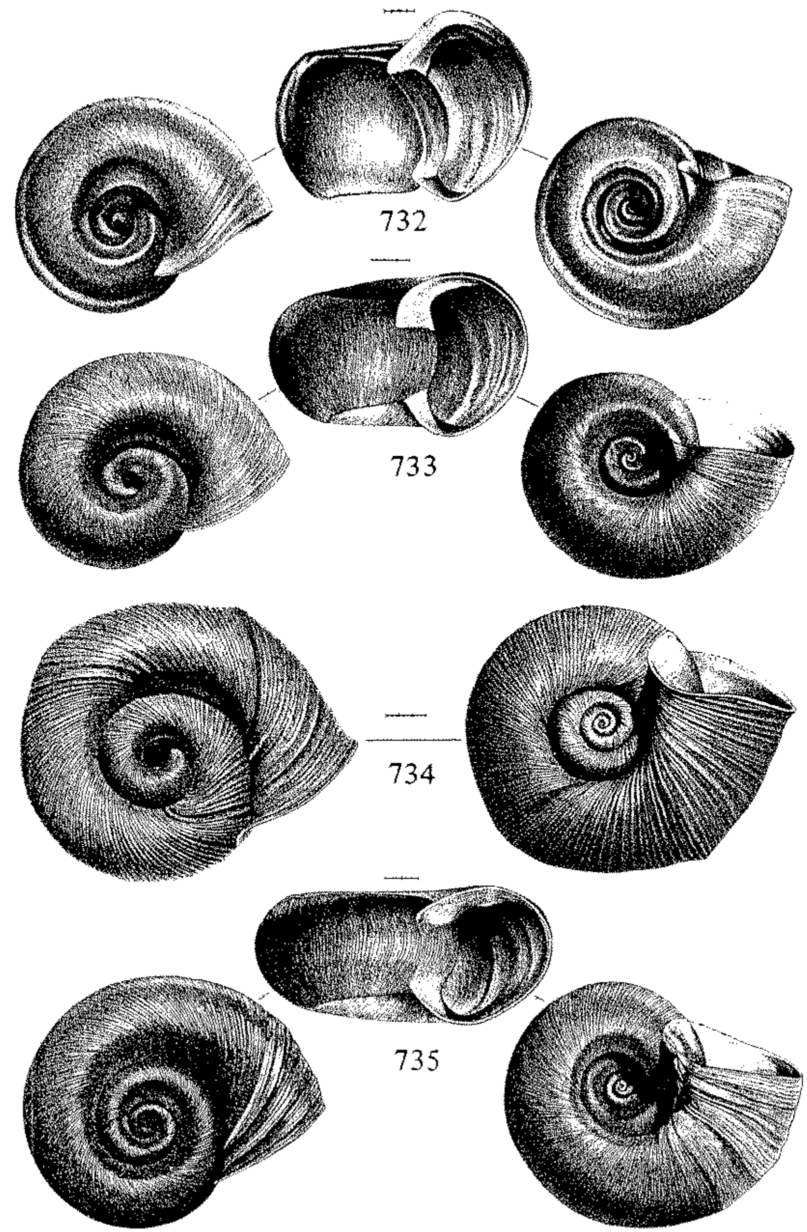
Planorbella (Pierosoma) trivolvis intertextum (Sowerby 1878)
From Long Pine Key, in the southern Everglades, throughout peninsular Florida and north along the coast to Lake Waccamaw, North Carolina (Pilsbry, 1934a).

Planorbella (Pierosoma) truncatum (Miles 1861) [Fig. 737]
Michigan, northern Illinois, and Wisconsin (F.C. Baker, 1928c).

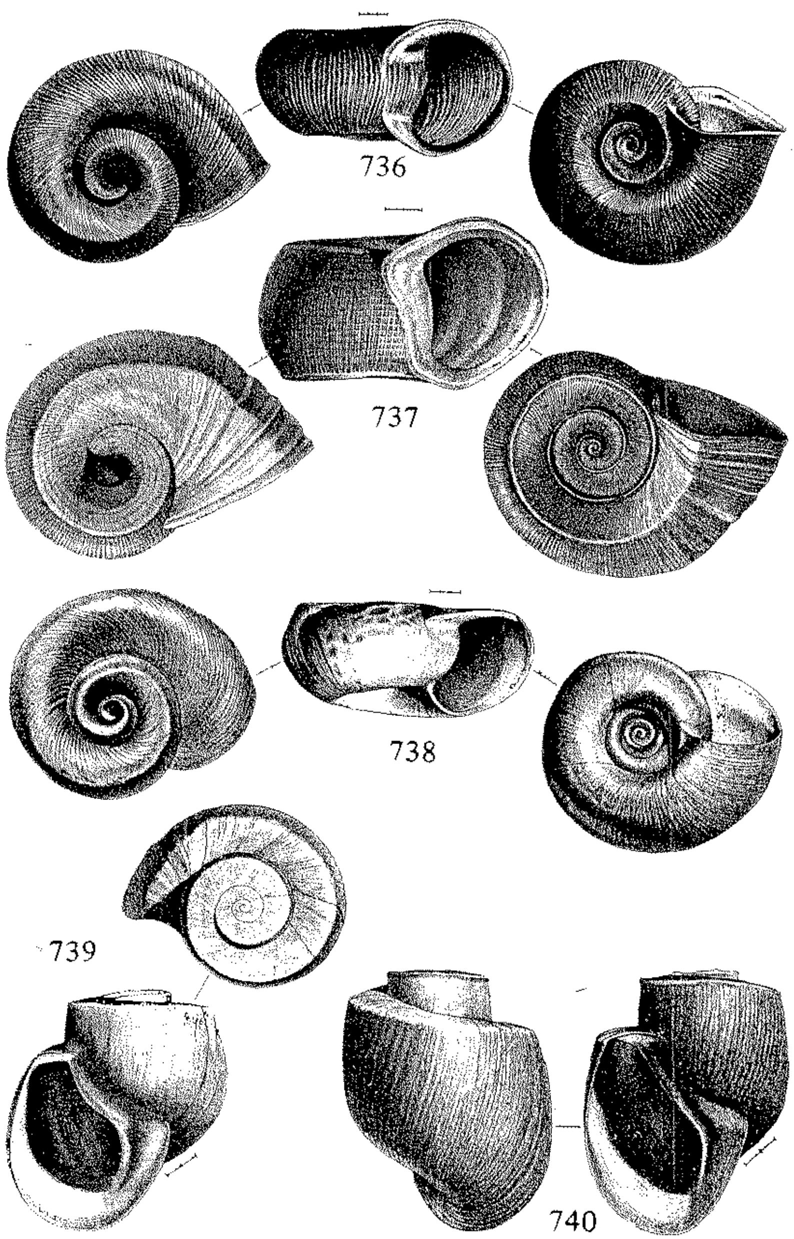
Subgenus *Seminolina* Pilsbry 1934

Planorbella (Seminolina) duryi (Wetherby 1879) [Figs. 738, 739]
Northern to southern Florida (see Pilsbry, 1934a).

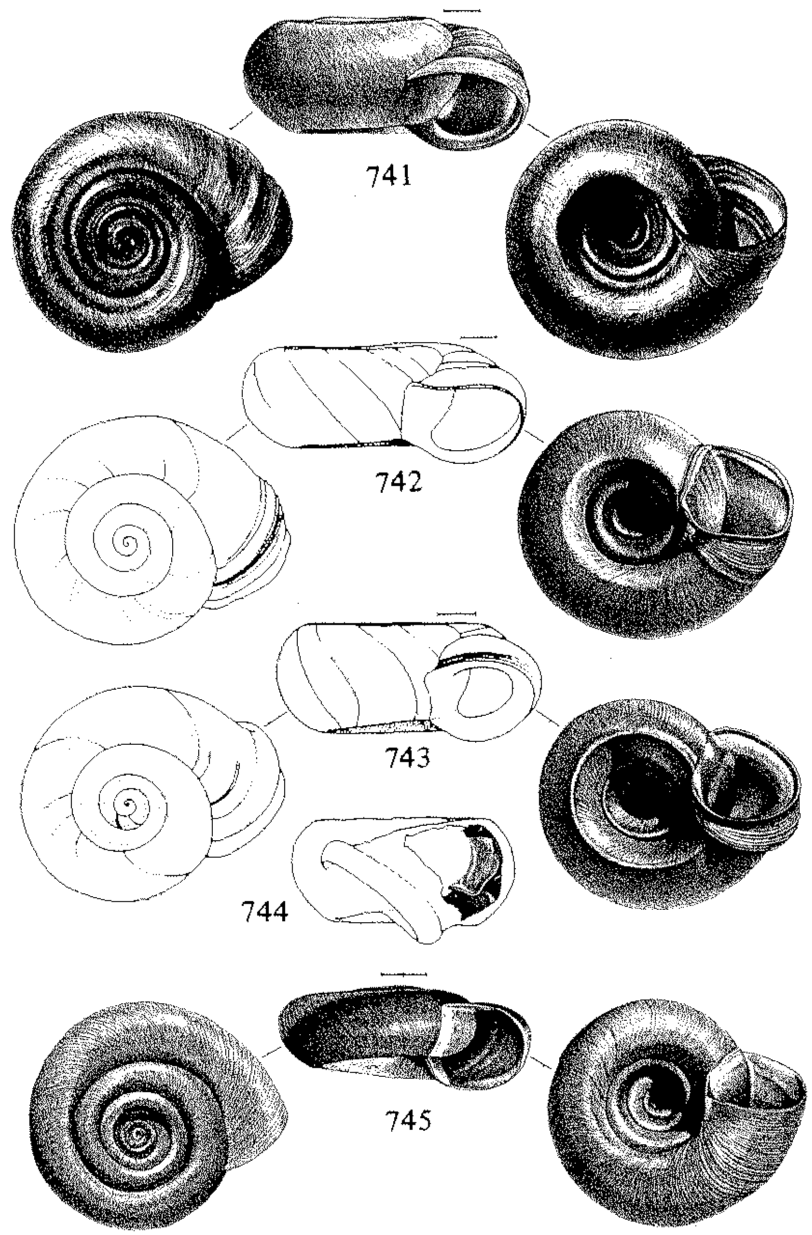
Planorbella (Seminolina) scalare (Jay 1839) [Fig. 740]
Southern Florida (see Pilsbry, 1934a).



FIGS. 732-735. Shells of Planorbidae (Planorbinae, Helisomini). FIG. 732. *Planorbella (Pierosoma) magnificum*, umbilical, apertural and spire views (left to right). FIG. 733. *Pl. (Pi.) occidentale*. FIG. 734. *Pl. (Pi.) subcrenatum*. FIG. 735. *Pl. (Pi.) tenue*. Measurement lines are divided into millimeters.



FIGS. 736-740. Shells of Planorbidae (Planorbinae, Helisomini). FIG. 736. *Planorbella (Pierosoma) trivolvis trivolvis*, umbilical, apertural and spire views (left to right). FIG. 737. *Pl. (Pi.) truncatum*. FIG. 738. *Pl. (Seminolina) duryi*. FIG. 739. *Pl. (S.) duryi* form *seminole*. FIG. 740. *Pl. (S.) scalare*. Measurement lines are divided into millimeters.



FIGS. 741-745. Shells of Planorbidae (Planorbinae, Helisomini). FIG. 741. *Planorbella armigera armigera*, umbilical, apertural and spire views (left to right). FIG. 742. *P. jenksii* = *P. armigera armigera*. FIG. 743. *P. armigera wheatleyi*. FIG. 744. *P. armigera wheatleyi*, showing lamellae in body whorl. FIG. 745. *P. campestris*. Measurement lines = 1 mm or are divided into millimeters.

Genus *Planorbula* Haldeman 1840

Planorbula armigera armigera (Say 1821) [Figs. 741, 742]
New Brunswick west to southeastern Ontario, west to Saskatchewan, northwest to the Mackenzie River system (Clarke, 1973); south to Georgia and Louisiana and west to Nebraska (F.C. Baker, 1928c).

Planorbula armigera wheatleyi (Lea 1858)[57] [Figs. 743, 744]
Alabama and Florida.

Planorbula campestris (Dawson 1875) [Fig. 745]
Southern Manitoba and North Dakota, south to Utah and New Mexico, west to British Columbia, and north to the Mackenzie River system (Clarke, 1973).

Genus *Promenetus* F.C. Baker 1935[58]

Promenetus exacuous (Say 1821) [Fig. 746]
United States east of the Rocky Mountains, north to Alaska and the Mackenzie River, south to New Mexico (F.C. Baker, 1928); in Canada absent from Quebec, but widely distributed west of James and Hudson bays, mainly south of the tree-line (Clarke, 1973).

Promenetus umbilicatellus (Cockerell 1887)[59] [Fig. 747]
Alaska south to Oregon, northern Utah, Colorado, New Mexico and eastern Oklahoma, east to eastern Ohio, western New York; in Canada, in Alberta, Saskatchewan and Manitoba (Hibbard & Taylor, 1960); also Texas, if *P. carus* (Pilsbry & Ferriss) is a synonym of *P. umbilicatellus*.

Genus *Vorticifex* Meek (in Dall) 1870[60]

Subgenus *Parapholyx* Hanna 1922

Vorticifex (Parapholyx) effusa (Lea 1856) [Fig. 748]
Rivers and lakes in California and Oregon.

Vorticifex (Parapholyx) solida Dall 1870)[61] [Fig. 751]
Lakes in Nevada and California.

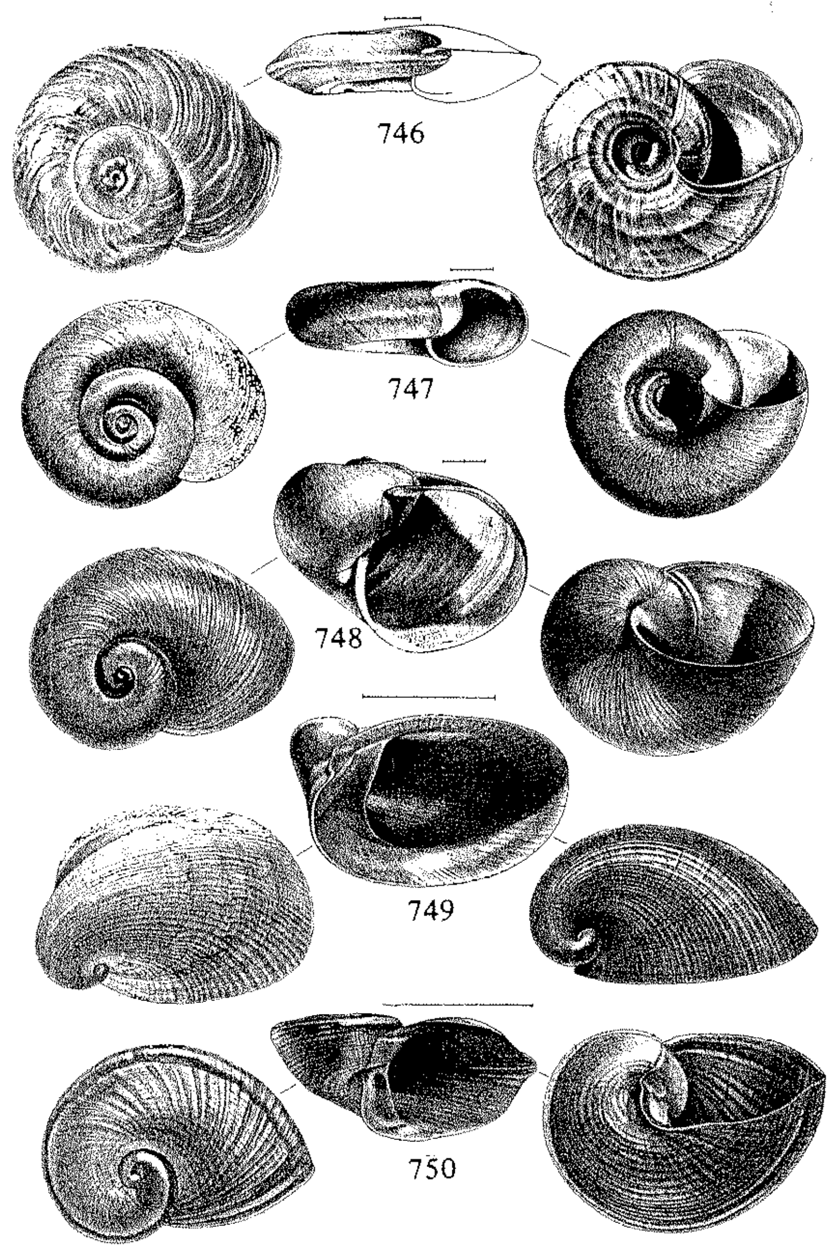
Subfamily Neoplanorbinae

Genus *Amphigyra* Pilsbry 1906

Amphigyra alabamensis Pilsbry 1906 [Fig. 749]
Coosa River, Alabama (Pilsbry, 1906b).

Genus *Neoplanorbis* Pilsbry 1906[62]

Neoplanorbis carinatus Walker 1908 [Fig. 752]
Coosa River, Alabama (Walker, 1908c).



FIGS. 746-750. Shells of Planorbidae (Planorbinae (Helisomini) and Neoplanorbinae). FIG. 746. *Promenetus exacuous*, umbilical, apertural and spire views (left to right). FIG. 747. *P. umbilicatellus*. FIG. 748. *Vorticifex (Parapholyx) effusa*. FIG. 749. *Amphigyra alabamensis*. FIG. 750. *Neoplanorbis tantillus*. Measurement lines = 1 mm or are divided into millimeters.

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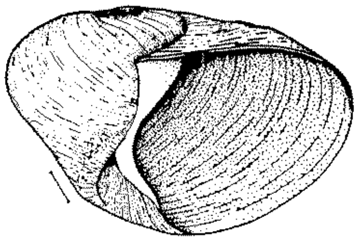

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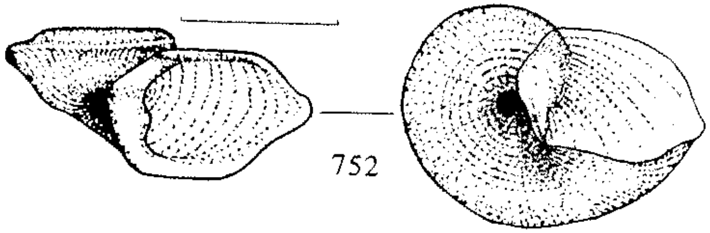

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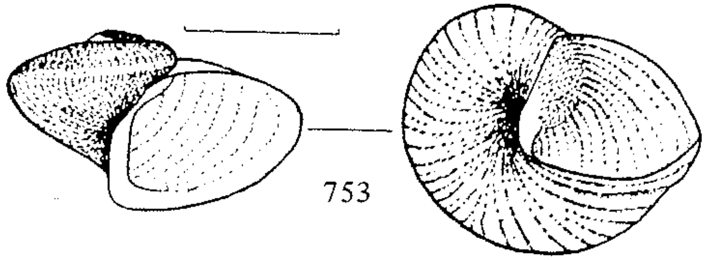

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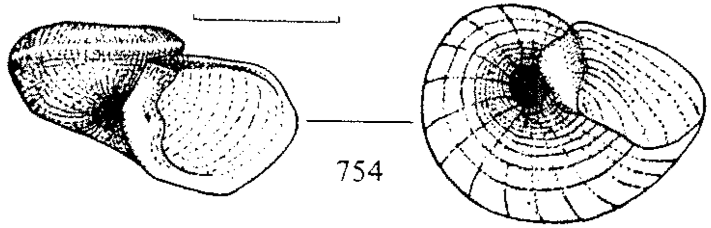

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FIGS. 751-754. Shells of Planorbidae (Planorbinae (Helisomini) and Neoplanorbinae). FIG. 751. *Vorticifex (Parapholyx) solida* form *optima*. FIG. 752. *Neoplanorbis carinatus*. FIG. 753. *N. smithi*. FIG. 754. *N. umbilicatus*. Measurement lines = 1 mm.

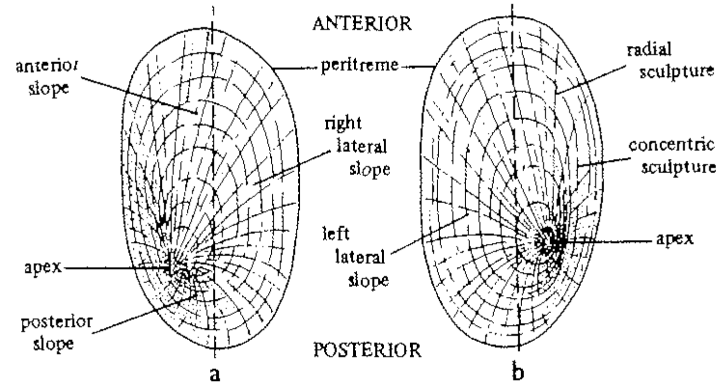
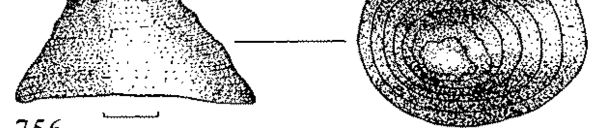


FIG. 755. Shell terminology of freshwater limpets. a, A dextral shell (note that the apex is directed to the *left*); b, a sinistral shell (note that the apex is directed to the *right*). "Radial" sculpture on ancyliform shells corresponds to "spiral" sculpture on coiled shells. "Concentric" sculpture on ancyliform shells corresponds to "transverse" sculpture on coiled shells; on freshwater limpets it usually consists only of growth lines.



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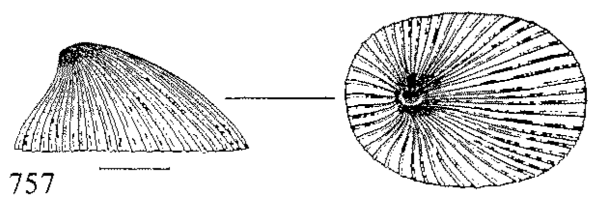

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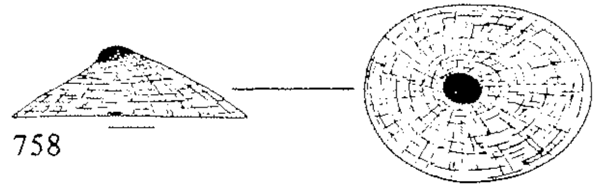

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FIGS. 756-758. Shells of Ancylidae (Ancylinae). FIG. 756. *Rhodacmea cahawbensis* = *R. elatior*. FIG. 757. *R. filosa*. FIG. 758. *R. rhodacme* = *R. hinkleyi*. Measurement lines = 1 mm. Fig. 756 is from Walker (1917b).

Neoplanorbis smithi Walker 1908 [Fig. 753]
Coosa River, Alabama (Walker, 1908c).
Neoplanorbis tantillus Pilsbry 1906 [Fig. 750]
Coosa River, Alabama (Pilsbry, 1906b).
Neoplanorbis umbilicatus Walker 1908 [Fig. 754]
Coosa River, Alabama (Walker, 1908c).

Family ANCYLIDAE

Subfamily Ancylinae

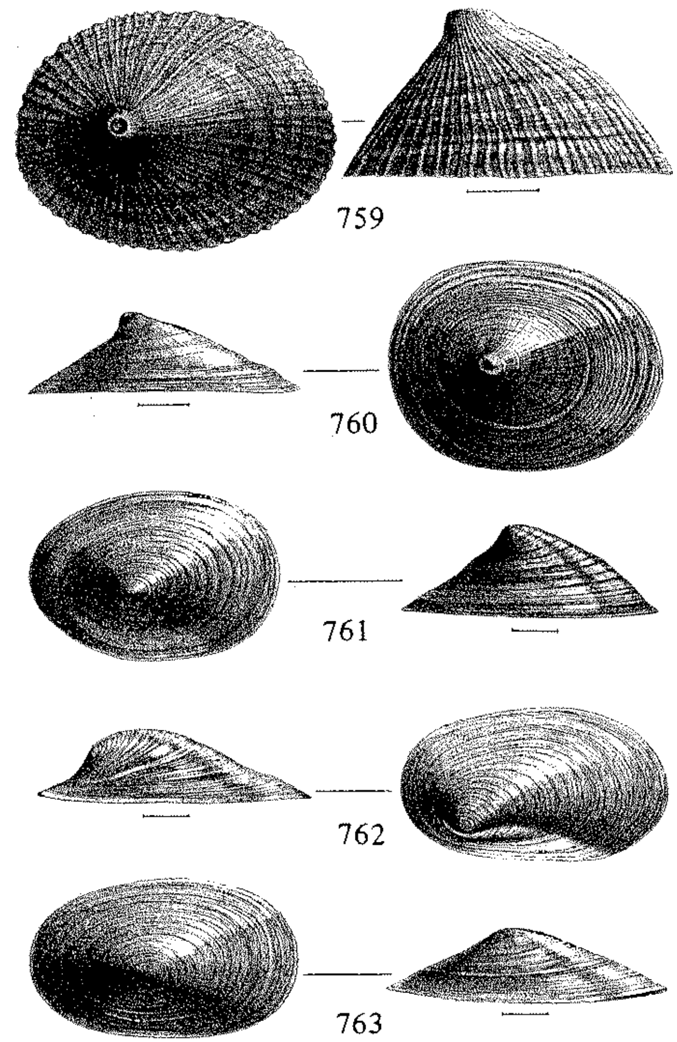
Genus *Rhodacmea* Walker 1917

Rhodacmea elatior (Anthony 1855) [Fig. 756]
Tennessee and Cahaba river systems (Basch, 1963).
Rhodacmea filosa (Conrad 1834) [Figs. 757, 759]
Black Warrior and Coosa rivers, Alabama, and tributaries; ? also in Tennessee River system (Basch, 1963).
Rhodacmea hinkleyi (Walker 1908) [Figs. 758, 760]
Coosa River, Alabama, and the Tennessee River drainage, extending irregularly northward to the southern borders of Illinois and Indiana (Basch, 1963).

Subfamily Ferrissinae

Genus *Ferrissia* Walker 1903

Ferrissia fragilis (Tryon 1863) [Figs. 764, 765]
"Among the most widely distributed of North American freshwater snails" (Basch, 1963); New York to Michigan, California and Texas.
Ferrissia mcneili Walker 1925 [Fig. 766]
Mobile area, Alabama (see Basch, 1963).
Ferrissia parallelus (Haldeman 1841)
In Canada and the northern United States from the Atlantic coast westward (Basch, 1963); Nova Scotia and New England west to Manitoba, Minnesota and Illinois in the Atlantic, St. Lawrence River, Hudson Bay and upper Mississippi River drainage areas (Clarke, 1973).
Ferrissia rivularis (Say 1817) [Figs. 761, 767]
Throughout most of North America; it extends northward into the Hudson Bay lowlands and northwestward to at least central Saskatchewan; south to North Carolina and New Mexico and west to California and Oregon (see Clarke, 1973).
Ferrissia walkeri (Pilsbry & Ferriss 1907) [Fig. 768]
Arkansas, Michigan and southern California (Basch, 1963).



FIGS. 759-763. Shells of Ancylidae (Ancylinae, Ferrissinae and Laevapecinae). FIG. 759. *Rhodacmea filosa*. FIG. 760. *R. rhodacme* = *R. hinkleyi*. FIG. 761. *Ferrissia rivularis*. FIG. 762. *Hebetancylus excentricus*. FIG. 763. *Laevapex fuscus*. Measurement lines = 1 mm.

Subfamily Laevapecinae

Genus *Hebetancylus* Pilsbry 1914

Hebetancylus excentricus (Morelet 1851) [Figs. 762, 769]
Central America; Georgia, Florida and Texas (Basch, 1963).

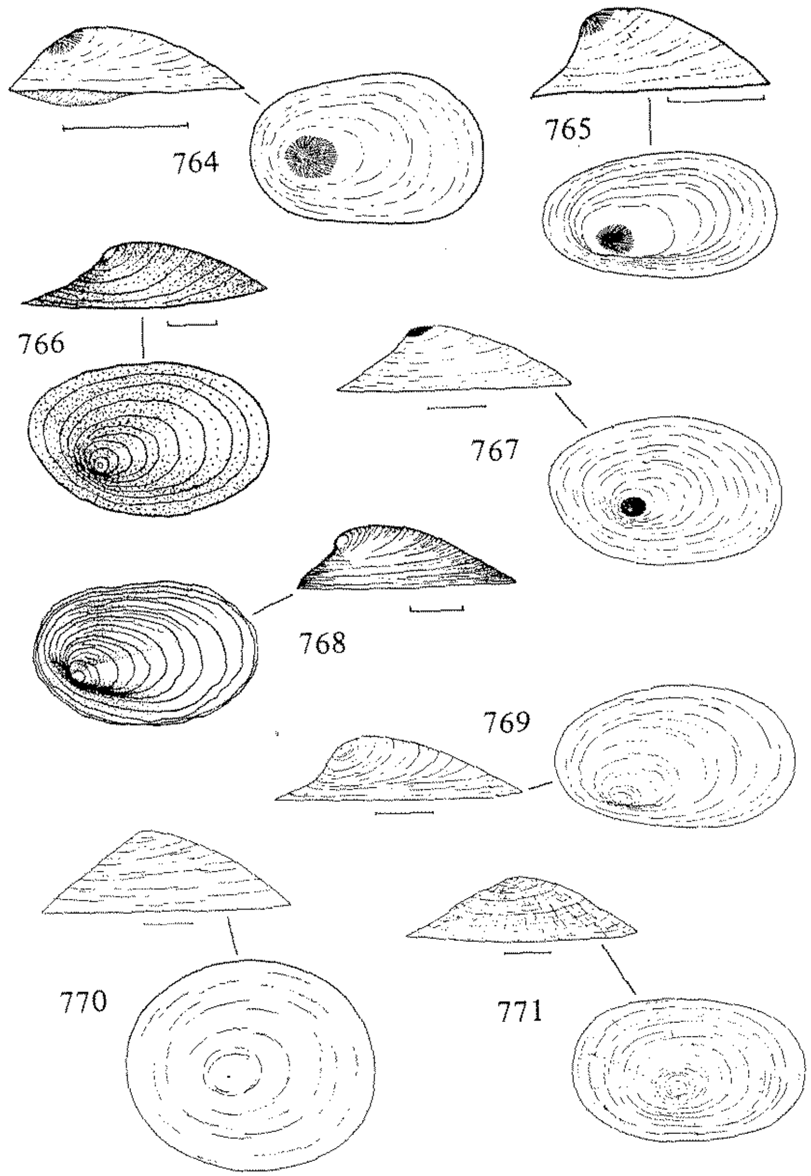
Genus *Laevapex* Walker 1903

Laevapex diaphanus (Haldeman 1841) [Fig. 770]
Delaware, Illinois, Ohio, Holston and Tennessee rivers (Walker, 1903b); Georgia and Alabama (Walker, 1908d, for *L. hemisphaericus*).

Laevapex fuscus (C.B. Adams 1841) [Figs. 763, 771]
United States and Canada, generally east of the Great Plains; Great Lakes area, Florida and southeastern states; generally absent from mountainous areas (Basch, 1963); west to Iowa, Kansas and Oklahoma (Clarke, 1973).

* * * * *

Permission has been granted by *Malacological Review* for reprinting illustrations of shells of the following species from the covers (Vols. 10, 11 and 12) of that journal:
Viviparidae: *Campeloma brevispirum, Ca. coarctatum, Ca. decampi, Ca. geniculum, Ca. obesum, Cipangopaludina chinensis malleatus, Ci. japonicus, Lioplax pilsbryi, L. subcarinata, Tulotoma angulata, T. magnifica, Viviparus georgianus* and *V. subpurpureus*.
Pleuroceridae: *Elimia striatula, E. strigosa, Pleurocera acuta acuta, P. annuliferum, P. brumbyi, P. canaliculatum undulatum, P. currierianum, P. nobile nobile, P. pyrenellum, P. trochiformis, P. unciale unciale, P. vestitum, P. viridulum, P. (Strephobasis) curtum curtum* and *P. (S.) walkeri*.
Physidae: *Physa skinneri, Physella columbiana, P. gyrina gyrina* morph *elliptica, P. gyrina ampullacea, P. gyrina aurea, P. gyrina cylindrica, P. gyrina sayi, P. parkeri latchfordi, P. (Costatella) costata, P. (C.) integra brevispira, P. (C.) johnsoni, P. (C.) osculans, P. (C.) squalida, P. (C.) virgata virgata, P. (C.) virgata virgata* morph *parva, P. (C.) virgata concolor* and *Aplexa elongata*.



FIGS. 764-771. Shells of Ancylidae (Ferrissinae and Laevapecinae). FIG. 764. *Ferrissia californica* = *F. fragilis*. FIG. 765. *F. shimeki* = *F. fragilis*. FIG. 766. *F. mcneili*. FIG. 767. *F. rivularis*. FIG. 768. *F. walkeri*. FIG. 769. *Hebetancylus excentricus*. FIG. 770. *Laevapex diaphanus*. FIG. 771. *L. fuscus*. Measurement lines = 1 mm. Fig. 766 is from Walker (1925b); Fig. 768 is from Pilsbry & Ferriss (1907).

* * *

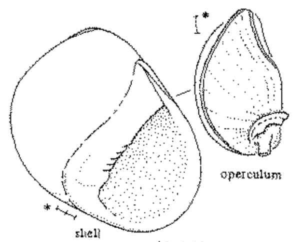
FAMILIES AND HIGHER TAXA

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

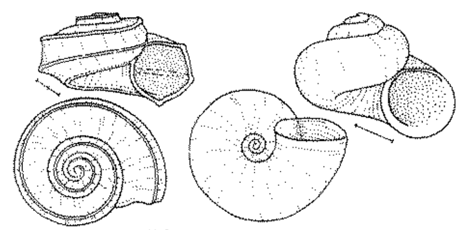
Animal without an operculum to seal its shell aperture when withdrawn; respiration by the vascularized lining of the mantle cavity (true gills are lacking) or by a pseudobranch (false gill) outside the mantle cavity (Fig. 773a); mantle opening directed to the side (to the right or left, depending on whether the animal is dextral [right coiled] or sinistral [left coiled] (Fig. 773a,b)). Subclass **Pulmonata**, Order **Lymnophila** 1f

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

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



Neritidae


Valvatidae

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

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*Measurement lines on illustrations throughout this section indicate millimeters.

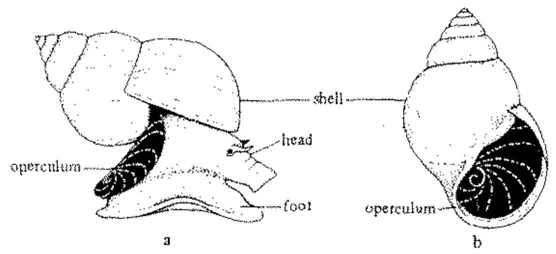


FIG. 772. An operculated snail, i.e., one which carries an operculum attached to its dorsal posterior foot. a, Position of the operculum when the snail is active; b, position of the operculum when the snail has withdrawn into its shell.

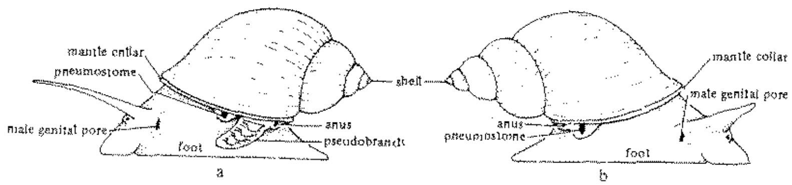


FIG. 773. a, A snail with *sinistral* organization of its body, i.e., respiratory, excretory and reproductive openings are on the *left* side; b, a snail with *dextral* organization of its body, i.e., respiratory, excretory and reproductive openings are on the *right* side.

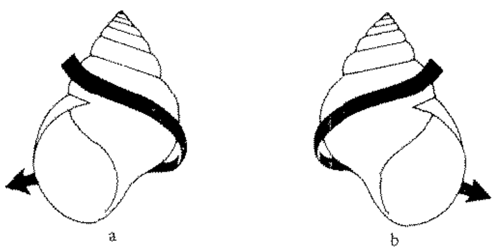


FIG. 774. Direction of coiling of gastropod shells. a, Shell coiled to the left, i.e., *sinistral*; b, shell coiled to the right, i.e., *dextral*.

Shell small to large, spire depressed to elongate; operculum multispiral (Fig. 780a), paucispiral (Fig. 780b) or concentric (Fig. 780c,d); gill monopectinate; pallial tentacle absent 4

4(3) Operculum multispiral or paucispiral (Fig. 780a,b), the distal margins not concentric 5

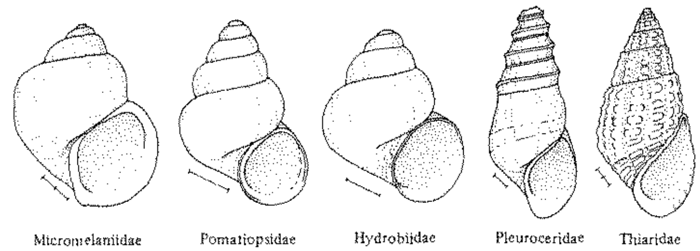
Operculum concentric (although the nucleus may be paucispiral) (Fig. 780c,d). Superfamily **Ampullarioidea** (Viviparoidea) 9

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. 81a). Inhabits streams in caves in Indiana and Kentucky . . . . Family MICROMELANIIDAE (page 231)

Shell of various shapes, usually smooth, but if sculpturing is present it does not consist of spiral epidermal ridges; central radular tooth with one or more basal denticles or cusps on each side (Fig. 81b,c) 7

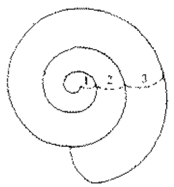


7(6) Shell high-spired, turriform; the head-foot region of the body is subdivided on each side by a longitudinal groove; central radular tooth with two or more basal cusps, which are situated on antero-posterior ridges (Fig. 81c); eyes in prominent swellings on the outer bases of the tentacles; amphibious 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[21] (page 241)

Mantle edge papillate; males generally absent (parthenogenetic reproduction common, often the rule); females brood their young in an adventitious ("subhaemocoelic"; not uterine) brood pouch in the postero-dorsal head-foot region. Introduced sporadically in the southernmost United States from Florida to Texas . . . . Family THIARIDAE (page 240)



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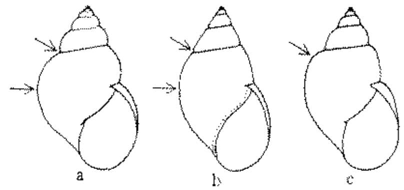

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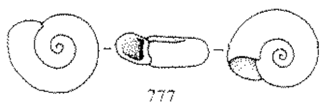

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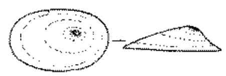

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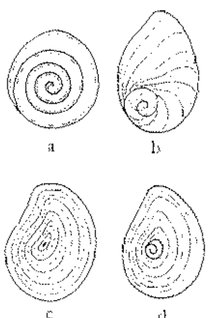

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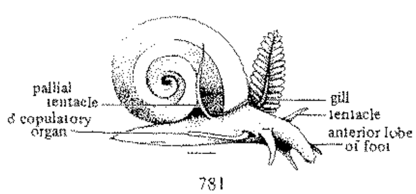

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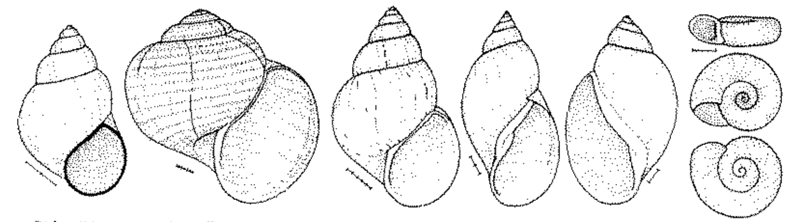
FIG. 775. Method of counting whorls. This shell has 3¼ whorls. FIGS. 776-779. Shell terminology. Fig. 776. a, Shell with well-rounded whorls and indented sutures; b, shell with flattened whorls and shallow sutures; c, shell with shouldered whorls. Fig. 777. Planorbiform or discoidal shell. Fig. 778. 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 Lymnaeoidea, in part . . . . Family LYMNAEIDAE, in part (page 247)

Animal and shell sinistral (coiled to the left) (Figs. 773a, 774a). Superfamily Ancyloidea, in part 13

13(12) Shell with a raised spire; blood (haemolymph) nearly colorless (the respiratory pigment is haemocyanin); animal without pseudobranch (false gill); mantle margin digitate or lobed . . . . Family PHYSIDAE (page 253)

Shell discoidal, with a sunken spire (Figs. 704, 777) (in some species the smaller (older) shell coils protrude on the umbilical side ("ultrasinistral" or pseudo-dextral shells)); blood (haemolymph) in nearly all species is red (contains haemoglobin); a pseudobranch (false gill) is situated near the pneumostome or anus (Fig. 773a); mantle margin simple . . . . Family PLANORBIDAE (page 254)

14(11) Adult shell relatively large (up to 12 mm in length), apex nearly central, not distinctly to the right or left of the median line; animal dextral. Pacific drainage. Superfamily Lymnaeoidea, in part . . . . Family LYMNAEIDAE, in part (page 247)

Adult shell smaller (7 mm or less in length), apex may be nearly central but often to the right or left of the median line; animal dextral or sinistral 15

15(14) Animal and shell dextral (Fig. 755a). Several lakes in the Rocky Mountains, northeastern Ontario and northcentral Quebec. Superfamily Acroloxoidea . . . . Family ACROLOXIDAE (page 247)

ARCHAEOGASTROPODA and NERITACEA

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

MESOGASTROPODA

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].

NEOGASTROPODA =Stenoglossa

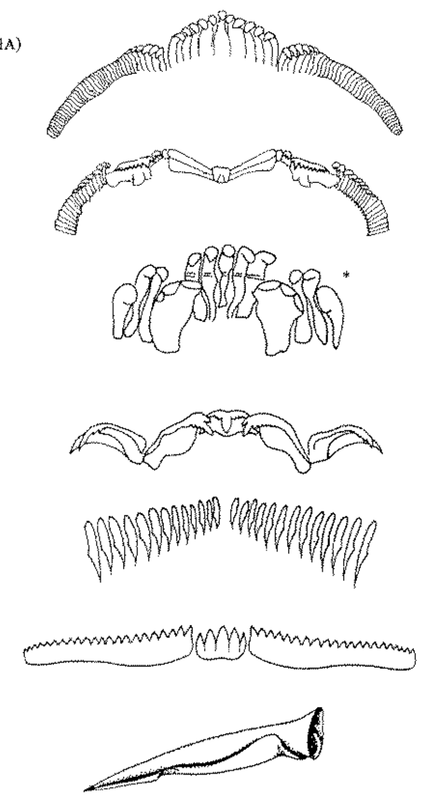
RACHIGLOSSA

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

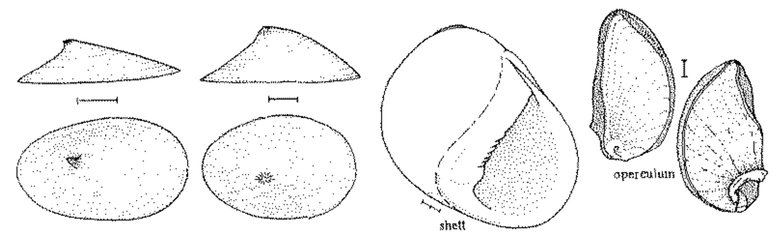


GYMNOGLOSSA

No radula; radula not needed because of parasitic existence.
Eulimidae - a mesogastropod [marine] family.
Pyramidellidae - an opisthobranch [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 taeniglossate (in the other prosobranch families) types of radulae. [*Figure after Thiele (1929).]

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



Acroloxidae Ancylidae *Neritina reclivata*

FAMILY NERITIDAE

The Neritidae[1] 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 Ojus, 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 whorls. These characteristics, together with the generally thickened shell with heavily calloused and expanded parietal apertural margin, produce a rather typical shape, referred to as *neritiform* (Burch, 1968a) or *neritiniform*. The shell is generally smooth, often polished, and its columellar margin is toothed. The operculum (Fig. 22) is paucispiral, calcified, and contains a pair of projections, or apophyses, on the inner columellar side.

The shell of *Neritina reclivata palmae* Dall is "quite small [maximum length 1 cm], . . . black, with a cerous labrum, but the tight 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 whorls, are dextral, and vary in form from discoid to high-turbinate. The nuclear whorls possess both axial and spiral sculpture; the rest of the shell contains lamellate to obsolete axial sculpture and is either spirally angulated, carinated or smooth. Several species are polymorphic in shell form and sculpture. The operculum is corneous, thin, flattened but slightly concave, circular in outline and multispiral (Fig. 780a).

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

[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

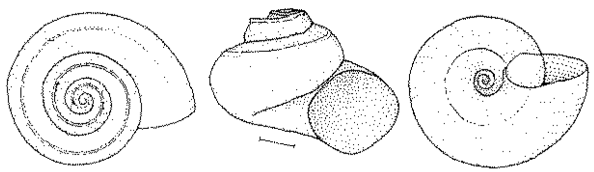
Shell with three spiral carinae or angulations 8

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



V. u. utahensis

Carina or angulation complete, continuing to the outer lip of the aperture. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia . . . . *Valvata tricarinata* morph *unicarinata* DeKay

5(2) Carinae or angulations in dorsal and peripheral locations on the body whorl. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia . . . . *Valvata tricarinata* morph *basalis* Vanatta

Carinae or angulations in peripheral and ventral locations on the body whorl. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia . . . . *Valvata tricarinata* morph *bakeri* Fluck

Carinae or angulations in dorsal and ventral locations on the body whorl 6

6(5) Shoulder on the body whorl sloping upward from the dorsal carina or angulation to the suture 7

Shoulder on the body whorl sloping downward from the dorsal carina to the suture (Fig. 23). Discontinuously distributed in eastern United States from New Jersey south to Alabama and west to Iowa . . . . *Valvata bicarinata bicarinata* Lea

7(6) Dorsal angulation incomplete, becoming obsolete on the body whorl. Idaho and Utah . . . . *Valvata utahensis* morph *horati* Baily & Baily

Dorsal carina or angulation complete, continuing to the outer lip of the aperture. Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia . . . . *Valvata tricarinata* morph *perconfusa* Walker

8(2) Shoulder of the body whorl sloping downward from the dorsal carina to the suture (Fig. 24). Discontinuously distributed in eastern United States from New Jersey south to Alabama and west to Iowa . . . . *Valvata bicarinata* morph *normalis* Walker

Shoulder of the body whorl sloping upward from the dorsal carina or angulation to the suture (Fig. 33). Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia . . . . . . *Valvata tricarinata tricarinata* (Say)

Shoulder of the body whorl sloping upward from the dorsal carina nearly to the suture, then turning downward (Fig. 36). Michigan, Minnesota and Wisconsin . . . . *Valvata winnebagoensis* F.C. Baker

9(1) Shell partly uncoiled with the body whorl broadly separated from the penultimate whorl (Fig. 27). Ontario in the region north of Lake Superior drained by the headwaters of the Attawapiskat, Albany and Severn river systems . . . . *Valvata lewisi* morph *ontarioensis* F.C. Baker

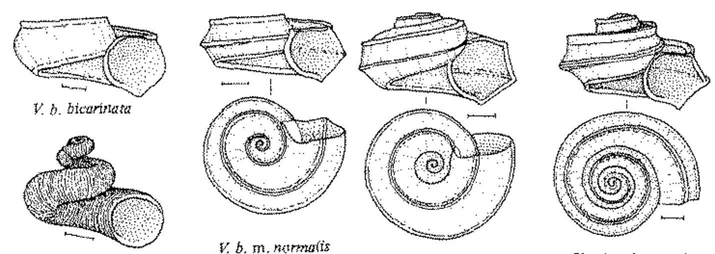
Shell not disjunctly coiled 10

10(9) Shell of discoid shape. Lakes Erie, Huron, Michigan and Ontario . . . . *Valvata perdepressa* ?form *walkeri* F.C. Baker

Shell with spire elevated above the body whorl 11

11(10) Shoulder of the body whorl flattened, sloping slightly upward toward the suture; often with a very faint angulation in dorsal location (and rarely also in peripheral locations). Quebec and New Brunswick west to Alberta, and south to Wyoming, Arkansas and Virginia . . . . *Valvata tricarinata* morph *simplex* Gould

Body whorl evenly convex, not flattened above (or elsewhere) 12



V. b. bicarinata; *V. l. m. ontarioensis*; *V. b. m. normalis*; *V. t. tricarinata*; *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

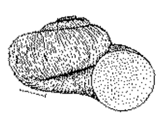
Apex of shell acute 18

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

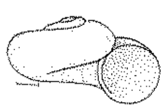
Shell color dark to often brilliant green; shell diameter less than 5 mm (Fig. 35). California, Nevada and Oregon .... *Valvata virens* Tryon

19(16) Axial striae lamellate. Quebec and Maine west to Ontario and Minnesota .... *Valvata sincera nylanderi* Dall

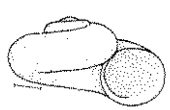
Axial striae fine (Fig. 31). Maine west to Alberta, and south to South Dakota and Illinois .... *Valvata sincera sincera* Say



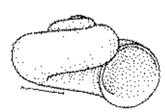
V. l. lewisi



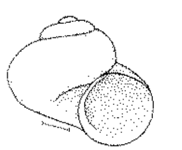
V. mergella



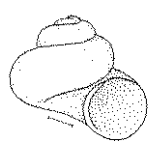
V. p. perdepressa



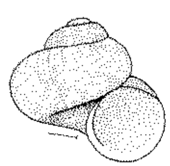
V. humeralis



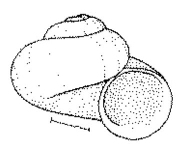
V. p. ?f. obtusa



V. s. ?f. danielsi



V. virens



V. s. sincera

FAMILY VIVIPARIDAE*

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

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

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

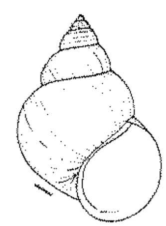
Identification Key for the Viviparidae

1 Shell large, adults over 35 mm and up to 50 mm in length; shell relatively thin; whorls not shouldered. Genus *Cipangopaludina* 2

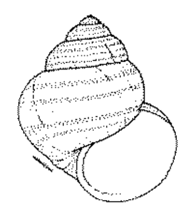
Shell medium to large, generally less than 35 mm in length, but if large, the shell is thick and ponderous, and the whorls are generally shouldered 3

2(1) Shell with acute spire and usually with spiral angulations or low carinae on the whorls; not malleated (Fig. 53). Sporadically but widely distributed in the United States .... *Cipangopaludina japonica* (Martens)

Shell with obtuse spire and without spiral angulations or low carinae; generally with surface malleations (Fig. 52). Sporadically but widely distributed in the United States .... *Cipangopaludina chinensis malleata* (Reeve)



C. japonica



C. c. malleata

T. magnifica

3(1) Shell with or without one or two spiral rows of nodules; outer margin of shell aperture concave (when observed from an angle parallel to the plane of the aperture) and its oblique margin to the shell axis quite exaggerated (Fig. 783); columellar margin of operculum reflected inward (Figs. 44, 45). Restricted to the Coosa-Alabama river system in Alabama .... *Tulotoma magnifica* (Conrad)[3]

Shell without rows of spiral nodules; outer margin of shell aperture not concave (when observed from an angle parallel to the plane of the aperture) and its oblique angle to the shell axis not exaggerated (Fig. 783); columellar margin of operculum not reflected inward 4

4(3) Operculum concentric, but with spiral nucleus; whorls commonly with a median spiral angle or low ridge or a spiral subsutural sulcus. Genus *Lioplax* 5

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*From Burch & Vail (1982).

Operculum entirely concentric, including its nucleus; whorls without spiral angles, ridges or sulci 10

5(4) Shell attenuate, compressed; whorls rarely angular (Fig. 43). Coosa-Alabama-Tombigbee river system in Georgia and Alabama, and Tensas River, Alabama . . . . *Lioplax cyclostomaformis* (Lea)

Shell subglobose, not attenuate and compressed; at least some of the whorls are generally angular or with a spiral subsutural sulcus 6

6(5) Shell large for the genus, adults up to 30 mm in length, dark olive-green to nearly black (Fig. 67). Chipola River, Florida . . . . *Lioplax pilsbryi pilsbryi* Walker

Shell smaller, adults less than 25 mm in length and seldom more than 20 mm, horn to pale or occasionally dark olive-green in color 7

7(6) Atlantic drainage and Gulf drainage 8

Mississippi drainage (Minnesota to Arkansas and Ohio)[7] . . . . . . *Lioplax sulculosa* (Menke)

8(7) Atlantic drainage (New York to South Carolina)[7] (Fig. 68) . . . . . *Lioplax subcarinata* (Say)

Gulf drainage 9

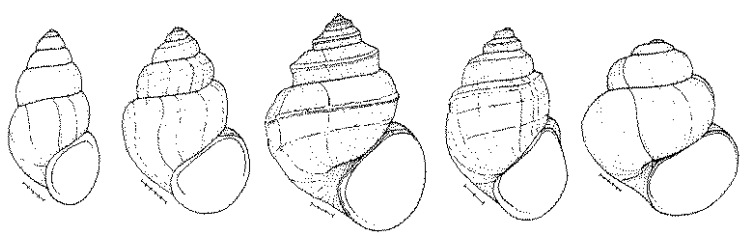
9(8) Whorls generally with a spiral subsutural sulcus, which tends to constrict the posterior aperture (Fig. 69). Ochlockonee and Yellow river systems, Florida and Alabama . . . . *Lioplax talquinensis* Vail

Whorls without a spiral subsutural sulcus; aperture rounded posteriorly. Choctawhatchee, Escambia, Flint and Suwannee river systems, Florida and Georgia . . . . *Lioplax pilsbryi choctawhatchensis* Vanatta[6]

10(4) Shell with or without spiral color bands; width and length of aperture usually nearly equal, making it round, or nearly so; lateral and marginal radular teeth with prominent cusps. Genus *Viviparus* 11

Shell without spiral color bands; length of aperture noticeably greater than width; lateral and marginal teeth simple with very fine, difficult-to-distinguish cusps. Genus *Campeloma*[4] 13

11(10) Shell dark yellowish-green to (usually) dark olivaceous-green, without spiral color bands; shell broadly ovate, whorls globosely rounded, spire obtuse (Fig. 48). Minnesota south to Louisiana, mainly in the Mississippi river drainage; Gulf drainage from Texas to Alabama; Atlantic drainage in Georgia and South Carolina . . . . *Viviparus intertextus* (Say)

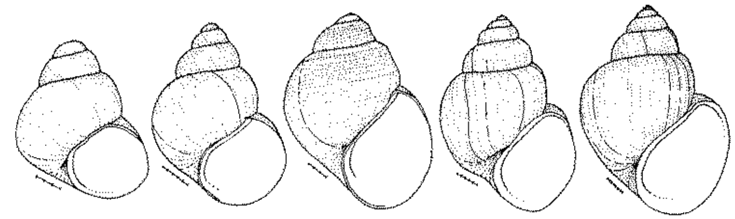


L. cyclostomaformis *L. p. pilsbryi* *L. subcarinata* *L. talquinensis* *V. intertextus*

Shell pale olivaceous-green to olivaceous-brown, with or without spiral color bands, ovate but not broadly so, whorls flattened to well rounded but not 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 . . . . *Viviparus subpurpureus* (Say)

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



V. subpurpureus *V. georgianus* *C. floridense* *C. geniculum* *C. crassula*

13(10) Inside of shell aperture deep reddish-brown or brown (Fig. 62); shell of newborn young uniformly dark brown. Eastern Florida . . . . *Campeloma floridense* Call

Inside of shell aperture white, bluish or faintly pinkish; shell of newborn young opaque white or light translucent beige 14

14(13) Shell whorls generally with angled shoulders. Southern in distribution 15

Shell whorls unshouldered or with rounded shoulders 16

15(14) Shell broadly ovate (Figs. 63, 64). Northwestern Florida, southwestern Georgia and southeastern Alabama . . . . *Campeloma geniculum* (Conrad)

Shell narrowly ovate (Fig. 41). Atlantic drainage from North Carolina to Georgia . . . . *Campeloma limum* (Anthony)

16(14) Shell narrow, relatively thin, generally with prominent raised spiral lines (Fig. 56). Northern Alabama . . . . *Campeloma decampi* Binney

Shell broader, relatively thin to thick and ponderous, spiral lines on adult shells when present are not prominent 17

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

Spire elongate, seldom depressed, body whorl rounded 18

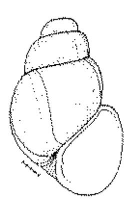
18(17) Shell large, heavy and ponderous (Figs. 42, 54, 55). Midwestern United States in the Great Lakes-St. Lawrence and Mississippi drainages . . . . *Campeloma crassula* Rafinesque

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

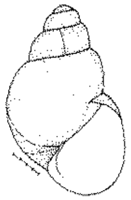
Campeloma coarctatum (pp. 86, 87, 91) is a synonym of *C. regulare*.

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

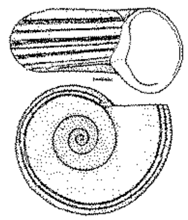
Ochlockonee river drainage in southern Georgia and northern Florida. Fig. 65 .... *Campeloma parthenum* Vail



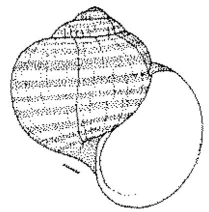
C. decisum



C. parthenum



M. cornuarietis



P. paludosa

FAMILY AMPULLARIIDAE

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

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

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

Identification Key for the Ampullariidae

1 Shell subglobose in shape. Alabama, Florida and Georgia. Genus *Pomacea* 2

Shell discoidal or planispiral in shape (Figs. 70, 71). Southern Florida .... *Marisa cornuarietis* (Linnaeus)

2(1) Shell large, often up to 60 mm or more in length, whorls with only weak or without shoulders, body whorl very wide, spire depressed, aperture narrowly oval (Figs. 72, 73). Alabama, Florida and Georgia .... *Pomacea paludosa* (Say)

Shell smaller, less than 50 mm in length, whorls more strongly shouldered, body whorl narrower, spire projecting and turreted, aperture more broadly oval. Florida .... *Pomacea bridgesi* (Reeve)

FAMILY BITHYNIIDAE

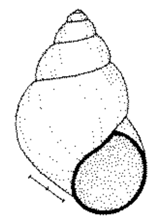
The Bithyniidae are found throughout Europe and Asia, and in Africa, Indonesia, the Philippines and Australia. The European *Bithynia tentaculata* (Linnaeus) was introduced long ago by man into

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

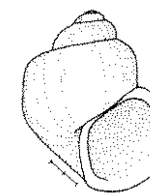
The Bithyniidae traditionally have been included in the family Hydrobiidae. However, Taylor (1966b) has recently argued that the bithyniids should be separated from the hydrobiids and transferred to the Viviparoidea (Ampullarioidea). Viviparoid characters of *Bithynia* are its size (adult shells are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

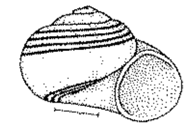
Bithynia tentaculata occurs in the Great Lakes region from Albany, New York, to Winnebago Lake, Wisconsin, and in the Potomac River in Virginia and Maryland (Pilsbry, 1932c; Marshall, 1933).



B. tentaculata



A. spiralis



C. riograndensis

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 west-central Kentucky. The latter was transferred to the Micromelaniidae by Taylor (1966b) because of its radular characters.

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

FAMILY HYDROBIIDAE

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

Shells of hydrobiids are small (many are minute), generally elongate, dextral (Fig. 774b), nearly always drab and unicolored, and generally have relatively few whorls. The shells of most species are plain, but some species have prominent surface sculpture, and one species in North America (north of Mexico), *Cochliopina riograndensis* (Pilsbry & Ferriss), has spiral color bands (Fig. 140). The shell aperture is closed by an operculum, which is generally paucispiral (Fig. 780b), but some species have round, multispiral opercula (Fig. 780a). Like most North American freshwater prosobranch snails, the sexes are separate in the Hydrobiidae, and the shells of some genera exhibit sexual dimorphism.

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

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

Identification Key for the Hydrobiidae

1 Males with single-ducted verges (Fig. 82a, b, c) 2

Males with two- or three-ducted verges (Fig. 82d, e) 52

2(1) Males with simple verges, lacking accessory lobes and glandular apical and subapical crests (Fig. 82a). Subfamily Lithoglyphinae 3

Males with verges bearing accessory lobes or glandular apical and subapical crests (Fig. 82b, c) 13

3(2) Shell neritiniform (Figs. 192, 193, 779). Cahaba and Coosa rivers, Alabama .... *Lepyrium showalteri* (Lea)

Shell conical, subglobose or heliciform 4

4(3) Shell depressed, heliciform, with spiral brown bands (Fig. 140). Texas .... *Cochliopina riograndensis* (Pilsbry & Ferriss)

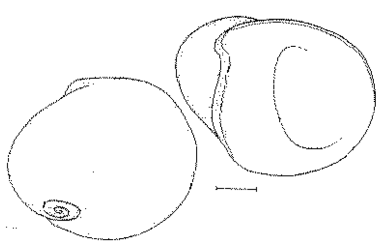
Shell conical to subglobose, without spiral color bands 5

5(4) Shell imperforate or narrowly perforate 6

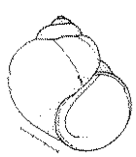
Shell umbilicate 11

6(5) Western in distribution, in the Pacific drainage (Figs. 141, 142, 145-148, 152) .... Genus *Fluminicola*[63]

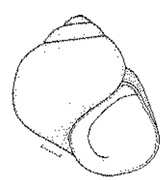
Eastern in distribution, in the Mississippi, Gulf and Atlantic drainages 7



L. showalteri



F. fusca



F. columbiana

7(6) Shell generally thick and solid, columella thickened. Mississippi and Gulf of Mexico drainage (except for *S. pennsylvanicus* and *S. virginicus*). Genus *Somatogyrus* 8

Shell rather thin, columella not thickened (Fig. 191). Atlantic drainage from New Jersey to South Carolina .... *Gillia altilis* (Lea)

8(7) Shell with spirally striate apical whorls. Subgenus *Walkerilla*[64] 9

Shell without spirally striate apical whorls (Figs. 149, 151, 153-185, 194, 195). Widely distributed in eastern North America in the Midwest and South .... Subgenus *Somatogyrus* s.s.[65]

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

Spire not depressed. Georgia and Virginia 10

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

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

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

Shell larger (3.0-3.5 mm in length), aperture ovate, columella thickened. Alabama. Genus *Clappia* 12

12(11) Shell aperture more elongate, spire less attenuate, umbilicus larger, animal black (Figs. 139, 143, 144). Coosa River, Alabama .... *Clappia umbilicata* (Walker)

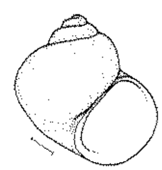
Shell aperture broader, less elongate, spire relatively attenuate, umbilicus smaller, animal white. Cahaba River, Alabama .... *Clappia cahabensis* Clench

13(2) Males with verges bearing accessory lobes (Fig. 82b). Subfamily Hydrobiinae[66] 14

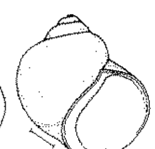
Males with verges bearing glandular apical crests (Fig. 82c). Subfamily Nymphophilinae 27

14(13) Top of shell spire truncated. The first several spire whorls coiled in the same plane (Figs. 107, 129-131). Widely distributed in eastern North America .... *Probythinella lacustris* (F. C. Baker)

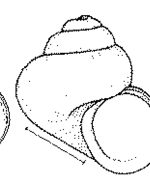
Top of shell spire not truncated, the first several spire whorls coiled in a descending spiral 15



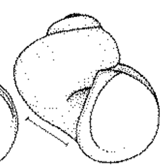
G. altilis



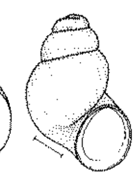
S. depressus



A. culveri



C. umbilicata



P. lacustris

15(14) Northern in distribution (Fig. 76). Lake Michigan, Wisconsin . . . . *Hoyia sheldoni* (Pilsbry)[67]

Southern and western in distribution 16

16(15) Western in distribution. Texas, Arizona, Nevada and California. Genus *Tryonia*[68] 17

Southern in distribution. Georgia and Florida 22

17(16) Found in Texas 18

Further western in distribution, Arizona, Nevada and California 20

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

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)

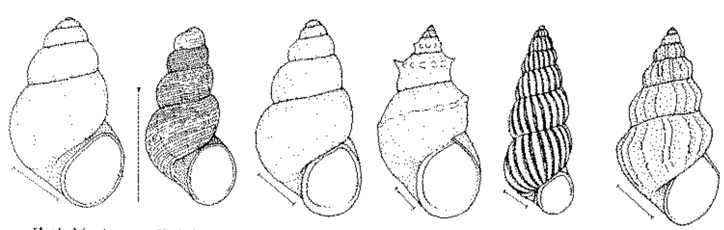
Shell surface sculptured with transverse ribs and sometimes with spiral lirae also 21

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



H. sheldoni *T. diaboli* *T. cheatumi* *P. spinosus* *T. protea* *T. clathrata*

23(22) Verge with a single row of 7-15 papillae along the right margin and 3-10 papillae around the base (Figs. 79, 87, 106, 125). Atlantic drainage of Florida and Georgia . . . . *Littoridinops tenuipes* Couper

Verge with 17-50 papillae arranged in three to five rows along the right margin, and no papillae at the base (Figs. 80, 85, 86, 105). Florida . . . . *Littoridinops monroensis* (Frauenfeld)

24(22) Shell sculptured with fine spiral lines; verge with 1-7 papillae along the right margin and papillae along the left margin 25

Shell without fine spiral sculpturing; verge with 0-6 papillae along the right margin, no other papillae present (Figs. 75, 95-103, 109-122). Florida . . . . Genus *Aphaostracon*[69]

25(24) Spiral sculpturing consisting of raised threads; verge with 3-7 papillae along the right margin, left margin usually with a papilla near the base and 1-4 papillae on a projection near the distal end (Figs. 88, 132). Southern Florida . . . . *Pyrgophorus platyrachis* Thompson

Spiral sculpturing consisting of fine incised striations; verge with one large papilla on the right margin near the base, and one or two smaller papillae on the left margin near the distal end. Genus *Hyalopyrgus* 26

26(25) Shell elongated conical, rimate or imperforate; verge with two papillae and an apical protrusion on the left margin (Figs. 77, 78, 83, 84, 104). Florida . . . . *Hyalopyrgus aequicostatus* (Pilsbry)

Shell ovate, openly umbilicate; verge with one papilla on the left margin (Figs. 123, 124). Central Florida . . . . *Hyalopyrgus brevissimus* (Pilsbry)

27(13) Shell almost completely uncoiled (Fig. 248). Texas . . . . Genus *Orygoceras*

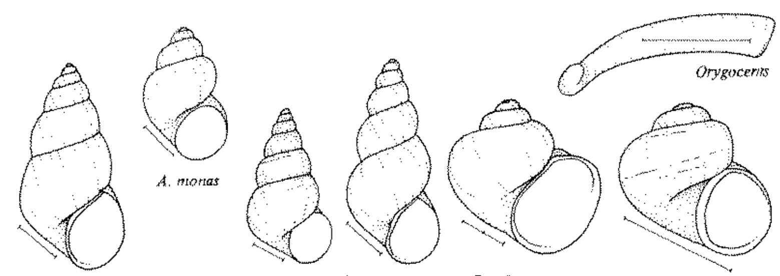
Shell coiled 28

28(27) Shell relatively large (that of adults to nearly 10 mm in length), subglobose (Figs. 188, 198, 202). Widely distributed in central United States from the Great Lakes to Alabama and Arkansas . . . . *Birgella subglobosa* (Say)

Shell smaller (that of adults generally less than 5 mm in length), globosely conic to broadly conic and rarely elongately conic, or subglobose, ovate or turbiniform 29

29(28) Shell turbiniform, minute (that of adults 1.2-1.4 mm long) (Figs. 265, 297). Alabama river system . . . . *Stiobia nana* Thompson

Shell conic, subglobose or ovate 30



Orygoceras *A. monas* *L. tenuipes* *P. platyrachis* *H. aequicostatus* *B. subglobosa* *S. nana*

30(29) Verge with a relatively simple glandular pattern 31

Verge with elaborate patterns of many glands 39

31(30) Shell elongate (conic or ovate); verge with a short terminal penis. Widely distributed in eastern North America. Genus *Marstonia*[70] 32

Shell subglobose; verge with a long, slender flagellar penis (Figs. 91, 257, 262). Chipola river drainage, Florida[70] . . . . *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

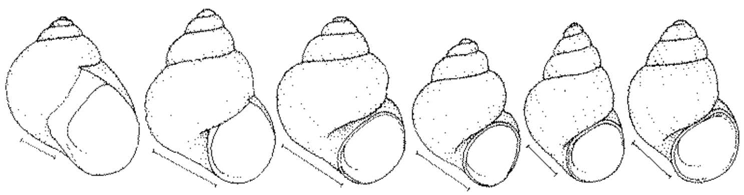
Shell ovately conical, 0.66-0.73 times as wide as high, whorls rounded, not strongly shouldered, umbilicus narrow, suture not descending to the aperture in lateral profile (Figs. 216, 234). Flint river system, Georgia . . . . *Marstonia castor* Thompson

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 ogmorphaphe* Thompson

Shell sutures shallow, whorls not shouldered, outer lip straight in lateral profile 38

38(37) Northern in distribution: southern Canada, Maine west to Minnesota and Iowa (Figs. 218, 219, 245, 246, 250, 251) . . . . *Marstonia lustrica* (Pilsbry)

Southern: Madison County, Alabama (Fig. 247) . . . . *Marstonia olivacea* (Pilsbry)

39(30) Shell subglobose or broadly ovate, imperforate. Alabama, Florida and Georgia. Genus *Notogillia* 40

Shell conic or ovate, but if subglobose or broadly ovate then it is umbilicate 41

40(39) Shell subglobose, relatively small (that of adults is 4.0-4.5 mm in length), periostracum greyish white (Figs. 90, 254). Southcentral Georgia . . . . *Notogillia sathon* Thompson

Shell broadly ovate, larger (that of adults is 4.5-7.5 mm in length), periostracum olivaceous-brown (Figs. 255, 260). Alabama, Florida and Georgia . . . . *Notogillia wetherbyi* (Dall)

41(39) Distribution east of the Continental Divide 42

Distribution west of the Continental Divide 48

42(41) Penis relatively large, spatulate, and having a long narrow gland running along each margin from the base to near its tip. Georgia and Florida. Genus *Spilochlamys* 43

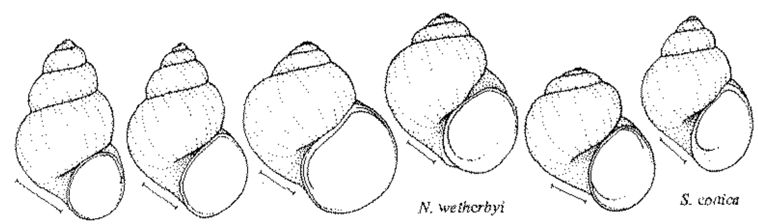
Penis small, slender, conical 45

43(42) Shell subglobose, spire depressed (Fig. 259). Tributaries of the Ocmulgee River, Georgia . . . . *Spilochlamys turgida* Thompson

Shell ovate, spire prominent. Florida 44

44(43) Shell solid, thick (Figs. 275, 276); apex of the accessory lobe of the verge without a terminal glandular crest (Fig. 264). St. Johns river drainage, Florida . . . . *Spilochlamys gravis* Thompson

Shell thin or only moderately thick (Fig. 258); apex of the accessory lobe of the verge with an apical glandular crest (Figs. 92, 263). Gulf of Mexico drainage in northcentral Florida . . . . *Spilochlamys conica* Thompson



M. lustrica *M. olivacea* *N. sathon* *N. wetherbyi* *S. turgida* *S. conica*

45(42) Shell elongately conical. Genus *Pyrgulopsis*, in part. Widely distributed 46

Shell broadly conical, globosely conical or ovate. Widely distributed (Figs. 189, 190, 199, 200, 203-213, 222-228, 235, 236) . . . . Genus *Cincinnatia*[71]

46(45) Shell umbilicate (Fig. 261). Ontario and Michigan to New York . . . . *Pyrgulopsis letsoni* (Walker)

Shell imperforate. Alabama and Arkansas 47

47(46) Whorls flat-sided, periphery angular or carinate (Fig. 273). Alabama . . . . *Pyrgulopsis scalariformis* (Wolf)

Whorls rounded, periphery rounded. Arkansas . . . . *Pyrgulopsis ozarkensis* Hinkley

48(41) Shell elongately conical, whorls wholly or nearly flat-sided, or concave, usually angulate or carinate. Genus *Pyrgulopsis*, in part 49

Shell conical, narrowly ovate to globosely conic, whorls rounded, not angulate or carinate. Genus *Fontelicella* 50

49(48) Periphery of body whorl concave (Fig. 274). Upper Klamath Lake, Oregon . . . . *Pyrgulopsis archimedis* S.S. Berry

Periphery of body whorl flat-sided (Figs. 256, 270-272). Pyramid and Walker's lakes, Nevada . . . . *Pyrgulopsis nevadensis* (Stearns)

50(48) Shell conical or narrowly ovate 51

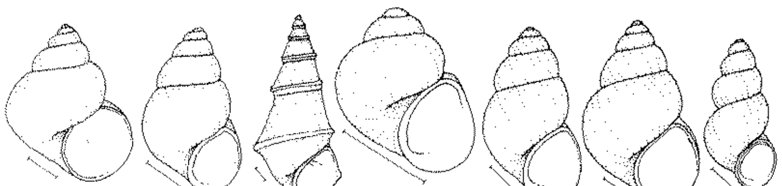
Shell globosely conic, minute (that of adults is less than 2 mm in length) (Figs. 231, 244). Subgenus *Microamnicola*. California and Nevada . . . . *Fontelicella (Microamnicola) micrococcus* Pilsbry (in Stearns) 1893

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 53

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



C. cincinnatiensis — *P. letsoni* — *P. scalariformis* — *Fonticella (M.) micrococcus* — *Fontelicella californiensis* — *Fontelicella (N.) robusta* — *Fontigens nickliniana*

53(52) Shell ovate or turbinate to globosely conic. Widely distributed. Genus *Amnicola* 54

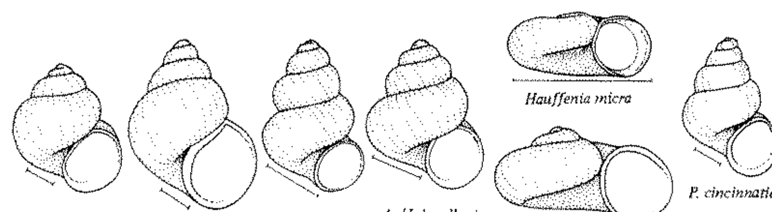
Shell discoidal or subdiscoidal. Texas (? also Alabama) 55

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 micra* (Pilsbry & Ferriss)[73]

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



A. l. limosa — *A. decisa* — *A. (L.) pupoidea* — *A. (L.) walkeri* — *Hauffenia micra* — *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)

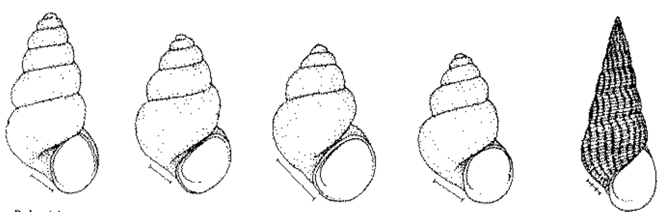
Spire more obtuse, body whorl proportionately larger, aperture narrowly oval, umbilicus nearly closed (Fig. 324). Found in several localities in Alabama, South Carolina and Tennessee . . . . *Pomatiopsis hinkleyi* Pilsbry[20]

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



P. lapidaria *P. hinkleyi* *P. binneyi* *P. californica* *M. tuberculata*

FAMILY THIARIDAE

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

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

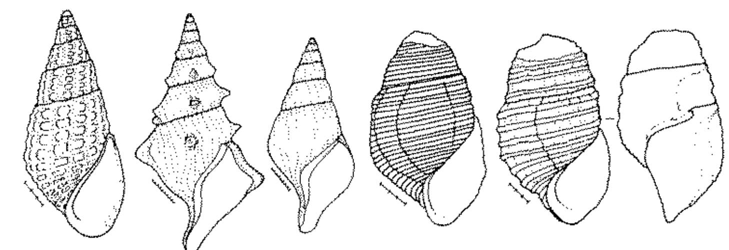
Pleuroceridae: Reproduction dioecious, with males present; females with egg-laying sinus on right side of foot; lays numerous eggs of small size.

A feature distinguishing *Thiara* and *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)



T. granifera *I. fluvialis* *G. lewisi* *G. pumilum*

FAMILY PLEUROCERIDAE

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

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

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

Identification Key for the Pleuroceridae

1 Shell large, fusiform, periphery of whorls angulated or inflated, periphery commonly with elongated spines (although some forms are smooth); anterior end or "base" of aperture prolonged into a long canal (Figs. 429, 430, 461-465). Tennessee River and several of its main tributaries in western Virginia and eastern Tennessee . . . . *Io fluvialis* (Say)[30]

Shell large to small, conical to subglobose*, surface smooth or sculptured, with or without short spines, nodules, lirae, carina and costae; anterior end or "base" of aperture without a long canal (a short canal may be present or the canal may be absent altogether) 2

2(1) Terminal whorl with a posterior slit along the sutural juncture. Coosa River, Alabama. Genus *Gyrotoma*[28, 29] 3

Terminal whorl without a posterior slit along the sutural juncture 8

*Shell shape refers to undecollated shells.

3(2) Shell sculptured with numerous and closely spaced lirae, nine or more on the body whorls of adults 4

Shell relatively smooth or sculptured with eight or less lirae on the body whorls of adults 5

4(3) Lirae fine and numerous, 20 or more on the body whorl; color bands 8-10 (Fig. 441). Coosa River in Shelby and Talladega counties, Alabama . . . . *Gyrotoma lewisi* (Lea)

Lirae coarser and less numerous, 9-12 on the body whorl; color bands seven or less (Figs. 444, 445). Coosa River, from Fort William Shoals to Wetumpka, Alabama . . . . *Gyrotoma pumilum* (Lea)

5(3) Spire with a single, very accentuated lira (sometimes a second lower lira is present) on the spire whorls, giving the shell a pagoda-like appearance (Figs. 442, 443). Coosa River, from The Bar to Wetumpka, Alabama . . . . *Gyrotoma pagodum* (Lea)

Spire not pagoda-like 6

6(5) Whorls flattened, tapering and lumpy, giving the shell a pyramidal shape (Fig. 446). Coosa River in Shelby and St. Clair counties, Alabama . . . . *Gyrotoma pyramidatum* Shuttleworth

Whorls not both flattened and tapering, or if so, not lumpy 7

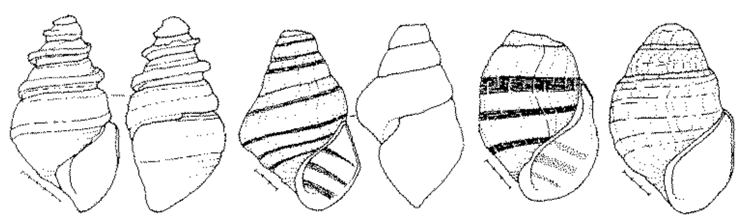
7(6) Small, decollated adult shells rarely over 16 mm long; sutural fissure very shallow (Fig. 447). Coosa River in Coosa and Shelby counties, Alabama . . . . *Gyrotoma walkeri* Smith

Larger, decollated adult shells usually more than 20 mm long; sutural fissure moderate to deep, not exceedingly shallow (Figs. 431-440). Coosa River in Chilton, Coosa, Elmore, Shelby, St. Clair and Talladega counties, Alabama . . . . *Gyrotoma excisum* (Lea)

8(2) Lateral radular teeth with broad, bluntly rounded or cleaver-like median cusps; shell medium to small, subglobose, globosely or broadly conic, or ovate. Genus *Leptoxis* 9

Lateral radular teeth with narrow, pointed, spade-shaped or triangular median cusps; shell large to small, generally elongately or narrowly conic, but several species are broadly conic, ovate or cylindrical 34

9(8) Shell with an elongated or short spire, body whorl generally tapering and usually without prominent surface sculpture, although several species have spiral striae, carinae or small shoulder nodules; aperture broadly ovate, its anterior end nearly always rounded 10



G. pagodum *G. pyramidatum* *G. walkeri* *G. excisum*

Shell with a very short spire and a nearly cylindrical body whorl with relatively large bumps or nodules on the shoulders; aperture pyriform, its anterior end pointed (Figs. 501, 502). Tennessee River and tributaries in Alabama and Tennessee. Subgenus *Athearnia* . . . . *Leptoxis (Athearnia) crassa* (Haldeman)[34]

10(9) Shell generally thick and solid. Ohio and Alabama river drainages. Subgenus *Leptoxis* s.s.[32, 74] 11

Shell commonly relatively thin. Ohio river and Atlantic drainages and White River, Arkansas. Subgenus *Mudalia*[75] 28

11(10) Ohio river drainage, including the Tennessee, Cumberland, Duck and Elk river drainages 12

Alabama river drainage 13

12(11) Base of adult shell without an umbilicus (Figs. 478-482). Cumberland, Duck, Ohio and Tennessee rivers and some of their drainages . . . . *Leptoxis praerosa* (Say)

Base of adult shell with an umbilicus (Fig. 528). Elk, Red and Stone's rivers, Tennessee, and in Ringgold Creek of the Cumberland River . . . . *Leptoxis umbilicata* (Wetherby)

13(11) Species inhabiting the Alabama River proper and very short distances up the Cahaba or Coosa rivers from their mouths 14

Species confined to tributaries of the Alabama River 15

14(13) Operculum ovate, loosely paucispiral (Fig. 476). Alabama and Coosa rivers, Alabama . . . . *Leptoxis picta* (Conrad)

Operculum elongate, tightly paucispiral (Figs. 484-486). Alabama and Cahaba rivers and the Coosa River and tributaries . . . . *Leptoxis taeniata* (Conrad)[76]

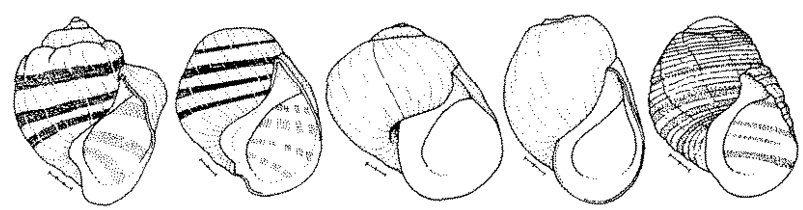
15(13) Species confined to the Coosa River and its tributaries 16

Species confined to the Cahaba and Black Warrior rivers and their tributaries 25

16(15) Shell strongly lirate 17

Shell smooth to spirally striate or weakly lirate, but not strongly lirate 19

17(16) Carinae may be well developed, but not highly accentuated (Figs. 484-486). Alabama and Cahaba rivers and the Coosa River and tributaries . . . . *Leptoxis taeniata* (Conrad)[76]



L. (A.) crassa *L. praerosa* *L. umbilicata* *L. picta* *L. taeniata*

Carinae high, accentuated 18

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

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

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

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

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

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

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

Operculum loosely paucispiral 22

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

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

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

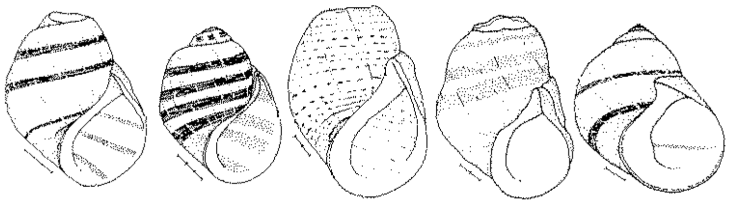
Right margin of operculum smooth, anterior or "basal" margin serrated regularly (Fig. 473). Coosa River, Alabama .... *Leptoxis ligata* (Anthony)

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

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

25(15) Species confined to the Cahaba River 26

Species confined to the Black Warrior River 27



L. taeniata *L. clipeata* *L. foremani* *L. ligata* *L. vittata*

26(25) Shell with depressed spire and subglobose body whorl (Figs. 456, 457). Cahaba River, Alabama, and tributaries .... *Leptoxis ampla* (Anthony)

Shell with elevated spire and elongated body whorl (Figs. 469, 470). Cahaba River and Buck Creek, Alabama .... *Leptoxis compacta* (Anthony)

27(25) Shell ovate, relatively large (that of adults more than 13 mm in length) (Fig. 477). Black Warrior River and Valley Creek, Alabama .... *Leptoxis plicata* (Conrad)

Shell broadly conic, relatively small (that of adults less than 13 mm in length) (Fig. 474). Black Warrior River, Alabama .... *Leptoxis melanoides* (Conrad)

28(10) In streams of the Atlantic drainage 29

In streams of the Mississippi river drainage 30

29(28) Shell of adults medium, 13 or more mm in length, commonly with one or several carinae (Figs. 489-492). New York to North Carolina .... *Leptoxis (Mudalia) carinata carinata* (Bruguière)

Shells of adults small, about 10 mm in length, elongately conic, without carinae (Fig. 493). Hot Springs, Bath County, Virginia .... *Leptoxis (Mudalia) carinata nickliniata* (Lea)

30(28) In streams of the Ohio river drainage 31

In the White River, Arkansas, and its North Fork, in Missouri; shell typically covered with thick whitish calcium deposits (Fig. 488) .... *Leptoxis (Mudalia) arkansensis* (Hinkley)

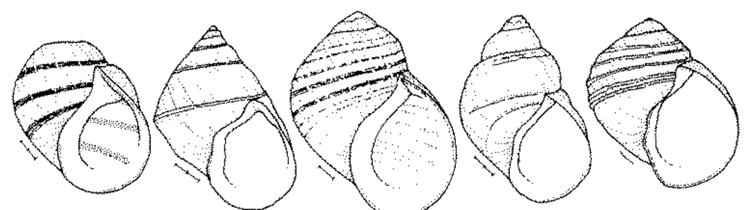
31(30) Shell small (that of adults 8 mm or less in length), periphery with a single angulation or carina (Fig. 495). Tennessee River at Muscle Shoals, Alabama .... *Leptoxis (Mudalia) minor* (Hinkley)

Shell medium in size (that of adults 10 mm or more in length), periphery smooth or with one, two or three angulations or carinae 32

32(31) Shell relatively large (that of adults 15 mm or more in length), high-spired, ovately conic, nearly always without color bands and carinae (Fig. 494). Kanawha River and tributaries, West Virginia ..... *Leptoxis (Mudalia) dilatata* (Conrad)

Shell smaller (that of adults 10-13 mm in length), ovately or globosely conic to subglobose, with or without color bands and carinae 33

33(32) Shell subglobose, generally with one to several carinae, usually without color bands (Figs. 496, 497). Ohio River in western Ohio and northern Kentucky and tributaries .... *Leptoxis (Mudalia) trilineata* (Say)



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

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

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

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

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

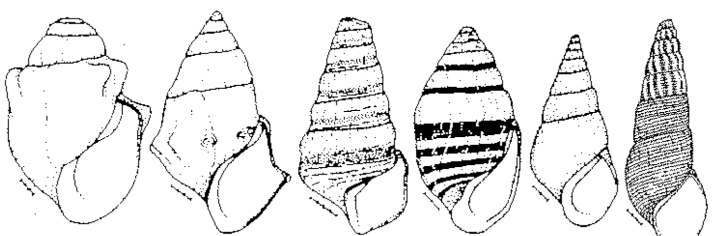
The most prominent spiral row of nodules, tubercles or spines is along or near the median periphery of the whorls (Figs. 514-520). Ohio and Tennessee rivers and their tributaries; Black and Spring rivers, Arkansas; Big Black River, Mississippi . . . . Subgenus *Angitrema*[78]

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

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

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

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



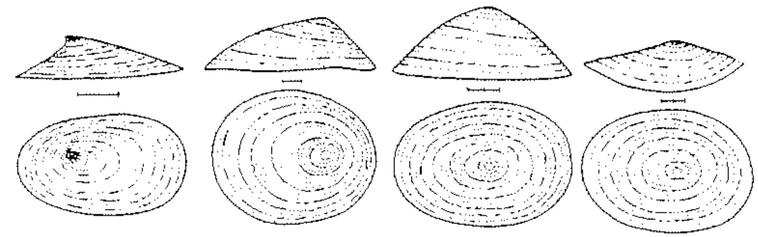
L. g. geniculata · *L. (A.) armigera* · *P. c. filum* · *P. (S.) corpulentum* · *E. l. livescens* · *J. silicula*

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.



A. coloradensis · *F. nuttalli* · *L. patelloides* · *L. (W.) klamathensis*

FAMILY LYMNAEIDAE

The Lymnaeidae are world-wide in distribution, but their greatest diversity is found in the northern United States and central Canada. Their shells range in shape from the coiled, needle-like *Acella haldemani* (Binney) (Fig. 565) to the uncoiled, limpet-shaped *Lanx* (Figs. 578-580, 633, 634) and *Fisherola* (Fig. 632). Those with coiled shells are easily distinguished from the Physidae by their dextral shells (the lone exception in the Lymnaeidae is the sinistral *Pseudisidora producta* (Mighels), which is restricted to Hawaii). No lymnaeids have planispiral shells, which immediately distinguishes them from the North American Planorbidae. The patelliform Lancinae, which occur only in the Pacific drainage region, can be distinguished from the 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 Laneinae[44] 2

Shell coiled. Common throughout North America. Subfamily Lymnaeinae 4

2(1) Apex subcentral. Genus *Lanx* 3

Apex close to the anterior end (Fig. 632). Columbia river drainage . . . . *Fisherola nuttalli* (Haldeman)

3(2) Entire shell or at least its apex elevated (Figs. 578-580, 633). Klamath and Sacramento rivers, California; Umpqua river system, Oregon . . . . . . Subgenus *Lanx* s.s.[79]

Shell and apex depressed (Fig. 634). Subgenus *Walkerola*. Klamath system in basin of Klamath River, Oregon . . . . *Lanx (Walkerola) klamathensis* Hannibal

4(1) Adult shell with large, globose body whorl, without spiral striations (Fig. 594). Widely distributed, but of spotty occurrence .... *Radix auricularia* (Linnaeus)

Adult shell with narrow or globose body whorl, but if globose, the shell is well sculptured with microscopic spiral striations 5

5(4) Shell attenuate, very narrow, almost needle-like (Fig. 565). Southern Ontario; north central United States to Vermont .... *Acella haldemani* (Binney)

Shell thicker, not especially narrow 6

6(5) Shell succiniform, i.e., thin and fragile, with a large, oval aperture and body whorl, and small spire; surface sculptured with microscopic, raised, spiral periostracal threads (Fig. 593). Eastern North America generally .... *Pseudosuccinea columella* (Say)

Shell not succiniform, aperture may or may not be large and oval, but if so, the shell is not thin and fragile and is not sculptured with microscopic, raised, spiral periostracal threads 7

7(6) Shell large, that of adults more than 35 mm in length 8

Shell smaller, that of adults less than 35 mm in length 13

8(7) Shell with a relatively narrow body whorl. Genus *Stagnicola*, in part[43, 79] 13

Shell with a wider, expanded, elongately oval to globose body whorl 9

9(8) Shell with a narrow, pointed spire. Genus *Lymnaea*[40] 10

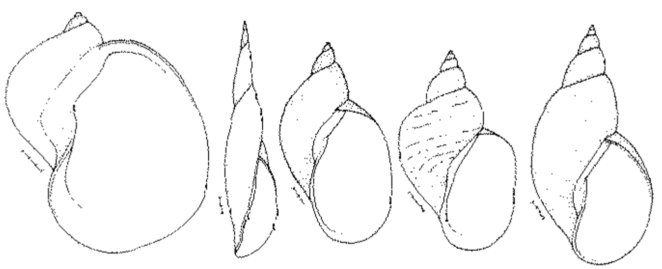
Shell with a relatively wider spire 12

10(9) Shell rimate, i.e., with a narrowly open umbilicus partially covered by the flare of the columellar lip (Fig. 590). Alaska and northwestern Canada .... *Lymnaea atkaensis* Dall

Shell imperforate 11

11(10) Shell with a large, subglobose body whorl (Fig. 592). Lake Superior, northern Lake Huron, Wisconsin river and Winnipeg river drainages .... *Lymnaea stagnalis sanctaemariae* Walker

Shell with an ample but not broad and subglobose body whorl (Fig. 591). Throughout much of Canada; in the northern United States and south to Colorado in the Rocky Mountains .... *Lymnaea stagnalis appressa* Say



R. auricularia *A. haldemani* *P. columella* *L. atkaensis* *L. s. appressa*

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 .... *Bulimnea 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 *Stagnicola*[43, 79]

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

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

[The genus *Fossaria* contains the small lymnaeids, very few specimens of which have shells more than 12 or 13 mm in length, most being smaller. The spiral striations of the shell, 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)[81]. *Galba* Schrank 1803 is another name sometimes used for the genus, especially in Europe, but the type species (*Galba pusilla* Schrank) on which the name is based is unidentifiable (Pilsbry & Bequaert, 1927). Other synonyms are *Simpsonia* F.C. Baker 1911, preoccupied by *Simpsonia* Rochebrune 1905, and *Pseudogalba* F.C. Baker 1913, a replacement name for *Simpsonia* Baker.

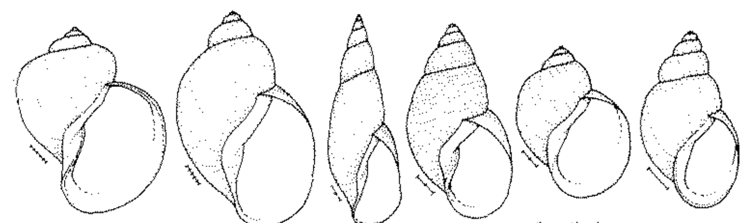
Some 40 species or subspecies of North American fossarias have been named, but the majority of these will prove to be synonyms. Hubendick (1951) recognized only three species ("*Lymnaea*" *bulimoides*, "*L.*" *cubensis* and "*L.*" *humilis*), but that amount of "lumping" seems excessive. A definitive 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*, preoccupied by *Nasonia* Ashmead 1904) with *Stagnicola*. However, they are more closely allied to *Fossaria*.]

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

Adult shell larger, more than 8 mm in length 16



S. mighelsi *B. megasoma* *S. exilis* *S. neopalustris* *S. 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)

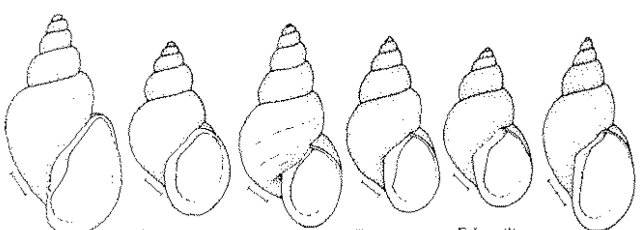
Southwestern Yukon and southern Alaska (Fig. 583) . . . . . . *Fossaria truncatula* (Müller)[81]

20(17) Whorls regularly increasing in size, terminating in a tumid, ovate body whorl; whorls evenly convex; spire broad; aperture ovate. Eastern and southeastern United States in distribution (Fig. 569) . . . . *Fossaria humilis* (Say)

Whorls regularly or irregularly increasing in size, terminating in an elongate-ovate, sometimes narrow body whorl; whorls convex to flattened; spire broad to narrow; aperture elongate-oval. Widely distributed in North America, but absent from the southeastern United States (Figs. 570, 573-577) . . . . *Fossaria obrussa* (Say) group

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

obrussa [Figs. 570, 575] – ". . . one of the most widely distributed . . . [and] . . . most variable, of the American 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."



F. galbana *F. cyclostoma* *F. tazewelliana* *F. truncatula* *F. humilis* *F. obrussa*

exigua [Fig. 573] – ". . . appears quite separable from *obrussa*. The spire is usually long and the whorls flatly rounded, the body whorl more or less compressed; the most noteworthy feature appears to be the very deep suture, which is almost channelled in some specimens, causing the whorls to be turban-shaped. This feature is present in the majority of the specimens examined. The aperture is also more regularly ovate than in *obrussa*, and the inner lip is peculiarly flattened near the umbilical region, giving rise to a pseudoplait. Some specimens resemble *modicella rustica*, but in that race the spire is acutely conical, the whorls regularly increase in size, the body whorl is not compressed in the middle, and the aperture is 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 confounded with forms of *exigua*, but in that species the aperture is longer and narrower and inclined to be squarish, while in *rustica* it is more acutely rounded at the extremities. The spire in *rustica* is longer and more acute than in *exigua*, the spire whorls being less inflated. Half-grown specimens of *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 *rustica* this part of the lip is gracefully curved. The aperture is sometimes almost round and the spire varies much in height. *Rustica* is evidently more nearly related to *modicella* than to *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)

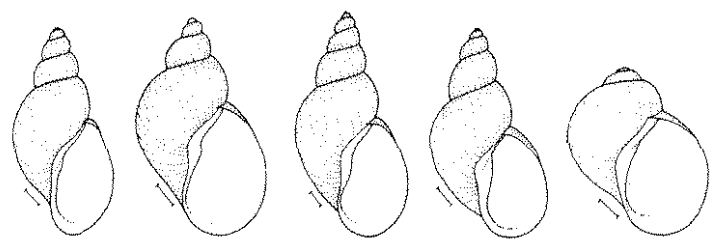
Shell globose, subglobose, ovate or conic, horn, pale yellowish, light to dark brown or pearl gray in color, generally moderately glossy, but may be dull 22

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)[82]

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

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

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



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

[Shells of the *Fossaria (Bakerilymnaea) bulimoides* group are quite variable, and several forms have been recognized as species, subspecies or morphs. The best known of these are *cockerelli* Pilsbry & Ferriss and *techella* Haldeman. Hibbard & Taylor (1960) believed *cockerelli* to be specifically distinct from *bulimoides* s.str. and *bulimoides*' subspecies *techella*. *Cockerelli* and *techella*, as well as *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)[83].

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

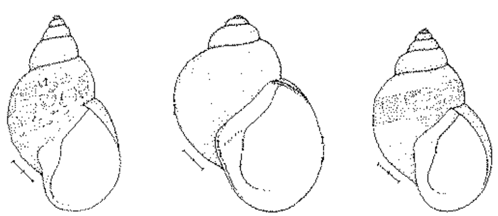
hendersoni – "Globose, very thin and fragile; periostracum light yellowish or brownish horn; ... spire very short, depressed. ... The only Lymnaeid likely to be confounded with *hendersoni* is *sonomaensis*, which differs in the form of the spire [higher] and the inner lip [not rolled over as much].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

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

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

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

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

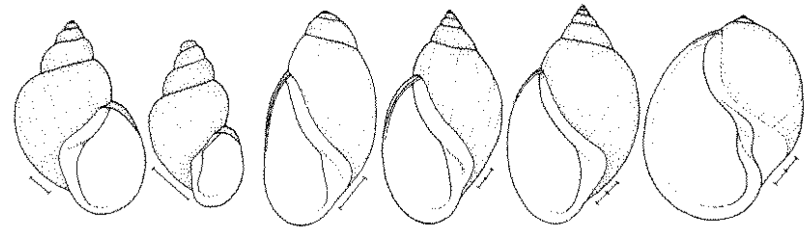


F. (B.) bulimoides *F. (B.) cockerelli* *F. (B.) techella*

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

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

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



F. (B.) cubensis *F. (B.) dalli* *Physa skinneri* *Physella g. gyrina* *Physella (C.) i. integra* *Physella globosa*

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[85]

1 Mantle edge digitate (with finger-like projections) 2

Mantle edge without digitations; mantle edge may or may not be serrated 3

2(1) Digitations occur on both sides of the mantle; tip of shell spire rounded (Figs. 635-637). Canada and northern United States . . . . Genus *Physa*[85]

Digitations occur only on the parietal side of the mantle (Figs. 581, 582, 638-698). Widely distributed and common throughout North America . . . . Genus *Physella*[85]

3(1) Mantle edge smooth; mantle does not extend beyond the edge of the shell apertural lip 5

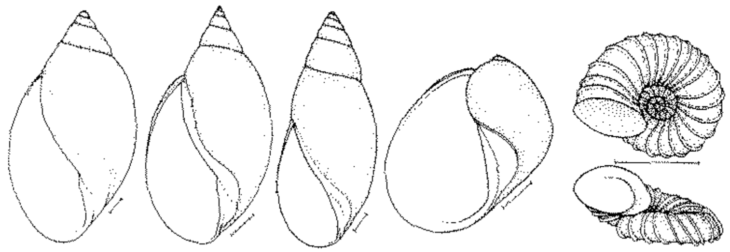
Mantle edge serrated and extending beyond the edge of the shell apertural lip, partly overlapping the shell. Texas. Genus *Stenophysa*[47] 4

4(3) Shell relatively small, less than 16 mm in length, horn to light or dark tan in color, usually translucent, seldom variegated (Fig. 701). Texas . . . . *Stenophysa marmorata* (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)[86]

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 dextral-appearing shells on a sinistral animal are termed "pseudodextral" or "ultrasinistral".

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

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

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

Identification Key for the Planorbidae

1 Shell small, that of adults less than 8 mm in diameter 2

Shell larger, that of adults more than 8 mm and up to or more than 30 mm in diameter 23

2(1) Shell costate (Fig. 706). Canada and northern United States . . . . *Gyraulus (Armiger) crista* (Linnaeus)

Shell not costate 3

3(2) Shell minute, that of adults 2 mm or less in diameter. Coosa River, Alabama 4

Shell larger, that of adults more than 2 mm in diameter 8

4(3) Shell crepiduliform in shape, i.e., limpet-like with a small coil at the apex (Fig. 749). Coosa River, Alabama . . . . *Amphigyra alabamensis* Pilsbry

Shell planorboid. Genus *Neoplanorbis*[62, 87] 5

5(4) Shell umbilicate, columella dentate 6

Shell perforate, columella smooth 7

6(5) Shell periphery carinate, umbilicus narrow (Fig. 752). Coosa River, Alabama . . . . *Neoplanorbis carinatus* Walker

Shell periphery obtusely angled, umbilicus wider (Fig. 754). Coosa River, Alabama . . . . *Neoplanorbis umbilicatus* Walker

7(5) Shell spirally striate, periphery carinate (Fig. 750). Coosa River, Alabama . . . . *Neoplanorbis tantillus* Pilsbry

Shell without spiral striae, periphery rounded (Fig. 753). Coosa River, Alabama . . . . *Neoplanorbis smithi* Walker

8(3) Shell very compressed, body whorl relatively flattened; aperture or body whorl without "teeth" or lamellae 9

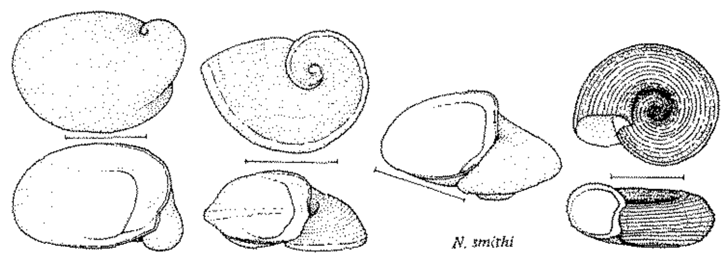
Shell higher, body whorl moderately high; inside aperture or body whorl with "teeth" or lamellae. Genus *Planorbula*, in part 22

9(8) Shell either extremely flattened and multi-whorled or with numerous, low, close-set spiral ridges (lirae). Florida, Texas and southern Arizona. Genus *Drepanotrema* 10

Shell flattened, but not extremely so; not multi-whorled; without spiral ridges (lirae) 12

10(9) Shell extremely flattened; multi-whorled; without spiral ridges (lirae). Subgenus *Fossulorbis* 11

Shell not extremely flattened; with fewer, more rapidly enlarging whorls; sculptured with numerous, low lirae. Subgenus *Antillorbis*. (Fig. 710). Southern Arizona and southern Texas . . . . *Drepanotrema (Antillorbis) aeruginosum* (Morelet)



A. alabamensis *N. tantillus* *N. smithi* *D. (A.) aeruginosam*

11(10) Shell periphery strongly keeled (Fig. 711). Florida, Texas . . . . *Drepanotrema (Fossulorbis) kermatoides* (d'Orbigny)

Shell periphery rounded or obtusely angular (Fig. 715). Southern Texas . . . . *Drepanotrema (Fossulorbis) cimex* (Moricand)

12(9) Spire pit (on left side of shell) shallow and wide 13

Spire pit (on left side of shell) relatively deep and narrow 17

13(12) Height of body whorl relatively rapidly increasing toward the aperture (Fig. 727). Illinois, Missouri and Arkansas . . . . *Menetus (Micromenetus) sampsoni* (Sampson)[53, 54, 55]

Height of body whorl nearly equal from one side to the other. Genus *Gyraulus* 14

14(13) Adult shells 4 to 7 mm in diameter, variable, with the body whorl not evenly rounded or with a peripheral keel or with a hirsute periostracum or a malleated surface or with any combination of these features.[88] Subgenus *Gyraulus* s.s. (Fig. 705). Canada and northern United States from Maine to Virginia and west to Idaho . . . . *Gyraulus deflectus* (Say)

Adult shells 3 to 5 mm in diameter, variable, with the body whorl evenly rounded or with upper lateral surface slightly flattened; without a peripheral keel or a hirsute periostracum or malleated surface.[88] Subgenus *Torquis* 15

15(14) Shell relatively high (Fig. 708). Canada, North Dakota and Wisconsin . . . . *Gyraulus (Torquis) hornensis* F.C. Baker[48]

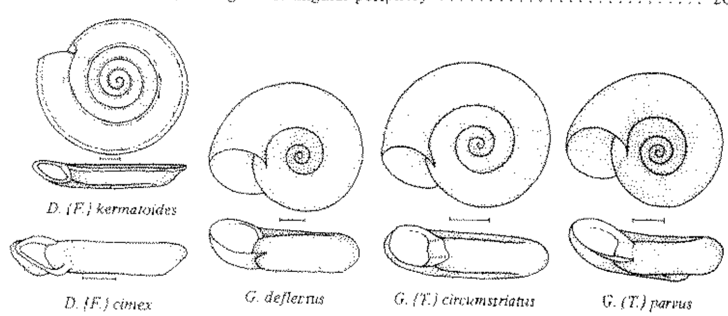
Shell relatively flattened 16

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[88] (Fig. 707). Canada and northern United States, south in the Rocky Mountains to New Mexico . . . . *Gyraulus (Torquis) circumstriatus* (Tryon)

Shell brownish, translucent but not transparent, not planispiral but with apical and umbilical aspects clearly different. Characteristic of permanent and (occasionally) temporary aquatic habitats[88] (Fig. 709). Widely distributed throughout North America . . . . *Gyraulus (Torquis) parvus* (Say)

17(12) Shell with carinate periphery 18

Shell with rounded, subangular or angular periphery 20



18(17) Western in distribution. Alaska south to Alberta and southern California (Figs. 722, 723) . . . . *Menetus opercularis* (Gould)[52]

Found east of the Rocky Mountains 19

19(18) Relative height of body whorl rapidly increasing toward the aperture (Fig. 725). Ohio, Alabama . . . . *Menetus (Micromenetus) brogniartianus* (Lea)[53, 54, 55]

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

20(17) Relative height of body whorl rapidly increasing toward the aperture (Figs. 724, 726). Widely distributed in the eastern United States . . . . *Menetus (Micromenetus) dilatatus* (Gould)[53, 54, 55]

Relative height of body whorl nearly equal from one side to the other 21

21(20) Periphery of body whorl more or less angular or subangular (Figs. 722, 723). Alaska south to Alberta and southern California . . . . *Menetus opercularis* (Gould)

Periphery of body whorl rounded (Fig. 747). Widely distributed in Canada, the western United States, and east to Oklahoma, Ohio and New York . . . . *Promenetus umbilicatellus* (Cockerell)[58, 59]

22(8) Lamellae in last whorl prominent but not especially large; lower palatal lamella relatively short and straight or only slightly curved (Figs. 741, 742). Widely distributed in eastern North America . . . . *Planorbula armigera armigera* (Say)

Lamellae in last whorl especially large; lower palatal lamella long, prominently curved (Figs. 743, 744). Alabama and Florida . . . . *Planorbula armigera wheatleyi* (Lea)[57]

23(1) Shell thin, often rather fragile, body whorl relatively depressed 24

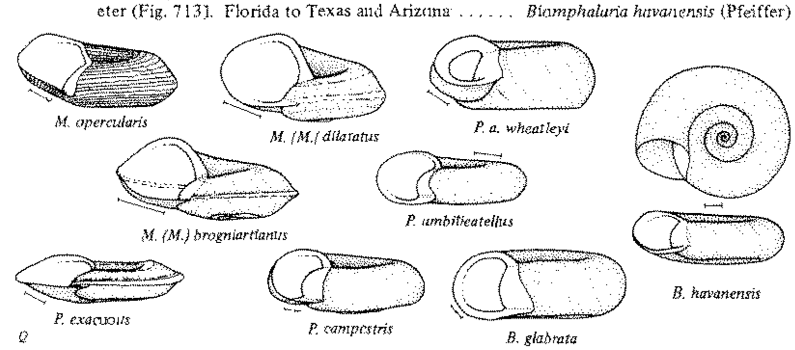
Shell thicker, usually rather solid, body whorl may or may not be relatively depressed, often high 26

24(23) Southern in distribution (Florida to Texas and Arizona). Genus *Biomphalaria* 25

Distribution northern and in the western mountains (Canada and North Dakota, south to New Mexico in the Rocky Mountains) (Fig. 745) . . . . *Planorbula campestris* (Dawson)

25(24) Shell medium in size, that of adults with five or more whorls larger than 15 mm in diameter (Fig. 712). Florida . . . . *Biomphalaria glabrata* (Say)

Shell small, that of adults with five or more whorls less than 10 mm in diameter (Fig. 713). Florida to Texas and Arizona . . . . . . *Biomphalaria havanensis* (Pfeiffer)



26(23) Body whorl containing lamellae or "teeth" (Figs. 741, 742). Widely distributed in eastern North America . . . . *Planorbula armigera armigera* (Say)

Body whorl without lamellae or "teeth" 27

27(26) Shell with few, rapidly increasing whorls; body whorl disproportionately large. Genus *Vorticifex*, subgenus *Parapholyx*.[60] Western in distribution 28

Shell with more than a few, often many whorls, that do not increase especially rapidly in size; body whorl not disproportionately large 29

28(27) Whorl angular or subangular around the concave columellar area (Fig. 751). Lakes in Nevada and California . . . . *Vorticifex (Parapholyx) solida* (Dall)[61]

Whorl not angular or subangular around the basal columellar area (Fig. 748). Rivers and lakes in California and Oregon . . . . *Vorticifex (Parapholyx) effusa* (Lea)

29(27) Shell spire (left side) strongly inverted, with a more or less deep conical depression; spire side of body whorl with or without a strong keel. Genus *Helisoma* 30

Shell spire (left side) not strongly inverted, with a shallow depression, no depression or exverted (raised above body whorl); spire side of body whorl rounded or angular. Genus *Planorbella* 35

30(29) Shell concave on both sides. Subgenus *Helisoma* s.s. 31

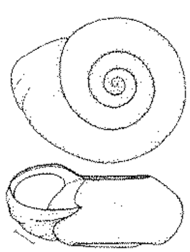
Shell concave on the left side, convex on the right side. Western in distribution. Subgenus *Carinifex* 33

31(30) Shell smaller, less than 7 mm in diameter, umbilical (basal, right) side with two chestnut-brown spiral bands. Isolated localities in North Carolina and Louisiana . . . . *Helisoma eucosmium* (Bartsch)[50]

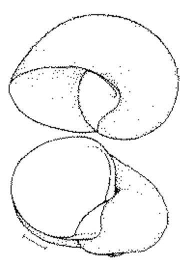
Shell larger, adults more than 7 mm in diameter, umbilical (basal, right) side without spiral color bands 32

32(31) Shell with basal (right) carina variously developed, but not close to the shoulder; transverse sculpture moderate to fine (Fig. 714). Widely distributed in most of North America . . . . *Helisoma anceps anceps* (Menke)[50]

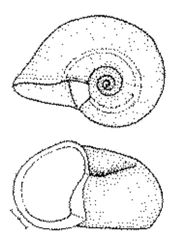
Shell with basal (right) carina very accentuated and at or close to the lower basal peripheral angle; transverse sculpture coarse. Lake Superior and Albany, Attawapiskat and Winnipeg river systems, Ontario . . . . *Helisoma anceps royalense* (Walker)[50]



P. a. armigera



V. (P.) effusa



H. a. anceps

33(30) Widely distributed and quite variable (Figs. 720, 721). California, Idaho, Nevada, Oregon and Utah . . . . *Helisoma (Carinifex) newberryi newberryi* (Lea)[51]

Restricted to either Jackson Lake, Wyoming, or Eagle Lake, California 34

34(33) Shell smaller (that of adults less than 12 mm in diameter), buff or tan in color (Figs. 716, 717). Jackson Lake, Wyoming . . . . *Helisoma (Carinifex) newberryi jacksonense* Henderson

Shell larger (that of adults up to 13.5 mm in diameter), white or horn in color (Figs. 718, 719). Eagle Lake, California . . . . *Helisoma (Carinifex) newberryi occidentale* Hanna

35(29) Body whorl at shell aperture campanulate (flared). Subgenus *Planorbella* s.s.[56, 89] 36

Body whorl at shell aperture straight, not campanulate 38

36(35) Shell spire (left side) conically raised above body whorl (Fig. 729). Howe Lake, Michigan . . . . *Planorbella multivolvis* (Case)

Shell spire (left side) either slightly inverted, flat or obtusely raised above body whorl 37

37(36) Shell spire (left side) slightly inverted, flat or very slightly raised above the body whorl (Fig. 728). Widely distributed in northern United States and Canada . . . . *Planorbella campanulata campanulata* (Say)

Shell spire (left side) obtusely raised above body whorl. Northwestern Ontario . . . . *Planorbella campanulata collinsi* (F.C. Baker)

38(35) Shell surface usually dull, usually rough in texture, with raised transverse thread-like striae. Widely distributed in North America. Subgenus *Pierosoma*[90] 39

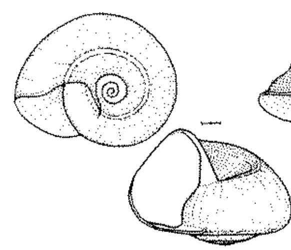
Shell surface usually glossy, relatively smooth, without raised transverse thread-like striae (Figs. 738-740). Florida. Subgenus *Seminolina*[91] 48

39(38) Species of western North America 40

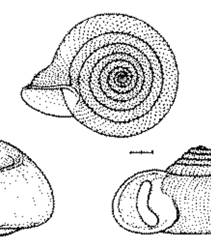
Species of central and eastern North America 42

40(39) Shell small, specimens with four whorls about 10 mm in major diameter. Southeastern Oregon and northwestern Utah . . . . *Planorbella (Pierosoma) oregonensis* (Tryon)

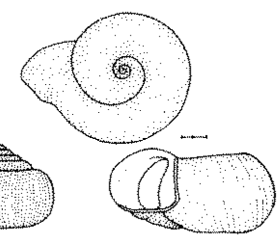
Shell larger, adults 15-30 mm in major diameter . . . . 41[93]



H. (C.) n. newberryi



P. multivolvis



P. c. campanulata

41(40) Greatest height of adults exceeding 12 mm; greatest width of shell less than twice the greatest height (Figs. 730, 733). Widely distributed in western North America . . . . *Planorbella (Pierosoma) ammon* (Gould) group[92]

Greatest height of adults 10-12 mm; greatest width of shell generally more than twice the greatest height (Fig. 734). Widely distributed in western North America . . . . *Planorbella (Pierosoma) trivolvis subcrenata* (Carpenter)[93]

42(39) Carinae or strong angulations present on the outer edges of both the right (umbilical) and left (spire) side of the body whorl of the shell 43

Carinae absent, although a rather strong angulation may be present on the upper surface of the body whorl of the spire 46

43(42) Shells larger, those of adults more than 18 mm in greatest diameter; spire may be flat or sunken into a bowl-like depression 44

Shells smaller, those of adults less than 18 mm in greatest diameter; spire flat, not inverted or sunken into a bowl-like depression (Fig. 737). Michigan, northern Illinois and Wisconsin . . . . *Planorbella (Pierosoma) truncata* (Miles)

44(43) Carinae cord-like, strong and acutely angled; body whorl flat or concave abaxially. Northern Minnesota . . . . *Planorbella (Pierosoma) corpulenta vermilionensis* (F.C. Baker)[94]

Carinae not cord-like 45

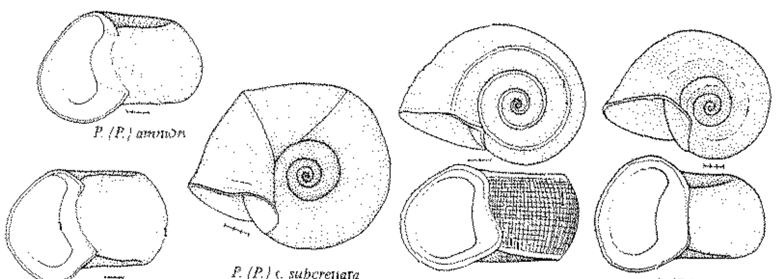
45(44) Upper surface of shell almost entirely flat; maximum height at aperture 14 mm or more; ratio of greater height to greater diameter more than 0.75 in many specimens. Headwaters of Rainy River system, western Ontario . . . . *Planorbella (Pierosoma) corpulenta whiteavesi* (F.C. Baker)[94]

Body whorl higher than penultimate whorl, causing spire to be sunken; maximum height at aperture less than 14 mm; ratio of greater height to greater diameter less than 0.75. Western Ontario, Minnesota and Manitoba . . . . *Planorbella (Pierosoma) corpulenta corpulenta* (Say)[95]

46(42) Shell height up to 24 mm or more; surface glossy, growth lines fine (Fig. 732). Lower Cape Fear River, North Carolina . . . . *Planorbella (Pierosoma) magnifica* (Pilsbry)

Shell more compressed, less than 16 mm in height; surface dull, growth lines pronounced . . . . 47[93]

47(46) Inverted portion of shell spire relatively wide, concavely smooth-sided and bowl-like (Fig. 731). Canadian Interior Basin and northern United States from Massachusetts west to Minnesota . . . *Planorbella (Pierosoma) pilsbryi* (F.C. Baker)[96]

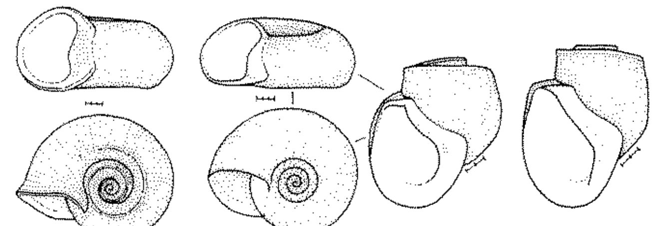


P. (P.) ammon; P. (P.) magnifica; P. (P.) t. subcrenata; P. (P.) truncata; P. (P.) pilsbryi

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)



P. (P.) trivolvis; P. (S.) duryi; P. (S.) scalaris

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 planorbids 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

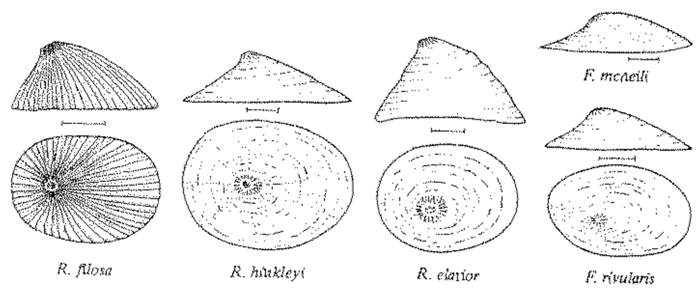
Shell not as above, usually more elevated, color variable from straw-yellow to dark gray. Apex prominent to obtuse, in the midline or to the right. Length from 2 to 10 mm. Widely distributed in various habitats 6

6(5) Shell robust, to 7 mm long, elevated, aperture elliptical. Apex in midline or slightly to the right; anterior slope convex, posterior slope gently concave, lateral slopes approximately straight. Calcareous material often thick inside the shell (Figs. 761, 767). Many populations are smaller, especially those west of the Rocky Mountains. Widely distributed in North America in rivers and streams . . . . *Ferrissia rivularis* (Say)

Shell not as above; habitat in standing water 7

7(6) Shell large, elevated, very narrow, length to 9 mm. Apex obtuse, in the midline; posterior slope flat or gently concave; lateral slopes straight or faintly concave. Apertural lip often arched. Canada and adjacent states, on vegetation in lakes . . . . *Ferrissia parallelus* (Haldeman)

Shell in standing water, but not as above 8



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

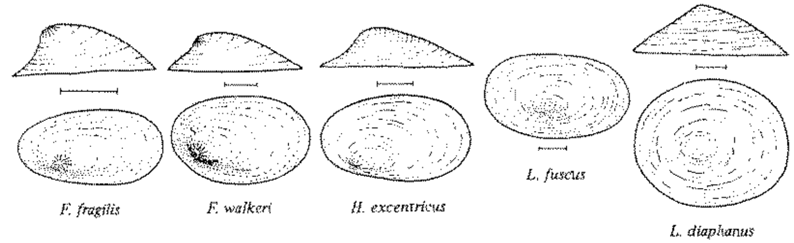
Shell to 6 mm long, usually depressed; aperture clearly oval, wider anteriorly, septum never present. Apex subacute, often far in the right posterior quadrant. Anterior and left slopes convex, posterior and right slopes concave (Fig. 768). Widely distributed, reported from Arkansas, Michigan and southern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

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

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.
Amarula Sowerby 1842 = *Thiara* Röding 1798.
Amblostoma 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.
Ambloxis Rafinesque 1818 = an unidentifiable name; occasionally mentioned as *possibly* being the same as *Campeloma* Rafinesque 1819.
Ambloxus 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.
Ancylotus 'Say' Herrmannsen 1846 = 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 Lymnaeidae, 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.
Armigerus Clessin 1884 = *Biomphalaria* Preston 1910. See Opinion 735 [1965] of the International Commission on Zoological Nomenclature.
Australorbis Pilsbry 1934 = *Biomphalaria* Preston 1910.
Bithinia Gray 1824 = *Bithynia* Leach (in Abel) 1818.
Bovillina Dall 1924 = *Orygoceras* Brusina 1882.
Bulimnaea '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.
Bythinia 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.
Ellipstoma 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 = *Angitrema* 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*.
Gundlachia Pfeiffer 1849, type *G. ancyliformis* 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*.
Hahlemania 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.
Kincaidilla 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.
Limneus Draparnaud 1801 = *Lymnaea* Lamarck 1799.
Limnophysa Fitzinger 1833 = *Stagnicola* Leach (in Jeffreys) 1830.
Lithoglyphus Hartman 1821 = a European genus, possibly congeneric with the North American *Fluminicola* Stimpson 1865 (see note 10, p. 269).
Lithoparches Gistel 1848 = *Thiara* Röding 1798.
Lutella Haldeman 1840 = *Bithynia* Leach (in Abel) 1818.
Lymnaeus Cuvier 1817 = *Lymnaea* Lamarck 1799.
Lymneus Brard 1810 = *Lymnaea* Lamarck 1799.
Lymnula Rafinesque 1819 = *Lymnaea* Lamarck 1799.

Lymnulus Rafinesque (in Binney) 1865 = *Amboxis* Rafinesque 1818, which is an unidentifiable name. Both names have the same type species, *A. elurnea* 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.
Megastrupha Walker 1918 = misspelling of *Megasystropha* Lea 1864.
Megasystropha Lea 1864 = *Carinifex* Binney 1865. See Opinion 432 [1956] of the International Commission on Zoological Nomenclature.
Melacantha Swainson 1840 = *Thiara* Röding 1798.
Melafusus Swainson 1840 = *Io* Lea 1831.
Melania Lamarck 1799 = *Thiara* Röding 1798.
Melanidia Rafinesque 1815 = *Melania* Lamarck 1799 = *Thiara* Röding 1798.
Melantho Bowdich 1822 = *Campeloma* Rafinesque 1819.
Melas Montfort 1810 = *Thiara* Röding 1798.
Melasma H. & A. Adams 1854 = *Elimia* H. & A. Adams 1854.
Melatoma Anthony 1843 (not *Melatoma* Swainson 1840) = *Gyrotoma* Shuttleworth 1845.
Melatoma Swainson 1840 = a marine group.
Meseschiza Lea 1864 = *Angitrema* Haldeman 1841.
Meseshiza Lea 1876 = spelling error of *Meseschiza* = *Angitrema* Haldeman 1841.
Nasonia F.C. Baker 1928, preoccupied = *Bakerilymnaea* Weyrauch 1964.
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.
Omphemis Rafinesque 1819, undeterminable = ? *Viviparus* Montfort 1810.
Omphiscola Rafinesque 1819 = an unidentifiable name.
Oxytrema Rafinesque 1819 = *nomen dubium*.
Paludestrina Orbigny 1839 = *Hydrobia* Hartmann 1821, a genus of Europe; it does not occur in North American fresh waters. In the earlier literature, many species of freshwater snails of the Western Hemisphere were listed under both of these generic names.
Paludina Lamarck (in Férussac) 1812 = *Viviparus* Montfort 1810.
Paradines Dall 1924 = *Vorticifex* Meek (in Dall) 1870.
Phreatomenetus Taylor 1960 = ? *Promenetus* F.C. Baker 1935.
Physina Rafinesque 1815 = *Physa* Draparnaud 1801.
Physodon Haldeman 1843 = *Physella* Haldeman 1843.
Planorbina Haldeman 1842 = *Biomphalaria* Preston 1910. See Opinion 735 [1965] of the International Commission on Zoological Nomenclature.
Planorbis Müller 1774 = a genus of the Palaearctic and Ethiopian regions. In the earlier literature, many or most planorbid species of the Western Hemisphere were assigned erroneously to the genus *Planorbis*.
Planorbulina Martens 1899, preoccupied = *Planorbula* Haldeman 1840.
Pleurovalvata Haas 1939 = *Valvata* Müller 1774.
Pompholyrodea Lindholm 1927 = *Parapholyx* Hanna 1922.
Pompholyx Lea 1856, preoccupied = *Parapholyx* Hanna 1922.
Pomus H. & A. Adams 1856 = *Pomacea* Perry 1810.
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.
Pseudogalba 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 'Klein' Mörch 1852 = *Vitta* Mörch 1852, the North American subgenus of freshwater *Neritina*.
Schizochilus Lea 1853 = *Gyrotoma* Shuttleworth 1845.
Schizostoma Lea 1843, preoccupied = *Gyrotoma* Shuttleworth 1845.
Segmentina Fleming 1817 = a genus of the Palaearctic region. In the earlier literature, species of *Planorbula* sometimes erroneously were assigned to the genus *Segmentina*.
Simpsonia F.C. Baker 1911, preoccupied = *Pseudogalba* F.C. Baker 1913 = *Fossaria* Westerlund 1885.
Spirodon 'Anthony' Tryon 1873 = *Mudalia* Haldeman 1840.
Stimpsonia Clessin 1878, preoccupied = *Fontigens* Pilsbry 1933.
Strepoma 'Rafinesque ms.' Haldeman 1863 = *Pleurocera* Rafinesque 1818.
Taphius H. & A. Adams 1855 = *Biomphalaria* Preston 1910. See Opinion 735 [1965] of the International Commission on Zoological Nomenclature.
Telescopella Gray 1847 = *Pleurocera* Rafinesque 1818.
Thomsonia Ancey 1886, preoccupied = *Seminolina* Pilsbry 1934.
Tiara Herrmannsen 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.
Vancleavia F.C. Baker 1930 = *Probythinella* Thiele 1928.
Velletea Haldeman 1841 = spelling variation of *Velletia* Gray (in Turton) 1840 = *Acroloxus* Beck 1837. (*Ancylus (Velletea) nuttallii* Haldeman 1841 = *Fisherola nuttalli* (Haldeman 1841).)
Vivipara Sowerby 1813 = *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 *Nérítines*"). In this family he listed two subfamilies and a number of generic names, which included *Neritina* 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, 295-308, 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. bimonilifera* (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*.

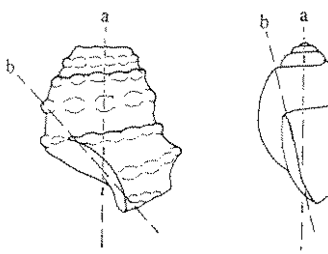


FIG. 783. Viviparid shells. *Tulotoma* is on the left. a = the columellar axis; b = the plane of the aperture.

[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, *crassula* Rafinesque 1819, *decampi* 'Currier' Binney 1865, *decisa* Say 1816, *exilis* Anthony 1860, *floridense* Call 1886, *genicula* Conrad 1834, *gibba* Currier 1867, *integra* Say 1821, *leptum* Mattox 1940, *lima* Anthony 1860, *milesi* Lea 1863, *regularis* Lea 1841 and *tannum* Mattox 1940. Clarke (1973: 220) considered "*Campeloma leptum* and *C. tannum* [to] differ from *C. decisum* and *C. integrum* by trivial characters only. They are certainly not distinct species but are simply slightly aberrant populations of *C. integrum* (and probably of *C. decisum*)." Further, Clarke (*loc. cit.*) suggested that *C. integrum*, 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 integrum* (Say

*The comments in this section refer to the superscript numbers located at various places in the text.

1821)) and to a hydrobioid (as *Cincinnatia integra* (Say 1821)). The shell length given by Say ("length ¼ inch") is undoubtedly a typographical error (? for 1¼ inch), since in his description Say compared *integra* to [*Campeloma*] *decisum* (cf. Say, 1821; Binney, 1865d; F.C. Baker, 1928e; Clarke, 1973). "*Amnicola integra* (Say)" of authors is *Cincinnatia cincinnatiensis* (Anthony).

[6]Vanatta (1935) distinguished *Lioplax pilsbryi choctawhatchensis* "from the typical form [*L. pilsbryi* Walker] by being smaller, but with similar sculpture. It is about the size of *L. subcarinata* Say, but is without the two spiral angles on the last whorl. It is smaller than *L. s. occidentalis* Pils. *L. cyclostomatiformis* Lea is narrower and smoother."

[7]Of *Lioplax subcarinata* and *L. sulculosa*, Clench & Turner (1955: 10) said, "This eastern species [*L. subcarinata*] of *Lioplax* is exceedingly close in its relationship to *L. sulculosa* Menke, the western form. Their characters differ mainly in degree. The shells of *L. subcarinata* Say are usually somewhat thinner and are proportionately a little more attenuate. It appears also that *Lioplax subcarinata* Say on the average is somewhat smaller, though selected examples of the largest specimens of both species are about equal in size. In addition, the umbilical opening of *L. sulculosa* is much larger."

[8]*Probythinella lacustris* (F.C. Baker) has gone under the name *emarginata* Küster 1852 (*Paludina*), but the latter apparently was based on the name *Lymnaeus* [*Stagnicola*] *emarginatus* Say 1821 (a lymnaeid), even though Küster described and figured a hydrobioid species. Küster's hydrobioid species did not receive a valid name until F.C. Baker (1928c) described the subspecies *lacustris*. Morrison (1947b) designated *Probythinella lacustris limafodens* Morrison 1947 as type species of *Probythinella* Thiele 1928.

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

[10]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*.

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

[12]*Somatogyrus virginicus* Walker is placed in the subgenus *Walkerilla* following Thompson (1969).

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

[14]*Marstonia lustrica* (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 lustrica*. Otherwise, *Amnicola lustrica* Pilsbry 1890 is preoccupied by *Amnicola lustrica* (Say 1821), should the latter (actually a *nomen dubium*) be considered a member of the genus *Amnicola*.

[15]*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 lustrica* 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 lustrica* Say 1821, although the latter species was considered as only doubtfully belonging to *Amnicola* (H.B. Baker, 1960c). Later, Haldeman (1845) accepted *Amnicola* as described by Gould (1841a) (not as listed by Haldeman (1840)), placed the previous "*Amnicola lustrica*" Haldeman (not of Say) in the synonymy of *Amnicola limosa* (Say) and recognized *Amnicola lustrica* (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, Herrmannsen (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 lustrica* Say as its type species.

Since 1846, *Amnicola* has been used almost entirely as though *A. porata* (Say) were its type species, although, in fact, *A. lustrica*, which is a *nomen dubium* (and a *nomen oblitum* as well, according to H.B. Baker (1964)), is the validly designated type species. Unfortunately, the type specimen of Say's *Paludina lustrica* has been lost. To end the nomenclatoral controversy which surrounds *Amnicola*, H.B. Baker (1960c) requested that the International Commission on Zoological Nomenclature use its plenary powers to suppress the specific name *Paludina lustrica* Say 1821, and to place *Amnicola* Gould & Haldeman 1840, with *Paludina porata* Say 1821 as its type species, on the Official List of Generic Names in Zoology. (The Commission has not yet made a decision on this request.) Subsequently, Clarke (1973) selected a "neotype" for *Paludina lustrica* Say, which is also the same specimen H.B. Baker (1964) designated as the lectotype of *Amnicola walkeri* Pilsbry 1898. In my 1978 outline, I followed that system. Although such a procedure would provide a belated identity for "*Amnicola lustrica* (Say)" (i.e., it then would be the same as *A. walkeri*), apparently *A. walkeri* actually belongs to 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/limosa* would be left without a subgeneric name (unless the European *Marstoniopsis* should be shown to be congeneric). 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.B. Baker's (1960c) proposal. F.G. 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.

[16]The reproductive anatomy has not been described, to my knowledge, of *aldrichi* 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.

[17]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* Boettger in the Palaearctic 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 artesian well at the U.S. fish hatchery at San Marcos, Texas, and in a subterranean stream in Manitou Cave, near Fort Payne, Alabama.

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

[19]*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 Pliocene road fill near the lake" (Thompson, 1968: 12).

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

[21]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 Strepomatidae 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 'nomina oblita' 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 Ceriphasiidae 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.

[22]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 intergrade at one point or another.

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 *Ellipstoma gibbosa* Rafinesque 1818 is too doubtful to give nomenclatural validity to *Ellipstoma* Rafinesque 1818.

[23]*Elimia* H. & A. Adams 1854 (type species *Melania acutacarinata* 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]*Elimia perstriata decampi* (Lea) is "possibly only an aberrant form" (Goodrich, 1940d: 16).

[25]*Goniobasis* (=*Elimia*) *pilsbryi* Goodrich is a replacement name for *Melania* (=*Elimia*) *showalteri* Lea 1861, which is not *Lithasia* (=*Elimia*) *showalteri* 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 leatherly, 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. pagodum* (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. pagodum, 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. spillmani, known only from two shoals of Talladega County;
G. walkeri, Weduska Shoals to Butting Ram Shoals, Coosa County, a range of only a few miles.

[29]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*.

[30]*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*: *angitremoides* C.C. Adams, *brevis* Anthony, *clinchensis* C.C. Adams, *fluvialis* Say, *loudonensis* C.C. Adams, *lyttonensis* C.C. Adams, *nolichuckyensis* C.C. Adams, *paulensis* C.C. Adams, *powellensis* C.C. Adams, *recta* Reeve, *spinosa* Lea, *turrita* Anthony[31], *unakensis* C.C. Adams and *verrucosa* Reeve. Several of these forms are illustrated on p. 153 (from Tryon, 1873b).

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

[32]*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 (1941b, 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.

[33]*Leptoxis lirata* may be only a form of *L. showalteri* (Goodrich, 1944d).

[34]In shell characters, especially the nodulose shoulders, *Leptoxis crassa* seems closer to *Lithasia* s.s., and that is 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 *Goniobasis umbonata* Lea 1864 (=*Anculosa (Lithasia) geniculata* Haldeman 1840, *fide* 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 spire 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.

[35]On shell characters, *Lithasia obovata* would seem to belong more naturally to the *Elimia/Pleurocera* group, and *L. geniculata pinguis* to *Leptoxis (Mudalia)*. 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).

[36]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. verrucosa* (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 *pinguis* 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* each has 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).

[37]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.

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

[39]Goodrich (1940d) thought that *Pleurocera viridulum* (Anthony) might be only a fast water modification of *P. pyrenellum*.

[40]The genus *Lymnaea* Lamarck 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 previous 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).

[41]*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).

[42]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

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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 largely 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 subglobose 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 serrata* 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 nuttalli, 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*."

[46]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) ancillaria* (Say 1825), an "unnamed morph" of *Physella (Costatella) osculans* (Haldeman 1841), and introduced as a subspecies of *Physella (Costatella) hendersoni* (Clench 1925) the *nomen nudum floridana* "Pilsbry ms."

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

[48]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.*

[49]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 Acrorbini Starobogatov 1958, predating Zilch's (1959) Drepanotremeae and Harry's (1962) Drepanotrematinae. (Starobogatov placed *Drepanotrema* in his Acrorbini (Starobogatov, 1970), and Harry (1962) placed *Acrorbis* in his Drepanotrematinae, but Zilch (1959) placed (questionably) *Acrorbis* in the tribe Segmentineae.)

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

names. An alphabetical list of names assigned to *Helisoma* s.s., with type localities in parentheses, follows: *anceps* Menke 1830 (Virginia), *angistoma* Haldeman 1844 (no locality given, not figured, and specimen lost), *angulata* Rackett 1821 [preoccupied] (near Lake Huron), *angulatum* Wood 1828 [preoccupied] (from Haldeman (1844); I have not seen this reference), *antrosum* Conrad 1834 (Randon's Creek, near Clairborne, Alabama) (=*anceps* Menke 1830), *aroostookense* Pilsbry 1895 (East branch of Salmon Brook, Woodland, Aroostook County, Maine), *bartschi* F.C. Baker 1945 (Brook at Great Falls, Virginia), *bicarinatum* Say 1817 [preoccupied] (Delaware River), *cahni* F.C. Baker 1927 (Big Muskallonge Lake, Vilas County, Wisconsin), *corrugatum* "Currier" Walker 1909 (Perch Lake, Kent County, Michigan), *engonatum* Conrad 1835 (Albany, New York), *idahoense* F.C. Baker 1945 (Pend Oreille River, Sand Point, Idaho), *jordanense* Winslow 1823 (South Arm of Pine Lake, about two miles north of East Jordan, Charlevoix County, Michigan), *latchfordi* Pilsbry 1927 (Meach's Lake, Hull, Quebec), *major* Walker 1893 [preoccupied, renamed *percarinatum* Walker 1909] (Crystal Lake, Benzie County, Michigan), *minnesotense* F.C. Baker 1927 (Frontenac, Minnesota), *percarinatum* Walker 1909 [new name for *major* Walker 1909] (Crystal Lake, Benzie County, Michigan), *politum* F.C. Baker 1945 (Honeywell Creek, Carleton County, Ontario, Canada), *portagensis* F.C. Baker 1908 (Portage Lake, on Fish River, Aroostook County, Maine), *royalense* Walker 1909 (Siskowit Lake, Isle Royale, Lake Superior, Michigan), *rushi* F.C. Baker 1939 (Toad Island, Georgian Bay, Ontario, Canada), *sayi* F.C. Baker 1928 (Tomahawk Lake, Oneida County, Wisconsin), *shellense* F.C. Baker 1927 (Shell Lake, Washburn County, Wisconsin), *striatum* F.C. Baker 1902 (Pleistocene fossil from sewer excavation, eight feet below the surface of the ground, Cold Spring Park, Milwaukee, Wisconsin), *unicarinatum* Haldeman 1844 (Schuylkill River).

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: *anticostianum* F.C. Baker 1945 (a Pleistocene fossil), *aroostookense, cahni, latchfordi, percarinatum, politum, portagensis, sayi, 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 topotype populations can be made."

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

[51]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 species *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).

[52]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 1895 (*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 *calliogyptus* Vanatta 1895, *centervillensis* Tryon 1871, *crassilabris* F.C. Baker 1945, *labiatus* F.C. Baker 1945, *planospirus* F.C. Baker 1945 and *portlandensis* 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*"] *callioglyptus* is seen to be identical. The variety *oregonensis* 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 is almost three times as long as the gland and is attached to the inner wall of the preputium 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 preputium . . . 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 formulae, 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* 'Ancey' 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*.

[56]Twelve Recent nominal specific or subspecific names are associated with *Planorbella* s.s.: *bella* Lea 1841, *campanulata* Say 1821, *canadensis* F.C. Baker & Cahn 1931, *collinsi* F.C. Baker 1939, *davisi* Winslow 1926, *michiganensis* F.C. Baker 1927, *minor* Dunker 1850, *multivolvis* Case 1847, *rideauensis* F.C. Baker 1945, *rudentis* Dall 1905, *smithi* F.C. Baker 1912 and *wisconsinensis* Winslow 1926. Say's *campanulata* is the type species of *Planorbella*. Binney (1865c) inspected Lea's type specimen of *bella*, an immature shell, and placed it in the synonymy of *P. campanulata*. F.C. Baker (1928c) synonymized *minor* with *P. campanulata* s.s. Clarke (1973) placed *canadensis, davisi, rudentis* and *wisconsinensis* in the synonymy of *P. campanulata* s.s.

[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, *harni* 'Pilsbry' Harn 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*. Harn's (1891) *harni* 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. I have not seen the type specimens of *P. carus*, but I anticipate

that they will prove to be the same as *P. umbilicatellus*.

[59]D.W. Taylor (1960) erected a subgenus, *Phreatomenetus*, for *Promenetus umbilicatellus* (Cockerell) (type species), the Texan *P. carus* (Pilsbry & Ferriss) and the Central American and Caribbean *P. circumlineatus* (Shuttleworth). However, because of the small number of species known from *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 *Promenetus*.

[60]The genus *Vorticifex* is based on the fossil species *V. tryoni* Meek (in Dall) 1870. Living species are included in the subgenus *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 *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]*Vorticifex (Parapholyx) solida* (Dall) may not be specifically distinct from *V. (P.) effusa* (Lea).

[62]Walter (1970) was of the opinion that all four species of *Neoplanorbis* are only variants of *Amphigyra alabamensis* Pilsbry. I have not had time to investigate this.

[63]The species of *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 *Walkerilla*, it is still not well defined. For example, in proposing the subgenus, Thiele (1928) mentioned that the radula of its type species, *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 *S. isogonus* (Say) he illustrated as having a prominent central cusp flanked by four lateral cusps, and a row of three basal cusps on each side. Yet Thompson (1969) illustrated *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 *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 *Somatogyrus* s.s. The sculpture of the apical whorls of *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 *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 *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 [*Hoyia*] *sheldoni* 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 *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 *Tryonia* as follows: "Shell turriform, with more whorls, a narrower outline, smaller aperture, and a deeper suture than in most *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 *Pyrgophorus*) are unknown in *Tryonia*.

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

[69]The species of *Aphaostracon* are not dealt with in the identification key. A list of species with distributions can be found on pp. 92, 98.

[70]The keys for the genera *Marstonia* and *Rhapinema* are from Thompson (1977).

[71]The species of *Cincinnatia, Fontelicella* 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.

[72]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.

[73]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 hydrobiids *Horatia* Bourguignat and *Daudebardiella* Boettger. 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.

[74]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).

[75]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.

[76]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).

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

[78]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.

[79]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.

[80]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 stagnicolas.

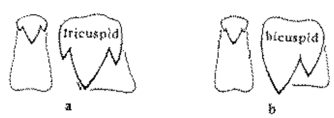

FIG. 784. Lymnaeid radular teeth. a, a central tooth and a *tricuspid* 1st lateral tooth; b, a central tooth and a *bicuspid* 1st lateral tooth.

[81]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.

[82]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).

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

[84]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).

[85]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, 184, 188, 190, 194.

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

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

[88]From Clarke (1973).

[89]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 ommitted 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 davisi* (Winslow 1926). Michigan and Wisconsin (F.C. Baker, 1928c); New Hampshire (F.C. Baker, 1942c).
- *P. campanulata canadensis* (F.C. Baker & Cahn 1931). Lakes of northern Ontario (F.C. Baker & Cahn, 1931).
- *P. campanulata collinsi* (F.C. Baker 1939). Lake of the Woods District, western Ontario (F.C. Baker, 1939b).
- *P. campanulata michiganensis* (F.C. Baker 1927). Mud Lake, Roscommon County, Michigan (F.C. Baker, 1927e).
- *P. campanulata rudentis* (Dall 1905). Knee Lake, on Hayes River, Keewatin, northern Manitoba, Canada (Dall 1905; F.C. Baker & Cahn, 1931).
- *P. campanulata smithi* (F.C. Baker 1912). Douglas Lake, Michigan; ? also northern Wisconsin (F.C. Baker, 1928c).
- *P. campanulata rideauensis* (F.C. Baker 1945). Rideau River, Ottawa, Canada (F.C. Baker, 1945).

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*.

[90]Most of the nominal taxa within the subgenus *Pierosoma* are not critically enough defined, especially in regard to geographic, microgeographic and ecophenotypic variation, to present more than a very tentative taxonomy at this time. F.C. Baker (1945: 149) recognized [as "*Helisoma (Pierosoma)*"] 17 species plus an additional 10 subspecies for North America north of Mexico: *ammon* (Gould), *binneyi* (Tryon), *chautauquensis* F.C. Baker, *corpulenta corpulenta* (Say), *corpulenta vermilionensis* F.C. Baker, *horni* (Tryon), *magnifica* (Pilsbry), *multicostata multicostata* F.C. Baker, *multicostata whiteavesi* F.C. Baker, *occidentalis occidentalis* (Cooper), *occidentalis depressa* F.C. Baker, *oregonensis* (Tryon), *pilsbryi pilsbryi* (F.C. Baker), *pilsbryi infracarinata* (F.C. Baker), *plexata* (Ingersoll), *subcrenata*

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 *multicostata* F.C. Baker in the synonymy of *corpulenta* (Say). He (*op. cit.*) considered *subcrenata* to be a subspecies of *trivolvis*.

[91]The subgenus *Seminolina* was named by Pilsbry (1934a) to include "*Helisoma*" *scalare* (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*."

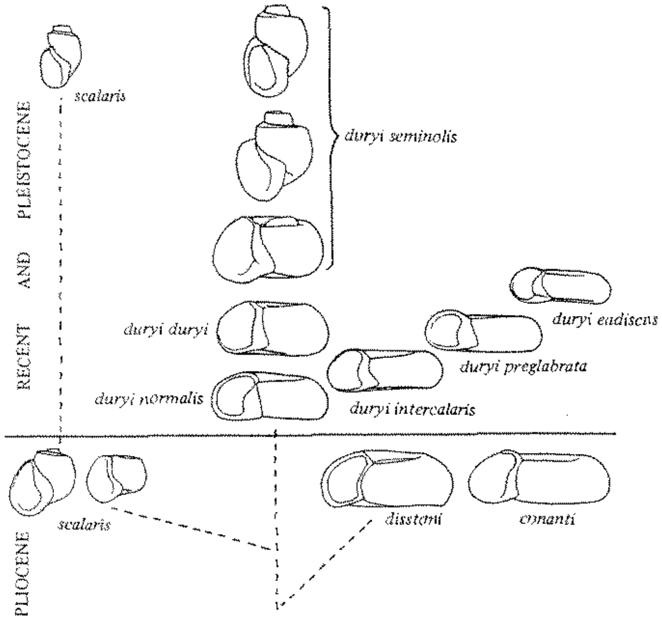

FIG. 785. Diagram showing relations of Florida forms of *Planorbella* of the subgenus *Seminolina* (from Pilsbry, 1934a).

[92]The *Planorbella (Pierosoma) ammon* (Gould) group includes the nominal species *ammon* Gould 1855, *traski* Lea 1856, *binneyi* Tryon 1867, *occidentalis* Cooper 1870 and *columbiensis* F.C. Baker 1945. "*H. binneyi, H. ammon, H. occidentale,* and *H. traskii* 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 *traskii*, 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 (Pierosoma) tenuis* (Fig. 735). It is not clear to me just which shell features can be used to separate it from *P. (P.) trivolvis 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 tenue californiense*. "This race is widely distributed in California from Santa Clara County southward. *Helisoma tenue* 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 tenue 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 (Pierosoma) 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 *trivolvis*. It resembles *pilsbryi* 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 *trivolvis* in the type lot, as well as in nearby waters, indicate a relationship to this large planorbid." Further, the shell characteristics of *P. (P.) winslowi* merge into *P. (P.) pilsbryi infracarinata*, which merge with *P. (P.) pilsbryi* s.s., which in turn seem to merge into *P. (P.) trivolvis*. (See note 96.)

[96]Clarke (1973: 459 ff.) recognized the subspecies *Helisoma* [=*Planorbella*] *(Pierosoma) pilsbryi infracarinatum* 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*] *pilsbryi* 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 (Pierosoma)*] *pilsbryi infracarinatum* as a frequently occurring morphological variant of *H. trivolvis* (Say). . . . It is also possible that *Helisoma pilsbryi infracarinatum* is a morph which is intermediate between *H. corpulentum* (*s. str.*) and *H. trivolvis* (*s. str.*) derived from sporadic introgressive hybridization or representing a surviving parental stock from which *H. corpulentum* arose. The status of *H. p. infracarinatum* as a separate taxon requires additional research" (Clarke, 1973: 461-462).

Clarke (1973) placed *Helisoma kennicotti* F.C. Baker 1945 and *Helisoma pilsbryi preblei* F.C. Baker 1945 in the synonymy of *Planorbella (Pierosoma) pilsbryi infracarinata* (F.C. Baker).

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.

P. trivolvis trivolvis (Say 1817). "This type of shell is abundantly distributed in the northeastern part of the United States from Maine westward to Nebraska. The southward extension of the typical form appears to be northern Illinois and Indiana, Ohio, Pennsylvania, and New Jersey" (F.C. Baker, 1936b). In 1945, Baker mentioned New York, Michigan and Wisconsin.

P. trivolvis fallax (Haldeman 1844). Massachusetts, Maine.

P. trivolvis lenta (Say 1834). Central Illinois, Tennessee, Louisiana, Texas.

P. trivolvis macrostoma (Whiteaves 1863). Southern Canada, northern Wisconsin.

P. trivolvis turgida (Jeffreys 1830) (= *intertexta* Sowerby 1878). South Carolina?, Florida, Alabama, Texas, Arkansas.

P. trivolvis marshalli (F.C. Baker 1945). New Jersey, New York, Maryland, Virginia.

P. trivolvis chautauquensis (F.C. Baker 1928). Chautauqua River, New York.

P. trivolvis holstonensis (F.C. Baker 1945). Holston River, southwestern Virginia.

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 wide-spread 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 Minnesota).

[98] Pilsbry (1934a) recognized six races of *Planorbella (Seminolina) duryi*: *duryi* s.s., *intercalaris* Pilsbry 1887, *preglabrata* Marshall 1926, *eudiscus* 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*).

[101] The lateral teeth of *Rhodacmea* 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].

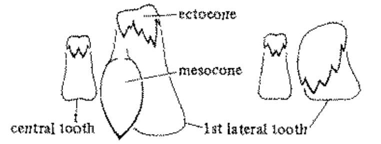

FIG. 786. Central and 1st radular teeth of ancylid limpets. *Rhodacmea* is on the left.

CORRIGENDA

The endings of the trivial names of *Cipangopaludina* [p. 86] should be *C. chinensis malleata* and *C. japonica*. [These two introduced snails, now 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 regulare* (Lea 1841) should replace *C. coarctatum* (Lea 1844) [pp. 86, 87 (Fig. 40), 91 (Fig. 66)]. *C. decisum* (Say) dates from 1817, rather than 1816 [p. 86].

Lioplax choctawhatchensis [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).

Pilsbry (1899b) should be Pilsbry (1899a) on pp. 102, 103 [see *Fluminicola erythopoma, F. nuttalliana, F. seminalis* and *F. virens*].

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

The endings of some of the trivial names given on pp. 149 and 198-206 should be changed as follows: *Gyrotoma amplum, G. cariniferum, G. incisum, Helisoma (Carinifex) newberryi jacksonense* [pp. 198, 199], *H. (C.) newberryi occidentale* [pp. 199, 202], *Menetus (Micromenetus) brogniartianus* [pp. 201, 202], *Planorbella (Pierosoma) columbiensis* [p. 202], *P. (P.) corpulenta corpulenta* [p. 202], *P. (P.) corpulenta vermilionensis* [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.) trivolvis intertexta* (= *turgida* Jeffreys 1830) [p. 204], *P. (P.) truncata* [pp. 204, 206], *P. (Seminolina) scalaris* [pp. 204, 206].

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

The date of Pilsbry's *Physa cubensis peninsularis* [*Physella (Costatella) cubensis peninsularis*] (see p. 188) is 1899.

Helisoma eucosmia (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 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) columbiensis (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 vermilionensis (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 (Pilsbry 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, 1865j); 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][93]
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]
Michigan, northern Illinois, and Wisconsin (F.C. Baker, 1928c).

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.

Acroloxid. 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).

Channeled. 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 whorls 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 corneous 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.

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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".

Rimate. 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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v

X. INDEX

TO SCIENTIFIC NAMES IN THE SPECIES LIST, IDENTIFICATION KEYS, SUPPLEMENTARY NOTES, AND GENERIC SYNONYMY