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UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 6

A Synopsis of the Classification of the Fresh-Water Mollusca of North America, North of Mexico,

AND

A Catalogue of the More Recently Described Species, With Notes

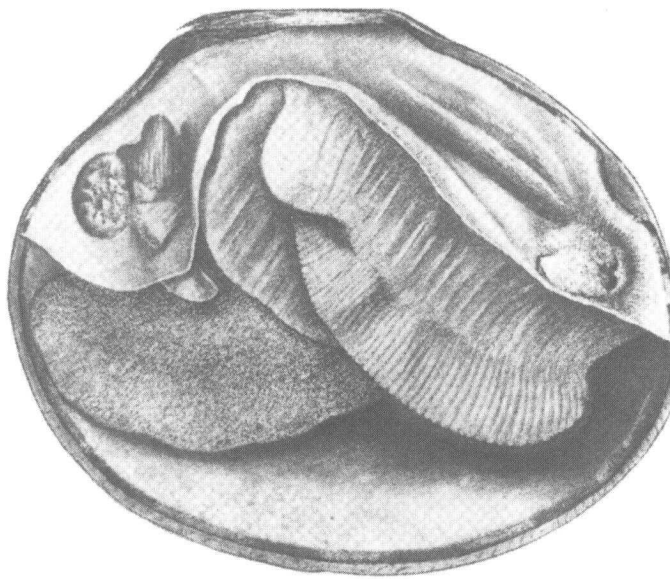
BY

BRYANT WALKER

ANN ARBOR, MICHIGAN

PUBLISHED BY THE UNIVERSITY

DECEMBER 30, 1918



DROMUS DROMAS (LEA).

UNIVERSITY OF MICHIGAN

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PART I—SYNOPSIS

ADVERTISEMENT

The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series here founded and are being supported by Dr. Bryant Walker, Mr. Bradshaw H. Swales and Dr. W. W. Newcomb, except that the cost of the illustrations and of distribution are borne by the University.

The Occasional Papers, publication of which was begun in 1913, serve as a medium for the publication of brief original papers based principally upon the collections in the Museum. The papers are issued separately to libraries and specialists, and, when a sufficient number of pages have been printed to make a volume, a title page, table of contents and index are supplied to libraries and individuals on the mailing list for the entire series.

The Miscellaneous Publications include papers on field and museum technique, monographic studies and other papers not within the scope of the Occasional Papers. The papers are published separately, and, as it is not intended that they shall be grouped into volumes, each number has a title page and when necessary a table of contents and index.

ALEXANDER G. RUTHVEN,

Director of the Museum of Zoology,

University of Michigan.

PREFACE

It has been many years since the students of the North American freshwater mollusca have had at their service a concise and complete synopsis of the classification in general use.

The several monographs published by the Smithsonian Institution of W. G. Binney and Prime in 1865 and Tryon in 1873, together with Lea's last Synopsis in 1870, gave a very complete representation of the systematic arrangement in use at that time.

Tryon's "Monograph of the Fresh-water Mollusca of the United States," a continuation of Haldeman's Monograph of 1842, did not include the Pleuroceridæ and did not add substantially to systematic classification.

Since that time, although our knowledge on the subject has greatly increased, there have been no general monographs published covering the entire field and the recorded advances in classification are only to be found in many scattered publications not always accessible to the ordinary collector.

Certain groups have, indeed, been studied monographically. Simpson's monumental "Synopsis of the Naiades" (1900) followed by his "Descriptive Catalogue" of 1914, revolutionized the classification of that great group and pointed the way to a natural classification that has since been greatly elaborated by Ortmann in many scattered papers.

Baker's elaborate "Lymnaeidæ of North and Middle America" (1911) marked another great advance in systematic classification.

Sterki's recent "Preliminary Catalog of North American Sphaeriidæ" (1916) embodies the results of many years of careful study of that family and is, it is to be hoped, but the fore-runner of a complete, illustrated monograph of that most interesting, but difficult, group.

With these exceptions, the many changes in systematic nomenclature resulting from the investigations of many different workers have been published piecemeal, as it were, and in many different publications.

The need of a concise synopsis, showing the state of the science at the present time as adopted by those who are most familiar with the subject, has been met by the Museum of Zoology of the University of Michigan in its endeavors to further the study of Natural History in the schools of the state and Part I of this paper is an attempt to place before the amateur student a summary of the classification of the fresh-water mollusca which is in current use. It is to be understood, of course, that with our constantly increasing knowledge, many changes will, undoubtedly, be necessary in the future and are to be expected and hoped for. The arrangement here presented is what the compiler understands to be the state of the science at the present time.

Part II is an out-growth of a card catalogue that the writer has maintained for his own convenience for many years. In the last half century the knowledge of our fauna has enormously increased, but the many new species have been described in many scattered publications not always accessible to the student and not to be found except by laborious and time-taking search. The convenience of a catalogue giving references to all of the new species described since the Smithsonian monographs were published is obvious. In addition to such references, it has been deemed of service to add under many of the species, old and new, the published opinions of many writers as to their specific validity and relationships. It will be understood, of course, that such quoted opinions are not necessarily those of the compiler and are not endorsed by him unless expressly so stated. They are given solely for what they are worth as representing the views of the author at the time of their publication.

The whole subject is brought down to May 1, 1918.

BRYANT WALKER.
Dated July 1, 1918.

A SYNOPSIS OF THE CLASSIFICATION OF THE FRESH-WATER MOLLUSCA OF NORTH AMERICA, NORTH OF MEXICO.

Class ..... GASTROPODA.
Subclass ..... EUTHYNEURA.
Order ..... PULMONATA.
Suborder ..... BASOMMATOPHORA.

Superfamily LIMNOPHILA.

The North American *Limnophilæ* are in the main inhabitants of fresh water, but are occasionally found in slightly brackish water along the sea coast. The epidermis is smooth; the contractile tentacles are flattened or cylindrical; the eyes are placed on the inner bases of the tentacles. The genital orifices are separated, the male orifice is near the tentacle, the female at the base of the neck, near the respiratory orifice. The jaw is simple or composed of three pieces. The radula has numerous rows of small teeth.

Key to the families of *Limnophila.*

I. Shell spiral, dextral, spire more or less elongated ..... *Lymnaeidæ.*
II. Shell discoidal, with the columellar margin simple, not dilated ..... *Planorbidæ.*
III. Shell spiral, sinistral ..... *Physidæ.*
IV. Shell patelliform or spiral, dextral, neritoid or planorboid with the columellar margin broadly dilated ..... *Ancylidæ.*

Family LYMNAEIDÆ.

Shell spiral, dextral, spire usually elongated and acute, but in some groups small and depressed.

Animal dextral. Head with a broad, short muzzle dilated at the end. Foot rounded behind. Tentacles flattened.

Jaw composed of three plates, a large one in the center, with two small, narrow laterals. Radula broad; central tooth small, simple or bicuspid, the laterals bi- or tricuspid. The marginals bi-, tri-, or multicuspid or serriform.

Genus LYMNÆA Lamarck, 1799.

Shell spiral, dextral, thin, unicolor or occasionally with longitudinal stripes; spire usually acute; aperture large, oval, rounded below, extremities united by a thin parietal callus; columella more or less twisted or plicate; lip thin, sometimes with an internal thickening or varix. Animal dextral; head large; tentacles flattened, triangular; eyes sessile on the inner bases of the tentacles.

Key to the subgenera of *Lymnæa.*

1. Spire elevated ..... 2.
   Spire short ..... 6.

2. Body-whorl greatly inflated ..... *Lymnæa.*
   Body-whorl slightly inflated ..... 3.

3. Shell very slender; spire longer than the aperture; lip continuous ..... *Acella.*
   Shell more or less inflated; spire shorter than the aperture; lip not continuous ..... 4.

4. Columella smooth, reflected over the umbilicus ..... *Galba.*
   Columella twisted or plicate ..... 5.

5. Surface with impressed, spiral lines ..... *Stagnicola.*
   Surface longitudinally costate ..... *Polyrhytis.*

6. Body-whorl large, not inflated, elongate ..... *Pseudosuccinea.*
   Body-whorl large, inflated ..... 7.

7. Shell large, solid, bulimiform; lip not expanded ..... *Bulimnea.*
   Shell moderate, spire very short, usually thin, lip more or less expanded ..... 8.

8. Shell thin, lip widely expanded, surface polished; spire acute, whorls rounded ..... *Radix.*
   Shell thicker; lip occasionally expanded; lines of growth distinct; spire broad, whorls shouldered ..... *Stagnicola* (*pars*).

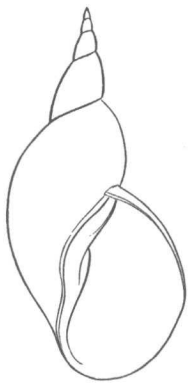


Fig. 1

Subgenus LYMNÆA s. s.

Shell large, thin, with an acute, slender spire and expanded body-whorl; axis gyrate, forming a (usually) pervious spiral coil without a true umbilicus; the callus on the body-whorl closely appressed; the outer lip flaring more or less, simple, sharp, normally without any thickening. Penis-sac very large; penis very short (about one-quarter the length of the penis-sac); penis retractors normally two, very large; anterior termination of the prostate bulb-shaped. Radula with unicuspid central and bicuspid lateral teeth, marginals serrate.

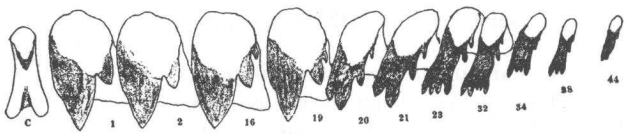


Fig. 2

Type: *L. stagnalis* L.

Example: *L. stagnalis appressa* Say, fig. 1. Radula, fig. 2.

Fig. 3

Subgenus PSEUDOSUCCINEA Baker, 1908.

Shell thin, succineiform; spire short; body-whorl large, elongated, not inflated; surface sculptured with spiral, incised lines; axis gyrate.

"Prostate long, narrowly cylindrical with a slight bulbous termination; penis thick, about half as long as penis-sac; lateral teeth bicuspid."

Fig. 5

Fig. 4

Type: *L. columella* Say, fig. 3. Radula, fig. 4. Jaw, fig. 5.

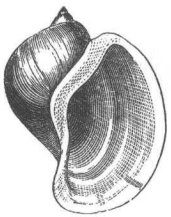


Fig. 6

Subgenus RADIX Montfort, 1810.

Shell thin, globose-oval; spire short, acute; body-whorl large, inflated; aperture very large; lip expanded.

"Prostate short, pear-shaped when viewed laterally; penis very slender, longer than penis-sac; first lateral tooth tricuspid, balance bicuspid."

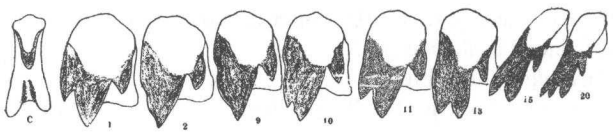


Fig. 7

Type: *L. auricularia* L., fig. 6. Radula, fig. 7.

Subgenus BULIMNEA Haldeman, 1841.

Shell large and solid, bulimiform, with an impervious axis, a twisted or subplicate pillar, the callus on the body-whorl and pillar closely appressed and the outer lip not thickened or expanded.

"Prostate very large, irregularly elongate-ovate; penis very large, one-fourth longer than penis-sac, gradually enlarging in diameter toward the distal end; lateral teeth tricuspid."

Type: *L. megasoma* Say, fig. 8. Radula, fig. 9.

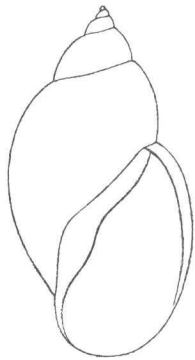


Fig. 8

Fig. 9

Subgenus ACELLA Haldeman, 1841.

Shell thin, smooth, acute, extremely slender; aperture expanded at the margin; the inner lip not appressed, a moderate chink behind it; axis gyrate, pervious, not plicate; outer lip simple, sharp.

"Prostate large, flatly cylindrical; penis thick, about four-sevenths the length of penis-sac; lateral teeth bicuspid; the mesocone with a distinct entoconic swelling."

Type: *L. haldemani* "Desh." W. G. Binn., fig. 10. Radula, fig. 11.

Fig. 10

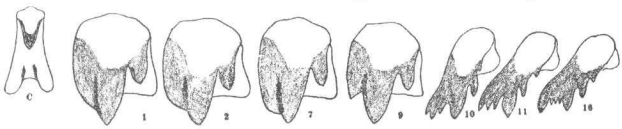


Fig. 11

Subgenus GALBA Schrank, 1803.

Shell small, turreted; spiral sculpture wanting or subobsolete; columella smooth; inner lip flatly reflected over the umbilicus.

"Prostate long-ovate; penis a trifle shorter than penis-sac, of narrow diameter; lateral teeth bicuspid."

Type: *L. truncatula* Müll. Fig. 12

Example: *L. caperata* Say, fig. 12. Radula, fig. 13.

Fig. 12

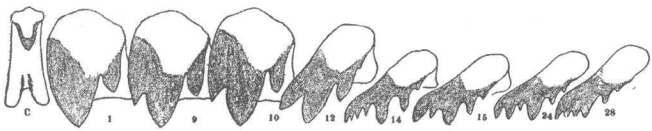


Fig. 13

Section PSEUDOGALBA Baker, 1913.

Shell as in *Galba,* but with the inner lip less expanded. Genitalia in *Galba.* Lateral teeth tricuspid.

Fig. 14

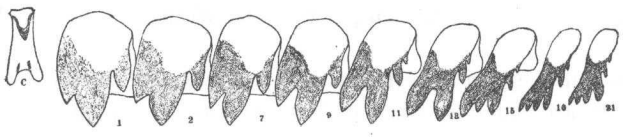


Fig. 15

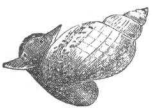


Fig. 16

Type: *L. humilis* Say, fig. 14. Radula (*L. obrussa* Say), fig. 15. Animal (ibid.), fig. 16.

Subgenus STAGNICOLA Leach, 1830.

Shell varying from elongate to short-ovate; outer lip (usually) somewhat thickened within; columella distinctly plicate; inner lip appressed; axis slightly or not all perforate; surface with strong, spirally impressed lines.

"Prostate elongate-pyriform; penis from three-fourths to four-fifths the length of penis-sac, very thick; lateral teeth bicuspid."

Type: *L. palustris* Müller, fig. 16. Radula; fig. 18.

Fig. 17

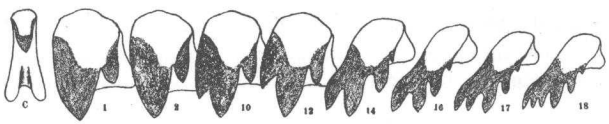


Fig. 18

Section POLYRHYTIS Meek, 1876.

Shell longitudinally costate. Soft anatomy unknown.

Type: *L. kingii* Meek.
Example: L. *utahensis* Call, fig. 19.

Fig. 19

Family PLANORBIDÆ.

Key to the subfamilies of Planorbidæ.

Shell discoidal ..... *Planorbinæ.*
Shell spiral ..... *Pompholiginæ.*

Subfamily PLANORBIDÆ H. and A. Adams, 1858.

Shell discoidal, ultra-dextral or sinistral. Animal sinistral, having the pulmonary, genital and excretory orifices on the left side. Tentacles long, slender and cylindrical. Jaw in three segments. Radula with the numerous teeth arranged in nearly horizontal rows, central small and bicuspid, marginals tricuspid, laterals multicuspid.

In the formation of the keys and descriptions of the various subdivisions of the family, the shells are treated with reference to their apparent mode of spiral growth.

Key to the genera of Planorbidæ.

1. Aperture dentate within ..... *Segmentina.*
2. Aperture without internal teeth ..... *Planorbis.*

Genus PLANORBIS Müller, 1774.

Shell discoidal, dextral or sinistral, spire very much depressed, not usually rising above the margin of the body whorl; no real columella; aperture oblique; outer lip simple and sharp or thickened. Animal smooth; head short; tentacles long, slender and cylindrical; eyes sessile on the inner bases of the tentacles; foot short, narrow, obtuse at both ends; jaw and radula as in the subfamily.

Key to the subgenera of *Planorbis*

1. Aperture simple, lip thickened ..... *Helisoma.*
   Aperture simple, lip sharp ..... 2.
   Aperture campanulate, lip thickened ..... *Planorbella.*

2. Shell sinistral ..... *Planorbis.*
   Shell dextral ..... 3.

3. Base of body-whorl flattened ..... *Tropidiscus.*
   Base of body-whorl convex ..... 4.

4. Body-whorl rounded or angulated ..... *Gyraulus.*
   Body-whorl acutely carinated or lenticular ..... *Hippeutis.*

Subgenus PLANORBIS s. s.

Shell sinistral, large, with a moderate number of gradually increasing whorls, rounded above and below; aperture slightly and gradually expanded, with its margin simple and sharp.

Represented in our fauna by a single section.

Section PLANORBINA Haldeman, 1842.

Shell like *Planorbis, s. s.,* but vertically compressed, with smaller and more numerous whorls and a very oblique aperture.
Type: *P. olivaceous* Spix.
Example: *P. glabratus* Say, fig. 20.

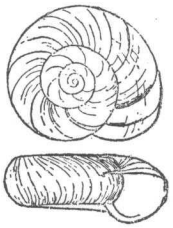


Fig. 20

Subgenus HELISOMA Swainson, 1840.

Shell dextral or sinistral, few whorled, the whorls carinate above and rapidly enlarging; base funicular; aperture suddenly expanding and thickened.

Key to the sections of *Helisoma.*

1. Shell dextral, carinated above and below, spire and base funicular ..... *Helisoma s. s.*
2. Shell sinistral, early whorls flattened and carinate above, base funicular .. *Pierosoma.*

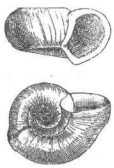


Fig. 21

Section of HELISOMA s. s.

Shell dextral, moderate size, few whorled, the whorls carinated above and below and rapidly enlarging; spire and base funicular, aperture suddenly expanded, with a thickened peritreme.

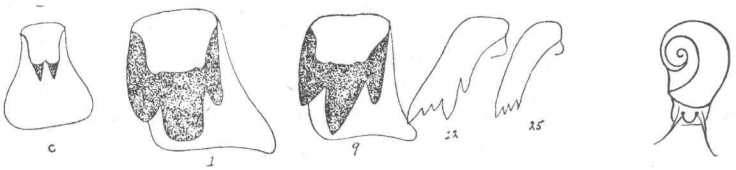


Fig. 22 Fig. 23

Type: *P. bicarinatus* Say, fig. 21. Radula, fig. 22. Animal, fig. 23.

Section PIEROSOMA Dall, 1905.

Shell sinistral, large, high, with few transversely sculptured whorls; the early whorls carinate and flattened above, funicular below; in the adult the flattened apex is usually depressed below the upper level of the body whorl; the aperture is suddenly expanded and somewhat thickened.

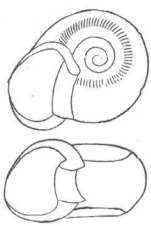


Fig. 24

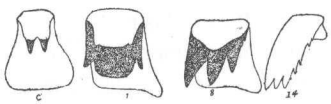


Fig. 25

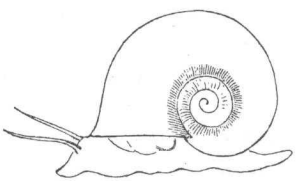


Fig. 26

Type: *P. trivolvis* Say, fig. 24. Radula, fig. 25. Animal, fig. 26.

Subgenus PLANORBELLA Haldeman, 1842.

Shell sinistral, depressed, whorls more numerous than in *Helisoma*; apex scarcely, if any, depressed below the level of the body-whorl; base funicular; body-whorl constricted behind the widely expanded, campanulate aperture.

Type: *P campanulatum* Say, fig. 27. Radula, fig. 28.

Fig. 27

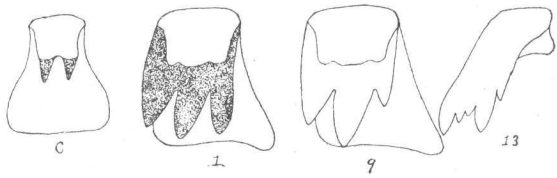


Fig. 28

Subgenus TROPIDISCUS Stein, 1850.

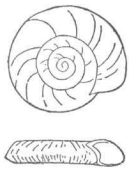


Fig. 29

Shell dextral, moderately large, depressed, upper surface convex, base flattened, adult periphery angular or carinate, the aperture oblique, slightly expanded, simple.

Type: *P. umbilicatus* Müller.
Example: *P. cultratus* d'Orb., fig. 29.

Subgenus HIPPEUTIS Agassiz, 1837.

Shell dextral, small, lenticular, with a small number of rapidly increasing whorls, the last enveloping a large part of the preceding whorl; apex slightly depressed, base with a narrow umbilicus, aperture oblique with a thin sharp margin.

Type: *Helix fontanus* Lightfoot.

Section MENETUS H. and A. Adams, 1855.

Like *Hippeutis,* but the last whorl not enveloping the preceding whorls to so large an extent.

Type: *P. opercularis* Gld., fig. 30.

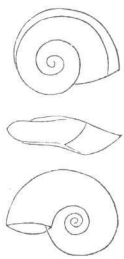


Fig. 30

Subgenus GYRAULUS Agassiz, 1837.

Shell dextral, small, with few, rapidly increasing whorls, fully exposed above and below, with a nearly median periphery, rounded or obtusely angulated, but not accurately carinated.

Key to the sections of *Gyraulus.*

1. Surface spirally striate and hispid ..... *Gyraulus s. s.*
2. Surface smooth or finely striate ..... *Torquis.*
3. Surface costate ..... *Armiger.*

Section GYRAULUS, s. s.

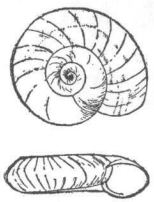


Fig. 31

Periphery rounded, or angulated, surface spirally striate and hispid; aperture simple, sharp-edged, oblique.

Type: *P. albus* Müller.

Example: *P. hirsutus* Gld., fig. 31.

Section TORQUIS Dall, 1905.

Like *Gyraulus s. s.,* but with more rounded, less rapidly increasing whorls, not hispid nor spirally striate; aperture expanded and slightly thickened in the adult.

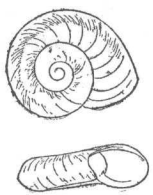


Fig. 32

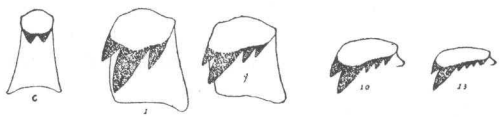


Fig. 33

Type: *P. parvus* Say, fig. 32. Radula, fig. 33.

Section ARMIGER Hartmann, 1840.

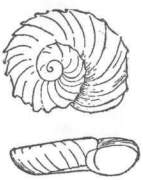


Fig. 34

Shell dextral, very small, with few rapidly increasing, costate whorls, the costæ projecting at the periphery; the form in a general way like *Gyraulus.*

Type: *P. crista* L., fig. 34.

Genus SEGMENTINA Fleming, 1817.

Shell discoidal, dextral, whorls few, rounded or carinated above and below, with one or more sets of laminæ or teeth in the interior of the shell.

Animal as in *Planorbis,* tentacles filiform; foot narrow anteriorly, wider behind, obtusely rounded at both ends. Radula, central tooth bicuspid; laterals tricuspid; marginals 4-5 cuspid.

Type: *Nautilus lacustris* Lightfoot.

Subgenus PLANORBULA Haldeman, 1842.

Shell rather small, whorls few, slowly and regularly increasing, rounded or carinated above and below; aperture somewhat expanded, lip more or less thickened within, a single persistent set of 6 dentiform lamellæ at short distance within the aperture.

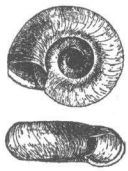


Fig. 35

Fig. 36

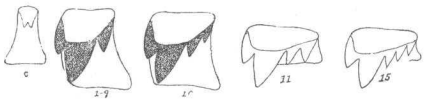


Fig. 37

Type: *Planorbis armigerus* Say, fig. 35. Aperture, fig. 36. Radula, fig. 37.

Subfamily POMPHOLIGINÆ Dall, 1866.

Shell spiral, dextral, flattened above; the body whorl very large.

Animal sinistral. Tentacles moderate, stout, cylindrical, slightly globose at the tips; eyes sessile, near the inner base of the tentacles; foot short, bluntly rounded behind; jaw single, subcordiform; radula with the teeth in nearly horizontal rows, central tooth small, bicuspid, laterals wide.

Key to the genera of *Pompholiginæ*

1. Shell imperforate ..... *Pompholyx.*
2. Shell deeply umbilicate ..... *Carinifex.*

Fig. 38

Genus POMPHOLYX Lea, 1856.

Shell spiral, dextral, globosely depressed, imperforate; whorls few, spire short, obtuse; last whorl very wide, ventricose; aperture very large, wide, subcircular, expanded; lip thin; columella thickened.

Animal as in the subfamily.

Type: *P. effusa* Lea, fig. 38. Radula, fig. 39. fig. 38

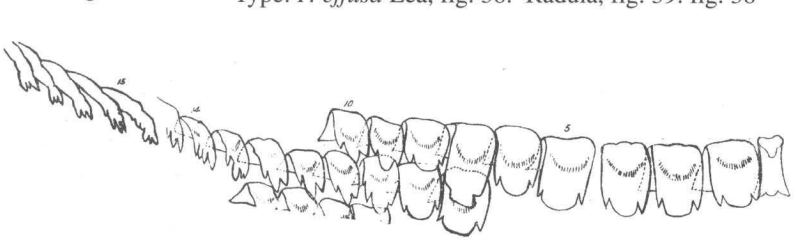


Fig. 39

Genus CARINIFEX W. G. Binney, 1863.

Shell spiral, dextral, inflated, angular; spire terraced; whorls numerous, visible above, last whorl very large, broad above, rapidly attenuated below, visible above, last whorl very large, broad above, rapidly attenuated below, umbilicus funnel shaped; aperture triangular, broad above, narrow below; inner lip slightly thickened; outer lip thin, acute, angular above, flexuose.

Fig. 40

Animal sinistral, resembling *Planorbis,* but with much shorter tentacles; jaw single; radula similar to that of *Pompholyx.*

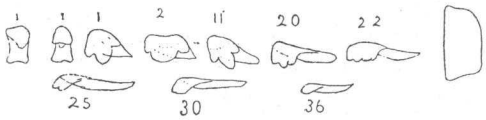


Fig. 41

Type: *Planorbis newberryi* Lea, fig. 40. Radula and jaw, fig. 41

Family PHYSIDÆ.

Shell spiral, sinistral, thin, smooth or with microscopic transverse striae, shining, spire more or less produced.

Animal sinistral, having the pulmonary, genital and excretory orifices on the left side; tentacles slender, cylindrical; foot narrow, pointed behind; jaw single, arcuate, with a vertical fibrous accessory process on the superior margin; radula with the teeth arranged in oblique rows. Central tooth wide, base with projecting processes before and behind, multicuspid; laterals obliquely bent, comb-like, multicuspid, with a peculiar process at their external angle.

1. Shell elongate, slender, smooth, polished, inner edge of the mantle simple, not digitate, not extending beyond the shell ..... *Aplexa.*
2. Shell less elongated, body whorl usually inflated, smooth or with microscopic revolving striæ; inner edge of the mantle digitate or lobed, extending partly over the shell ..... *Physa.*

Genus PHYSA Draparnaud, 1801.

Shell sinistral, oblong, thin, translucent, shining; spire acute, usually short; whorls convex; aperture ovate, rounded below, columella twisted, lip thin, acute, sometimes thickened within.

Animal as in the family, but with the inner margin of the mantle digitate or lobed, and extending over the shell.

Section PHYSA s. s.

Shell smooth.

Fig. 42

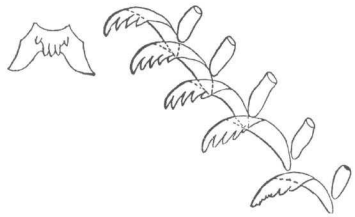


Fig. 43

Fig. 44

Type: *Bulla fontinalis* L.
Example: *P. gyrina* Say, fig. 42.
Radula: *P. humerosa* Gld., fig. 43.
Animal: *P. heterostropha* Say, fig. 44.

Section COSTATELLA Dall, 1870.

Shell longitudinally costate.
Type: *P. costata* Newc., fig. 45.

Fig. 45

Genus APLEXA Fleming, 1822.

Shell sinistral, elongated, slender, smooth, shining; spire acute; lip simple, sharp, columella but slightly twisted.

Animal similar to that of *Physa,* but with the inner edge of the mantle simple, not digitate nor reflected over on the body whorl.

Fig. 46

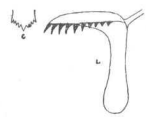


Fig. 47

Fig. 48

Type: *Bulla hypnorum* L., fig. 46. Radula, fig. 47. Animal, fig. 48.

Family ANCYLIDÆ.

Shell patelliform or dextrally spiral, neritiform or planorbiform.

Animal (fig. 49) sinistral or dextral, with a large oval foot; tentacles short, blunt, cylindrical; eyes sessile on their inner bases; jaw in three parts or the whole segmented in plates; radula with the teeth arranged in rows nearly horizontal or slightly curved, central tooth small, unicuspid or bicuspid, laterals bicuspid or comb-like, marginals comb-like or subobsolete.

Fig. 49

Key to the subfamilies of *Ancylidæ*.

1. Shell patelliform 2
   Shell planorbiform or neritiform ..... *Neoplanorbinæ*.

2. Shell and apex unicolored ..... 3.
   Shell small, with pink apex ..... *Rhodacmeinæ*.

3. Shell large, apex submedial ..... *Lancinæ*.
   Shell small, apex more or less posterior and excentric ..... *Ferrissinæ*.

Subfamily LANCINÆ Hannibal, 1914.

Shell large for the family, ovate-elliptical, depressed or roundly arched; apex submedial, not prominent, smooth or concentrically striate. Animal with the jaw as in *Lymnæa* with two accessory plates. Radula also lymnæid in character. Central tooth unicuspid or tricuspid; laterals bicuspid with large quadrate bases; marginals comb-like, the cusps extending beyond the base.

Key to the genera of *Lancinæ*.

Shell larger, apex subcentral ..... *Lanx*.
Shell smaller, apex subterminal ..... *Fisherola*.

Genus LANX Clessin, 1880.

Shell large, broadly ovate, roundly arched, rather solid, apex not prominent, smooth or concentrically striate, subcentral. Radula as in the subfamily.

Type: *Ancylus newberryi* Lea, fig. 50.
Radula: *Lanx pattelloides* (Lea), fig. 51.

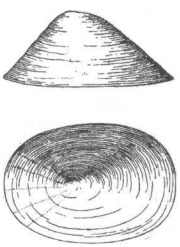


Fig. 50

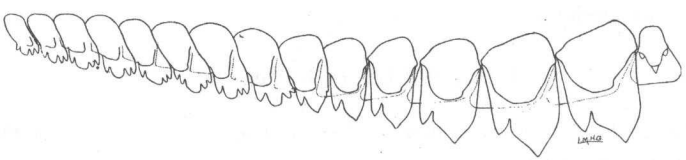


Fig. 51

Subgenus WALKEROLA Hannibal.

Shell as in *Lanx,* but thinner and more depressed.

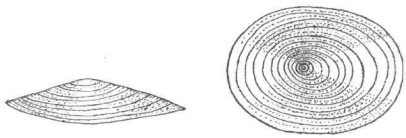


Fig. 52

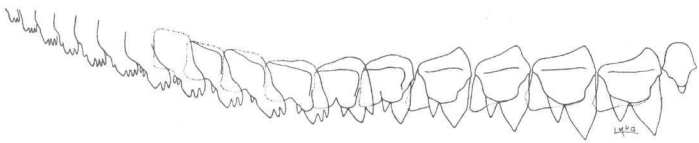


Fig. 53

Type: *Lanx klamathensis* Hann., fig. 52. Radula, fig. 53.

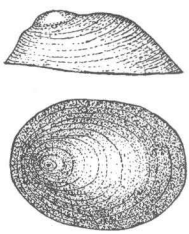


Fig. 54

Genus FISHEROLA Hannibal, 1912.

Shell rounded-ovate, somewhat broader anteriorly, depressed-conic, finely concentrically striate, apex small, indistinct, subterminal, but not inclined. Anatomy unknown.

Type: *Fisherola lancides* Hann., fig. 54.

Subfamily FERRISSIINÆ Walker, 1917.

Shell small, thin, broadly ovate to oblong; apex more or less posterior and eccentric, apex (in North American species) smooth or radially striate. Animal having the jaw segmented in plates. Radula with a bicuspid central, laterals obliquely reflected with from two to five small cusps, arranged like the teeth of a comb, marginals also comb-like, cusps not (usually) extending to the basal line.

Key to the genera of *Ferrissiinæ.*

Shell never septate ..... *Ferrissia.*
Shell in maturity septate ..... *Gundlachia.*

Genus FERRISSIA Walker, 1903.

Shell ovate to oblong, conic, more or less elevated, apex excentric and posterior, radially striate or smooth.

Animal as in the subfamily.

Key to the subgenera of *Ferrissia.*

Shell elevated, apex radially striate ..... *Ferrissia s. s.*
Shell depressed, apex smooth ..... *Laevapex.*

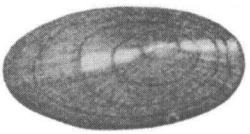
Subgenus FERRISSIA s. s.

Fig. 55

Shell conic, elevated, apex radially striate.
Type: *Ancylus rivularis* Say, fig. 55. Radula, fig. 56.

Fig. 56

Subgenus LAEVAPEX Walker, 1903.



Shell more or less depressed, apex smooth.
Type: *Ancylus fuscus* C. B. Ads., fig. 57.
Radula: *Ferrissia diaphana* (Hald.), fig. 58.

Fig. 57

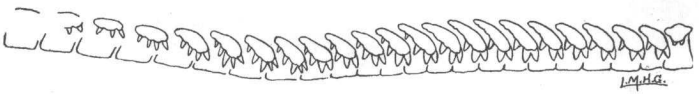


Fig. 58

Genus GUNDLACHIA Pfeiffer, 1849.

Shell small, thin, ancyliform, obliquely conical; apex posterior, excentric, smooth or radially striate, inclined to the right; basal side more or less closed by a flat, horizontal septum; aperture broad-oval; margin continuous, simple, entire. Animal as in *Ferrissia.* Radula with a bicuspid central and tricuspid laterals and marginals, the cusps short and broad.

Key to the subgenera of *Gundlachia.*

Apex smooth or concentrically wrinkled ..... *Gundlachia s. s.*
Apex radially striate ..... *Kincaidella.*

Subgenus GUNDLACHIA s. s.

Apex smooth.

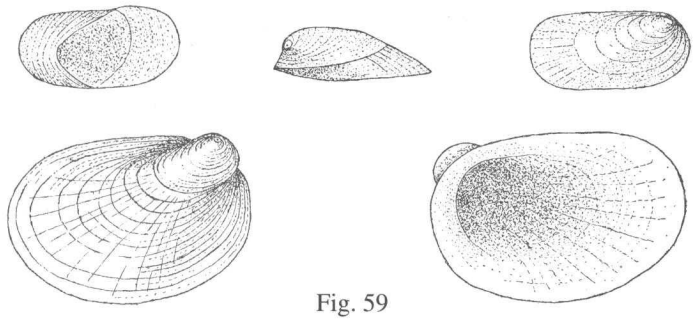


Fig. 59

Fig. 60

Type: *Gundlachia ancyliformis* Pfr.
Example: *Gundlachia hinkleyi* Walk., fig. 59. Radula, fig. 60.

Subgenus KINCAIDELLA Hannibal, 1912.

Apex radially striate.
Type: *Ancylus fragilis* Try. = *G. californica* Row.
Example: *G. meekiana* Stimp., fig. 61. Radula, fig. 62.

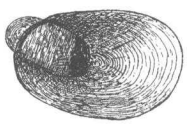


Fig. 61

Fig. 62

Subfamily RHODACMEINÆ Walker, 1917.

Shell patelliform, conical, elevated or depressed, apex tinged with pink. Animal having the jaw composed of numerous segmented plates. Radula with a long, slender central, unicuspid or faintly bicuspid, and with the base widely expanded in some species; the first lateral very large, with 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; the next four laterals are similar in shape, but diminish rapidly in size towards the margin; these are succeeded by two or three transition teeth, smaller and with more or less imperfect cusps. The marginals are very small, rapidly decreasing in size towards the outer edge, with large quadrate bases wider than high, vestigial, the cusps being nearly, if not quite obsolete.

Genus RHODACMEA Walker, 1917.

Shell and animal as in the subfamily.

Key to the sections of *Rhodacmea.*

Shell elevated. Radula having the base of the central tooth expanded and not overlapped by the mesocone of the first lateral ..... *Rhodacmea s. s.*
Shell depressed. Base of central tooth of radula not expanded, overlapped by the mesocone of the first lateral ..... *Rhodocephala.*

Section RHODACMEA s. s.

Shell elevated. Radula with a unicuspid central, which has the base triangularly expanded; laterals with the cusp of the mesocone extending but little beyond the base and not overlapping the base of the central tooth.
Type: *Ancylus filosus* Con., fig. 63. Radula, fig. 64.

Fig. 63

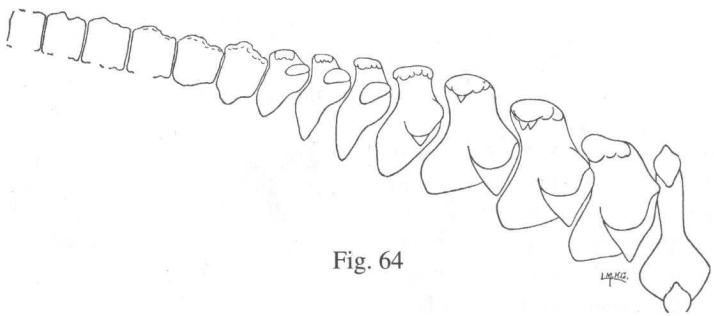


Fig. 64

Section RHODOCEPHALA Walker, 1917

Shell depressed. Radula with a faintly bicuspid central, which has the sides of the base straight and not expanded; laterals with the cusp of the mesocone extending far beyond the base and overlapping the base of the central tooth.

Fig. 65

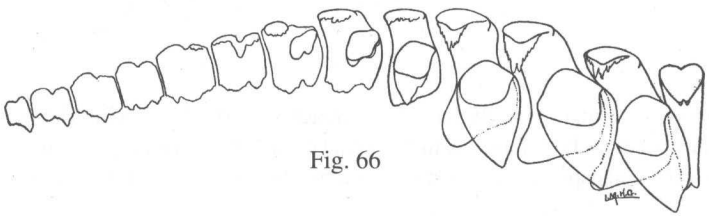


Fig. 66

Type: *Rhodacmea rhodacme* Walk., fig. 65. Radula, fig. 66.

Subfamily NEOPLANORBINÆ Hannibal, I912.

Shell small, planorbiform or neritiform.

Key to the genera of *Neoplanorbinæ.*

Shell planorbiform ..... *Neoplanorbis.*
Shell neritiform ..... *Amphigyra.*

Genus NEOPLANORBIS Pilsbry, 1906

Shell very minute, planorboid, dextral, subdiscoidal, nearly flat above, convex below, usually carinate at the periphery; whorls two, rapidly enlarging; aperture very oblique, wider than high, a little dilated at the base; lip thin, not continuous; columellar margin straight and broadly dilated, somewhat thickened within. Dentition and anatomy so far as known similar to *Amphigyra.*

Fig. 67

Type: *N. tantillus* Pils., fig. 67.

Genus AMPHIGYRA Pilsbry, 1906

Shell minute, dextral, neritoid or crepiduliform, imperforate, with a small, depressed, lateral spire; whorls about 1 1/2, very rapidly enlarging, the last very convex dorsally; apex smooth; body-whorl spirally striate; aperture very large transversely oval; lip continuous and full, thin; cavity of the spire very small, a thin, broad, concave, columellar plate projecting across the end next the spire.

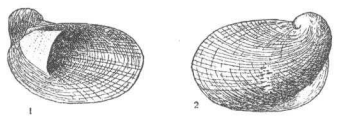


Fig. 68

Fig. 69

Animal sinistral, externally lymnæid; tentacles short, blunt, cylindric; eyes near their inner bases; a short, false gill in the pallial cavity. Radula arranged as in *Lymnæa,* central tooth unicuspid, laterals bicuspid, marginals low, wide, with four or five cusps.

Type: *A. alabamensis* Pils., fig. 68. Radula, fig. 69.

Subclass STREPTONEURA.
Order PECTINIBRANCHIA.
Suborder TAENIOGLOSSA.

Superfamily PLATYPODA.
Key to the families of Platypoda.

1. Operculum concentric ..... 2.
   Operculum spiral ..... 3.

2. Shell very large; animal with both gill and lung ..... *Ampullariidæ.*
   Shell smaller; animal with gill only ..... *Viviparidæ.*

3. Operculum circular, multispiral ..... *Valvatidæ.*
   Operculum paucispiral ..... 4.

4. Animal with external verge, central tooth with basal denticles ..... *Amnicolidæ.*
   Animal without verge; no basal denticles on central tooth ..... *Pleuroceridæ.*

Family AMPULIARIIDÆ.

Shell large, spiral, globosely turbinate; aperture entire; operculum (in the North American species) corneus, concentric, with a sub-central nucleus.

Animal with snout divided into two long, tentacular lobes; tentacles long and filiform; eyes on peduncles on the outer bases of the tentacles; mantle with two cervical lobes, that on the left forming a more or less elongated siphon; genital orifices on the right side in the pallial cavity; the respiratory chamber divided into two parts, the one being a lung and the other containing a large gill; foot large, simple; jaws two; radula with seven rows of teeth, central large, subtrapezoidal, multicuspid, no basal denticles; the laterals and marginal narrow, uni- or bicuspid. Oviparous.

Genus AMPULLARIA Lamarck, 1799.

Shell dextral, globose, with a green or brown epidermis; spire short, last whorl rounded, inflated; umbilicate; aperture entire, angular above, rounded below, lip simple.

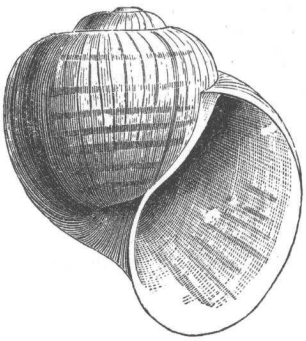


Fig. 70

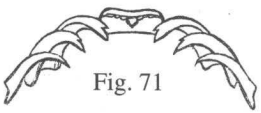


Fig. 71

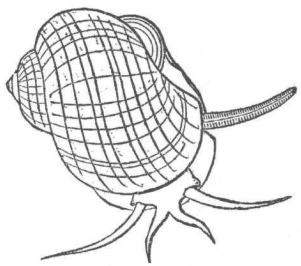


Fig. 72

Type: *Nerita urceus* Müll.
Example: *A. paludosa* Say, fig. 70. Radula, fig. 71. Animal, fig. 72.

Family VIVIPARIDÆ.

Shell moderately large, turbinate, imperforate, or subperforate; whorls convex; aperture entire, subcircular or somewhat angled above; lip simple; operculum convex, concentric, nucleus subcentral, sometimes subspiral.

Animal with a long snout, not divided into tentacular lobes; tentacles long and slender, in the male the right one is shorter, truncated and forms a sheath for the verge; eyes on peduncles on the exterior base of the tentacles; mantle with two cervical lobes, of which the right is the larger, forming with the mantle distinct tubular conduits for the ingress and egress of water for respiration; jaws two; radula with the teeth simple or denti-culate, central tooth large, broad, without basal denticles, laterals large, subtrigonal, marginals narrow, elongated. Ovoviviparous.

Key to the genera of Viviparidæ.

1. Operculum wholly concentric ..... 2.
   Operculum with subspiral nucleus ..... *Lioplax.*
2. Reflected apices of the lateral teeth simple ..... *Campeloma.*
   Reflected apices of the lateral teeth denticulate ..... 3.
3. Inner margin of the operculum simple ..... *Viviparus.*
   Inner margin of the operculum reflected, forming an elevated marginal fold ..... *Tulotoma.*

Genus VIVIPARUS Montfort, 1810.

Shell dextral, spiral, subconoidal; rather thin, smooth, imperforate or slightly umbilicate; light green or olivaceous, unicolored or banded with brown or tinged with purple; whorls convex, aperture entire, subcircular; lip simple, acute; columellar and parietal margin not usually thickened; operculum concentric, inner margin simple, not reflected.

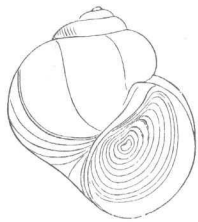


Fig. 73

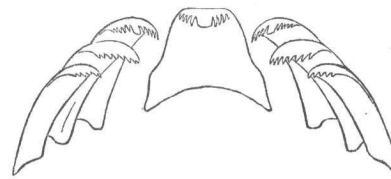


Fig. 74

Animal with foot of moderate size, not produced beyond the snout. Teeth of the radula multicuspid.
Type: *Helix vivipara* L.
Example: *V. intertextus* (Say), fig. 73. Radula, fig. 74.

Genus CAMPELOMA Rafinesque, 1819.

Shell dextral: spiral, imperforate, thick and solid; olivaceous green, unicolored, spire produced; whorls smooth, rounded or shouldered; aperture oval; lip simple, columella and parietal wall usually callously thickened. Operculum concentric, inner margin simple.

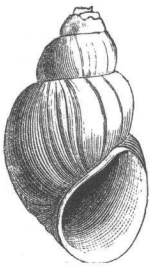


Fig. 75

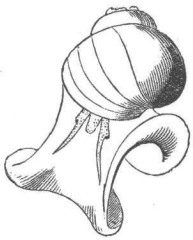


Fig. 76

Fig. 77

Fig. 78

Animal with the foot large, rather thin, much produced beyond the snout; snout small; teeth of the radula simple or only very minutely crenulated.

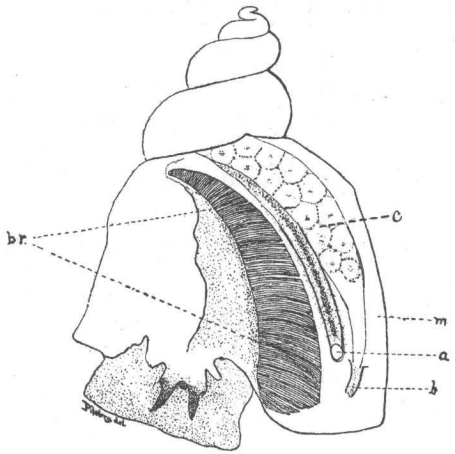


Fig 78A

a.—Anus. b-c—Uterus.
br.—Gill. m.—Mantle.

Type: *C. crassula* Raf.
Example: *C. decisum* (Say), fig. 75. Animal, fig. 76. Operculum, fig. 77.
Radula: *C. integrum* (Say), fig. 78.
Animal: *C. subsolidum* (Anth.), fig. 78A.

Genus LIOPLAX Troschel, 1856.

Shell dextral, spiral, thin, ovate, turreted, imperforate, spire produced; whorls rounded, or carinated; olivaceous green or dark brown; aperture oval subcircular; lip thin, continuous; operculum concentric, with a subspiral nucleus.

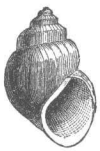


Fig. 79

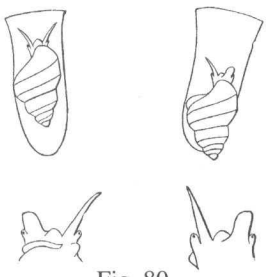


Fig. 80

Fig. 81

Fig. 82

Animal with the foot very large, greatly produced beyond the snout; snout very short. Lingual teeth smooth at their apices.

Type: *Limnæa subcarinata* Say, fig. 79. Animal, fig. 80. Operculum, fig. 81. Radula, fig. 82.

Genus TULOTOMA Haldeman, 1840.

Shell (typically) large, solid, thick, imperforate, obtusely conic, spire elevated; whorls flattened, nodulous, carinated; peristome thin, continuous; operculum concentric, subtriangular, with the inner margin reflected forming an elevated marginal fold.

Animal with a moderate foot, not produced beyond the snout; snout small; lingual teeth multicuspid.

Type: *Paludina magnifica* Con., fig. 83. Radula, fig. 84. Operculum, fig. 85.

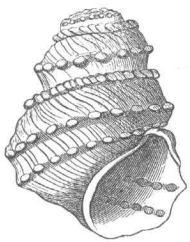


Fig. 83

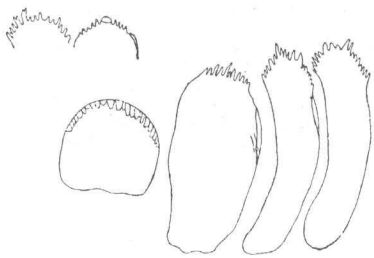


Fig. 84

Fig. 85

Family VALVATIDÆ

Shell small, spiral, dextral, turbinate, or subdiscoidal; whorls rounded or carinated; aperture entire, circular; lip simple, sharp; operculum orbicular, multispiral, whorls with a thin elevated edge.

Animal dioecious; tentacles long, slender, cylindrical; eyes sessile on the internal bases of the tentacles; snout long; foot large, bilobed in front; gill external, plumose, protected by a long, slender pallial appendage; verge exterior, placed on the right side, at the base of and below the tentacle; jaws two; lingual teeth multicuspid, no basal denticles on the central tooth.

Genus VALVATA Müller, 1774.

The characters of the genus are those of family.
Type: *V. cristata* Müll.
Example: *V. tricarinata* (Say), fig. 86. Animal, fig. 87. Radula, fig. 88.

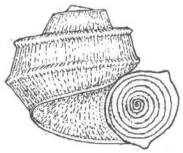


Fig. 86

Fig. 87

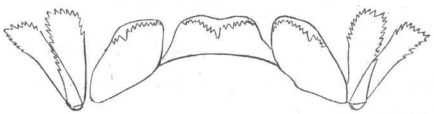


Fig. 88

Family AMNICOLIDÆ.

Shell small, spiral, dextral, conical, imperforate or umbilicated; unicolored; aperture entire, lip simple, acute; operculum concentric, spiral or subspiral.

Animal with a long snout; tentacles long, cylindrical, with the eyes at their outer bases; foot oblong, truncate before, rounded behind; gills internal; verge exserted, placed on the back, some distance behind the right tentacles; jaws two; central tooth of the radula multicuspid and with one or more basal denticles; laterals hatchet-shaped, multicuspid; marginals slender, multicuspid.

Key to subfamilies of *Amnicolidæ.*

1. Operculum multispiral ..... *Lyogyrinæ.*
   Operculum concentric ..... *Bythininæ.*
   Operculum paucispiral ..... 2.

2. Foot divided ..... *Pomatiopsinæ.*
   Foot simple ..... 3.

3. Shell thin, subglobose to elongate; columella not thickened ..... *Amnicolinæ.*
   Shell thick, short, body-whorl very large; columella thickened ... *Lithoglyphinæ.*

Subfamily BYTHININÆ Stimpson, 1865.

Shell small, spiral, dextral, turbinate, spire produced; operculum calcareous, concentric.

Foot simple; central tooth of the radula with several basal denticles.

Genus BYTHINIA Leach, 1818.

Shell large for the family, spiral, elevated, subperforate; aperture oval; peristome thin, continuous; lip simple, sharp; operculum calcareous, concentric.
Type: *Helix tentaculata* L., fig. 89. Animal, fig. 90. Radula fig 91

Fig. 89

Fig. 90

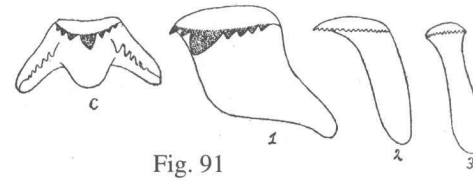


Fig. 91

Subfamily AMNICOLINÆ Gill, 1871.

Shell small, spiral, dextral, subglobose to elongate, thin; imperforate or umbilicate; columella and parietal wall not callously thickened; operculum corneous, paucispiral.

Foot simple; central tooth of the radula with several denticles.

Key to genera of *Amnicolinæ*.

1. Shell smooth, periphery rounded ..... 2.
   Shell smooth, periphery angulate ..... *Littoridina.*
   Shell strongly carinated ..... *Pyrgulopsis.*
   Shell spinose ..... *Potamopyrgus.*
   Shell longitudinally ribbed ..... *Tryonia.*

2. Shell slender, spire long ..... *Paludestrina.*
   Shell ventricose, spire usually short ..... *Amnicola.*

Genus AMNICOLA Gould and Haldeman, 1841.

Shell small, oval-conic, rather short, spire subacute; whorls 4-6, convex; aperture oval; peritreme continuous; lip simple, sharp; columella not thickened. Operculum thin, corneous, paucispiral.

Fig. 92

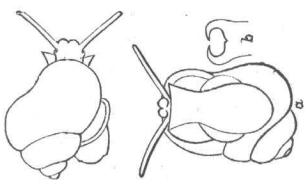


Fig. 93

Fig. 94

Animal oviparous; central tooth of the radula multicuspid, with a tooth-shaped process from the middle of the anterior surface, reaching beyond the base, and

with several basal denticles; laterals and marginals multicuspid. Verge short, bifid, with a globular base.
Type: *Paludina limosa* Say, fig. 92. Animal, fig. 93. Operculum, fig. 94. Radula, fig. 95.

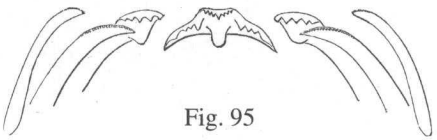


Fig. 95

Fig. 96

Subgenus CINCINNATIA Pilsbry, 1891.

Radula more minute and the denticulations of the cusps finer and sharper.
Type: *Paludina cincinnatiensis* Anth., fig. 96. Radula, fig. 97.

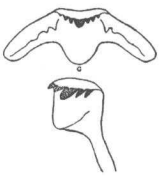


Fig. 97

Genus PALUDESTRINA d'Orbigny, 1840.

Shell similar to *Amnicola,* but more slender and elongated. Central tooth with but one basal denticle on each side, and without the tongue shaped process of *Amnicola.* Verge bifid.

Fig. 98

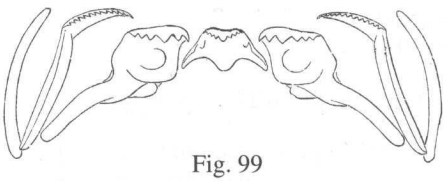


Fig. 99

Type: *Cyclostoma acutum* Drap.
Example: *P. nickliniana* (Lea), fig. 98. Radula, fig. 99.

Genus TRYONIA Stimpson, 1865.

Shell perforate, elongated, turreted, subulate; apex acute; surface longitudinally ribbed or plicated; whorls numerous, shouldered; aperture small, oblique, rhombo-ovate, lip sharp, thin and effuse at the base; peritreme continuous.
Type: *T. clathrata* Stimp., fig. 100.

Fig. 100

Genus PYRGULOPSIS Call and Pilsbry, 1886.

Shell ovate-conical or turreted, imperforate, whorls having a single, strong carina at the periphery, which may or may not be concealed on the spire; apex acute; whorls 4 1/2 to 6; aperture ovate, peristome continuous; central tooth

of the radula with but one basal denticle on each side; denticles of the lateral teeth large and angular, those of the laterals small and slender.

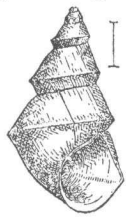


Fig. 101

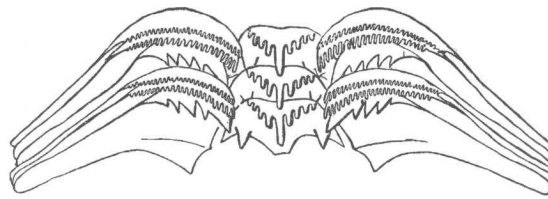


Fig. 102

Type: *Pyrgula nevadensis* Stearns, fig. 101. Radula, fig. 102.

Fig. 103

Genus POTAMOPYRGUS Stimpson, 1865.

Shell ovate-conic, imperforate; apex acute; whorls angulated and usually coronated with spines; body-whorl two-thirds the length of the shell; aperture ovate, lip acute.

Animal with rostrum of moderate length; tentacles very long, slender, tapering and pointed; eyes on prominent tubercles; foot rather short, strongly auriculated in front; central tooth of radula trapezoidal, inferior margin nearly straight; faintly enlobate; basal teeth minute and close to the lateral margin; denticles of the intermediate tooth numerous and of equal size.

Type: *Melania corolla* Gld.

Example: *P. coronatus* (Pfr.), fig. 103.

Genus LITTORIDINA Souleyet, 1852.

Shell narrowly perforate, subpyramidal, solid, opaque, body-whorl sub-angulate at the periphery; aperture pyriform, acutely angulated above; columella thickened, white; peritreme not continuous, lip sharp.

Verge very large, with five or six small, digitate appendices. Radula as in *Amnicola.*

Fig. 104

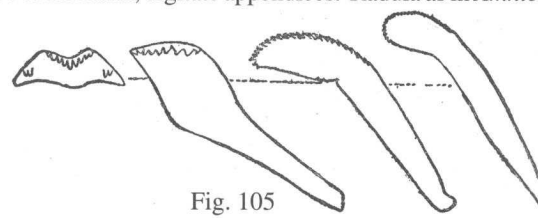


Fig. 105

Type: *L. gaudichaudii* Soul.

Example: *L. monroensis* (Frfld.), fig. 104. Radula, (*L. hatcheri* Pils.), fig. 105.

Subfamily LITHOGLYPHINÆ Fischer, 1885.

Shell small, spiral, dextral, spire short, body-whorl large, forming most of the shell; columella usually callously thickened; operculum corneous, subspiral.

Foot simple; central tooth of the radula with several basal denticles.

Key to the genera of *Lithoglyphinæ.*

1. { Shell imperforate or narrowly perforate ..... 2.
   { Shell widely umbilicate ..... 3.

2. { Peritreme sinuous, lip effuse below, verge winged ..... *Fluminicola.*
   { Peritreme continuous in same plane, verge simple ..... *Gillia.*
   { Peritreme very oblique, lip effuse above, verge bifid ..... *Somatogyrus.*

3. { Shell spirally striate, depressed, turbinate, widely umbilicate ..... *Cochliopa.*
   { Shell smooth, globose-turbinate, umbilicus narrower, but deep ..... *Clappia.*

Genus COCHLIOPA Stimpson, 1865.

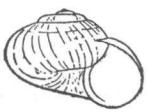


Fig. 106

Shell depressed-conic; base concave, umbilicus large and deep; aperture oblique; operculum corneous, subspiral.

Rostrum of moderate size; tentacles rather long and tapering. Teeth of the radula multicuspid, basal denticles on central tooth 2 or 3 on each side. Verge rather elongated, compressed, geniculated and bifid.

Type: *Amnicola rowellii* Tryon.
Example: *C. riograndensis* P. and F., fig. 106.

Genus CLAPPIA Walker, 1909.

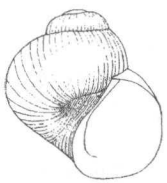


Fig. 107

Shell minute, spiral, dextral, globose-turbinate, narrowly but deeply umbilicate. Spire short; body whorl large; whorls round; aperture large; lip simple; columellar lip thin, appressed to the body-whorl only at the upper end; operculum paucispiral, nuclear whorls large, slowly and regularly increasing.

Fig. 108

Rachidian tooth as in *Somatogyrus,* intermediate tooth with a long peduncle and a strong tooth projecting from the infero-anterior angle, laterals multicuspid.

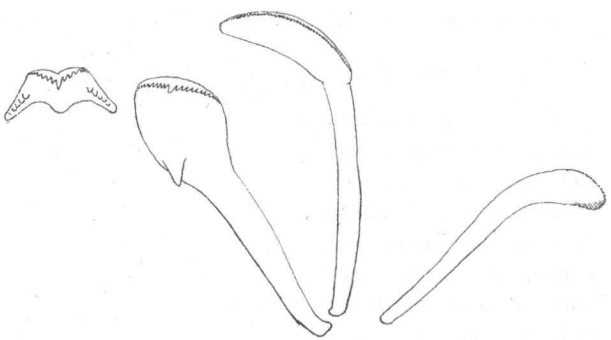


Fig. 109

Type: *C. clappii* Walker, fig. 107. Operculum, fig. 108. Radula, fig. 109.

Genus FLUMINICOLA Stimpson, 1865.

Fig. 110

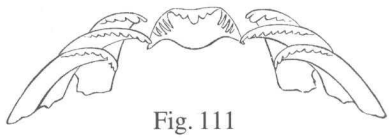


Fig. 111

Shell spiral, dextral, obliquely ovate, thick, solid, smooth, imperforate; spire moderate, obtuse; aperture ovate; columella flattened, calloused; lip effuse and projecting anteriorly so that the peritreme is not continuously in the same plane; operculum corneous, subspiral.

Rostrum rather large; tentacles tapering, foot broad; central tooth of the radula with several basal denticles on each side; outer lateral teeth with a smaller number of denticles than the inner. Verge large, compressed, with a broad semicircular wing on the left side.

Type: *Paludina nuttalliana* Lea, fig. 110. Radula, fig. 111.

Genus SOMATOGYRUS Gill, 1863.

Shell dextral, spiral, usually rather thick and solid, smooth, imperforate or narrowly perforate; spire usually short; apical whorl spirally punctate or lirate; bodywhorl large, more or less inflated; aperture very oblique; lip sharp, projecting above; columella callously thickened. Operculum corneous, subspiral, nuclear whorls small, rapidly increasing.

Fig. 112

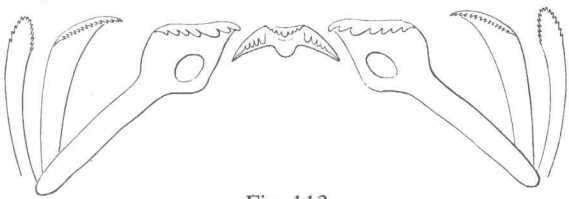


Fig. 113

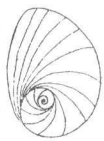


Fig. 114

Rostrum rather broad, flat and square-cut; tentacles rather short and flattened; teeth of the radula multicuspid, basal denticles on the central tooth 3-4 on each side. Verge broad, compressed and bifid.

Type: *Amnicola depressa* Tryon, fig. 112. Radula, fig. 113. Operculum, fig. 114.

Genus GILLIA Stimpson, 1865

Fig. 115

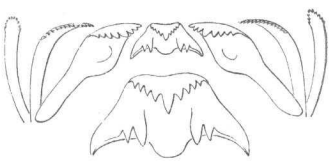


Fig. 116

Shell spiral, dextral, not very thick, smooth, imperforate; spire short, obtuse, body whorl large, inflated; aperture large, oblique; peritreme continuous on the same plane, lip thin, sharp; columella very slightly thickened; operculum corneous, subspiral.

Rostrum broad, subtruncate, foot oblong, rounded behind and auriculate in

front; tentacles long, slender and pointed; teeth of the radula multicuspid; central tooth with two basal denticles on each side. Verge small, simple, lunate.
Type: *Melania altilis* Lea, fig. 115. Radula, fig. 116.

Subfamily LYOGYRINÆ Pilsbry, 1916.

Shell minute, conical or subdepressed. Operculum circular, multispiral.

Key to the genera of *Lyogyrinæ.*

Shell amnicoliform ..... *Lyogyrus.*
Shell valvatæform ..... (s. g.) *Hauffenia.*

Genus LYOGYRUS Gill, 1863.

Fig. 117

Shell very small, spiral, dextral, smooth, umbilicate; globose-turbinate or elongate-ovate; aperture nearly circular; peritreme continuous, frequently quite separated from the body-whorl. Operculum corneous, circular, multispiral.

Rostrum bilobed in front, half as long as the tentacles, which are rather stout; foot auriculated in front; gill external. Dentition as in *Paludestrina,* basal denticles on rachidian tooth two on each side.
Type: *Valvata pupoidea* Gld., fig. 117.

Genus HORATIA Bourguignat, 1887.

Shell very small, amnicoliform, thick-shelled, umbilicate, almost smooth; whorls only 3-4, convex, rapidly increasing, the last large, rounded; suture impressed; aperture very oblique, rounded; lip adherent, straight, sharp; columella thickened, incurved. Operculum corneous, transparent, purple-red, with 3-4 slowly increasing spirals and an almost central nucleus.

Type: (first species) *Horatia klecakiana* Bgt.

Subgenus HAUFFENIA Pollonera, 1898.

Shell minute, rather thin, valvatæform, widely umbilicate.

Type: (first species) *Horatia tellini* Poll.

Example: *Horatia micra* (P. and F.), fig. 118.

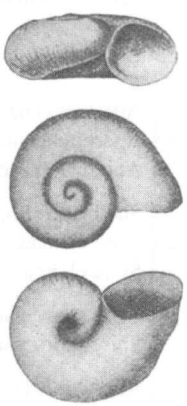


Fig. 118

Subfamily POMATIOPSINÆ Stimpson, 1865.

Foot divided by a transverse sulcus at about its anterior third. Verge simple. Rachidian tooth with one basal denticle on each side, denticles of the lateral and marginal teeth fewer and proportionately larger than in the other subfamilies. Only one genus.

Genus POMATIOPSIS Tryon, 1862.

Shell dextral, spiral, thin, smooth, long, turreted, umbilicated; aperture somewhat expanded; lip simple or slightly reflected; operculum corneous, subspiral.

Fig. 119

Fig. 120

Fig. 121

Animal not as long as the shell, rostrum large, longer than the tentacles, which are short and subulate. Verge very large, simple, convoluted, outer margin rounded and smooth, inner margin sharp and wrinkled.
Type: *Cyclostoma lapidaria* Say, fig. 119. Animals fig. 120. Radula, fig. 121.

Family PLEUROCERIDÆ.

Animal oviparous, edge of mantle smooth; eyes on the external bases of the tentacles; no verge. Rachidian tooth large, broader than long, rounded below, multicuspid; laterals subrhomboidal, multicuspid; marginals narrow, multicuspid.

Shell dextral, spiral, thick and solid, globose or elongated; aperture entire or more or less canaliculated below, operculum corneous, subspiral.

Key to the genera of *Pleuroceridæ*

1. Aperture canaliculate below ..... 2.
   Aperture angulated below, not canaliculate ..... 4.
   Aperture entire, rounded below ..... *Anculosa.*

2. Shell fusiform, canal long ..... *Io.*
   Shell conical, canal short ..... 3.
   Spire elongated; no callus thickening on parietal wall ..... *Pleurocera.*

3. Spire short; parietal wall callously thickened above and below ..... *Lithasia.*
   Spire short; parietal wall callously thickened above ..... *Eurycælon.*

4. Aperture entire above ..... *Goniobasis.*
   Aperture with a sutural slit ..... *Gyrotoma.*

Genus IO Lea, 1831.

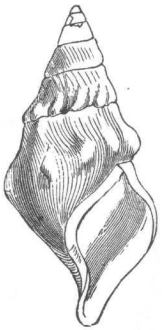


Fig. 122

Shell large, spiral, dextral, imperforate, fusiform, smooth, tuberculate or spinose; spire elevated, base of aperture prolonged in a long canal; columella round, smooth and concave; lip thin; operculum corneous, sub-spiral. Animal as in the family.

Type: *Fusus fluvialis* Say.

Example: *I. spinosa* Lea, fig. 122. Radula, fig. 123.

Fig. 123

Fig. 124

Genus LITHASIA Haldeman, 1840.

Shell of medium size, spire dextral, imperforate, globose conic, smooth or tuberculate; thick and solid, spire elevated, obtusely conic; aperture large, rhomboidal; columella smooth, callously thickened above and below; base of the aperture shortly channelled below. Animal as in the family.

Type: *L. geniculata* Hald., fig. 124.

Operculum, *L. obovata* (Say), fig. 125.

Fig. 125

Section ANGITREMA Haldeman, 1841.

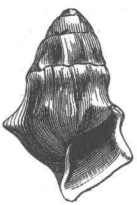


Fig. 126

Shell similar to *Lithasia* but with the basal canal more produced.

Type: *Melania armigera* Say, fig. 126.

Genus EURYCÆLON Lea, 1864.

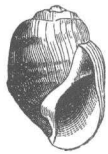


Fig. 127

Shell large, obovate, thick, solid; spire short; body-whorl large; columella callously thickened above, incurved below and subtruncate.
Type: *Anculosa anthonyi* Budd, fig. 127.

Genus PLEUROCERA Rafinesque, 1818.

Fig. 128

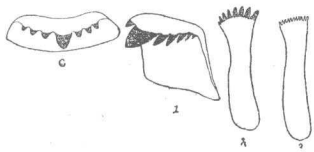


Fig. 129

Shell usually lengthened, conic or cerithiform, spiral, dextral, imperforate; smooth, tuberculate, spirally striate or carinate; aperture moderate, subrhomboidal, prolonged into a short canal below; columella smooth, twisted, not callously thickened; lip simple, sharp, sinuous, somewhat expanded.
Type: *P. acuta* Raf., fig. 128. Radula, fig. 129.

Section STREPHOBASIS Lea, 1861.

Fig. 130

Shell smooth, spire rather short, obtusely conical, body-whorl subcylindrical; aperture subquadrate; columella thickened below, twisted and drawn back, base subcanaliculate; lip acute, very sinuous.
Type: *Melania plena* Anth., fig. 130.

Genus GONIOBASIS Lea, 1862.

Fig. 131

Shell medium size, dextral, spiral, imperforate; smooth, longitudinally plicate, transversely striate or tuberculate; thick, solid, ovate-conic to elongate turreted; aperture subrhomboidal, subangular at the base but not canaliculate; columella smooth, not twisted; lip simple, acute.

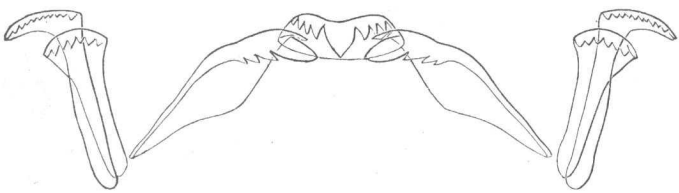


Fig. 132

Type: *G. osculata* Lea, fig. 131. Radula, *G. depygis* (Say), fig. 132.

Genus GYROTOMA Shuttleworth, 1845.

Fig. 133

Shell of moderate size, spiral, dextral, imperforate, smooth or spirally striate, rather thick and solid, conical or globosely ovate; aperture oval or elliptical, with a sutural slit or fissure above, entire below; lip thin and sharp.
Type: *G. ovoidea* Shutt., fig. 133. Radula, fig. 134.

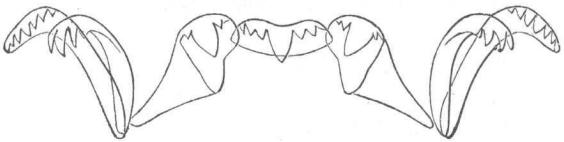


Fig. 134

Genus ANCULOSA Say, 1821.

Shell of moderate size, dextral, imperforate (except in one species), smooth, tuberculate, spirally striate, sulcate or carinate, thick, solid, subglobose with a very short spire or thinner and conical; aperture oval or subcircular, entire, rounded below; columella callously thickened; lip simple, acute.
Type: *Melania prærosa* Say, fig. 135. Radula, fig. 136.

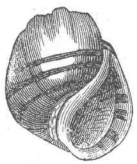


Fig. 135

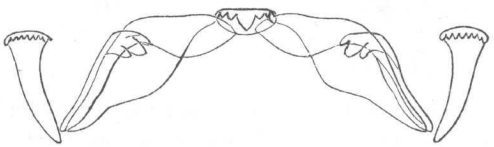


Fig. 136

Order ASPIDOBRANCHIA.

Suborder RHIPIDOGLOSSA.

The Rhipidoglossæ differ radically from the Tænioglossæ in the character of the lingual dentition. The radula has many rows of teeth, consisting of a central, 2-5 laterals and numerous marginals arranged like the sticks of a fan.

Family NERITIDÆ.

Head large, rostrum divided and lobed in front; tentacles long and slender; eyes carried on peduncles placed at the external base of the tentacles; foot large, truncate before and obtuse behind, sides simple; gill large, triangular, pointed, free at its extremity; branchial and excretory orifices on the right side. Radula with a very small

central tooth, 2 to 5 lateral teeth of varying size and shape and numerous spatulate marginals. Shell imperforate, globose, spire short; internal divisions of the shell absorbed; aperture semi-ovate, entire, columellar region expanded and flattened, usually thickened; lip acute; operculum subspiral.

Key to the genera of *Neritidæ*.

1. Operculum calcareous, edge with projecting processes (apophyses) articulating with the columella ..... *Neritina.*
2. Operculum corneous, without apophyses ..... *Lepyrium.*

Genus NERITINA Lamarck, 1809.

Shell dextral, spiral, thick and solid, subglobose; spire short; surface smooth (in American species); aperture semi-circular, columella flattened, straight, smooth or finely denticulate; lip acute, inner surface smooth; operculum calcareous, semi-circular, paucispiral, nucleus excentric; with two apophyses, the upper shorter, sometimes dilated and crested; the lateral in the form of an arched rib.

Fig. 137

Fig. 138

Animal as in the family. Radula with the central tooth small, subquadrangular, cusp smooth; first lateral large, second and third small, fourth very large, prolonged below and with the cusp semicircular and denticulate, laterals numerous, spatulate.

Type: *N. perversa* Gmel.
Example: *N. reclivata* Say, fig. 137. Radula, fig. 138.

Genus LEPYRIUM Dall, 1896.

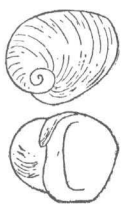


Fig. 139

Shell small, dextral, spiral, corneous, thin, semi-transparent; spire very small and depressed, body-whorl large; aperture large, semi-circular; columella concavely flattened, calloused, straight, smooth; lip thin, acute operculum thin, corneous, paucispiral without apophyses.

Radula with a wide rachidian tooth with a finely denticulated cusp; laterals two, the inner small and oblique, the other large with the cusp finely denticulate; laterals spatulate, numerous. Animal otherwise unknown.
Type: *Neritina showalteri* Lea, fig. 139.

Class LAMELLIBRANCHIA.
Order EULAMELLIBRANCHIA.
Suborder SUBMYTILACEA.

Key to the families of Submytilacea.

1. Ligament external ..... 2.
   Ligament internal ..... 5.

2. Hinge with cardinal, anterior and posterior lateral teeth ..... 4.
   Hinge with cardinal teeth only ..... *Cyrenellidæ.*
   Hinge with lateral teeth only (no true cardinals) or edentate ..... 3.

3. Gills with distinct, interlamellar septa, parallel with the gill filaments .... *Unionidæ.*
   Gills either without distinct. interlamellar septa or, when present, oblique to the gill-filaments ..... *Margaritanidæ.*

4. Pallial line simple ..... *Sphæriidæ.*
   Pallial line sinuate ..... *Cyrenidæ.*

5. Hinge with cardinal and lateral teeth ..... *Rangiidæ.*
   Hinge without distinct teeth ..... *Dreissensiidæ.*

Family MARGARITANIDÆ.

"Diaphragm incomplete, formed by the gills; posteriorly the outer lamina of the outer gills not connected with the mantle for a considerable distance; anterior end of the inner gills separated from the palpi by a gap; branchial and anal openings ill-defined, and the latter not closed above; no super-anal developed; gills without water-tubes and with scattered interlamellar connections, which in certain places form irregular rows or with continuous septa which run obliquely forwards; marsupium formed by all four gills; larva a small semicircular glochidium, without distinct hooks; shell elongated; sculpture of the beak concentric; hinge-teeth imperfect; epidermis blackish." (Ortmann.)

Genus MARGARITANA Schumacher, 1817.

Shell elongated, usually arcuate, rounded in front, almost lacking a posterior ridge; beaks rather low, sculpture consisting of a few coarse, parallel ridges which follow the growth lines; epidermis concentrically striate, brownish or blackish; hinge-teeth generally imperfect or not fully developed, two more or less perfect pseudocardinals in the left valve and one in the right, often reduced to mere tubercles; laterals short, usually imperfect or wholly wanting; cavity of the beaks rather shallow.

Key to the subgenera of *Margaritana.*

Gills with scattered interlamellar connections forming irregular rows running obliquely forwards ..... *Margaritana s. s.*
GilIs with continuous septa running obliquely forwards ..... *Cumberlandia.*

Subgenus MARGARITANA s. s.

Shell as in the genus.

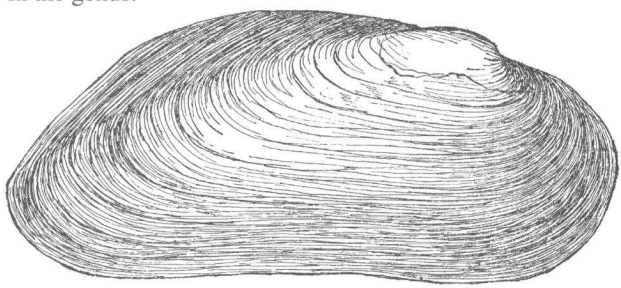


Fig. 140

Animal as in the family, but having the gills without water-tubes and with scattered interlamellar connections which in certain places form irregular rows, running obliquely forwards.

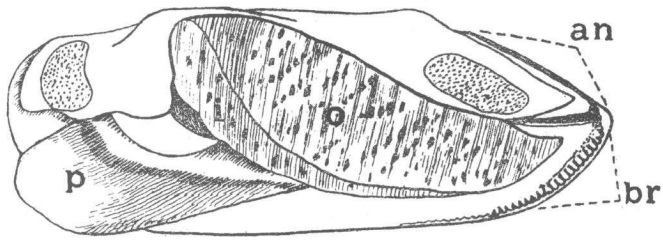


Fig. 141*

Type: *Mya margaritifera* L., fig. 140. Animal, fig. 141.

*The following lettering applies to all the figures of the animals of the Margaritanidæ and Unionidæ except as otherwise stated:

an.—anal opening.
br.—branchial opening.
f.—flaps of margin of mantle.
i.—inner gill.
o.—outer gill.
p.—foot.
pp.—papillæ on margin of mantle.
sa.—supra-anal opening.
mp.—marsupium.

Subgenus CUMBERLANDIA Ortmann, 1912.

Shell as in the genus.

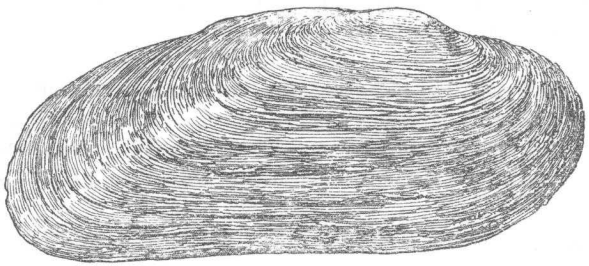


Fig. 142

Animal as in the family, but having the gills with incomplete water-tubes and with continuous septa, which run obliquely forwards.

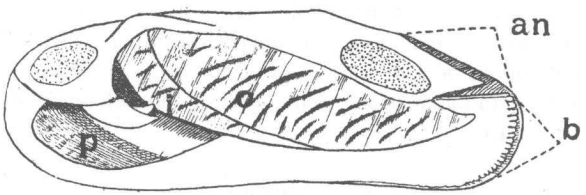


Fig. 143

Type: *Unio monodonta* Say, fig. 142. Animal, fig. 143.

Family UNIONIDÆ.

"Diaphragm complete, formed by the gills; posteriorly the outer lamina of the outer gill connected with the mantle to its posterior end; anterior end of the inner gills separated from the palpi by a gap; branchial and anal openings sharply separated from one another by the diaphragm; anal openings very rarely not closed above and without supra-anal, generally closed and with a supra-anal opening (which very rarely may be obliterated); gills with water-tubes and distinct, interlamellar septa, running parallel to the filaments. Marsupium in all four gills or only in the outer gills; larva a glochidium. Shell of very variable shape; sculpture of the beak more or less reduced, of various types, but originally of the concentric or zig-zag pattern; hinge teeth perfect or imperfect; epidermis plain or with color-markings." (Ortmann.)

Key to the subfamilies of *Unionidæ.*

1. Water-tubes simple in the gravid female ..... 2.
   Water-tubes in the gravid female divided into three tubes, of which only the centre one is used as an ovisac ..... *Anodontinæ.*

2. Male and female shells usually alike; edge of the gravid marsupium always sharp and not distending ..... *Unioninæ.*
   Male and female shells usually different; edge of the gravid marsupium distending and bulging out beyond the original edge of the gill ..... *Lampsilinæ.*

Subfamily UNIONINÆ (Swainson, 1840) Ortmann, 1910.

"Inner lamina of the inner gills generally free from the abdominal sac (sometimes, in extralimital forms, connected); supra-anal opening sometimes not separated from the anal, normally present, the closed part rather short; branchial opening well-defined; no papillae nor flaps on the edge of mantle in front; marsupium formed by all four gills or by the outer gills only; edge of marsupium always sharp and not distending; water-tubes not divided in the gravid female; glochidium semielliptic or semicircular, without spines; shell generally heavy and solid, rounded to elongated, mostly with dull-colored epidermis; sculpture of the beak generally rather indistinct, concentric or pustulous or with indications of double loops or zig-zag bars; hinge always complete, with rather strong teeth; generally no difference of sex shown in the shell." (Ortmann.)

Key to the genera of *Unioninæ.*

1. All four gills serving as marsupia ..... 2.
   Outer gills only serving as marsupia ..... 6.

2. Male and female shells alike ..... 3.
   Male and female shells different ..... *Tritogonia.*

3. Hinge with perfect pseudocardinals and laterals ..... 4.
   Hinge teeth rudimentary or wanting ..... *Gonidea.*

4. Surface plicate ..... 5.
   Surface pustulose ..... *Quadrula.*
   Surface smooth ..... *Fusconaia.*

5. Beaks sculptured with coarse, concentric or somewhat double-looped ridges, which do not extend over the surface. ..... *Amblema*
   Beaks sculptured with strong, zig-zag ridges extending over the upper surface ..... *Megalonaias.*

6. Surface tuberculous ..... 7.
   Surface smooth or spiny ..... 8.

7. Nacre deep purple ..... *Rotundaria.*
   Nacre white or tinged with pink ..... *Plethobasis.*

8. Hinge with perfect pseudocardinals and laterals ..... 9.
   Hinge teeth imperfect, vestigial ..... *Lastena.*

9. Shell short, rounded, quadrate or oblique ..... 10.
   Shell (usually) elongate and straight ..... 11.

10. Beak sculpture distinct, subconcentric rounded upon the posterior slope ..... *Lexingtonia.*
    Beak sculpture coarser, inclined to be more or less double-looped ... *Pleurobema.*

11. Beak sculpture running parallel with the growth-lines and angled on the posterior slope ..... *Elliptio.*
    Beak sculpture concentric, rounded behind ..... *Uniomerus.*

Genus QUADRULA (Rafinesque, 1820) Agassiz.

Shell triangular, quadrate or rhomboid; solid, inflated with rather coarse prominent beaks, which are generally sculptured with a few coarse, irregular, subparallel ridges that are inflated where they cross the posterior ridge; posterior ridge ordinarily well developed; disk sculptured or smooth; epidermis usually dull-colored, dark and rayless or feebly rayed; hinge plate heavy, wide, flattened; pseudocardinals solid, direct, ragged; laterals double in the left and single in the right valve; cavity of the beaks deep and compressed. Marsupium occupying all four of the gills throughout, the whole smooth and pad-like.

Key to the sections of *Quadrula.*

Posterior slope with a radial furrow above the posterior ridge which do not extend over the surface. ..... *Quadrula s. s.*

No radial furrow above posterior ridge ..... *Theliderma.*

Section QUADRULA s. s.

Shell quadrate or rhomboid; surface pustulous, with a high, rounded or sharp posterior ridge, above which on the posterior slope is a decided radial furrow; umbonal region high; epidermis shining, usually painted with a beautiful pattern of triangular spots or chevron-shaped lines.

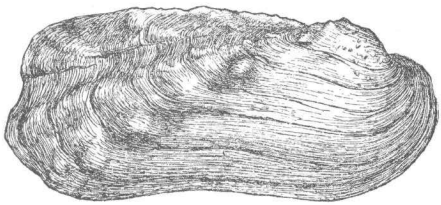


Fig. 144

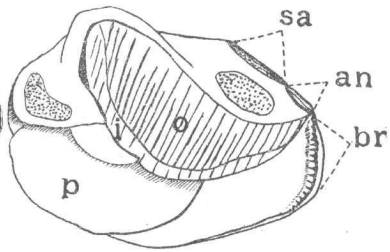


Fig. 145

Type: *Unio cylindricus* Say, fig. 144. Animal, *Q. metanevra* Raf., fig. 145.

Section THELIDERMA (Swainson, 1840) Simpson.

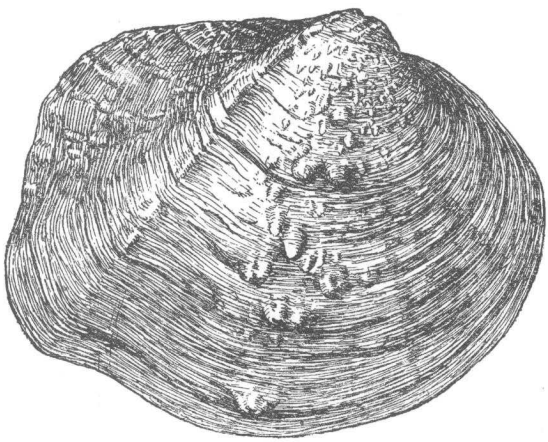


Fig. 146

Shell rounded, quadrate to rhomboid, solid, pustulous; beaks rather prominent, sculpture consisting of a few, rather coarse, subparallel ridges; anterior end rounded, base often arcuate, posterior end truncate, high and angled behind the ligament, epidermis rarely rayed, never as in *Quadrula s. s.*
Type: *Unio lachrymosus* Lea, fig. 146.

Genus TRITOGONIA Agassiz, 1852.

Shell solid, elongate, rhomboid, having a strong, irregular posterior ridge, obliquely truncated behind in the male, in the female this region is somewhat compressed and expanded into a broad wing; base curved; whole surface, except the rounded wing of the females, covered with pustules; beaks rather low, incurved and

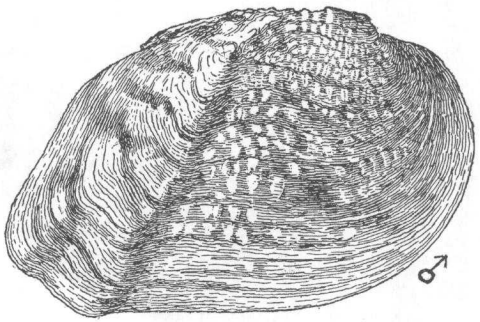


Fig. 147

turned forward over the well developed lunule; beak sculpture strong, consisting of irregular, subparallel ridges which are curved upwards behind and fine radiating ridges in front of and behind them; epidermis dark olive; hinge plate rather narrow;

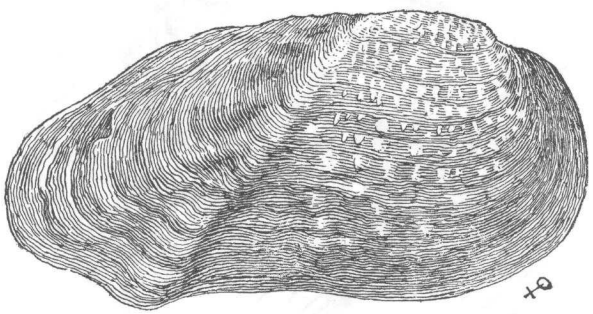


Fig. 147

pseudocardinals strong, ragged; laterals long and straight, near to the pseudocardinals; cavity of beaks rather deep and compressed; female shell more compressed than that of the male. Marsupium occupying all four gills.

Type: *Unio tuberculatus* Bar., fig. 147.

Genus MEGALONAIAS Utterback, 1915.

Shell large, heavy, obovate or rhomboid, alate post-dorsally, disk obliquely folded; beaks sculptured with coarse, double-looped corrugations, which extend over the upper surface of the disk as nodulous plications; epidermis dark-brown or blackish;

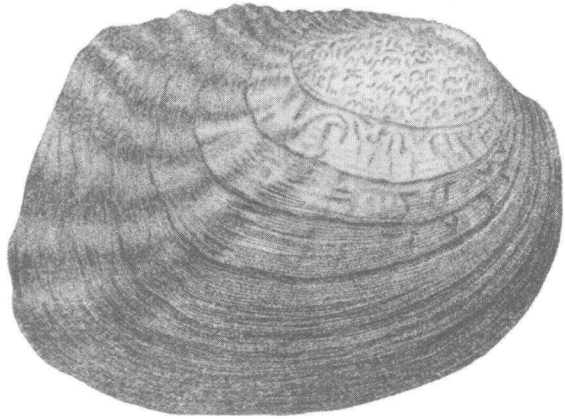


Fig. 148

beak cavities narrow and deep; anterior muscle scars deep and filled with a nacreous deposit, posterior scars large and indistinct.

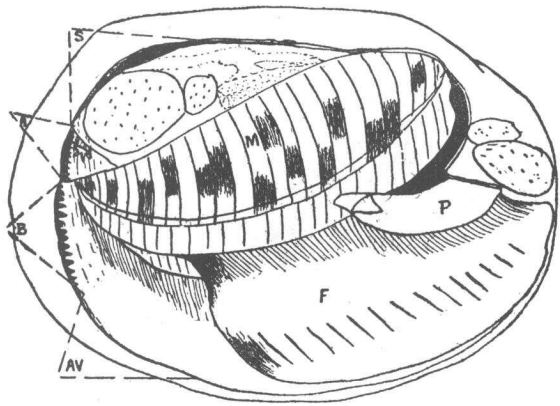


Fig. 149*

Type: *Unio heros* Say, fig. 148. Animal, fig. 149.

*The following lettering applies to figs. 149, 165 and 201:

A.—Anal opening.	F.—Foot	P.—Palp.
Av.—Antero-ventral margin.	I.—Inner gill.	S.—Supra-anal opening.
B.—Branchial opening.	M.—Marsupium.	

Genus AMBLEMA Rafinesque, 1819

Shell more or less alate; beaks prominent, sculptured with coarse, concentric or somewhat double-looped ridges which do not extend over the surface of the shell; surface of the valves usually sculptured with oblique folds; posterior slope generally having small radial plications, which curve upwards behind; epidermis brownish or

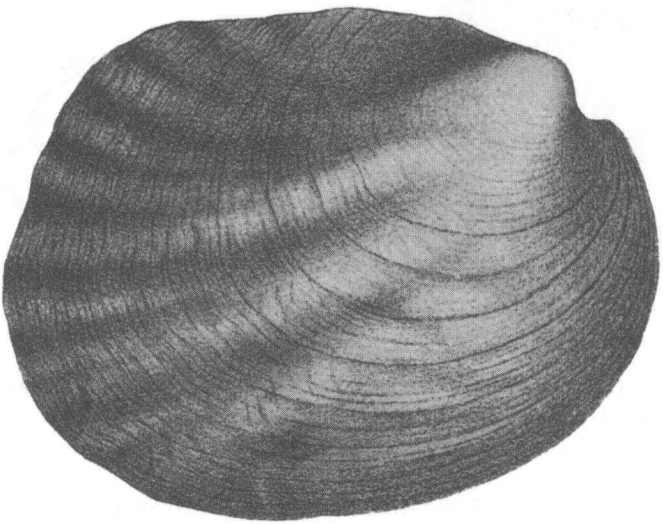


Fig. 150

blackish; anterior muscle scars large, distinct, very shallow, the anterior edge smooth, the rest apparently filled with roughened shelly matter; posterior scars large, shallow, indistinct; escutcheon large and dark.

Marsupium occupying all four gills.

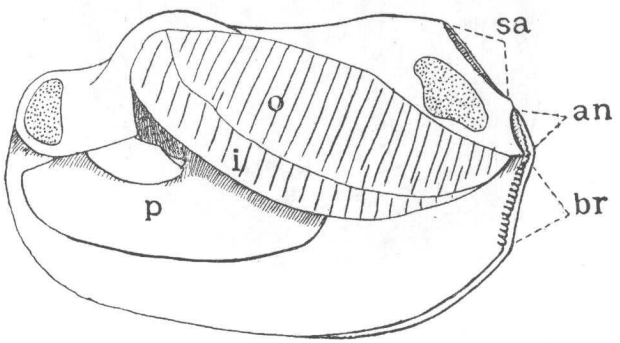


Fig. 151

Type: A. *costata* Raf.

Example: *A. undulata* (Bar.), fig. 150. Animal, *A. trapezoides* (Lea), fig. 151.

Genus FUSCONAIA Simpson, 1900.

Shell round, rhomboid, triangular or short elliptical, with a moderate posterior ridge; beaks high and full, curved inward and forward, sculptured with a few coarse, parallel ridges, which curve upward behind; epidermis dark; surface not sculptured;

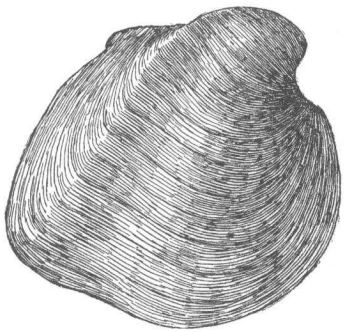


Fig. 152

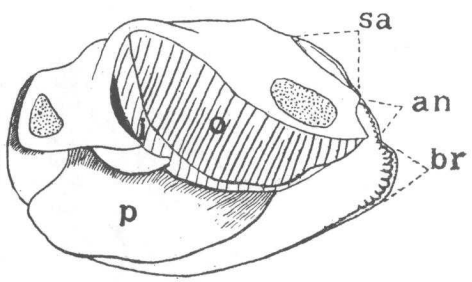


Fig. 153

hinge plate of moderate width; pseudocardinals strong; nacre white, salmon or purple.

All four gills marsupial.

Type: *Unio trigonus* Lea, fig. 152. Animal, (*F. rubiginosa* (Lea)), fig. 153.

Genus ROTUNDARIA (Rafinesque, 1820) Simpson.

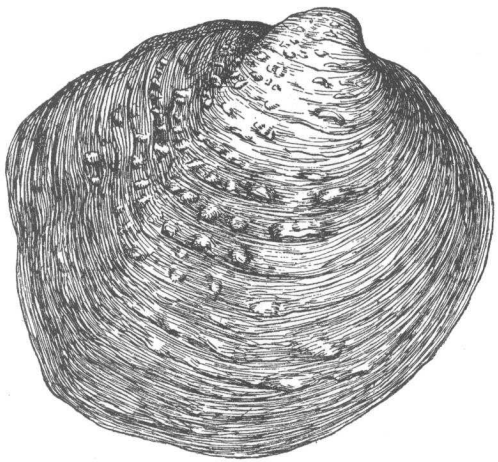


Fig. 154

Shell rounded; slightly truncated above in front; posterior ridge low; beaks prominent, curved inward and forward over a strongly marked lunule; beak sculpture

consisting of numerous, fine, irregular, broken, somewhat concentric corrugations; posterior three-fifths of the shell tuberculate; epidermis brown; nacre purple.

Only the outer gills serving as marsupium.

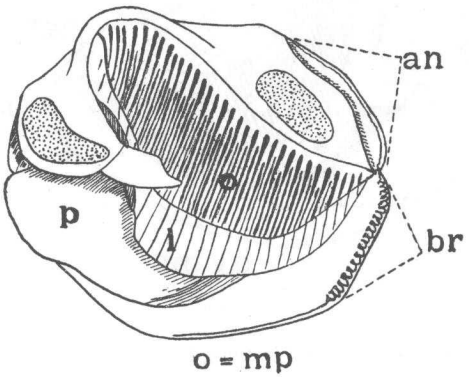


Fig. 155

Type: *Obliquaria* (*Rotundaria*) *tuberculata* Raf., fig. 154. Animal, fig. 155.

Genus PLETHOBASUS Simpson, 1900.

Shell large, irregularly oval, inflated, solid, somewhat suddenly swollen at the posterior base; posterior ridge low and rounded; beaks rather high, near the anterior end, having a few strong ridges, which are curved upwards behind; a row of low, irregular

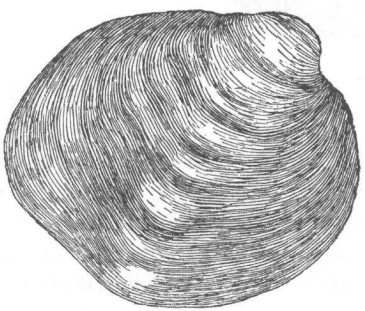


Fig. 156

tubercles extends from near the beaks to post-basal part of the valves; epidermis tawny yellow to dark brown; hinge plate solid, not flattened; pseudocardinals triangular, rough;

cavity of the beaks not deep; front part of the shell very heavy, thinner behind. Outer gills only serving as marsupium.

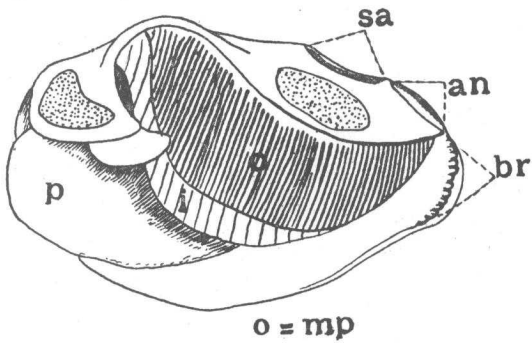


Fig. 157

Type: *Unio æsopus* Green, fig. 156. Animal, fig. 157.

Genus PLEUROBEMA (Rafinesque, 1820) Agassiz.

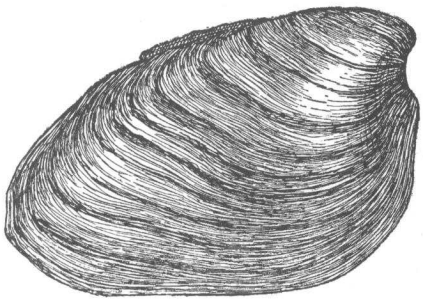


Fig. 158

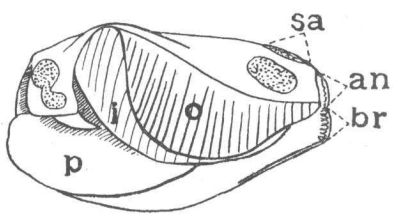


Fig. 159

Shell solid, triangular to rhomboid, usually with a prominent umbonal region; beaks at or near the anterior end of the shell, incurved and pointed forward over a small, but well developed lunule; beak sculpture coarse, consisting of a few, often broken, ridges, which curve upward posteriorly; posterior ridge present, but low and rounded; epidermis showing the rest periods plainly, tawny to olive, often ornamented with rays which show a tendency to break into square spots; hinge rather strong, plate generally narrow; pseudocardinals double in both valves. Cavity of the beaks shallow.

Outer gills only serving as marsupium.

Type: *Unio clava* Lam., fig. 159. Animal, fig. 159.

Genus LEXINGTONIA Ortmann, 1914.

"Shell subquadrate or subtrapezoidal, with slightly elevated beaks and well developed hinge teeth. Beaks not much anterior. Outer surface without sculpture. Epidermis lighter or darker brownish, with rather indistinct rays, which are narrower or wider and do not break up into blotches. Beak sculpture distinct, consisting of rather numerous (six to eight), rather crowded, subconcentric ridges, which form an indistinct, rounded angle up on the posterior ridge and are in front of this somewhat wavy and corrugated, but without showing any distinct zigzag pattern. Towards the disk, they disappear. Nacre whitish or pinkish."

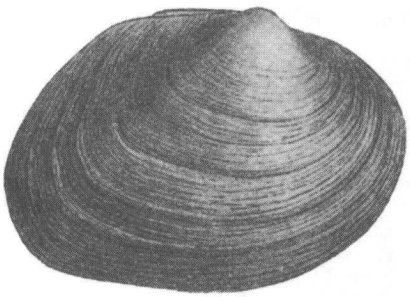


Fig. 160

Animal having only the outer gills marsupial and subcylindrical, red placentæ. Type: *Unio subplanus* Con., fig. 160.

Genus ELLIPTIO Rafinesque, 1819.

Shell inequilateral, ovate to elongated, rounded in front and pointed or biangulate behind, with a more or less developed posterior ridge, often becoming slightly arcuate when old; beaks only moderately full, generally sculptured with coarse ridges, which run parallel with the growth lines or are somewhat doubly looped, sometimes broken and showing fine radiating lines behind; surface smooth, slightly concentrically ridged or pustulous; epidermis generally rather dull colored, rayless or fully rayed; hinge-plate narrow, two pseudocardinals and two laterals in the left valve and one pseudocardinal and one lateral in the right, with rarely a vestige of a second lateral; cavity of the beaks not deep or compressed. Marsupium occupying the whole length of the outer gills only, forming a thick, smooth pad when filled with young.

Key to the sections of *Elliptio.*

Shell spinose ..... *Canthyria.*
Shell smooth or feebly corrugated ..... *Elliptio s. s.*

Section ELLIPTIO s. s.

Shell elongated, rhomboid or oval, usually more or less biangulate behind; beak sculpture consisting of a few rather strong ridges, which are nearly parallel to the growth lines or slightly doubly looped; the surface smooth or feebly corrugated. Type: *Unio crassidens* Lam., fig. 161. Animal, fig. 162.

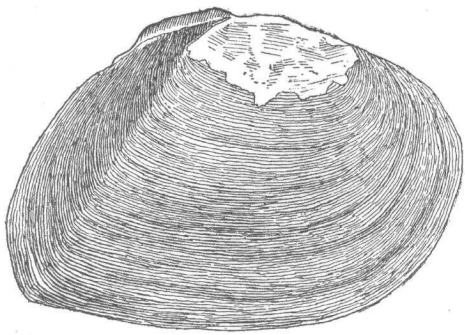


Fig. 161

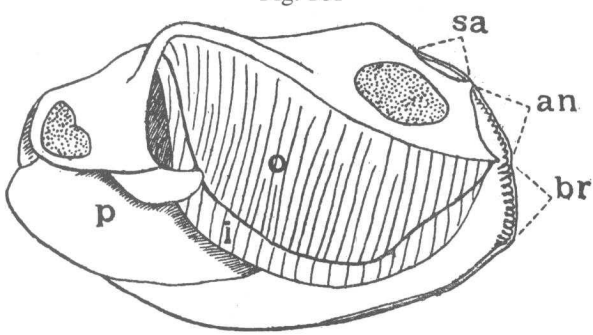


Fig. 162

Section CANTHYRIA Swainson, 1840.

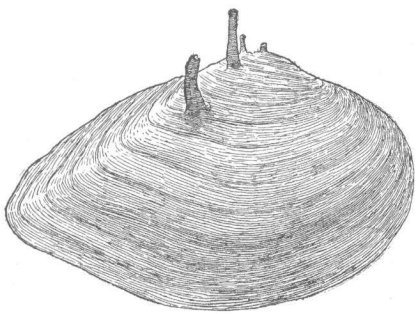


Fig. 163

Shell inflated, suboval, spinose, with a high, rather sharp posterior ridge, above which it is somewhat truncated; beaks rather compressed; epidermis smooth and shining, variegated with angular blotches; hinge sharply curved at the centre; pseudocardinals rather compressed; laterals short, remote; beak cavities rather deep.

Type: Unio *spinosus* Lea, fig. 163.

Genus UNIOMERUS Conrad, 1853.

Shell trapezoidal, with a rounded posterior ridge and pointed or feebly biangulate behind; beaks not prominent, sculptured with curved, rather strong, concentric ridges;

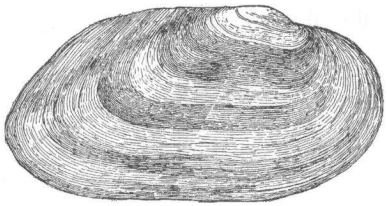


Fig. 164

epidermis generally rayless; pseudocardinals usually compressed, laterals delicate, slightly curved.

Outer gills only marsupial.

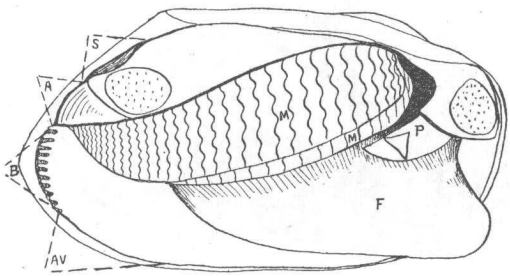


Fig. 165

Type: *Unio tetralasmus* Say, fig. 164. Animal, fig. 165.

Genus LASTENA Rafinesque, 1820.

Shell elongated, subsolid, inequilateral, generally wider in front, rounded and truncate at the anterior base, pointed at the post-basal region, and having a low pos-

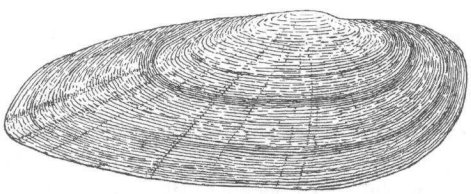


Fig. 166

terior ridge, with one or more secondary ridges above it; beaks low, sculptured with a few coarse, irregular, longitudinal folds; epidermis shining, often rayed; a single

imperfect tooth in each valve and sometimes vestiges of laterals; nacre purplish shading to blue at the edge; pallial line radially ridged.

Animal having the foot very large, as long as the shell when extended, of a subcylindrical, compressed shape, with a distal swelling. The middle portion of the outer gills only marsupial. Glochidia semicircular, slightly oblique, inequivalve, without points or hooks.

Type: *Anodonta* (*Lastena*) *lata* Raf., fig. 166.

Genus GONIDEA Conrad, 1857.

Shell elongated, subtriangular, much narrowed in front, wide behind, inflated, subsolid, usually with a high, sharp posterior ridge; beaks rather sharp but not high, the sculpture consisting of a few, strong, concentric bars: epidermis rayless; hinge with a rudimentary pseudocardinal and lateral in each valve, though these are sometimes wanting; pallial line with a trace of a sinus behind; nacre lurid to purplish.

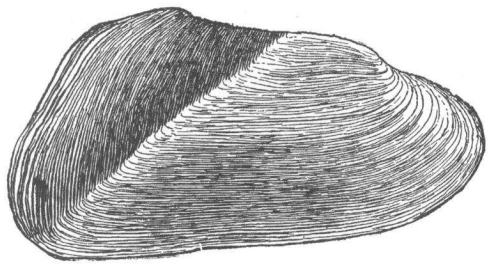


Fig. 167

Female having all four gills marsupial; with well developed septa, running parallel to the gill filaments and forming water tubes; septa not all continuous, but are often interrupted, chiefly so toward the proximal (basal) part of the gill and, towards the edge, frequently shorter septa are intercalated. Glochidia subovate or nearly subcircular, without hooks.

Type: *Anodonta angulata* Lea, fig. 167.

Subfamily ANODONTINÆ Ortmann, 1912.

"Inner lamina of inner gill free from the abdominal sac, or more or less connected with it, rarely entirely connected; supra-anal opening well separated from the anal, sometimes the connection of the mantle separating it from the anal is very long and the supra-anal is quite short; branchial opening well defined, no papillæ or flaps in front of it on the edge of the mantle; marsupium formed by the outer gills in their length, distending, when charged and the thickened tissue at the edge capable so

stretching out in a direction transverse to the gill, but not beyond the edge (or only slightly so); water-tubes in the gravid female divided longitudinally into three tubes with only the one in the middle used as an ovisac, and closed at the base of the gill; glochidium semicircular or triangular, with a spine (hook), in the middle of the ventral margin of each valve; shell generally very heavy, often thin, never round, but more or less elongated; color of epidermis generally bright and with color markings; sculpture of the beak double-looped or concentric, in the latter case often extremely heavy; hinge rarely complete and, if so, of peculiar structure; generally there is a distinct tendency toward the reduction of the hinge-teeth, and often they are completely absent; sexual differences in the shell very rarely present." (Ortmann.)

Key to the genera of *Anodontinæ*.

1. Beak sculpture concentric ..... 2.
   Beak sculpture double-looped ..... 4.

2. Beak sculpture fine ..... *Anodontoides.*
   Beak sculpture coarse ..... 3.

3. Pseudocardinals well developed ..... *Alasmidonta.*
   Pseudocardinals rudimentary ..... *Strophitus.*

4. Hinge wholly edentulous ..... *Anodonta.*
   Hinge teeth more or less developed ..... 5.

5. Beak sculpture tubercular; surface tubercular or folded: ..... 6.
   Beak sculpture not tubercular; surface smooth except on posterior slope ..... 7.

6. Beak sculpture strong and continuous with tubercular surface sculpture ..... *Arcidens.*
   Beak sculpture poorly developed and not continuous with surface sculpture ..... *Arkansia.*

7. Beak sculpture double-looped; pseudocardinals fully developed ..... *Lasmigona.*
   Beak sculpture open behind; a single pseudocardinal in each valve ..... *Simpsoniconcha.*

Genus STROPHITUS Rafinesque, 1820.

Shell elliptical to rhomboid, inflated, subsolid, pointed or biangulate behind, with a low posterior ridge, which is sometimes double; beaks full, sculpture consisting of a few, strong, concentric ridges, which curve sharply upwards behind; epidermis rayed

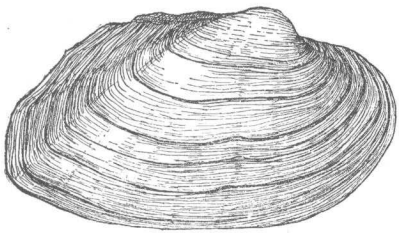


Fig. 168

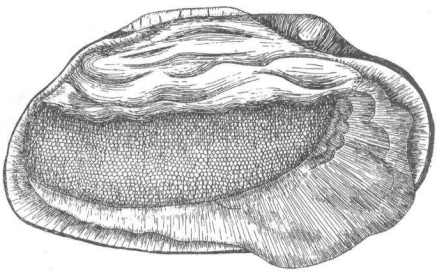


Fig. 169

or rayless, shining; hinge line incurved in front of the beaks; teeth rudimentary, a vestigial, compressed tooth in each valve, and sometimes a secondary tooth; laterals rarely present. Marsupium occupying the whole of the outer gills, consisting of short, horizontal ovisacs, which run directly across the gills.
Type: *Anodonta undulata* Say.
Example: *S. edentulus* (Say), fig. 168. Animal, fig. 169.

Genus ANODONTA Lamarck, 1799.

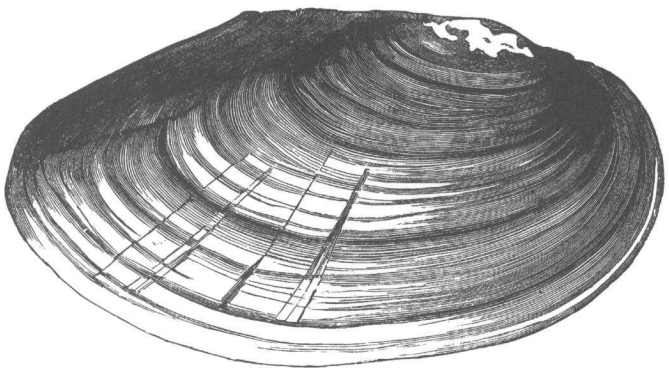


Fig. 170

Shell elliptical, thin, inflated, often slightly winged posteriorly; beak sculpture consisting of rather numerous, more or less parallel ridges, usually somewhat doubly looped and becoming slightly nodulous on the loops; surface generally smooth, shining, hinge edentulous, reduced to a mere line, regularly curved; nacre dull.

Marsupium occupying the whole outer gills, when filled forming a smooth, very thick, liver-colored pad.

Type: *Mytilus cygneus* L.
Example: *A. cataracta* Say, fig. 170. Animal, fig. 171.

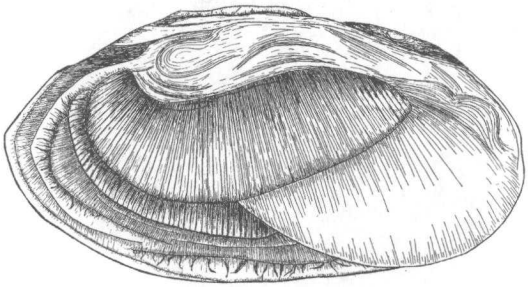


Fig. 171

Genus ANODONTOIDES Simpson, 1898.

Shell elliptical, inflated, thin, with a faint posterior ridge, sometimes constricted at the centre of the base; beaks rather full, with a few, not very coarse, subparallel, concentric ridges, which are curved up rather suddenly, behind and back of these are fine radiating ridges; epidermis smooth and shining, often rayed; hinge line slightly

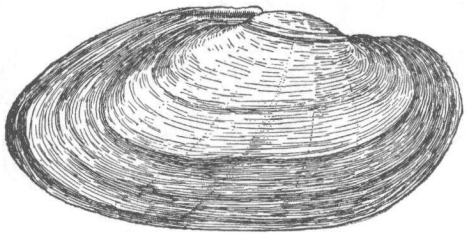


Fig. 172

incurved in front of the beaks, edentulous or bearing the merest rudiments of teeth; nacre bluish-white. Marsupium occupying the outer gills only.

Type: *Anodonta ferussaciana* Lea, fig. 172.

Genus ARCIDENS Simpson, 1900.

Shell subsolid, inflated, subrhomboidal, with full high beaks; beak sculpture very strong, consisting of irregular corrugations, which fall into two loops, at the base of which the ridges are swollen into knobs that continue out in two radiating rows on to the disk of the shell; in front of and behind the beaks are many fine, radial wrinkles,

the posterior ones being zig-zagged; surface of the shell covered with oblique folds and wrinkles; epidermis dark olive, shining; left valve with two elongated, compressed pseudocardinals, the posterior under the beak and curved upwards, cutting

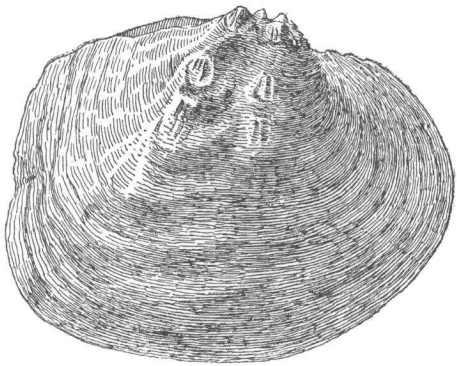


Fig. 173

off the hinge plate in the right valve, which had a single, compressed pseudocardinal in front; laterals numerous, short, blurred; nacre white. Marsupium occupying the outer gills.

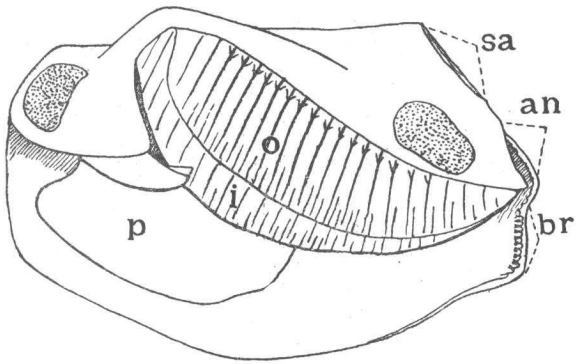


Fig. 174

Type: *Alasmodona confragosa* Say, fig. 173. Animal, fig. 174.

Genus ARKANSIA Ortmann and Walker, 1912.

Shell moderately thick, subrotund to subovate or subrhomboidal, inflated, with full beaks. Disk sculptured with irregular, oblique folds, which are sometimes indistinct. Beak sculpture poorly developed, consisting of two to three double-looped

bars, the loops slightly swollen or tubercular, disappearing toward the disk and not continuous with the sculpture of the latter. Hinge well developed, with strong pseudo-

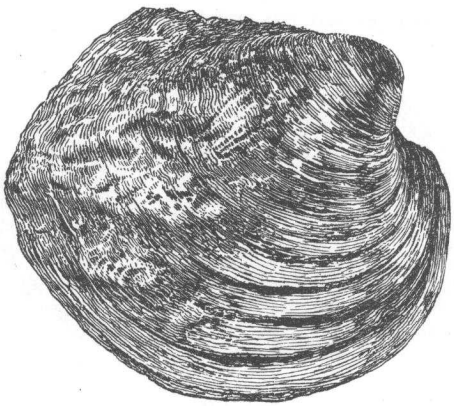


Fig. 175

cardinals, a very strong interdental projection in the left valve and well developed, strong, but rather short laterals.

Outer gills only marsupial.

Type: *Arkansia wheeleri* O. and W., fig. 175.

Genus LASMIGONA Rafinesque, 1831.

Shell elliptic-rhomboid, compressed; beaks low, their sculpture consisting of strong bars; one pseudocardinal in the right valve and two in the left, the hinder somewhat Λ-shaped, cutting off the hinge-plate in the right valve; laterals generally imperfect. Marsupium thick, padlike, filling the outer gills.

Key to the subgenera of *Lasmigona.*

1. Shell corrugated on posterior slope ..... *Lasmigona s. s.*
   Shell smooth ..... 2.

2. Hinge teeth delicate ..... 3.
   Hinge teeth very heavy ..... *Pterosyna.*

3. Lateral teeth compressed, moderately developed ..... *Platynaias.*
   Lateral teeth nearly or quite wanting ..... *Alasminota.*

Subgenus PLATYNAIAS Walker, 1917.

Shell smooth, subsolid, shining, rayed; beak sculpture sharply double-looped; teeth delicate; laterals compressed, moderately developed.

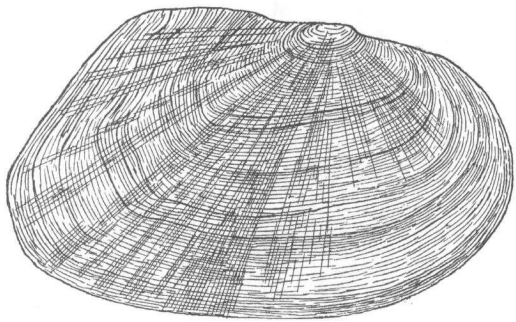


Fig. 176

Type: *Symphynota compressa* Lea, fig. 176.

Subgenus LASMIGONA s. s.

Shell subrhomboid, compressed, corrugated behind; beaks low, their sculpture consisting of several coarse ridges, which generally fall into two slight loops, and often with radiating ridges in front and behind; epidermis shining; laterals partly dev-

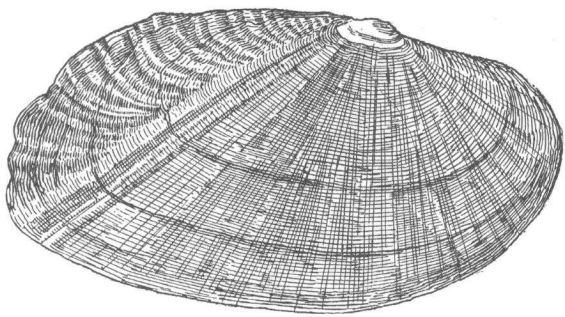


Fig. 177

eloped, consisting of blurred ridges, which slope diagonally downward and backward on the hinge-plate; cavities of the beaks shallow.

Type: *Alasmidonta costata* Raf., fig. 177.

Subgenus ALASMINOTA Ortmann, 1914.

Shell elongated elliptical, rather small. Surface without sculpture. Pseudocardinals delicate; laterals nearly or quite wanting. Beak sculpture not heavy, consisting of four to six rather fine, sharp bars, the first one or two subconcentric, the following

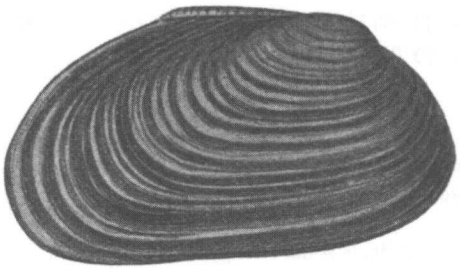


Fig. 178

ones sharply double-looped, the posterior loop smaller, separated from the anterior by a deep, sharp, re-entering angle.

Type: *Margaritana holstonia* Lea, fig. 178.

Subgenus PTEROSYNA Rafinesque, 1831.

Shell large, ovate-rhomboid, inflated in the post-basal region; beaks much compressed; their sculpture sharply and strongly doubly looped; epidermis dark, scarcely rayed; teeth very heavy.

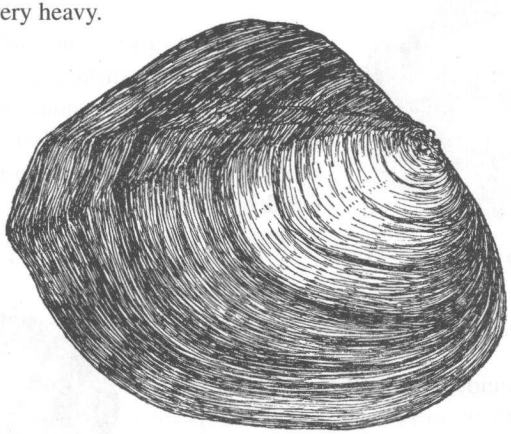


Fig. 179

Type: *Alasmodonta complanata* Bar., fig. 179.

Genus ALASMIDONTA Say, 1818.

Shell generally rhomboid, inflated, with a well developed posterior ridge, which ends in a point when it is single or a biangulation when double; beaks full and high, with coarse, concentric or slightly doubly looped bars; epidermis rayed, shining; hinge with two pseudocardinals in the left valve and one in the right; laterals usually wanting or imperfect, present in *Prolasmidonta,* cavity of the beaks deep; nacre bluish. Marsupium occupying the entire outer gills.

Key to the subgenera of *Alasmidonta.*

1. Lateral teeth present ..... *Prolasmidonta.*
   Lateral teeth absent or obsolete ..... 2.

2. Shell solid, pseudocardinals solid, stumpy ..... 3.
   Shell thinner, pseudocardinals compressed or imperfect ..... 4.

3. Shell ovate-rhomboid, inflated ..... *Alasmidonta s. s.*
   Shell smaller, compressed, very solid ..... *Pegias.*

4. Posterior slope slightly corrugated ..... *Rugifera.*
   Posterior slope smooth ..... 5.

5. Shell rhomboid, posterior ridge low, rounded ..... *Pressodonta.*
   Shell subtriangular, posterior ridge high, sharp ..... *Bullella.*

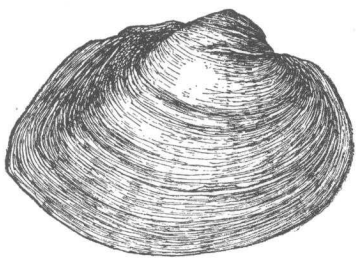


Fig. 180

Subgenus ALASMIDONTA s. s.

Shell ovate-rhomboid, solid, inflated, shining, with very strong, generally concentric, beak sculpture; pseudocardinals solid, stumpy, somewhat radiately ridged; laterals short, very imperfect or wanting; beak cavities deep, compressed.

Type: *Monodonta undulata* Say, fig. 180.

Subgenus PRESSODONTA Simpson, 1900.

Shell small, decidedly rhomboid, surface generally painted with unbroken rays; beak sculpture slightly corrugated; teeth compressed.

Type: *Unio calceolus* Lea, fig. 181.

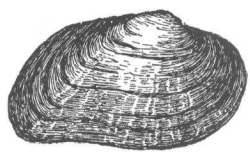


Fig. 181

Subgenus PROLASMIDONTA Ortmann, 1914.

Lateral hinge teeth present, but their number reversed, two in the right, one in the left valve. Beak sculpture moderately heavy, bars with an angle upon the posterior ridge and a slight sinus in front of it. Inner lamina of inner gills free. Female shell recognizable by a slight swelling in the region of the posterior ridge.

Fig. 182

Type: *Unio heterodon* Lea, fig. 182.

Subgenus PEGIAS Simpson, 1900.

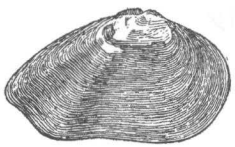


Fig. 183

Shell small, thickened in front, with a sharp posterior ridge, in front of which is a wide, radial impression, ending in a basal sinus; above this ridge is another, making the shell decidedly biangulate and truncate behind; beak sculpture consisting of sub-conic corrugations, generally swollen on the posterior ridge; epidermis decorticated, but showing a few, dark radial rays on the base of the shell; pseudocardinals rather solid; laterals wanting.

Type: *Margaritana fabula* Lea, fig. 183.

Subgenus RUGIFERA Simpson, 1900.

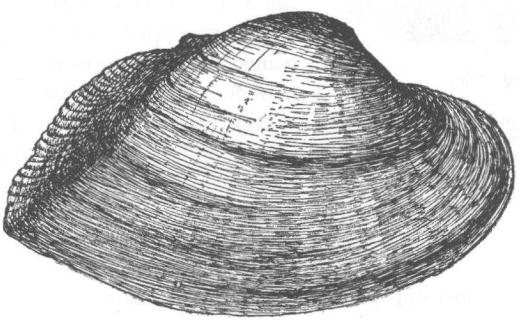


Fig. 184

Shell elongated, rhomboid, inflated, surface brilliantly painted with radiations which often break into dappled or splashed pattern of color; posterior slope slightly corrugated; teeth very imperfect; laterals wanting.

Type: *Alasmodonta marginata* Say, fig. 184.

Subgenus BULLELLA Simpson, 1900.

Shell thin, greatly inflated, somewhat triangular, with a high, sharp posterior ridge; beaks very full, having exceedingly strong, concentric sculpture, extending well on to the disk; pseudocardinals reflexed, compressed.

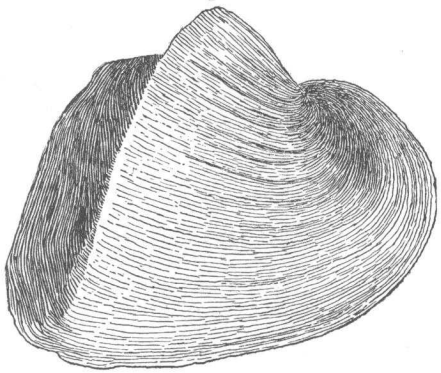


Fig. 185

Type: *Margaritana arcula* Lea, fig. 185.

Genus SIMPSONICONCHA Frierson, 1914.

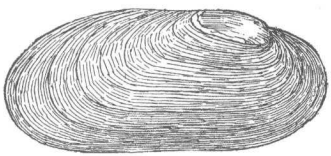


Fig. 186

Shell small, elongate elliptical, rounded in front and behind, often slightly incurved at the central base; beak rather sharp, but not full; sculpture consisting of fine parallel ridges which are looped up in the middle and open behind; epidermis brownish, rayless; teeth imperfect, a single, irregular, compressed tooth in each valve; laterals nearly or quite wanting; anterior end of the shell much thickened; nacre dull whitish. Marsupium occupying the whole of the outer gills.
Type: *Alasmodonta ambigua* Say, fig. 186.

Subfamily LAMPSILINÆ Ortmann, 1912.

"Inner lamina of inner gills rarely more or less free from the abdominal sac, generally connected with it throughout; supra-anal opening separated from the anal, rarely entirely closed; branchial openings well defined; edge of the mantle in front of the branchial opening smooth to crenulated or with peculiar papillæ or a flap; marsupium rarely formed by the whole outer gill, generally only by or within the posterior part of the outer gill; edge of marsupium, when charged, distending and bulging out beyond the original edge of the gill, generally assuming a beaded appearance; water-tubes simple in the gravid female; glochidium semicircular or semi-elliptic, without

spine, rarely celt-shaped and with two spines; shell heavy or lighter, rounded, or oval to elongate; color of the epidermis rarely dull, mostly bright, with color markings; sculpture of the beak generally double-looped, but often obsolete; more rarely concentric; hinge generally complete, with well developed teeth, which only in rare cases show a tendency to become reduced; sexual differences more or less noticeable in the shell, often very strongly expressed." (Ortmann.)

Key to the genera of *Lampsilinæ*.

1. { Male and female shells alike ..... 2.
   { Male and female shells different ..... 5.

2. { Shell elongate-triangular ..... *Ptychobranchus.*
   { Shell rounded-triangular or oval ..... 3.

3. { Shell oval, with a medial row of large tubercles ..... *Obliquaria.*
   { Shell rounded-triangular, nodulously wrinkled or lachrymose ..... 4.

4. { Epidermis painted with delicate mottlings on a light ground, beak cavities shallow ..... *Cyprogenia.*
   { Epidermis painted with radiating hair-lines, beak cavities deep and compressed ..... *Dromus.*

5. { Female shell more or less expanded in the post-basal region ..... 6.
   { Female shell slightly swollen just behind the middle of the base ..... *Medionidus.*

6. { Dorsal margin winged ..... 7.
   { Dorsal margin not winged ..... 8.

7. { Pseudocardinals perfect; glochidium celt-shaped, with two spines ..... *Proptera.*
   { Pseudocardinals rudimentary; glochidium semicircular, without spines ... *Paraptera.*

8. { Pseudocardinals well developed, complete ..... 9.
   { Pseudocardinals divided into irregular laminæ ..... *Glebula.*

9. { Shell with a distinct posterior ridge, dorsal-slope smooth ..... 10.
   { Shell usually without a distinct posterior ridge, or when distinct, dorsal-slope radiately sculptured ..... 11.

10. { Hinge heavy and strong; hinge-plate wide and flat ..... *Plagiola.*
    { Hinge delicate; hinge-plate narrow ..... *Amygdalonaias.*

11. Marsupial expansion of the female shell of the same texture as the rest of the shell ..... 12.
Marsupial expansion of the female shell of different texture from the rest of the shell and usually radiately sculptured ..... *Truncilla.*

12. Inner edge of the mantle in front of the branchial opening differentiated with papillæ or flaps ..... 13.
Inner edge of mantle in front of branchial opening without papillæ or flaps ... 16.

13. Shell smooth ..... 14.
Shell strongly sculptured posteriorly ..... *Lemiox.*

14. Beak sculpture double-looped ..... 15.
Beak sculpture concentric ..... *Carunculina.*

15. Inner edge of mantle in front of branchial opening in female distinctly papillate ..... *Eurynia.*
Inner edge of mantle in front of branchial opening in female with a ribbon-like flap ..... *Lampsilis.*

16. Shell inflated, usually higher than long ..... *Obovaria.*
Shell subcompressed, longer than high ..... *Actinonaias.*

Genus PTYCHOBRANCHUS Simpson, 1900.

Shell triangular, solid, sometimes becoming arcuate in old specimens; umbonal region rather elevated; beak sculpture consisting of faint, somewhat broken ridges, which have a tendency to be doubly looped; posterior ridge rounded, but well devel-

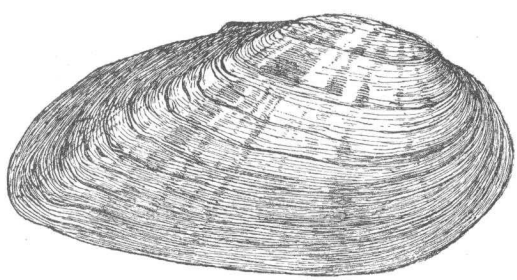


Fig. 187

oped; epidermis usually painted with wavy hair-like rays or broken, radiating bars, which show a tendency to form square spots; hinge-plate rather wide and flat; pseudocardinals small, low, triangular and roughened; laterals club-shaped, remote.

Marsupium occupying the basal half of the entire length of the outer gills and having in front six to twenty beautiful folds; ovisacs distinct, each ending below in an enlarged, rounded bulb, which has a colored spot in the centre.

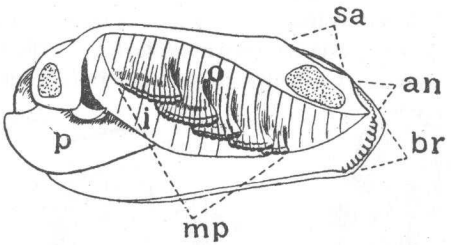


Fig. 188

Type: *Unio phaseolus* Hild., fig. 187. Animal, *P. subtentus* (Say), fig. 188.

Genus OBLIQUARIA Rafinesque, 1820.

Shell inflated, solid, oval, ending in a tolerably sharp point behind, having a row of large, compressed, longitudinal knobs running from the beaks to the centre of the base, those of one valve alternating with the knobs of the other, and a well developed posterior ridge, the space between the ridge and the knobs somewhat excavated; posterior slope and sometimes the entire shell more or less corrugately sculptured; beaks prominent, incurved and pointed slightly forward toward a tolerably well developed lunule; beak sculpture strong, consisting of four or five heavy, parallel ridges,

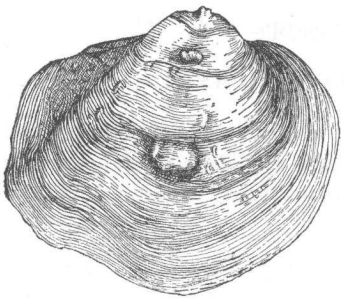


Fig. 189

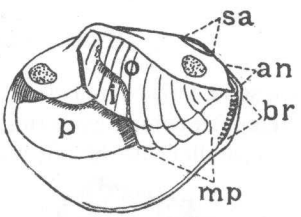


Fig. 190

which fall low in front, but are curved upwards behind; epidermis smooth, generally shining, painted with numerous, delicate, wavy, darker, broken rays; pseudocardinals strong, distinct and ragged; laterals short, nearly straight; front part of the shell very solid, suddenly becoming rather thin, just behind the knobs. Marsupium consisting of a few, distinctly marked ovisacs (4 to 7) occupying a position just behind the centre of the outer gills, projecting far below the rest of the branchiæ, their bases rounded.

Type: *O. reflexa* Raf., fig. 189. Animal, fig. 190.

Genus DROMUS Simpson, 1900.

Shell solid, rounded triangular; beaks well forward, rather high; beak sculpture consisting of fine ridges running parallel with the growth lines, the furrow between the ridges interrupted at the posterior ridge; posterior ridge distinct; a series of humps runs from the beaks down to the central part of the base of the shell, which is otherwise sculptured by irregular, concentric ridges; epidermis beautifully painted by un-

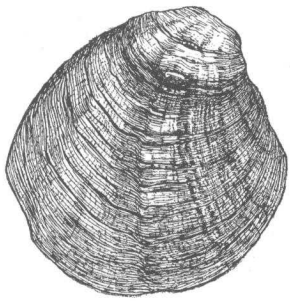


Fig. 191

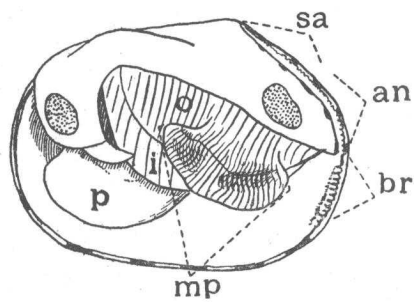


Fig. 192

dulated, radiating, broken hair-lines or fine maculations; hinge plate wide and flat; pseudocardinals triangular, small and low, ragged; laterals low, short, club-shaped; cavity of the beaks deep and compressed; front part of the shell very thick, suddenly becoming thinner at the row of humps. Marsupium occupying the base of nearly the whole outer gills in numerous narrow ovisacs, which extend beyond the original edge of the gill.

Type: *Unio dromas* Lea, fig. 191. Animal, frontispiece, fig. 192.

Genus CYPROGENIA Agassiz, 1852.

Shell solid, inflated, rounded, triangular, sometimes slightly retuse, generally a little biangular behind; posterior ridge usually well developed; umbonal region flattened parallel with the axis of the shell, sometimes compressed; beaks curved

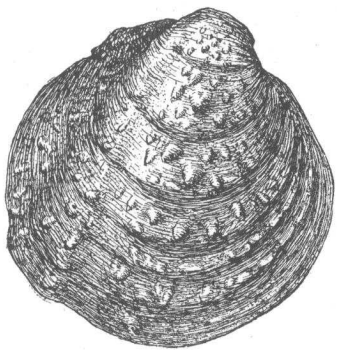


Fig. 193

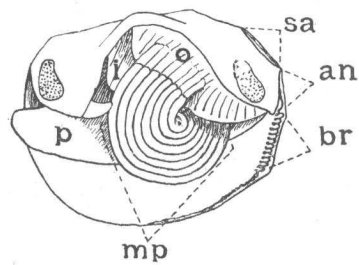


Fig. 194

inward and forward, their sculpture very faint; consisting of slightly double looped ridges; sculpture of the shell nodular, radiately wrinkled or lachrymose; ligament black and conspicuous; lunule distinct, well developed; epidermis shining, painted with a delicate mottling on a light ground; hinge plate wide and flat; pseudocardinals heavy, triangular, blunt and ragged; laterals short, obliquely striated, cavity of the beaks not deep; nacre bright and silvery.

Marsupium consisting of from seven to twenty-three very long, purple ovisacs pendant from near the central base of the outer gills and formed into a close coil with the ends turned inward.

Type: *Unio irroratus* Lea, fig. 193. Animal, fig. 194.

Genus PLAGIOLA (Rafinesque, 1819), Agassiz.

Shell solid, surface irregularly, concentrically ridged; epidermis smoothish, but here and there wrinkled; painted with larger and smaller scattered rays, which are generally broken into irregular lunate or squarish blotches; hinge heavy and strong;

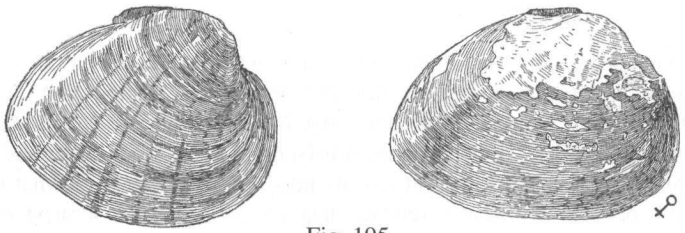


Fig. 195

hinge plate wide and flat; female shell smaller than the male, more inflated and swollen at the post basal region. Marsupium large, projecting far below the inner gills.

Type: *Unio securis* Lea, fig. 195.

Genus AMYGDALONAIAS Fischer and Crosse, 1893.

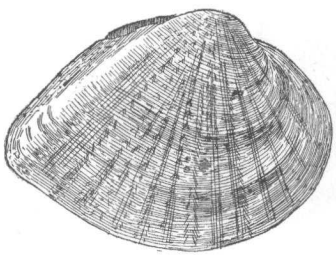


Fig. 196

Shell inflated, decidedly truncate at the posterior slope; surface slightly concentrically sculptured; posterior ridge sharp and well defined; epidermis shining, sometimes wrinkled, looped and painted with a beautiful pattern of broken or arrow-marked rays; area of the beaks flattened off in the direction of the axis of the shell, but not compressed; beak sculpture delicate, somewhat broken and doubly looped, the anterior loop rounded, the posterior sharp below, the ribs fading out where they cross the posterior ridge; hinge delicate; pseudo-

cardinals rather compressed, high and ragged; hinge plate narrow; female shell very slightly swollen at the post-base. Marsupium consisting of numerous, distinct ovisacs and having a well marked sulcus extending around it at some distance above its base.

Type: *Unio cognatus* Lea.
Example: *P. elegans* (Lea), fig. 196.

Genus MEDIONIDUS Simpson, 1900.

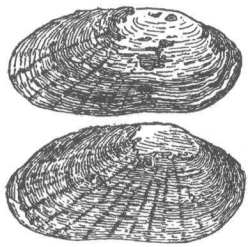


Fig. 197

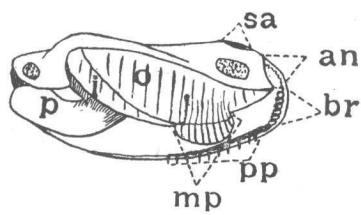


Fig. 198

Shell elongated, rather inflated, often arcuate when adult, sometimes having a posterior ridge; dorsal slope and occasionally the posterior portion of the shell plicately or nodulously wrinkled; epidermis smooth and bright, variegated with broken green rays and blotches; beak sculpture consisting of rather fine, subparallel, often broken ridges in two loops, the anterior rounded, the posterior somewhat angled, occasionally broken into zigzags; pseudocardinals small, stumpy and somewhat roughened; laterals rather short, slightly curved and club-shaped; female shell slightly swollen behind the middle of the base. Marsupium occupying the central posterior part of the outer gills, sometimes extending nearly their whole length.

Type: *Unio conradicus* Lea, fig. 197. Animal, fig. 198.

Genus GLEBULA Conrad, 1853.

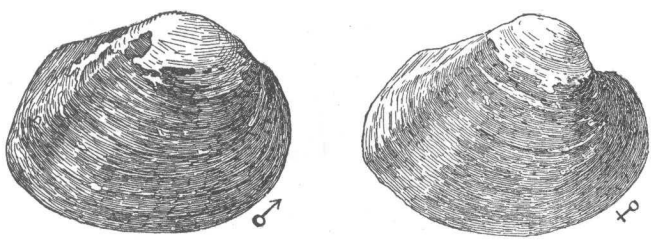


Fig. 199

Shell solid, much inflated, short, elliptical, bluntly pointed and slightly biangulate behind, with a low, posterior ridge; female shell swollen at the post-base; beaks

compressed, sculpture unknown; epidermis brownish, cloth-like; pseudocardinals divided into irregularly radiating, granular lamina, sometimes to the number of a dozen or more in each valve; hinge-plate reduced to a mere rounded line behind the pseudocardinals; laterals short, remote. Ovisacs apparently separated from each other by a sulcus.

Type: *Unio rotundata* Lam., fig. 199.

Genus PROPTERA Rafinesque, 1819.

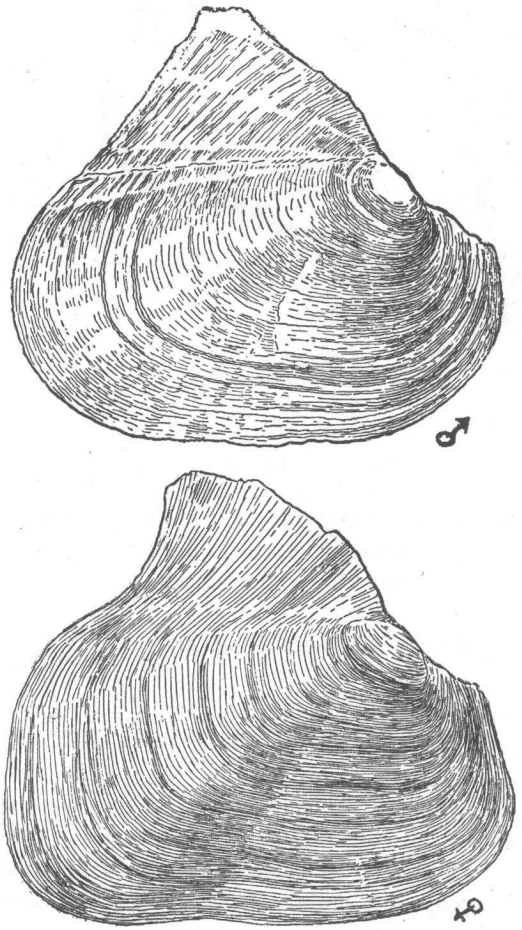


Fig. 200

Shell usually large, gaping at anterior edge and edge of dorsal slope, winged along the dorsal region when young and often when adult; beak sculpture feeble, consist-

ing, when developed, of an anterior and posterior loop, the former often wanting; epidermis generally brown, often cloth-like when fresh, rayless or feebly rayed; teeth rather compressed, pseudocardinals frequently imperfect or nearly wanting; laterals remote. Marsupium kidney-shaped, consisting of numerous ovisacs occupying the

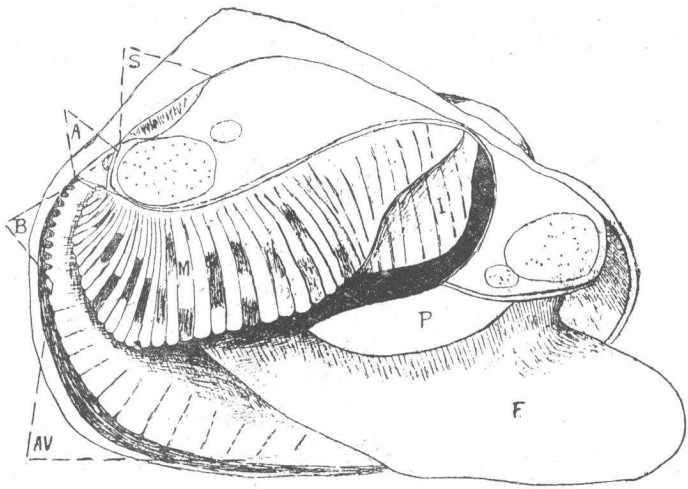


Fig. 201

posterior part of the outer gill; edge of mantle in female slightly lamellar in front of the branchial opening with granulations, but without papillæ. Glochidia celt-shaped, with two spines, one at each of the ventral corners.

Type: *Unio alatus* Say, fig. 200. Animal, fig. 201.

Genus PARAPTERA Ortmann, 1911.

Shell large, thin, elliptical or slightly obovate, more or less compressed, winged on the dorsal margin; beaks low; epidermis rather smooth, often feebly rayed, dull colored, but usually glossy; teeth compressed, pseudocardinals but feebly and often imperfectly developed; nacre purplish. Male and female shells nearly alike, the latter scarcely swollen at post-basal region.

Marsupium kidney-shaped, swollen, consisting of many ovisacs occupying the posterior part of the outer gill; mantle edge of the female slightly lamellar in front

of the branchial opening, with crenulations, but not with papillæ. Glochidia very small, of suboval shape.

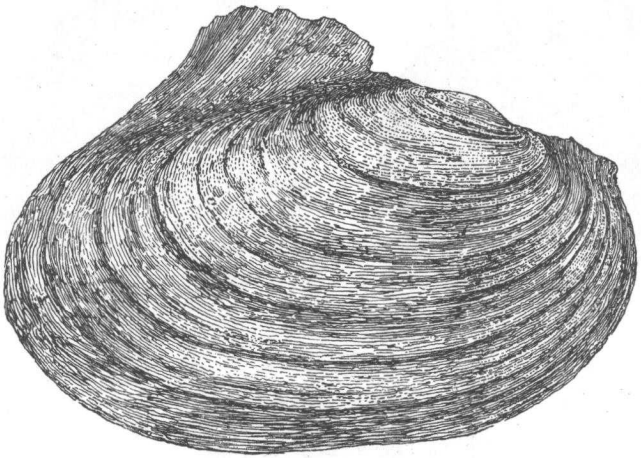


Fig. 202

Type: *Unio gracilis* Bar., fig. 202.

Genus OBOVARIA Rafinesque, 1819.

Shell short, oval, rounded or retuse, solid, inflated, thick in front, thinner behind, with high beaks, which are sculptured with very faint, irregular, often broken and slightly nodulous ridges, which show a tendency to fall into two loops, the posterior often open behind, epidermis dull, brownish, silky or cloth-like, rarely rayed, rays indistinct; female shell but slightly inflated in the post basal region, commonly having a shallow furrow or a flattened area at the posterior end; pseudocardinals solid; stumpy; laterals short, club-shaped. Marsupium kidney-shaped, projecting far below the edge of the gill and occupying the posterior portion of the outer gills.

Key to the subgenera of *Obovaria.*

Shell retrorse, to short oval, beaks high and central ..... *Obovaria s. s.*
Shell elliptical, beaks anterior ..... *Pseudoön*

Subgenus OBOVARIA s. s

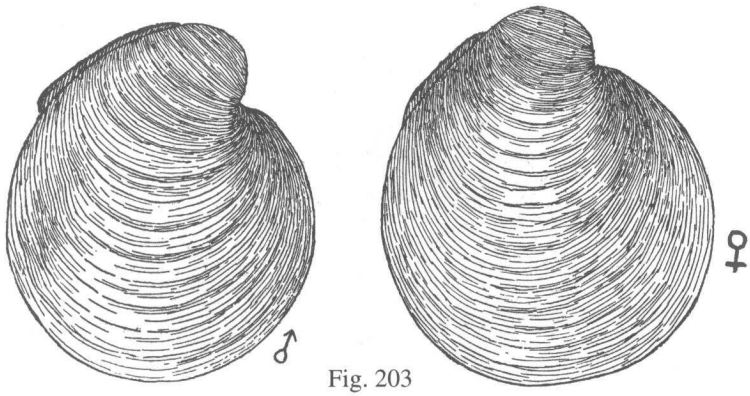


Fig. 203

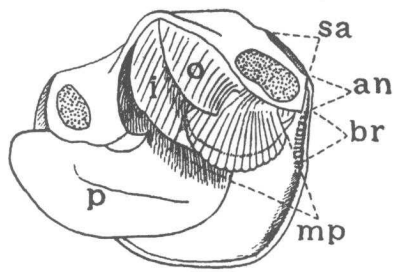


Fig. 204

Shell retrorse to short oval; beaks high, central; pseudocardinals rarely parallel with the laterals; cavity of the beaks deep, subcompressed; nacre bluish-white or purple. Marsupium as in the genus.
Type: *Unio retusa* Lam., fig 203. Animal, fig. 204.

Subgenus PSEUDOÖN Simpson, 1900.

Shell elliptical, inflated, solid; that of the male slightly pointed at the upper posterior part; epidermis brownish or blackish, rayless or very feebly rayed; beaks

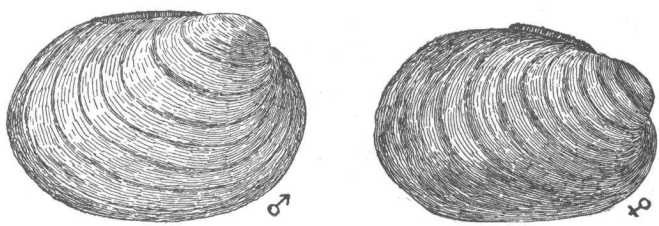


Fig. 205

anterior; pseudocardinals solid, stumpy or slightly elongate in age, and showing a tendency toward being parallel with the laterals; nacre silvery, iridescent posteriorly. Marsupium kidney-shaped, not reaching to the posterior end of the outer gill, though extending quite well forward.

Type: *Unio ellipsis* Lea, fig. 205.

Genus ACTINONAIAS Fischer and Crosse, 1893.

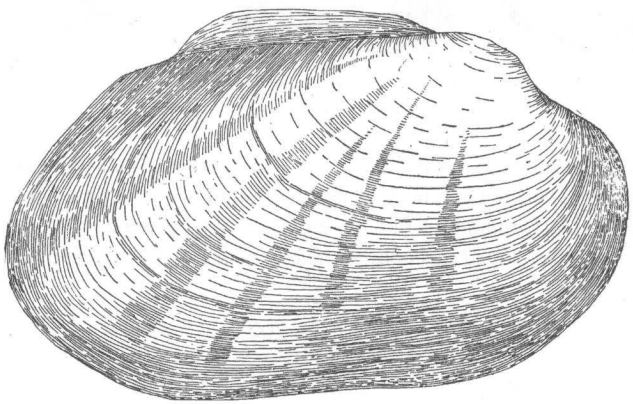


Fig. 206

"Shell ovate or subelliptical, distinctly longer than high, compressed or slightly inflated, without, or with, indistinct posterior ridge. Disk not sculptured. Beaks moderately anterior, never in the middle of the shell and never very near the anterior end. Beak-sculpture poorly developed, consisting of a few faint bars, which have a tendency to become double-looped, with the central part between the loops obliterated. Epidermis yellowish to greenish, generally with distinct rays. Male and female shells differing in shape, but the difference often hardly noticeable.

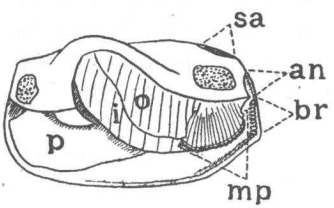


Fig. 207

Soft parts agreeing with those of *Obovaria* in every respect: the glochidia also of the same type:" (Ortmann.)

Type: *Unio sapotalensis* Lea, (animal), fig. 207.
Example: *A. ligamentinus* (Lam.), fig. 206.

Genus CARUNCULINA Simpson, 1898.

Shell small, inflated, obovate, rather solid, with a thick dark epidermis, which is rayless or only feebly rayed; beak sculpture consisting of rather strong, concentric ridges, which form, as a general thing, only a single rounded loop in front and are strongly curved upward behind. Pseudocardinals compressed, smooth on the inside,

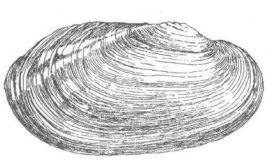


Fig. 208

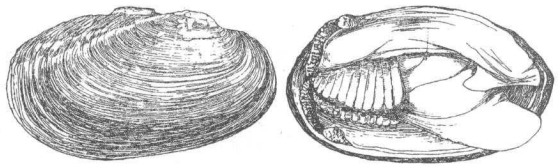


Fig. 209

generally reflected upward, somewhat torn on the edges. Shell quite commonly pointed posteriorly, that of the female truncated obliquely on the post-base. Marsupium kidney-shaped, formed by a few large ovisacs, projecting beyond the gill; female having a well developed caruncle on the inner edge of the mantle in front of the branchial opening.

Type: *Unio parvus* Bar., fig. 208. Animal, fig. 209.

Genus EURYNIA Rafinesque, 1820.

Shell oval to oblong; surface smooth; beak sculpture delicate, double-looped; female shell more or less expanded or swollen in the post-basal region.

Inner edge of the mantle in the female distinctly papillate. Marsupium kidney-shaped, occupying the posterior part of the outer gill.

Key to the subgenera of *Eurynia.*

Shell elongate, more or less pointed behind.
Papillæ on inner edge of mantle regular, uniform, reaching to middle of lower margin ..... *Eurynia s. s.*

Shell subovate or subelliptical, not much pointed behind.
Papillæ on inner edge of mantle irregular, not reaching to middle of lower margin ..... *Micromya.*

Subgenus EURYNIA s. s.

Shell usually of good size, subelliptical, elongated, more or less pointed behind; beak sculpture double-looped, the posterior loop often open behind.

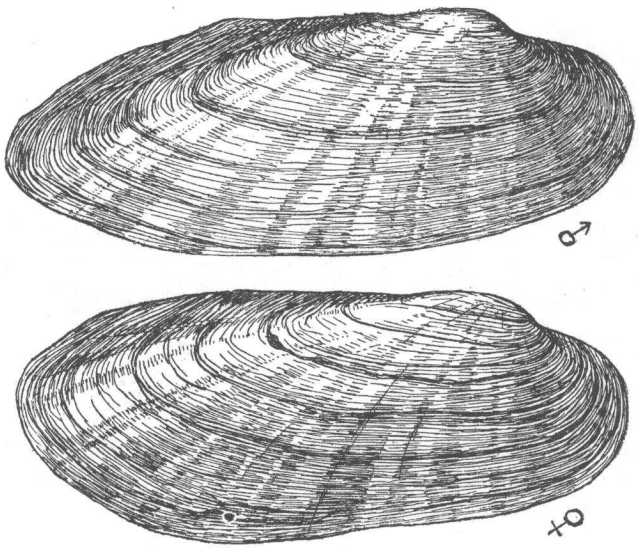


Fig. 210

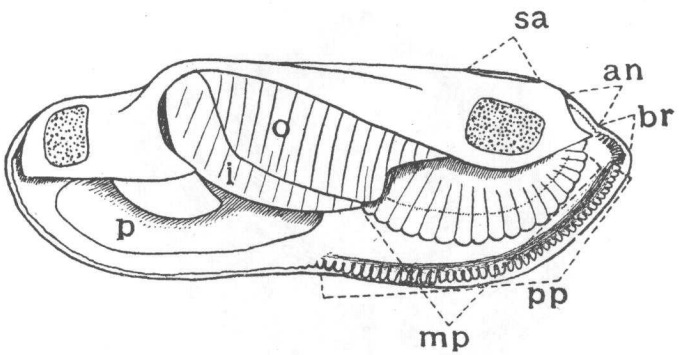


Fig. 211

Inner edge of the mantle in the female in front of the branchial opening with a long row of quite regular, uniform, subequal papillæ, reaching to about the middle of the lower margin.

Type: *Unio recta* Lam., fig. 210. Animal, fig. 211.

Subgenus MICROMYA Agassiz, 1852.

Shell small or of medium size, suboval or subelliptical, not very long and not much pointed behind; beak sculpture distinctly double-looped, but often obsolete, the posterior loop often showing a tendency to be open.

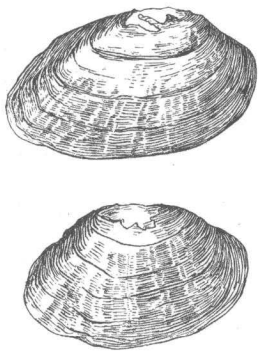


Fig. 212

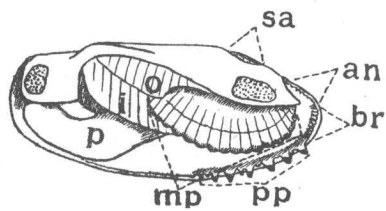


Fig. 213

Inner edge of the mantle of the female in front of the branchial opening with a shorter or longer row of rather irregular, larger and smaller papillæ reaching not quite to the middle of the lower margin.

Type: *Unio fabalis* Lea, fig. 212. Animal, *E. iris* (Lea), fig. 213.

Genus LAMPSILIS Rafinesque, 1820.

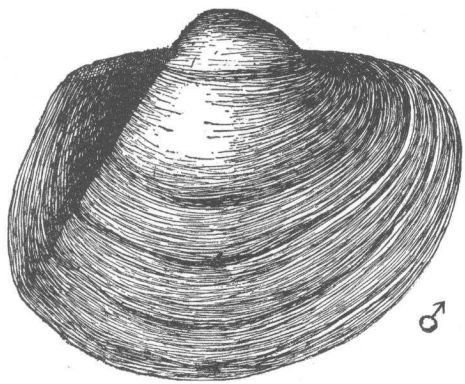


Fig. 214

Shell oval to elliptical, smooth or slightly, concentrically sculptured, usually without a posterior ridge; epidermis generally smooth and shining, often rayed; beak sculpture, consisting of double-looped, parallel ridges, sometimes the posterior loop open behind or the sculpture is obsolete; hinge with one or two pseudocardinals and

one lateral in the right valve, and two pseudocardinals and two laterals in the left; female shell having a strong inflation of the shell and dilatation in the post-basal region, producing a distinct posterior truncation of the shell. Marsupium kidney-shaped,

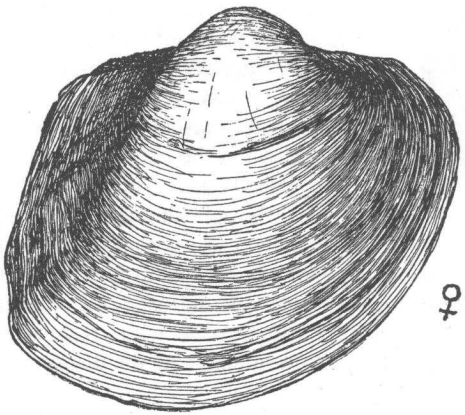


Fig. 214

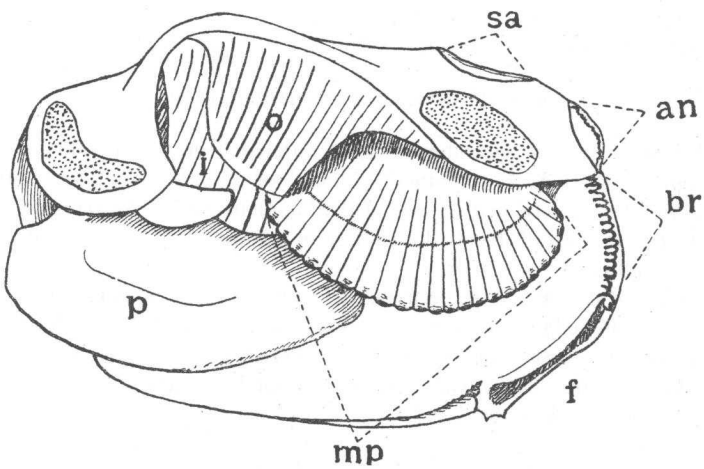


Fig. 215

occupying the posterior part of the outer gills; edge of the mantle of the female in front of the branchial opening developed into a ribbon-like flap, generally produced anteriorly into a full, projecting lobe, which has a lacerated appearance.

Type: *Unio ovatus* Say, fig. 214. Animal, fig. 215.

Genus LEMIOX (Rafinesque ??) Ortmann, 1916.

Shell triangularly ovate, solid, more or less inflated, with a low, rounded posterior ridge; beaks high, turned forward over a small lunule, sculpture distinctly double-looped; surface with strong, corrugated, subradial sculpture on the posterior half, which is divaricate on the posterior ridge and which sometimes covers the entire shell; epidermis clouded, dull-green or yellowish green, usually feebly rayed; pseudocardinals low, subradial, ragged, two in the left valve, one to three in the right valve; laterals heavy, double in the left valve, partly double in the right; muscle scars small, impressed; nacre silvery white, iridescent behind, thicker in front. Male shell subovate or subtriangular, with a broad, shallow, radial depression in front of the posterior ridge or having the whole disk, at least, flattened. Female shell usually ovate, sometimes inflated, smaller than the male, with a feebly developed marsupial swelling, distinctly, but irregularly, denticulate on the margin, at the base near the posterior end.

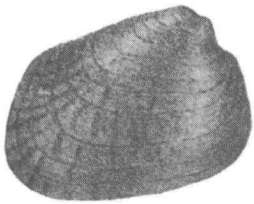


Fig. 216

Mantle margin of the female in front of the branchial opening denticulate on the outer margin. The inner margin has, just in front of the branchial, a few small papillæ and then is laminate and elevated and rather smooth and probably capable of some expansion.

Type: *Unio cælatus* Con. (*Unio rimosus* Raf. ??), fig. 216.

Genus TRUNCILLA Rafinesque, 1819.

Shell rounded, oval or subtriangular, solid, inflated, generally smooth and rayed; beak sculpture, delicate, often obsolete, double-looped; female shell very different from that of the male, having a very decided inflation in the post basal region, which is thinner than the rest of the shell, of different texture, often toothed and usually radiately sculptured.

Inner edge of the mantle in the female in front of the branchial opening is not parallel to the outer edge, but is more or less remote from it, often quite distant from it and has finer or coarser papillæ. The mantle between the two edges is peculiarly spongy. Marsupium swollen, kidney-shaped, formed by many ovisacs, occupying the posterior portion of the outer gill.

Key to the subgenera of *Truncilla.*

1. Male shell smooth, no radiate posterior furrow; female shell inflated along posterior ridge ..... *Truncilla s. s.*
   Male shell with a wide, radiate, posterior furrow ..... 2.

2. Female shell with a small, rounded, radial post-basal swelling ..... *Scalenaria.*
   Female shell with a greatly produced basal swelling, nearly in the centre of the base ..... *Dysnomia.*
   Female shell with a rounded, foliaceous swelling at the posterior base ..... *Pilea.*

Subgenus TRUNCILLA s. s.

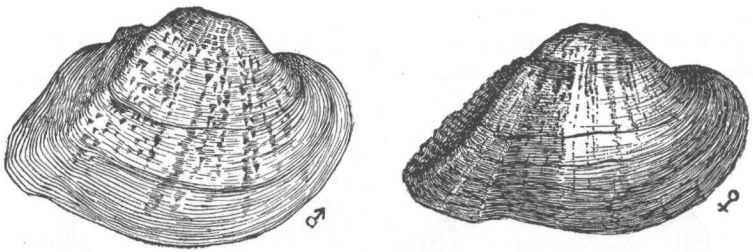


Fig. 217

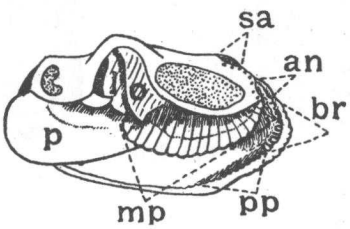


Fig. 218

Shell covered with broken rays, somewhat triangular and without a wide, radiate, posterior furrow.

Type: *T. triqueter* Raf., fig. 217. Animal, fig. 218.

Subgenus SCALENARIA (Rafinesque, 1820) Agassiz.

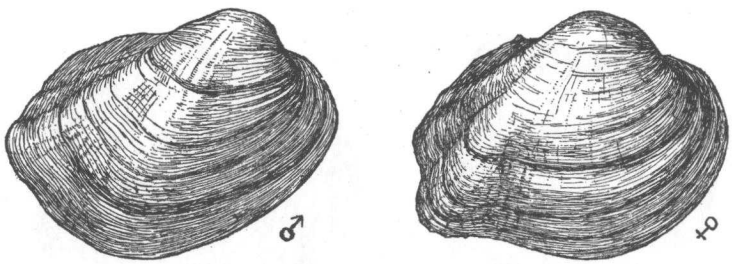


Fig. 219

Male shell having wide, radiating, shallow depression in front of the posterior ridge; that of the female having a small, rounded, well-defined, radial post-basal swelling.

Type: *Unio sulcatus* Lea, fig. 219.

Subgenus DYSNOMIA Agassiz, 1852.

Shell of the male with a posterior and central radiating ridge, with a wide flattened space between, that of the female with a greatly produced inflation a little

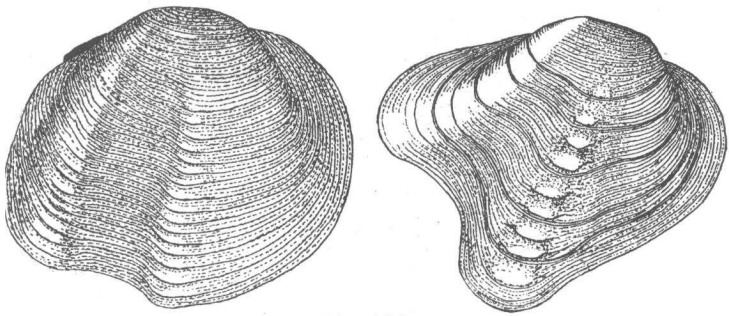


Fig. 220

behind the centre of the base, being a continuation of the central ridge.

Type: *Unio foliatus* Hild., fig. 220.

Subgenus PILEA Simpson, 1900.

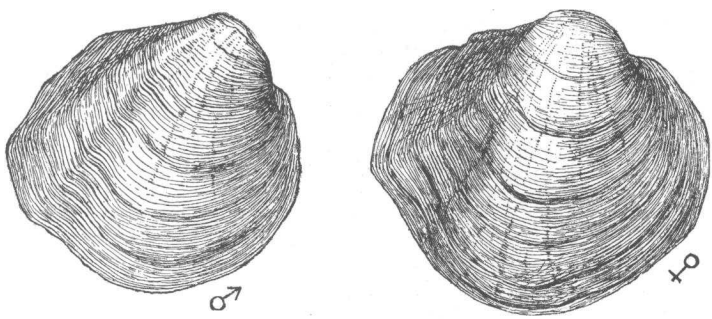


Fig. 221

Male shell with a wide, shallow, radiating depression in front of the posterior ridge, that of the female with a rounded foliaceous swelling at the posterior base.

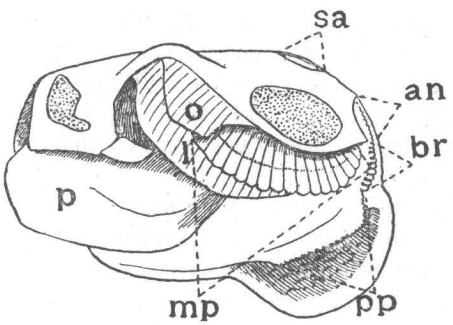


Fig. 222

Type: *Unio personatus* Say, fig. 221. Animal, *T. rangiana* (Lea), fig. 222.

Genus *incertæ sedis.*

Genus COKERIA Marshall, 1916.

"Shell gaping anteriorly, moderately thin, subquadrangular to subtriangular; abruptly rounded anteriorly, posterior margin nearly straight and perpendicular, dorsal margin straight, ventral margin gently curving throughout its entire length. Valves widest just in front of the posterior ventral angle. Umbones at about the anterior third of the dorsal margin, high and incurved, the second growth line nearly horizontal.

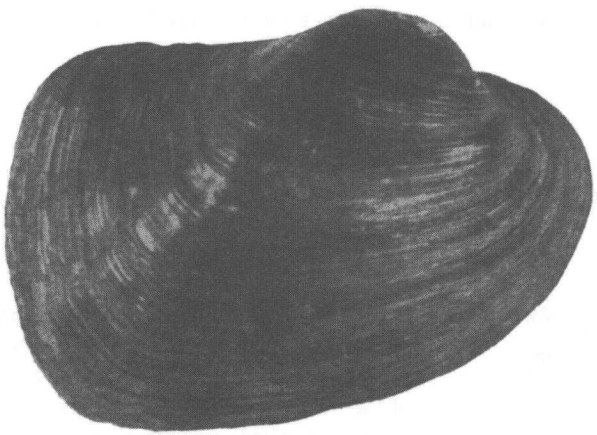


Fig. 223

Posterior dorsal ridge very high, obtusely angular. Posterior area descending abruptly from the ridge and somewhat wing-like. Greatest inflation is along the umbonal ridge. A pronounced furrow extends from the umbo to the lower third of the poste-

rior margin. Seven rest periods distinctly marked by concentric dark lines. Anteriorly from the middle portion a bold rounded rib occurs just below each rest-period. Dorsal area faintly radiately striate. Color, varying shades of chestnut, lighter (nearly straw color) anteriorly, darker posteriorly, rest stages sharply defined by blackish lines. Umbonal region faintly tinged with green. Periostracum thin, slightly glossy, closely adhering.

"Nacre anteriorly lustrous white and thickened; posteriorly thin violaceous and brilliantly iridescent. Pallial line not sharply defined and with several concentric striæ above it, its anterior portion radiately striated. Anterior adductor and retractor scars separated, deep and rough, posterior scars superficial. Dorsal scars concealed by the incurving of the upper portion of the valve.

"Lateral tooth of the right valve thin, very high, wing-like, striated longitudinally. Laterals of the left valve similar to that of the right valve, but smaller, the groove between them being very narrow. Pseudocardinals of the right valve two, thin, opposite, the upper one being the stronger. Pseudocardinals of the right (left?) valve coalescing, standing in the same straight line, the anterior one high, slightly curved, the posterior low, its summit irregularly crenulated. The sculpture of each umbo consists of four concentric ridges, highest (almost a nodule) at their posterior ends, and numerous concentric striæ." (Marshall).

Type: *Cokeria southalli* Marshall, fig. 223.

Family DREISSENSIIDÆ.

Shell mytiliform, equivalve, of prevailing prismatic substance, ligament subinternal; anterior adductor and pedal protectors inserted on a septum in the beak. Byssiferous.

Genus CONGERIA Partsch, 1835.

Type: *Congeria subglobosa* Partsch.

Typical *Congeria* is not represented in our fauna.

Subgenus MYTILOPSIS Conrad, 1857.

Shell mytiliform, attached by a byssus; hinge with a septum, beneath which on the cardinal side is a triangular cup-shaped, thin, white process, which projects obliquely towards the cavity of the valves; cartilage groove rather deep. Edge of the mantle united and extended posteriorly in two distinct siphons and open on the base for the extension of the foot.

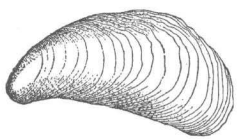


Fig. 224

Type: *Mytilus leucophæatus* Con., fig. 224.

Family CYRENIDÆ.

Shell porcellanous, thick, solid, hinge-plate developed, teeth strong, prominent; equivalve; ligament external. Siphons distinctly developed; diœcious.

Genus CYRENA Lamarck, 1818.

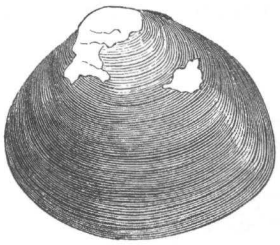


Fig. 225

Shell oval or subtrigonal, thick, solid, cardinal teeth, three in each valve; two anterior and two posterior laterals in the right valve and one anterior, and one posterior in the left; pallial line (in the American species, Section *Polymesoda* Rafinesque, 1820) with a deep, narrow sinus.

Type: *C. bengalensis* Lam.
Type: Section *Polymesoda, Cyclas caroliniana* Bosc, fig. 225

Family SPHÆRIIDÆ.

Shell small and thin, ligament feeble, short; pallial line simple; no hinge plate; cardinal teeth usually two in each valve; laterals four in the right valve, two anterior and two posterior and two in the left, one anterior and one posterior; foot long, narrow, grooved, byssiferous when young; monœcious; the young incubated in a marsupium formed by the inner gill.

Key to the genera of *Sphæriidæ*.

1. Shell nearly equilateral; beaks subcentral ..... 2.
   Shell inequilateral; beaks terminal ..... *Pisidium.*

2. Nepeonic valves not distinctly separated from the subsequent growth of the shell ..... 3.
   Nepeonic valves inflated, separated from the adult growth by a distinct sulcus ..... *Musculium.*

3. Shell oval, cardinal teeth, two in each valve ..... *Sphaerium.*
   Shell rhomboidal, one cardinal tooth in each valve ..... *Eupera.*

Genus SPHÆRIUM Scopoli, 1777.

Shell thin, oval, more or less inflated; subequilateral, beaks subcentral; surface smooth or concentrically striate, teeth small, cardinals two in each valve, lateral teeth double in the right, single in the left valve. Siphons united at the base, but double at the extremity.

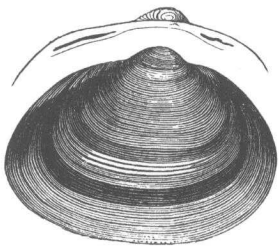


Fig. 226

Shell oval, relatively thick, nepeonic-shell passing into the adult without any distinct demarcation; anterior end shorter; surface usually concentrically striate or sulcate; cardinal teeth small but distinct.

Type: *Tellina cornea* L.

Example: *S. sulcatum* (Lam.), fig. 226. Animal, fig. 227.

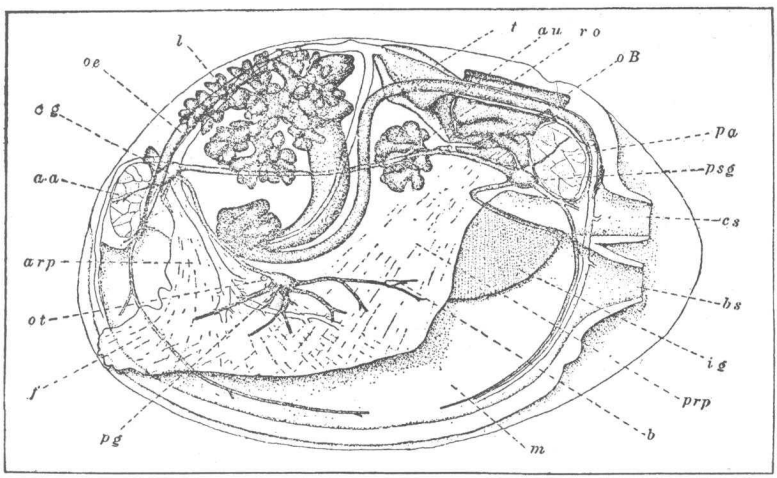


Fig. 227

aa.—Anterior adductor muscle.
ao.—Anterior aorta.
arp.—Ant. retractor pedis muscle.
as.—Ant. adductor muscle scar.
au.—Auricle.
b.—Byssal gland rudiment.
bls.—Blood space.
bs.—Branchial siphon.
c.—Cloacal chamber.
cg.—Cerebral ganglion.
cr.—chitinous rods.
cs.—Cloacal siphon.
f.—Foot.
fil.—Gill filament.
ifj.—Inter-filamentar junctions.
ig.—Inner gill.
io.—Inhalent ostea.
l.—Liver.
lp.—Labial palpus.
m.—Mantle.
oB.—Organ of Bojanus.
oe.—Œsophagus.
og.—Outer gill.
ot.—Otocyst.
ov.—Ovarian follicle.
p.—Pericardial cavity.
pa.—Posterior adductor muscle.
pg.—Pedal ganglion.
prp.—Post. retractor pedis muscle.
ps.—Post adductor muscle scar.
psg.—Parieto-splanchnic ganglion.
r.—Mantle ridge.
ro.—Reproductive organs.
t.—Male follicle.
vt.—Ventricle.
wt.—Water-tube.

Fig. 228

Genus MUSCULIUM Link 1807.

Shell thin, suborbicular or oblong, smooth, shining, striæ very fine and delicate; beaks calyculate; cardinal teeth minute, often obsolete.

Type: *Tellina lacustris* Müll.

Example: *M. jayanum* (Pme.), fig. 228. Animal, *M. truncatum* (Lins.); fig. 229.

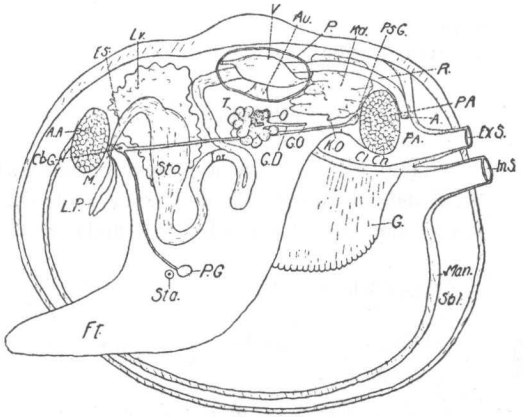


Fig. 229

M.—Mouth.
Lp.—Labial palps.
Es.—Oesophagus.
Lv.—Liver.
Sto.—Stomach.
Int.—Intestine.
R.—Rectum.
A.—Anus.
CbG.—Cerebral ganglion.
PsG.—Parieto-splanchnic ganglion.
PG.—Pedal ganglion.
Sta.—Statocyst.
V.—Ventricle.
Au.—Auricle.
Pl.—Pericardium.
KO.—Kidney opening.
T.—Sperm follicles.
O.—Egg follicles.
GD.—Genital opening.
AA.—Ant. adductor muscle.
PA.—Post. adductor muscle.
Ft.—Foot.
ClCh.—Cloacal chamber.
ExS.—Excurrent siphon.
InS.—Incurrent siphon.
G.—Gill.
Man.—Mantle.
Shl.—Shell.
Kd.—Kidney.

Genus EUPERA Bourguignat, 1854.

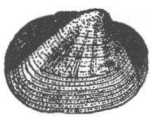


Fig. 230

Shell subrhomboidal. Moderately inflated, thin, with the posterior side longer; cardinal teeth feeble, one only in each valve. Animal as in *Sphaerium.*

Type: *Pisidium moquinianum* Bgt.
Example: *E. singleyi* (Pils.), fig. 230.

Genus PISIDIUM C. Pfeiffer, 1821.

Fig. 231

Shell small, rounded, oval or obliquely cuneiform; inequilateral, anterior side longer; beaks terminal; cardinal teeth double in each valve, at times united, situated immediately under the beaks; laterals elongated, lamelliform, double in the right, single in the left valve; ligament on the shorter side, internal.

Animal with a single siphon, the excurrent orifice being merged with that of the foot.

Type: *Tellina amnica* Müll.
Example: *P. virginicum* (Gmel.), fig. 231.

Family CYRENELLIDÆ.

Shell rounded, inflated, thin, with a conspicuous epidermis; beaks forward; cardinal teeth two on the right and one on the left valve; no lateral teeth; pallial line not sinuate. Animal with two contractile siphons, elongated and united to their tips.

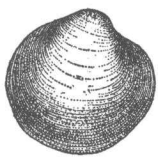


Fig. 232

Genus CYRENELLA Deshayes, 1835.

Shell as in the family, surface smooth or slightly concentrically sculptured.

Type: *Cyrenoidea dupontiæ* Joannis.

Example: *C. floridana* (Dall), fig. 232.

Family RANGIIDÆ.

Shell equivalve, covered with an epidermis, no internal nacre; beaks prominent, separated; hinge with two cardinal and anterior and posterior lateral teeth in each valve and an internal, central cavity for the ligament; pallial line sinuous. Mantle with two short siphons united at their bases and with papillose orifices; foot large, linguiform, compressed.

Genus RANGIA Desmoulins, 1832.

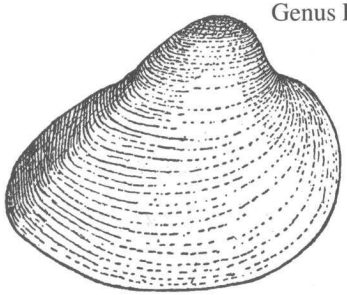


Fig. 233

Shell thick, oval, subtrigonal, ventricose, smooth, epidermis olive, beaks prominent, separated; ligament and resilium both enclosed in a single pit and invisible externally; laterals curved, cross-striated, more or less unequal, the posterior longer, anterior with the proximal end vertically hooked; pallial sinus small.

Type: *Gnathodon cuneatus* Gray, fig. 233.

Walkerana, 1999, 10(24): 89-102

RECTIFICATION OF WALKER'S CLASSIFICATION OF THE FRESHWATER MOLLUSCA OF NORTH AMERICA, NORTH OF MEXICO

John B. Burch
Museum of Zoology, University of Michigan

The publication of Bryant Walker's (1918a,b) "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, pp. i-ii, 1-213, 1918) was the first such comprehensive synopsis for North American non-marine mollusks published in the 20th Century, and it served as the basis for the classification of North American freshwater mollusks for the first three quarters of the century. In his Synopsis, Walker brought up-to-date the many changes that had been made in the classification of North American freshwater mollusks during the latter half of the 19th Century and the first 18 years of the 20th Century. Due to the historic importance of Walker's Synopsis, and because it now has been out-of-print for a number of years*, it was reprinted as the preceding article in this issue of *Walkerana* (Vol. 10, No. 24, pp. i-ii, 1-88).

Since the publication of Walker's Synopsis, there have been numerous taxonomic and nomenclatural changes for various taxa of North America's freshwater mollusks (*e.g.*, see Burch, 1975a,b, 1979, 1982), and Walker foresaw this: "It is to be understood, of course, that with our increasing knowledge, many changes will, undoubtedly, be necessary in the future and are to be expected and hoped for. The arrangement here presented is what the compiler understands to be the state of the science at the present time."

My purpose for the information given here is to reconcile Walker's classification with current nomenclature and taxonomy. Below is Walker's (1918a) classification. The superscript endnote numbers throughout the list refer to changes made in, or alternatives for, the classification of North American (north of Mexico) freshwater gastropods since Walker's time (see pp. 98-102).

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*Walker's Synopsis and Catalogue was reprinted piecemeal in consecutive issues of *Sterkiana* (nos. 33-46) during the years 1969-1972, being reproduced by a cheap photo-offset method, which made the Walker monograph available for a short period of time. *Sterkiana*, a minor periodical with limited distribution, stopped publishing (by Aurèle La Rocque) with no. 70 in 1978 (although several additional nos. were published by Henry van der Schalie and John M. Bates). The reprinted sections of Walker's monograph were gathered together by La Rocque, soft-bound, and sold in a limited number during the 1970s.

OUTLINE OF BRYANT WALKER'S CLASSIFICATION

Class GASTROPODA
Subclass EUTHYNEURA[1]
Order PULMONATA[2]
Suborder BASOMMATOPHORA[3]
Superfamily LIMNOPHILA[4]

Family LYMNAEIDÆ
Genus ***Lymnæa*** Lamarck 1799
- Subgenus *Lymnæa s.s.* (*L. stagnalis* Linnaeus)[5]
- Subgenus *Pseudosuccinea* Baker 1908 (*L. columella* Say)
- Subgenus *Radix* Montfort 1810 (*L. auricularia* Linnaeus)
- Subgenus *Bulimnea* Haldeman 1841 (*L. megasoma* Say)
- Subgenus *Acella* Haldeman 1841 (*L. haldemani* "Desh." W.G. Binney)
- Subgenus *Galba* Schrank 1803 (*L. truncatula* Müller)[6]
  - Section *Pseudogalba* Baker 1913 (*L. humilis* Say)[7]
- Subgenus *Stagnicola* Leach 1830 (*L. palustris* Müller)
  - Section *Polyrhytis* Meek 1876 (*L. kingii* Meek)[8]

Family PLANORBIDÆ
Subfamily PLANORBINÆ H. & A. Adams 1858
Genus ***Planorbis*** Müller 1774[9]
- Subgenus *Planorbis s.s.*
  - Section *Planorbina* Haldeman, 1842 (*P. olivaceous* Spix)[10]
- Subgenus *Helisoma* Swainson 1840
  - Section of *Helisoma s.s.* (*P. bicarinatus* Say)
  - Section *Pierosoma* Dall 1905 (*P. trivolvis* Say)
- Subgenus *Planorbella* Haldeman 1842 (*P campanulatum* Say)
- Subgenus *Tropidiscus* Stein 1850 (*P. umbilicatus* Müller)[11]
- Subgenus *Hippeutis* Agassiz 1837 (*Helix fontanus* Lightfoot)[12]
  - Section *Menetus* H. & A. Adams 1855 (*P. opercularis* Gould)
- Subgenus *Gyraulus* Agassiz 1837
  - Section *Gyraulus, s.s.* (*P. albus* Müller)
  - Section *Torquis* Dall 1905 (*P. parvus* Say)
  - Section *Armiger* Hartmann 1840 (*P. crista* Linnaeus)

Genus ***Segmentina*** Fleming 1817 (*Nautilus lacustris* Lightfoot)[13]
- Subgenus *Planorbula* Haldeman 1842 (*Planorbis armigerus* Say)

Subfamily POMPHOLIGINÆ Dall 1866[14]
Genus ***Pompholyx*** Lea 1856 (*P. effusa* Lea)[15]
Genus ***Carinifex*** W.G. Binney 1863 (*Planorbis newberryi* Lea)[16]

Family PHYSIDÆ
Genus ***Physa*** Draparnaud 1801[17]
- Section *Physa s.s.* (*Bulla fontinalis* Linnaeus)
- Section *Costatella* Dall 1870 (*P. costata* Newcomb)

Genus ***Aplexa*** Fleming 1822 (*Bulla hypnorum* Linnaeus)

Family ANCYLIDÆ[18]
Subfamily LANCINÆ Hannibal 1914[19]
Genus ***Lanx*** Clessin 1880 (*Ancylus newberryi* Lea)
Subgenus *Walkerola* Hannibal (*Lanx klamathensis* Hannibal)
Genus ***Fisherola*** Hannibal 1912 (*Fisherola lancides* Hannibal)

Subfamily FERRISSINÆ Walker 1917
Genus ***Ferrissia*** Walker 1903
Subgenus *Ferrissia s.s.* (*Ancylus rivularis* Say)
Subgenus *Lævapex* Walker 1903 (*Ancylus fuscus* C.B. Adams)
Genus ***Gundlachia*** Pfeiffer 1849 (*Gundlachia ancyliformis* Pfreiffer)[20]
Subgenus *Kincaidella* Hannibal 1912 (*Ancylus fragilis* Tryon = *G. californica* Rowell)[21]

Subfamily RHODACMEINÆ Walker 1917[22]
Genus ***Rhodacmea*** Walker 1917 (*Ancylus filosus* Conrad)
Section *Rhodocephala* Walker 1917 (*Rhodacmea rhodacme* Walker)[23]

Subfamily NEOPLANORBINÆ Hannibal 1912[24]
Genus ***Neoplanorbis*** Pilsbry 1906 (*N. tantillus* Pilsbry)
Genus ***Amphigyra*** Pilsbry 1906 (*A. alabamensis* Pilsbry)

Subclass STREPTONEURA[25]
Order PECTINIBRANCHIA[26]
Suborder TAENIOGLOSSA[27]
Superfamily PLATYPODA[28]

Family AMPULIARIIDÆ
Genus ***Ampullaria*** Lamarck 1799 (*Nerita urceus* Müller)

Family VIVIPARIDÆ
Genus ***Viviparus*** Montfort 1810 (*Helix vivipara* Linnaeus)
Genus ***Campeloma*** Rafinesque 1819 (*C. crassula* Rafinesque)
Genus ***Lioplax*** Troschel 1856 (*Limnæa subcarinata* Say)
Genus ***Tulotoma*** Haldeman 1840 (*Paludina magnifica* Conrad)

Family VALVATIDÆ
Genus ***Valvata*** Müller 1774 (*V. cristata* Müller)

Family AMNICOLIDÆ[29, 30, 31]
Subfamily BYTHININÆ Stimpson 1865[32]
Genus ***Bythinia*** Leach 1818 (*Helix tentaculata* Linnaeus)[33]

Subfamily AMNICOLINÆ Gill 1871
Genus ***Amnicola*** Gould & Haldeman 1841 (*Paludina limosa* Say)
Subgenus *Cincinnatia* Pilsbry 1891 (*Paludina cincinnatiensis* Anthony)[34]
Genus ***Paludestrina*** Orbigny 1840 (*Cyclostoma acutum* Drap.)[35]

Genus ***Tryonia*** Stimpson 1865 (*T. clathrata* Stimpson)
Genus ***Pyrgulopsis*** Call & Pilsbry 1886 (*Pyrgula nevadensis* Stearns)
Genus ***Potamopyrgus*** Stimpson 1865 (*Melania corolla* Gould)[36]
Genus ***Littoridina*** Souleyet 1852 (*L. gaudichaudii* Souleyet)[37]
Subfamily LITHOGLYPHINÆ Fischer 1885
Genus ***Cochliopa*** Stimpson 1865 (*Amnicola rowellii* Tryon)[38]
Genus ***Clappia*** Walker 1909 (*C. clappii* Walker)
Genus ***Fluminicola*** Stimpson 1865 (*Paludina nuttalliana* Lea)
Genus ***Somatogyrus*** Gill 1863 (*Amnicola depressa* Tryon)
Genus ***Gillia*** Stimpson 1865 (*Melania altilis* Lea)

Subfamily LYOGYRINÆ Pilsbry 1916
Genus ***Lyogyrus*** Gill 1863 (*Valvata pupoidea* Gould)
Genus ***Horatia*** Bourguignat 1887 (*Horatia klecakiana* Bourguignat)[39]
Subgenus *Hauffenia* Pollonera 1898 (*Horatia tellini* Pollonera)

Subfamily POMATIOPSINÆ Stimpson 1865[40]
Genus ***Pomatiopsis*** Tryon 1862 (*Cyclostoma lapidaria* Say)

Family PLEUROCERIDÆ
Genus ***Io*** Lea 1831 (*Fusus fluvialis* Say)
Genus ***Lithasia*** Haldeman 1840 (*L. geniculata* Haldeman)
Section *Angitrema* Haldeman 1841 (*Melania armigera* Say)
Genus ***Eurycælon*** Lea 1864 (*Anculosa anthonyi* Budd)[41]
Genus ***Pleurocera*** Rafinesque 1818 (*P. acuta* Rafinesque)
Section *Strephobasis* Lea 1861 (*Melania plena* Anthony)
Genus ***Goniobasis*** Lea 1862 (*G. osculata* Lea)[42, 43]
Genus ***Gyrotoma*** Shuttleworth 1845 (*G. ovoidea* Shuttleworth)
Genus ***Anculosa*** Say 1821 (*Melania prærosa* Say)[44]

Order ASPIDOBRANCHIA[45]
Suborder RHIPIDOGLOSSA[46]
Family NERITIDÆ[47]
Genus ***Neritina*** Lamarck 1809 (*N. perversa* Gmelin)
Genus ***Lepyrium*** Dall 1896 (*Neritina showalteri* Lea)[48]

Class LAMELLIBRANCHIA[49]
Order EULAMELLIBRANCHIA[50]
Suborder SUBMYTILACEA[51]
Family MARGARITANIDÆ[52]
Genus ***Margaritana*** Schumacher 1817[53]
Subgenus *Margaritana s.s.* (*Mya margaritifera* Linnaeus)
Subgenus *Cumberlandia* Ortmann, 1912 (*Unio monodonta* Say)

Family UNIONIDÆ[54]
Subfamily UNIONINÆ (Swainson 1840) Ortmann 1910

Genus ***Quadrula*** (Rafinesque 1820) Agassiz
Section *Quadrula s.s.*
Section *Theliderma* (Swainson 1840) Simpson (*Unio lachrymosus* Lea)
Genus ***Tritogonia*** Agassiz 1852 (*Unio tuberculatus* Barns)
Genus ***Megalonaias*** Utterback 1915 (*Unio heros* Say)
Genus ***Amblema*** Rafinesque 1819 (A. *costata* Rafinesque)
Genus ***Fusconaia*** Simpson 1900 (*Unio trigonus* Lea)
Genus ***Rotundaria*** (Rafinesque 1820) Simpson (*Obliquaria* (*Rotundaria*) *tuberculata* Rafinesque)[55]
Genus ***Plethobasus*** Simpson 1900 (*Unio æsopus* Green)
Genus ***Pleurobema*** (Rafinesque 1820) Agassiz (*Unio clava* Lamarck)
Genus ***Lexingtonia*** Ortmann 1914 (*Unio subplanus* Conrad)
Genus ***Elliptio*** Rafinesque 1819
Section *Elliptio s.s.* (*Unio crassidens* Lamarck)
Section *Canthyria* Swainson 1840 (*Unio spinosus* Lea)[56]
Genus ***Uniomerus*** Conrad 1853 (*Unio tetralasmus* Say)
Genus ***Lastena*** Rafinesque 1820 (*Anodonta* (*Lastena*) *lata* Rafinesque)
Genus ***Gonidea*** Conrad 1857 (*Anodonta angulata* Lea)

Subfamily ANODONTINÆ Ortmann 1912

Genus ***Strophitus*** Rafinesque 1820 (*Anodonta undulata* Say)
Genus ***Anodonta*** Lamarck 1799 (*Mytilus cygneus* Linnaeus)[57]
Genus ***Anodontoides*** Simpson 1898 (*Anodonta ferussaciana* Lea)
Genus ***Arcidens*** Simpson 1900 (*Alasmodonta confragosa* Say)
Genus ***Arkansia*** Ortmann & Walker 1912 (*Arkansia wheeleri* Ortmann & Walker)
Genus ***Lasmigona*** Rafinesque 1831
Subgenus *Platynaias* Walker 1917 (*Symphynota compressa* Lea)
Subgenus *Lasmigona s.s.* (*Alasmidonta costata* Rafinesque)
Subgenus *Alasminota* Ortmann 1914 (*Margaritana holstonia* Lea)[58]
Subgenus *Pterosyna* Rafinesque 1831 (*Alasmodonta complanata* Barnes)
Genus ***Alasmidonta*** Say 1818
Subgenus *Alasmidonta s.s.* (*Monodonta undulata* Say)
Subgenus *Pressodonta* Simpson 1900 (*Unio calceolus* Lea)
Subgenus *Prolasmidonta* Ortmann 1914 (*Unio heterodon* Lea)
Subgenus *Pegias* Simpson 1900 (*Margaritana fabula* Lea)
Subgenus *Rugifera* Simpson 1900 (*Alasmodonta marginata* Say)[59]
Subgenus *Bullella* Simpson 1900 (*Margaritana arcula* Lea)
Genus ***Simpsoniconcha*** Frierson 1914 (*Alasmodonta ambigua* Say)[60]

Subfamily LAMPSILINÆ Ortmann 1912

Genus ***Ptychobranchus*** Simpson 1900 (*Unio phaseolus* Hild.)
Genus ***Obliquaria*** Rafinesque 1820 (*O. reflexa* Rafinesque)
Genus ***Dromus*** Simpson 1900 (*Unio dromas* Lea)
Genus ***Cyprogenia*** Agassiz 1852 (*Unio irroratus* Lea)
Genus ***Plagiola*** (Rafinesque 1819) Agassiz (*Unio securis* Lea)
Genus ***Amygdalonaias*** Fischer & Crosse 1893 (*Unio cognatus* Lea)[61]

Genus ***Medionidus*** Simpson 1900 (*Unio conradicus* Lea)
Genus ***Glebula*** Conrad 1853 (*Unio rotundata* Lamarck)
Genus ***Proptera*** Rafinesque 1819 (*Unio alatus* Say)[62]
Genus ***Paraptera*** Ortmann 1911 (*Unio gracilis* Barnes)[63]
Genus ***Obovaria*** Rafinesque 1819
  Subgenus *Obovaria s.s.*
  Subgenus *Pseudoön* Simpson 1900 (*Unio ellipsis* Lea)
Genus ***Actinonaias*** Fischer & Crosse 1893 (*Unio sapotalensis* Lea)
Genus ***Carunculina*** Simpson 1898 (*Unio parvus* Barnes)[64]
Genus ***Eurynia*** Rafinesque 1820
  Subgenus *Eurynia s.s.* (*Unio recta* Lamarck) [65]
  Subgenus *Micromya* Agassiz 1852 (*Unio fabalis* Lea)[66]
Genus ***Lampsilis*** Rafinesque 1820 (*Unio ovatus* Say)
Genus ***Lemiox*** (Rafinesque ??[67]) Ortmann 1916 (*Unio cælatus* Conrad = *Unio rimosus* Rafinesque ??)
Genus ***Truncilla*** Rafinesque 1819[68]
  Subgenus *Truncilla s.s.* (*T. triqueter* Rafinesque)
  Subgenus *Scalenaria* (Rafinesque 1820) Agassiz (*Unio sulcatus* Lea)
  Subgenus *Dysnomia* Agassiz 1852 (*Unio foliatus* Hild.)[69]
  Subgenus *Pilea* Simpson 1900 (*Unio personatus* Say)
Genus ***incertæ sedis*:** Genus ***Cokeria*** Marshall 1916 (*Cokeria southalli* Marshall)[70]

Family DREISSENSIIDÆ[71]
Genus ***Congeria*** Partsch 1835 (*Congeria subglobosa* Partsch)[72]
  Subgenus *Mytilopsis* Conrad 1857 (*Mytilus leucophæatus* Conrad)[73]

Family CYRENIDÆ[74]
Genus ***Cyrena*** Lamarck 1818 (*C. bengalensis* Lamarck)[75]

Family SPHÆRIIDÆ[76]
Genus ***Sphærium*** Scopoli 1777 (*Tellina cornea* Linnaeus)
Genus ***Musculium*** Link 1807 (*Tellina lacustris* Müller)
Genus ***Eupera*** Bourguignat 1854 (*Pisidium moquinianum* Bourguignat)
Genus ***Pisidium*** C. Pfeiffer 1821 (*Tellina amnica* Müller)

Family CYRENELLIDÆ[77]
Genus ***Cyrenella*** Deshayes 1835 (*Cyrenoidea dupontiæ* Joannis)[78]

Family RANGIIDÆ
Genus ***Rangia*** Desmoulins 1832 (*Gnathodon cuneatus* Gray)[79]

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ENDNOTES

[1]The higher taxon name Euthyneura is an alternative name for the combined Opisthobranchia and the Pulmonata (*e.g.*, see Zilch, 1959). In this alternative classification, Streptoneura is equivalent to Prosobranchia.

[2]Pulmonata is now generally used as a subclass, parallel in rank to the Subclass Prosobranchia and the Subclass Opisthobranchia.

[3]The taxon name Basommatophora (for the freshwater, strandline and primitive marine pulmonate snails) is generally used as an order, parallel to the Order Stylommatophora (the terrestrial pulmonate snails).

[4]Other superfamily names used for these "higher limnic" basommatophoran families are, *e.g.*, Hygrophila (in Thiele, 1931), Lymnaeacea (in Zilch, 1959), Lymnaeoidea (in H.B. Baker, 1964). The first author of the family-group name, based on the genus *Lymnaea* Lamarck 1799, is Rafinesque (1815).

[5]In this list, type species are placed in parentheses after most generic-group names.

[6]The genus name *Fossaria* Westerlund 1885 is now used, especially by American authors, for the group of small lymnaeids, rather than *Galba* auct. (which is only doubtfully the same as *Galba* Schrank 1803; *e.g.*, see Hesse, 1923; Pilsbry & Bequaert, 1927; F.C. Baker, 1928; Clarke, 1973; Burch, 1989).

[7]*Pseudogalba* F.C. Baker 1913 = *Fossaria* Westerlund 1885.

[8]The fossil *Stagnicola kingi* (Meek 1870) and the Recent *S. utahensis* (Call 1884) are probably synonymous. The latter species belongs to the North American *catascopium/elodes/emarginata* species complex.

[9]*Planorbis* Müller 1774 is a genus of the Palaearctic and Ethiopian regions. In the earlier literature, many or most planorbid species of the Western Hemisphere were asigned to the genus *Planorbis*.

[10]Opinion 735 (see refs.) of the International Commission on Zoological Nomenclature gives *Biomphalaria* Preston 1910 precedence over *Planorbina* Haldeman 1842.

[11]*Tropidiscus* Stein 1850 is a synonym of *Planorbis* Müller 1774 (*e.g.*, see Zilch, 1959; *et al.*).

[12]Previously, *Hippeutis* was treated as a more inclusive genus than it is today, containing subordinate taxa now raised in rank to full genera. Walker's more inclusive taxonomy included the North American *Menetus* as a subgenus of the European and northern Asian *Hippeutis*.

[13]*Segmentina* Fleming 1817 is a genus of the Palaearctic region. In the earlier literature, species of *Planorbula* sometimes were assigned to the genus *Segmentina*.

[14]The subfamily name Pompholiginae may no longer be useful in planorbid taxonomy.

[15]*Pompholyx* Lea 1856 (preoccupied) = *Parapholyx* Hanna 1922. *Parapholyx* was placed by Zilch (1959) as a subgenus containing Recent species in the otherwise fossil genus *Vorticifex* Meek (in Dall) 1870.

[16]Taylor (1966) placed *Carinifex* as a subgenus in the genus *Helisoma*.

[17]Te (1979) separated the genus *Physa* (type species *Bulla fontinalis* Linnaeus 1758), as represented by the type species in Europe and by *Physa jennessi* Dall 1919 and *Physa skinneri* Taylor 1954 in North America, from the other "physas," which he placed in the genus *Physella* Haldeman 1843.

[18]A North American freshwater limpet not included here is *Acroloxus coloradensis* (Henderson 1930), placed in the family Acroloxidae (cf. Walker, 1925; Henderson, 1930; Burch, 1962).

[19]Pilsbry (1925) made a new family, the Lancidae, for *Lanx* because its radular characteristics were like those of the Lymnaeidae, but the animals had a body and shell shaped like that of the Ancylidae. H.B. Baker's (1925) anatomical study of *Lanx* confirmed its relationship to the Lymnaeidae. Thiele (1931) placed *Lanx*, *Fisherola* and *Walkerola* in the Lymnaeidae, reducing Pilsbry's family to subfamilial rank. This procedure also transfers the closely related *Fisherola* and *Walkerola* to the Lymnaeidae.

[20]*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* Goulding 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*.

[21]*Kincaidilla* Hannibal 1912 = *Ferrissia* Walker 1903.

[22]Whether or not *Rhodacmea* deserves its own subfamily (or family, cf. Zilch, 1959) needs more attention. Burch (1974) pointed out characters that *Rhodacmea* held in common with the European *Ancylus*, differing in those aspects to other freshwater ancyliform gastropods.

[23]*Rhodocephala* Walker 1917 = *Rhodacmea* Walker 1917 (ref. Basch, 1963).

[24]*Amphigyra* and *Neoplanorbis* were transferred to the Planorbidae (Walter, 1970; Burch, 1982, 1989).

[25]The higher taxon name Streptoneura, used by some malacologists, is equivalent to the name Prosobranchia, which now is more commonly used. For an alternative classification/nomenclature, see Ponder & Lindberg (1997).

[26]Pectinibranchia de Blainville 1814 included snails with comb-like ctenidia. The taxon was later restricted by omitting the scutibranchs (zygobranchs), but then later exended to include all archaeogastropods except the Docoglossa. Pectinibranchia is a taxon name not in general use today.

[27]A higher taxon characterized by radular characters. The group includes most gastropods now placed in the prosobranch order Mesogastropoda (ref. Cox, 1960).

[28]Platypoda Gray 1857, a taxon name no longer in general usage, refers to a group of mesogastropod snails characterized by a flat foot adapted for creeping.

[29]The family name now generally used for these small rissooidean snails is Hydrobiidae Troschel 1857.

[30]In a series of publications in recent years, Thompson (*e.g.*, 1968, 1969, 1977, 1981, 1984a,b, 2000) and Hershler (*e.g.*, 1988, 1989, 1994, 1996, 1998, 1999), and with various co-workers, have studied the North American hydrobiid fauna, redefined the taxa, and named new genera and many new species.

[31]The following North American hydrobiid genera have been named since Walker's (1918) Synopsis (listed here alphabetically): *Antrobia* Hubricht 1971, *Antrorbis* Hershler & Thompson 1990, *Antroselates* Hubricht 1963, *Aphaostracon* Thompson 1968, *Balconorbis* Hershler & Longley 1986, *Cochliopina* Morrison 1946, *Colligyrus* Hershler 1999, *Dasyscias* Hershler & Thompson 1991, *Eremopyrgus* Hershler 1999, *Fontigens* Pilsbry 1933, *Littoridinops* Pilsbry 1952, *Notogillia* Pilsbry 1953, *Phreatoceras* Hershler & Longley 1987, *Phreatodrobia* Hershler & Longley 1986, *Pristinicola* Hershler, Frest, Johannes, Bowler & Thompson 1994, *Probythinella* Thiele 1928, *Pyrgophorus* Ancey 1888, *Rhapinema* Thompson 1870, *Spilochlamys* Thompson 1968, *Stygopyrgus* Hershler & Longley 1986, *Taylorconcha* Hershler, Frest, Johannes, Bowler & Thompson 1994, and *Texapyrgus* Thompson & Hershler 1991.

[32]The Bythinidae [Bithyniidae] are now considered a separate family, distinct from the Hydrobiidae.

[33]Opinion 475 (see refs.) of the International Commission on Zoological Nomenclature fixes the spelling of the genus as *Bithynia*, and, accordingly, the spelling of the family as Bithyniidae.

[34]*Cincinnatia* is now recognized as an independent genus.

[35]*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.

[36]*Potamopyrgus* Stimpson 1865 is a New Zealand genus; *P. antipodarum* (Gray) has been

introduced to, and is widely distributed in, Britain and Europe (as "*P. jenkinsi* (Smith)"), and recently has been reported (Bowler & Frest, 1996; Zaranko *et al.*, 1997; Turgeon *et al.*, 1998) also introduced, in North America. North American endemic species previously referred to *Potamopyrgus* are now assigned to other genera.

[37]*Littoridina* occurs in brackish marshes and streams in Middle and South America (cf. Hershler & Thompson, 1992).

[38]*Cochliopa* is a genus of South America (cf. Hershler & Thompson, 1992).

[39]*Horatia* and *Hauffenia* are European taxa. The two American species formerly placed in these two taxa are now placed in the genus *Phreatodrobia* (see Hershler & Longley, 1986).

[40]*Pomatiopsis* and its relatives are now generally considered to comprise a separate rissooidean family.

[41]*Eurycaelon* Lea 1864 = *Lithasia* Haldeman 1840.

[42]*Goniobasis* Lea 1862 = *Elimia* H. & A. Adams 1854 [e.g., see Pilsbry & Rhoads, 1896; H.B. Baker, 1963; Taylor, 1966; Burch, 1979]. 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, 1941) 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*.

[43]The western pleurocerid snails are placed in the genus *Juga* H. & A. Adams 1854 (cf. Taylor, 1966; Burch, 1989).

[44]*Anculosa* Say 1821 = *Leptoxis* Rafinesque 1819.

[45]Aspidobranchia Schweigger 1820, as extended by later authors, is equivalent to the Archaeogastropoda (excluding the Docoglossa) (cf. Cox, 1960). For doubt about the validity of "Archaeogastropoda" as a higher taxon, see Ponder & Lindberg (1997).

[46]The Rhipidoglossa Mörch 1865 is a taxon identified by radular characters; together with the Docoglossa, the Rhipidoglossa encompass the same taxa as the Archaeogastropoda (cf. Cox, 1960).

[47]Because of their anatomical peculiarities, the Neritidae are often placed in a separate ordinal taxon, sometimes referred to as the Neritacea.

[48]The genus *Lepyrium* is now placed in the Hydrobiidae.

[49]The most commonly used class name in recent years for the lamellibranchs, pelecypods and bivalves is Bivalvia Linnaeus 1758. The subclass name used by McCormick & Moore (1969) is Palaeoheterodonta.

[50]Thiele (1935) used the ordinal name Eulamellibranchia. McCormick & Moore (1969), both paleontologists, instead used the name Unionoida.

[51]Thiele (1935) used the suborder name Schizodonta.

[52]Opinion 475 (see refs.) of the International Commission on Zoological Nomenclature validates the name Margaritiferidae Haas 1940 and suppresses the family-group name Margaritaninae. An earlier use of the family name Margaritiferidae was by Henderson (1929).

[53]*Margaritana* Schumacher 1817is a synonym of *Margaritifera* Schumacher 1817.

[54]Opinion 495 (see refs.) of the International Commission on Zoological Nomenclature placed Unionidae Fleming 1828 on the Official List of Family-group Names in Zoology. An earlier authority for the family name is Rafinesque (1820).

[55]"Agassiz [1852] and Simpson's [1900, 1914] conception of *Rotundaria* with *O. tuberculata* as type cannot stand, since Herrmannsen ('47) designated *O. subrotunda* as the type of this genus, which makes *Rotundaria* the same as *Obovaria* as used by Simpson (type, *U. retusa* Lam., congeneric with *O. subrotunda* Raf.). ... Dr. Pilsbry has suggested that of

'*Cyclonaias*,' which we adopt here with the type given above" (Ortmann & Walker, 1922: 18-19).

[56]*Canthyria* Swainson 1840 has been raised to generic rank (cf. Haas, 1969).

[57]The genus *Anodonta* has been divided by Hoeh (1990) into three generic groups: *Anodonta* s.s. Lamarck 1799, *Pyganodon* Crosse & Fischer 1894 and *Utterbackia* F.C. Baker 1927.

[58]*Alasminota* Ortmann 1914 is a synonym of *Sulcularia* Rafinesque 1831 according to Haas (1969). Clarke (1985), however, rejected *Sulcularia* and used *Alasminota* as a subgenus of *Lasmigona*.

[59]*Rugifera* Simpson 1900 is a synonym of *Decurambis* Rafinesque 1831 according to Haas (1969). Clarke (1981) treated *Decurambis* as a subgroup of *Alasmidonta*.

[60]*Simpsoniconcha* Frierson 1914 = *Simpsonaias* Frierson 1914.

[61]*Amygdalonaias* Fischer & Crosse 1893 is a synonym of *Truncilla* Rafinesque 1819 (cf. Haas, 1969).

[62]*Proptera* Rafinesque 1819 = *Potamilus* Rafinesque 1818.

[63]*Unio gracilis* Barnes is now placed in the genus *Leptodea*.

[64]*Carunculina* F.C. Baker 1898 = *Toxolasma* Rafinesque 1831.

[65]*Eurynia* Rafinesque 1820 was placed in the synonymy of *Elliptio* Rafinesque 1819 by Haas (1969).

[66]*Micromya* Agassiz 1852 (preoccupied) is replaced by *Villosa* Frierson 1927.

[67]The question marks here (and in the line below) refer to the uncertainty of the identity of Rafinesque's (1831) "*Unio* (*Lemiox*) *rimosus*." According to Pilsbry (in Ortmann & Walker, 1922: 58), "*Unio rimosus* is not identifiable." Ortmann (1921) proposed the name *Conradilla* for the generic group identified with Rafinesque's *Lemiox*.

[68]*Truncilla* (as used by Walker) and the species of its four subgenera now comprise the genus *Epioblasma*. *Truncilla*, in modern usage, contains the species *T. donaciformis* (Lea), *T. macrodon* (Lea), and *T. truncata* Rafinesque.

[69]*Dysnomia* Agassiz 1852 = *Epioblasma* Rafinesque 1831 (cf. Bogan, 1997).

[70]"Based on a unique individual, hence doubtful; perhaps an abnormality of *Quadrula* (*Quadrula*) *undulata* (Barnes)" (Haas, 1969: 437). Parmalee & Bogan (1998) placed *Cokeria* in the synonymy of *Amblema plicata*.

[71]Two species of the Eurasian-African *Dreissena* (*D. polymorpha* (Pallas) and *D. bugensis* Andrusov 1897) have been introduced into North America since Walker's time.

[72]*Congeria* [a fossil] is not represented in the Western Hemisphere.

[73]Raised to genus rank; *Mytilopsis leucophaeatus* (Conrad) was reported from Virginia; also found in the upper Mississippi (cf. Koch, 1989).

[74]See *Cyrena* below.

[75]*Cyrena* is a synonym of *Corbicula* Megerle von Mühlfeld 1811 (cf. Thiele, 1935). *Corbicula leana* [in North America formerly called *C. manilensis* (Philippi) or *C. fluminea* (Müller)] [family Corbiculidae Gray 1847] has been introduced into North America and is now widespread.

[76]The family name Pisidiidae Gray 1857 has priority over Sphaeriidae Jeffreys 1862. However, some taxonomists regard the genera *Sphaerium* and *Musculium*, and perhaps *Eupera*, to be sufficiently distinct from *Pisidium* to be placed in their own family, the Sphaeriidae.

[77]Cyrenellidae Fischer 1882 = Cyrenoididae H. & A. Adams 1857.

[78]*Cyrenella* is a synonym of *Cyrenoida* Joannis 1835 (cf. Thiele, 1935).

[79]*Rangia* is a marine and brackish-water taxon.

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FOSSIL *LIOPLAX* (GASTROPODA: VIVIPARIDAE) FROM PLEISTOCENE DEPOSITS IN MICHIGAN, WISCONSIN, INDIANA AND ONTARIO

Barry B. Miller[1], Mudge Morris[2] and June E. Mirecki[3]

ABSTRACT

Fossil *Lioplax* have been recovered from Pleistocene sediments collected at sites near Port Huron, Michigan; Kenosha, Wisconsin; Connersville, Indiana and Woodbridge, Ontario. The Michigan, Wisconsin, and Ontario fossil records of *Lioplax* are from deposits interpreted as *Lioplax subcarinata occidentalis* Sangamonian in age and indicate that during the last interglacial the species had a distribution that included parts of the Lake Huron and Lake Ontario drainages. The present disjunct distribution of *L. subcarinata* (Say 1816) and *L. sulculosa* (Menke 1828) appears to be a relic of multiple ice margin fluctuations in the southern Great Lakes during the Wisconsinan Stage.

The fossil materials from Michigan and Ontario, occur in areas that are now unoccupied by *Lioplax*. In the present paper we have assigned the fossil materials to the extant taxon that they most closely resemble in the University of Michigan Museum of Zoology collections The Mill Creek *Lioplax* are most similar to the smaller stream forms *L. subcarinata,* from east of the Appalachians in New York and Pennsylvania. The Kenosha *Lioplax* most closely resemble *L. subcarinata wisconsinensis* Baker. The Porter Farm *Lioplax* most closely resemble *L. subcarinata occidentalis* from the Wabash River, near Terre Haute, Indiana. The Woodbridge locality *Lioplax* were too fragmentary to invite comparison with modern populations, and were assigned to *Lioplax* sp.

Keywords: *Lioplax*, Fossil, systematics, paleogeography, Pleistocene.

INTRODUCTION

The systematics and nomenclature of the genus *Lioplax* Troschel 1856 as currently conceived in North America, follow the revisions suggested in Clench & Turner (1955) which recognizes two northern nominal species, *L. sulculosa* (Menke) 1828 and *L. subcarinata* (Say) 1817 (Vail, 1979; Burch, 1989). These two nominal taxa now occupy very different geographic areas that are separated by a gap of over 600 kilometers (Fig. 1). The data base used by Clench & Turner (1955) for the revision of the two northern nominal species was apparently limited to modern shells. There is no indication that Pleistocene *Lioplax*

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from the Don Valley Brickyard site, reported by Coleman (1933), were used in the revision. Since the Clench & Turner revision, *Lioplax* has been recovered from Pleistocene deposits in Michigan, Wisconsin, Indiana, and a second Ontario site along the Canadian National Railroad berm near Woodbridge (unpublished data). The Ontario and Michigan fossil materials are of particular interest because they include geographic occurrences for *Lioplax* which are outside the modern range of any extant members of the genus (Clench & Turner, 1955; Vail, 1979; Burch, 1989).

In this paper we describe fossil materials collected from Pleistocene deposits: 1) at Mill Creek, in southeastern Michigan; 2) in southeastern Wisconsin, near Kenosha; 3) at Porter Farm, in southeastern Indiana; and 4) exposed along the Canadian National Railroad right-of-way, near Woodbridge, Ontario (Fig. 1). The new fossil data, together with information based on observation of modern shells in the University of Michigan Museum of Zoology (UMMZ), provide the basis for assignent within the genus and offer a mechanism for explaining origin of the modern disjunct distribution of the northern populations of *Lioplax*.

SYSTEMATICS

Recent compilations of the North American freshwater gastropod fauna usually recognize five species of *Lioplax*. These include *L. cyclostomaformis* (Lea 1841), *L. pilsbryi* Walker 1905, *L. subcarinata* (Say 1816) *L. sulculosa* (Menke 1828) and *L. talquinensis* Vail 1979 (Burch, 1989). Prior to the taxonomic revisions of *Lioplax* proposed by Clench & Turner (1955), *L. sulculosa* and *L. subcarinata* were considered to be one species, with a disjunct distribution (Fig. 1).

Lioplax subcarinata was represented by two western subspecies, *L. subcarinata wisconsinensis* Baker 1928, from Brown and Winnebago counties, Wisconsin; and *L. subcarinata occidentalis* Pilsbry 1935, from eastern Minnesota, south to northeastern Arkansas, north central Kentucky, Illinois (Illinois and Rock rivers), Indiana (Wabash River), and southwestern Ohio (Ohio River). The revision of *Lioplax* proposed by Clench & Turner (1955) placed *L. subcarinata wisconsinensis* Baker and *L. subcarinata occidentalis* Pilsbry, in the synonymy of *L. sulculosa* (Menke). East of the Appalachians, from New York and Pennsylvania south to South Carolina, the genus was represented by *L. subcarinata* (Vail, 1979) (Fig. 1). Pilsbry (1935) synonymized *sulculosa* with *subcarinata* because of the probability that the type of *L. sulculosa* (Menke), which was said to have been collected from the Ohio River

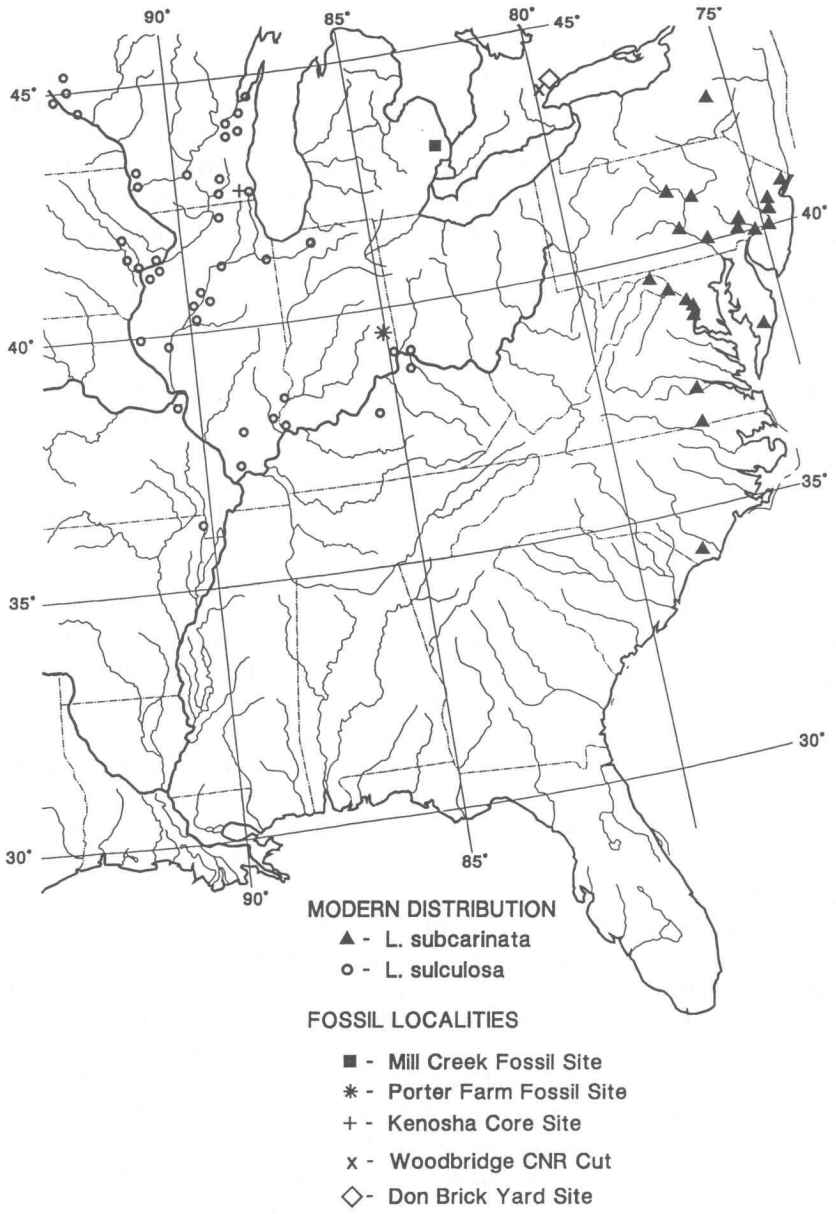

FIG. 1. Map showing the fossil and Recent occurrences of the northern taxa of *Lioplax* (modified from Clench & Turner (1955).

near Cincinnati, Ohio, was identical to *L. subcarinata* from the Delaware River near Philadelphia.

The similarity of the two nominal species, *Lioplax sulculosa* and *L. subcarinata,* was reiterated by Clench & Turner (1955; p.10) who stated that the "... eastern species of *Lioplax* [*L. subcarinata*] Say is exceedingly close in its relationship to *L. sulculosa* the western form. Their characters differ mainly in degree. The shells of *L. subcarinata* Say are usually somewhat thinner and are proportionally a little more attenuate. It appears also that *L. 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."

The fossil materials from Mill Creek, Michigan, Woodbridge, Ontario, and the Don Valley Brickyard, Ontario, occur in areas that are now unoccupied by either *Lioplax sulculosa* or *L. subcarinata* (Fig. 1). The systematic placement of these fossil materials was based on the similarities with modern shells of *L. sulculosa* and *L. subcarinata* in the UMMZ collections.

The five broken individuals of *Lioplax subcarinata* (Kent State University, Geology Department catalog numbers [KSU] 10608; 10624, 10634) recovered from the Mill Creek fossil bed look most similar to the smaller creek forms of *L. subcarinata* in the UMMZ collections from Pennsylvania (UMMZ 95148, Perkiomen Creek) and New Jersey (UMMZ 143757, Raritan River) in terms of size, and carination. Fossil *L. subcarinata* (KSU 11327) from the Kenosha site are relatively small for the genus, and are similar in size to *L. subcarinata wisconsinensis* (Baker) from the Fox River and Lake Winnebago, Wisconsin (Baker, 1928). They differ, however, by the presence in many individuals of distinct carinae.

Most of the 22 relatively complete fossil *Lioplax subcarinata* (KSU 10649) from Porter Farm contain a sulcus above the carina on the apertural whorl. In general, these specimens are larger and wider at the aperture than the modern *Lioplax subcarinata* examined in the UMMZ collections. The shell morphology of the Porter Farm *Lioplax* is most similar to that of modern shells of *Lioplax subcarinata occidentalis* Pilsbry (UMMZ 182432) from the Wabash River near Terre Haute, Indiana. Both *L. subcarinata wisconsinensis* and *Lioplax subcarinata occidentalis,* were synonymised with *L. sulculosa* by Clench & Turner (1955).

We have not examined the *Lioplax* reported by Coleman (1933) from the Don Brick Yard site near Toronto. The Woodbridge locality specimens of *Lioplax* (KSU 11326) are too incomplete to invite comparison

with extant populations of the species. This occurrence represents the second record of this *Lioplax* from interglacial deposits of the Toronto area (Coleman, 1933).

AGE OF THE FOSSIL DEPOSITS

Estimates of the relative age of fossil *Lioplax* recovered from the Mill Creek, Kenosha, and Porter Farm sites are based on: 1) the stratigraphic position of the fossil horizons relative to the local till stratigraphy; and 2) the extent of amino acid racemization in shell protein from associated molluscs. Studies by Miller *et al.* (1994), Mirecki & Miller (1994) and Dethier & McCoy (1993) have demonstrated the utility of isoleucine epimerization in the total hydrolysate and free fraction from nonmarine molluscan shell as a relative dating method. It is based on the conversion of L-isoleucine (Ile) to D-alloisoleucine (aIle) over long time intervals. The extent of isoleucine epimerization (aIle/Ile) is related to the molluscan taxon, the age of the fossils, and the thermal history of the sample. Amino acid epimerization ratios can be used as indicators of relative age if comparisons are made between the same taxon and the localities are sufficiently close to each other that they can be assumed to have had similar temperature histories because of their geographic proximity.

Mill Creek, Michigan

The fossil-bearing unit occurs near the base of a 30 m bluff beneath several Wisconsinan-age tills. Although three different dating methods have been used, the age of the Mill Creek biota still remains uncertain (Karrow *et al.*, 1997). Radiocarbon ages imply a Middle Wisconsinan age. Thermoluminescence dating suggest either an Illinoisan or Middle Wisconsinan age. Amino acid epimerization data suggest two different ages. One group of aIle/Ile total hydrolysate values (approximately 0.20) are similar to, but slightly higher than, ratios obtained for the same taxa from Sangamonian(?) age strata of the Don Formation at Toronto, Ontario (Kerr-Lawson *et al.*, 1992), and the Fernbank beds near Ithaca, New York (Karrow *et al.*, 1990).

A second group of higher aIle/Ile total hydrolysate values (approximately 0.30) suggest a probable Illinoisan age. The occurrence of *Lioplax subcarinata* in the assemblage imply that at least this faunal element probably lived during an interglacial climate and that the age for this

part of the Mill Creek biota is most likely Sangamonian.

Kenosha, Wisconsin

The Kenosha fossils were recovered from sand and gravel at a depth of 192-200 feet below the surface, where it rests upon bedrock. The site is a water-well, located in the town of Pleasant Prairie, about 5 km southwest of Kenosha, Wisconsin in the NW1/4 of SE1/4 section 26, T. 1 N., R. 22 E., Kenosha County, Wisconsin.

Relative age of the Kenosha fossils can be inferred from the aIle/Ile values in the total hydrolysate fraction for an associated species of the genus *Sphaerium*. AIle/Ile peak height values for 10 chromatogams range from 0.07 to 0.10 (Mirecki, unpublished data). These values are slightly lower than the values for this same taxon recovered from Sangamonian deposits at the Fernbank site, near Ithaca, N.Y., and the Don Formation, Toronto (Table 1), and suggest an early Wisconsinan to late Sangamonian age. The abundance of *Lioplax* in the assemblage would appear to favor deposition during the Sangamonian Interglacial.

Porter Farm, Indiana

The Porter Farm fossil site is located along a high cutbank of Williams Creek, about 3.2 km southwest of Connersville, Indiana (Fig. 1). A small collection of fossil shells was reported by Nave (1969) from in-

TABLE 1. Total Hydrolysate aIloIsoluecine/Isoleucine peak height ratios. N = number of specimens analyzed. S.D. = standard deviation.

Taxon	Lab	Number	Mean Peak Height	S.D. +/-	n	Locality
Sphaerium	MSU	93031	0.19	0.01	3	Mill Creek, MI.
Sphaerium	MSU	94004	0.13	0.01	2	Toronto, Ont.*
Sphaerium	MSU	93030	0.14	0.01	2	Toronto, Ont.*
Sphaerium	MSU	94001	0.14	0.03	4	Woodbridge, Ont.
Sphaerium	MSU	94000	0.13	0.02	4	Woodbridge, Ont.
Sphaerium	MSU	94098	0.09	0.01	4	Kenosha, WI.
Sphaerium	AGL	1828	0.57	0.03	2	Porter Farm, IN.

MSU = Memphis State University Amino Acid Geochronology Laboratory (Mirecki is now at the College of Charleston).

AGL = Amino Acid Geochronology Laboratory, reported in Hall (1992).

*Refers to samples analyzed from the Don Formation.

clusions in an unnamed till exposed between 268-283 cm below the top of the exposure. He reported five species, *Lithasia armigera* (Say 1821), *Lioplax subcarinata occidentalis, Pleurocera canaliculatum* (Say 1821), *Amblema plicata* Say 1817 and *Elliptio cf. E. dilatata* Rafinesque 1820, from inclusions in the till. Subsequent collecting at the site by field parties from Indiana University-Purdue University at Indianapolis (Hall, 1992) has provided a large amount of additional shell material. Careful removal of matrix trapped within these shells has increased the associated molluscan fauna. The 17 species identified from these materials include a large component of extant species that are typically associated with a riverine environment. The Porter Farm till inclusions containing the molluscs are obviously incongruous and apparently represent materials eroded by glacial ice from older nonglacial sediments

Amino acid epimerization data from the shell protein of *Sphaerium* recovered from silt inclusions in the upper till at Porter Farm have aIle/Ile values in the total hydrolysate fraction of 0.57 +/- 0.003 (Table 1) similar to those obtained for *Sphaerium* collected from magnetically reversed sediments at Handley Farm, several miles downstream from the Porter Farm site (Miller *et al.*, 1993). The high aIle/Ile values suggest that the Porter Farm molluscs were either reworked from older pre-Illinoisan interglacial deposit, and may represent a chronostratigraphic equivalent of the Handley Farm assemblage, or that the shells are younger than the Handley Farm assemblage, but were exposed to warm, near surface temperatures during the Sangamonian Interglacial. The latter scenario is considered very unlikely because the necessary duration of extended exposure to warm temperatures near the surface required to achieve these values would probably also have resulted in destruction of the shell material. The Porter Farm molluscs, therefore, are probably pre-Illinoian, and as such represent the oldest record of *Lioplax subcarinata occidentalis.*

Woodbridge, Ontario

The Woodbridge site is located west of the Humber River in berm cuts exposed along the right-of-way of the Canadian National Railroad at latitude 43°45'46" north and longitude 79°35'36" west. *Lioplax* sp. was recovered from colluvial sediments that range from several centimeters to 60 cm thick, exposed near the east end of the main berm cut. At some exposures the mollusc bearing unit rests upon the Illinoisan York Till and beneath the Early Wisconsinan Sunnybrook

Till. The age of the colluvial unit, therefore, is probably Sangamonian.

DISCUSSION AND CONCLUSIONS

The Porter Farm, and possibly the Mill Creek *Lioplax subcarinata*, represent pre-Illinoian occurrences of this species. If the suggested correlation between the Porter Farm and Handley Farm fossils is correct, then the Porter Farm fossils are older than 730 ka, the approximate age of the Brunhes-Matuyama boundary, and indicate that the species has undergone little or no evolutionary change in shell morphology over this time span.

The fossil occurrences suggest that the modern disjunct distribution of the modern northern *Lioplax* is probably the result of isolation caused by multiple ice advances into the lower Great Lakes during the Pleistocene. With the exception of the southeast and east-central Wisconsin occurrences (Fig. 1), the species is now absent from most of the areas covered by the lobate southern margin of the late Wisconsinan Laurentide Ice Sheet (Dyke & Prest, 1987).

Prior to the fossil occurrences reported here, the only extant records of *Lioplax subcarinata* in the Great Lakes-St. Lawrence drainage system were modern shells from the vicinity of Green Bay, Wisconsin (Clench & Turner, 1955). The modern distribution pattern led Clench & Turner (1955) to speculate that the genus is probably slowly extending its range and that eventually it would occupy a larger area in the Great Lakes system.

The fossil *Lioplax* from Mill Creek, Kenosha, Don Valley Brickyard and Woodbridge could be similarly interpreted and may represent a post-glacial expansion of range for the genus into the Great Lakes basin during the Sangamonian interglacial, after Illinoisan ice withdrew from the area. The fossils suggest that formerly *Lioplax* had a broader distribution in the Great Lakes basin during the Sangamonian.

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We would like to thank Dr. Floyd Nave (Emeritus, Wittenburg University); Dr. Robert Hall, Indiana University-Purdue University at Indianapolis; Dr. Paul Karrow, University of Waterloo; and Dr. Lee Clayton, Wisconsin Geological and Natural History Survey, who provided the fossil materials used in this study. Dr. John B. Burch, University of Michigan Museum of Zoology, provided access to the shell collections in his charge. We would like to thank Dr. Rodney M. Feldmann, Kent State University, for his useful comments on an earlier draft of the paper and the constructive remarks of an unidentified reviewer that have helped to improve the final version of the paper.

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APPENDIX

Amino acid epimeric data from interlaboratory standard (ilc-b) samples*.

Standard	peak height aIle/Ile value	s.d. +/-	(n)
ILC-B:MSU91147	0.47	0.02	(3)
ILC-B:MSU92034	0.42	0.07	(7)
ILC-B:MSU92050	0.43	0.05	(10)
ILC-B:MSU93045	0.42	0.05	(4)
ILC-B:MSU94027	0.43	0.03	(8)

* An ILC-standard of powdered fossil mollusc shell (Wehmiller,1984) was run with each batch of fossils to provide a basis for comparing these data with those from other laboratories. An ILC-B standard was run with each batch of fossil molluscs as an internal check on analytical precision.

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NEW TAXA OF PUPILLIDAE (PULMONATA: STYLOMMATOPHORA) FROM THAILAND

Somsak Panha[1,2] and J.B. Burch[2,3]

ABSTRACT

Five new species and a new genus of Thai pupilloid land snails are described. ***Boysidia tholos* n. sp.** has a small, short, dome-shaped shell, an open umbilicus, and a tilted tuba. The aperture contains five barriers: well developed parieto-angular and columellar lamellae, a tiny infraparietal lamella, a deeply entering upper palatal plica, and a deep-set lower palatal plica. ***Systenostoma edentatum* n. sp.** has a high spired, loosely coiled shell with flat-sided ultimate and penultimate whorls, and sculpture of close-set, raised spiral striae and irregularly spaced transverse striae. The shell aperture is without barriers, and has a simple, unthickened peristome. ***Systenostoma tamlod* n. sp.** has a high spired, tightly coiled shell with rounded whorls and raised spiral striae and irregularly spaced transverse striae. The shell aperture has two barriers: a small lamella on the parietal wall, and a poorly developed plica on the palatal peristome. ***Krobylos* n. gen.** is characterized by the helicoid, rimate shell with angular teleoconch whorls, the sharp, unexpanded, unreflected peristome, the lack of spiral or transverse striae, the absence of barriers in the aperture, and the presence of well developed, irregular growth lines that give the shell a rough appearance. ***Krobylos pomjuk* n. sp.** has a depressed spire, rapidly expanding whorls, and very large body whorl. ***Krobylos maehongsonensis* n. sp.** is high-spired.

Key words: Pulmonata, Pupilloidea, *Boysidia tholos, Krobylos pomjuk, K. maehongsonensis, Systenostoma edentatum, S. tamlod,* Thailand.

INTRODUCTION

The very large land snail family Pupillidae has a worldwide distribution and comprises a multitude of taxa at various levels in the taxonomic hierarchies. Previous papers on Thai pupillids are those of Möllendorff (1894), Thompson & Lee (1988), Thompson & Upatham (1997), Panha (1997a, b, c), and Panha & Burch (1999). Papers that include pupillid snails from surrounding or nearby countries (Myanmar [Burma], Malaysia [Malaya], and Vietnam [Tonkin]) include those of Blanford (1863), Stoliczka (1871, 1873), Möllendorff (1881, 1886), Bavay & Dautzenberg (1908, 1909b, 1912), Tweedie (1947), and Benthem Jutting (1949a,b, 1960,

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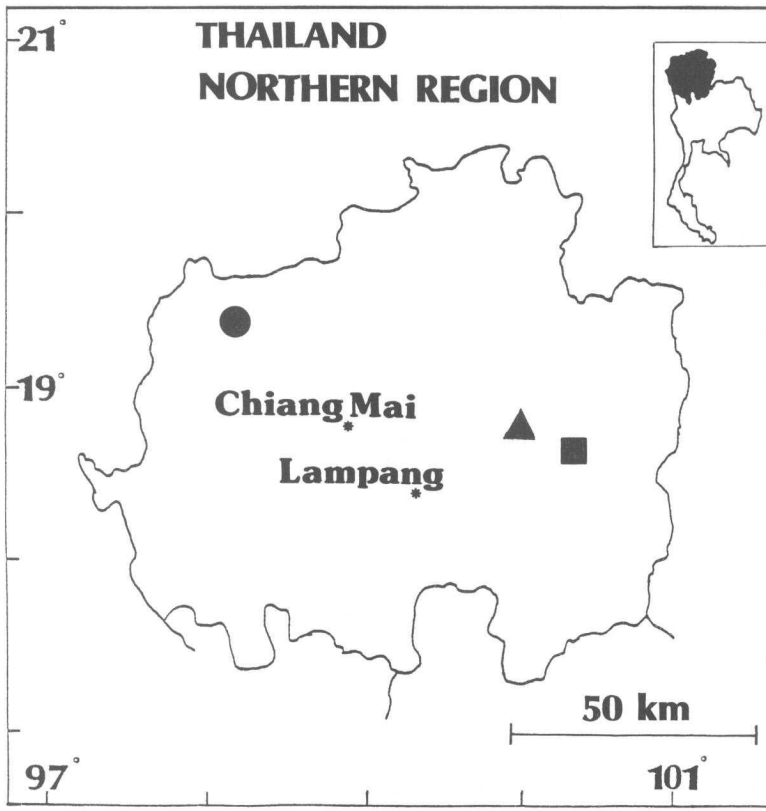

FIG. 1. Map showing Phanangkoy (■), Phrae Province; Lod Cave area (●), Mae Hong Son Province; and limestone mountain area at Tamphatai National Park, Phrae Province (▲).

1961, 1962). The present paper describes five new species for Thailand, two of which are placed in a new genus.

Boysidia Ancey 1881

The genus *Boysidia* Ancey is distributed from China to the Malay peninsula (Pilsbry, 1917; Benthem Jutting, 1949b). Previously named species and subspecies are *B. dorsata* (Ancey), *B. hunana hunana* (Gredler), *B. hunana conspicua* (Möllendorff), *B. strophostoma* (Möllendorff), *B. hangchowensis* (Pilsbry & Hirase), *B. gracilis* Haas, *B. ringens* Benthem Jutting, and, from Thailand, *Boysidia chiangmaiensis* Panha & Burch. The second species of *Boysidia* to be found in Thailand is described below.

Boysidia tholos n. sp.
(Fig. 2)

Description of holotype. Shell with 4 3/4 convex whorls, umbilicate, and dome-shaped, but with a pointed apex,. Surface sculptured with growth lines, and there is evidence of irregularly placed transverse raised striae, but spiral striations are lacking. There are five apertural barriers: the parietal lamella is largest and reaches the posterior edge of the peristome, its anterior end and edge nearly touch the upper palatal plica, making almost a separate apertural chamber; the palatal plicae and the collumellar lamella are not as prominent; the lower palatal plica is situated deeper within the aperture; there is also a tiny infraparietal lamella. The peristome is complete, thickened and broadly rather expanded. Shell height 2.1 mm; width 1.5 mm; aperture height 1.0 mm. The dimensions of the type specimens are given in Table 1.

Type locality. Thailand, Phanangkoy, Phrae Province (Fig. 1) at 18°20'01" N, 100°21'10" E, 380 meters elevation (CUIZM, Ver 012).

Etymology. The specific epithet *tholos*, meaning dome shaped, is a Latin noun in apposition. It refers to the shape of the shell.

Type materials. The holotype (CUIZM, Ver 012) is deposited in the Chulalongkorn University Zoological Museum together with four paratype shells (CUIZM, Ver 013). Another three paratype shells will be placed in the Museum of Zoology, University of Michigan, Ann Arbor. Legacy S. Panha.

Geographic distribution and habitat. *Boysidia tholos* is probably limited to northern Thailand. The shells were collected from soil samples. *Chloritis* (*Trichochloritis*) *deliciosa* (Pfeiffer 1863) was also found in this habitat.

TABLE 1. Holotype and paratypes dimensions (in mm) of *Boysidia tholus* n. sp.

Types	Height	Width	Height of aperture
Holotype	2.1	1.5	1.0
Paratypes			
1	2.2	1.6	1.0
2	2.2	1.6	1.0
3	2.1	1.5	1.0
4	2.1	1.5	1.0
5	2.1	1.5	1.0
6	2.1	1.5	1.0
7	2.0	1.5	1.0

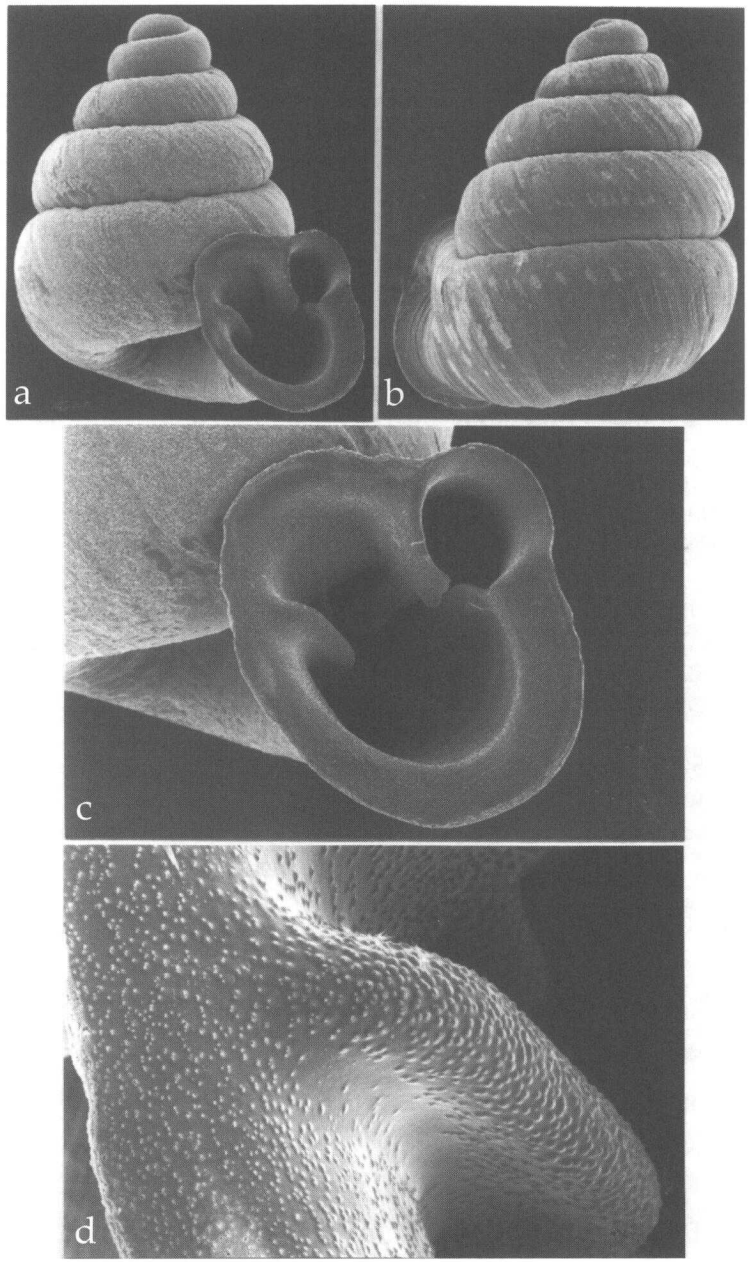

FIG. 2. *Boysidia tholos.* Holotype shell. **a**, Apertural view; **b**, abapertural side; **c**, enlarged view of the aperture and peristome; **d**, higher magnification of the collumellar tooth showing fine characteristics of the surface. Fig. 2a,b, ca. X25; Fig. 2c, ca. X52; Fig. 2d, ca. X250.

Diagnosis. A small *Boysidia* species that has a short, dome-shaped shell, with an open umbilicus, and a tilted tuba. The aperture contains five barriers: well developed parieto-angular and columellar lamellae, a tiny infraparietal lamella, a deeply entering upper palatal plica, and a deep-set lower palatal plica.

Remarks. Both *Boysidia tholos* and *B. chiangmaiensis* are very similar, differing mainly in the lengths of their shells (Tables 1, 2), the shapes of their shell spires, and the axis of their apertures in relation to the shells' columellar axes. The shell apertures of both species are very similar to that of *B. hangchowensis* (Pilsbry & Hirase) (see Pilsbry, 1917, p. 196, text fig. 17), but differ in the round shape of their right posterior aperture enbayments and in the concave outlines of their spire peripheries.

Systenostoma Bavay & Dautzenberg 1909

Systenostoma is a genus of Thailand and Vietnam. It was first recognized and named by Bavay & Dautzenberg (1908, 1909b) as a subgenus of *Helix*, but Bavay & Dautzenberg (1912) decided that a more proper placement for these minute snails would be with the pupillids: "... le genre *Systenostoma*, que nous avions placé parmi les Hélicéens, appartient plutôt aux Pupidés et qu'il doit être mis dans le voisinage des *Hyselostoma* et

TABLE 2. Holotype and paratypes dimensions (in mm) of *Boysidia chiangmaiensis* Panha & Burch.

Types	Height	Width	Height of aperture
Holotype	4.1	2.4	1.4
Paratypes			
1	4.2	2.4	1.4
2	4.2	2.4	1.4
3	4.2	2.4	1.4
4	4.2	2.4	1.4
5	4.2	2.4	1.4
6	4.2	2.4	1.4
7	4.2	2.4	1.4
8	4.1	2.4	1.4
9	4.1	2.4	1.4
10	4.1	2.4	1.4
11	4.1	2.4	1.4
12	4.0	2.3	1.4
13	4.0	2.3	1.4
14	4.0	2.3	1.4
15	3.9	2.3	1.3
16	3.9	2.3	1.3

des *Boysidia*: les *Systenostoma* seraient, pour ainsi dire, des *Boysidia* édentules."

Four species of *Systenostoma* have been described from Vietnam, *S. pauperima*, *S. pulverea* and *S. defixa* by Bavay & Dautzenberg (1909a, 1912), and *S. depressa* by Jaeckel (1950). Two species were previously described for Thailand, *S. concava* and *S. elevata* (Thompson & Upatham, 1997). An additional two species for Thailand are described below.

Systenostoma tamlod n. sp.
(Fig. 3)

Description of holotype. Shell 1.0 mm high 0.8 mm wide with 4 3/4 whorls consisting of conical spire, the last whorl is the largest. Aperture is not downwardly directed, oval, with a distinct parietal tooth located near the edge. There is an indistinct palatal tooth-like located near the edge, spiral striation appeared distinctly from the second whorl. The shell is white. The dimensions of holotype and paratypes are shown in Table 3.

Type locality. Lod Cave (Fig. 1), Pang Ma Pa District, Mae Hong Son Province, 19°29'36" N, 98°17'18" E and 10°34 '03" N, 98°16'41" E, 800 meters elevation (CUIZM, Ver 025), Thailand. All specimens were collected inside the cave, almost two kilometers from the entrance.

Etymology. The specific epithet *tamlod*, used as a noun in apposition, refers to Lod Cave. Tamlod in the Thai language means Lod Cave.

Type material. The holotype (CUIZM, Ver 025) is deposited in the Chulalongkorn University Zoological Museum together with eight paratype specimens (CUIZM, Ver 026). Another three paratype shells

TABLE 3. Holotype and paratype dimensions (in mm) of *Systenostoma tamlod*.

Type	Height	Width	Height of aperture
Holotype	1.0	0.8	0.3
Paratypes			
1	1.0	0.8	0.3
2	1.0	0.8	0.3
3	1.0	0.8	0.3
4	1.0	0.8	0.3
5	1.0	0.8	0.3
6	0.9	0.8	0.3
7	0.9	0.8	0.3
8	0.9	0.8	0.3

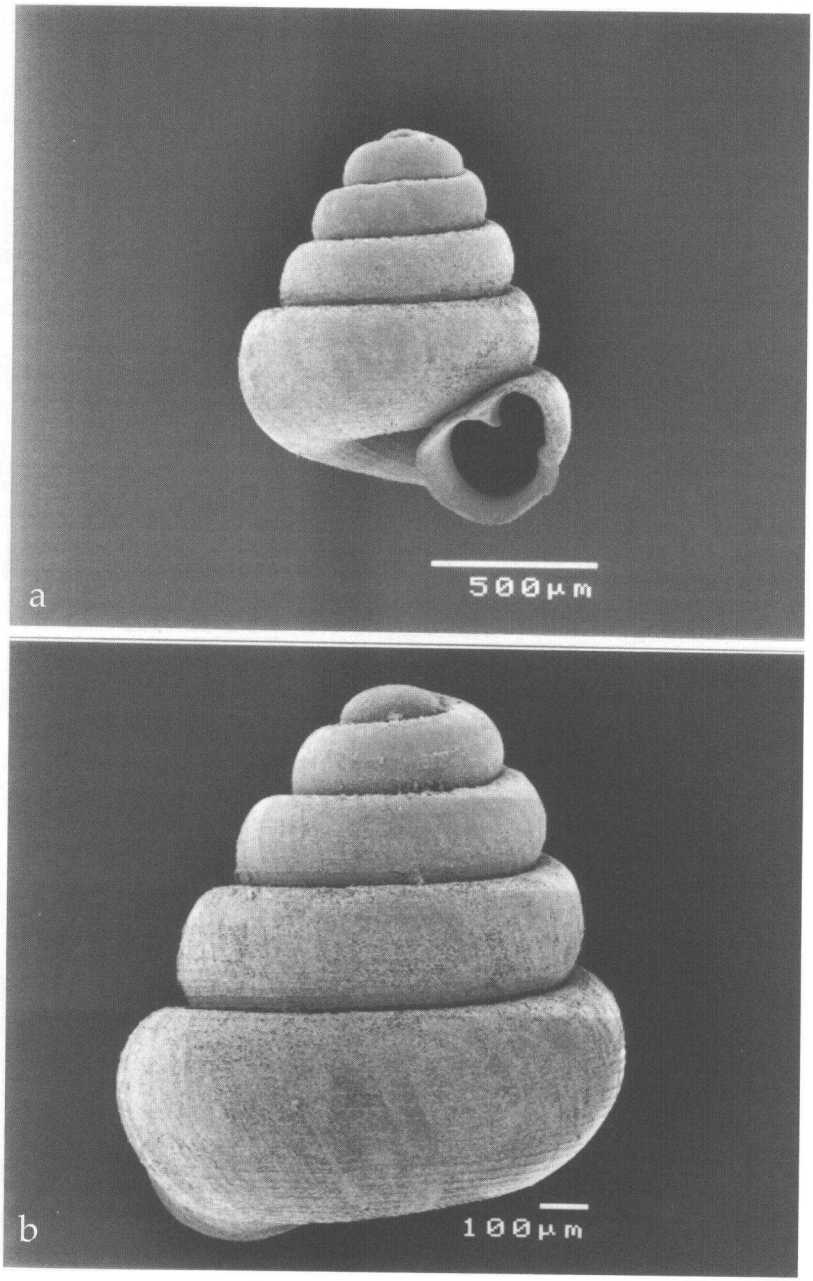

FIG. 3. *Systenostoma tamlod*. **a**, **b**, Holotype (CUIZM, Ver 025).

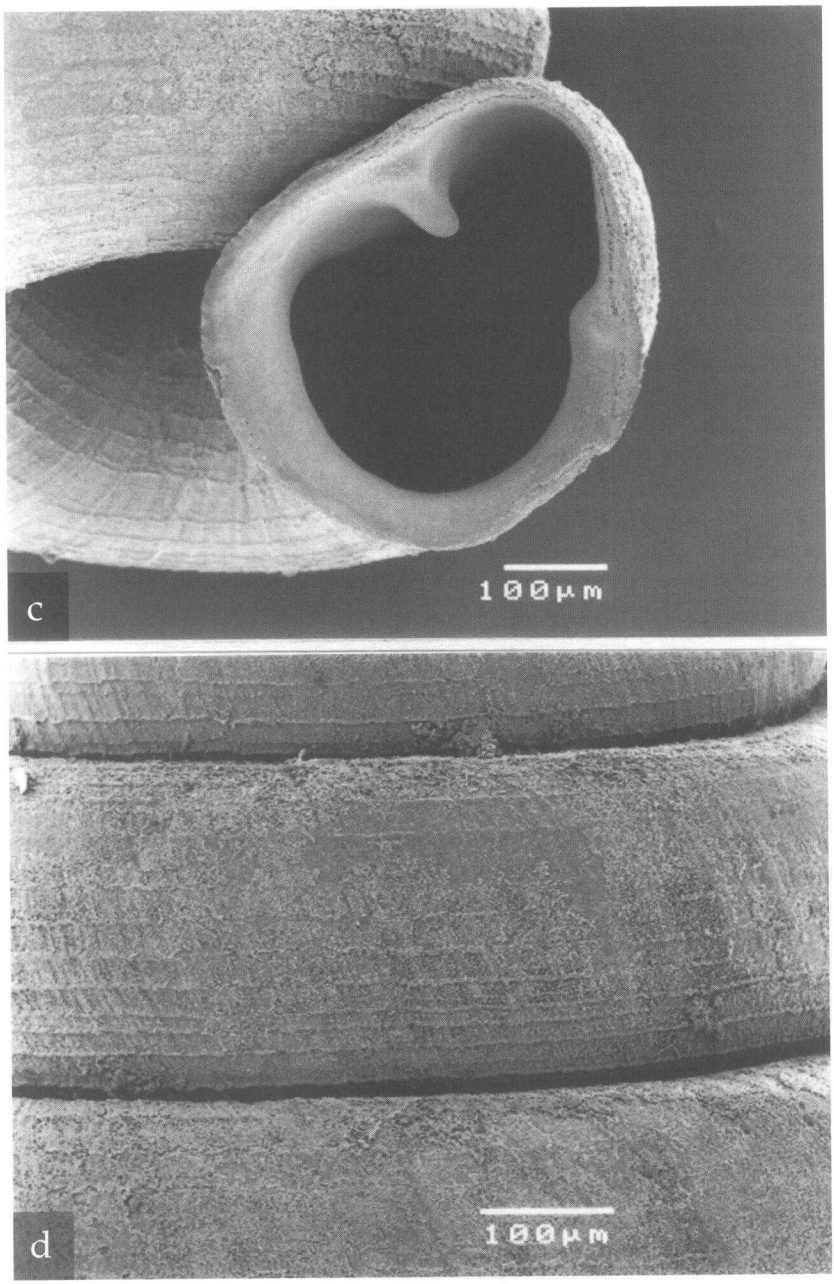

FIG. 3 (continued). **c**, Aperture and apertural teeth; **d**, spiral striation on whorls.

will be placed in the Museum of Zoology, University of Michigan, Ann Arbor. Legacy S. Panha.

Geographic distribution and Habitat. *Systenostoma tamlod* may be limited to northern Thailand. The specimens were collected on limestone walls deep inside Lod Cave.

Diagnosis. *Systenostoma tamlod* has a high spired, tightly coiled shell with rounded whorls, and sculpture of close-set, raised spiral striae and irregularly spaced transverse striae. The shell aperture has a simple, unthickened peristome, and contains two barriers: a small lamella on the parietal wall, and a poorly developed plica on the palatal peristome.

Systenostoma edentatum n. sp.
(Fig. 4)

Description of holotype. The very small shell measures 2.2 mm in height and 1.4 mm in width, and has 4 3/4 whorls. The last whorl is remarkably enlarged. The shell surface is sculptured with five, raised, close-set spiral striae (threads) and irregularly spaced transverse growth lines or striae. The shell aperture is nearly round, and has an unthickened, unreflected and unexpanded peristome (except on the columellar side, where the peristome is reflected), and lacks lamellae and plicae. The last part of the body whorl and peristome are attached to the preceeding whorl. The umbilicus is rather narrow.

The evenly conical shell is high-spired and rather loosely coiled. The

TABLE 4. Holotype and paratype dimensions (in mm) of *Systenostoma edentatum*.

Type	Height	Width	Height of aperture
Holotype	2.2	1.4	0.7
Paratypes			
1	2.2	1.4	0.7
2	2.2	1.4	0.7
3	2.2	1.4	0.7
4	2.1	1.4	0.7
5	2.1	1.4	0.7
6	2.1	1.4	0.7
7	2.1	1.4	0.7
8	2.1	1.4	0.7
9	2.0	1.3	0.6
10	2.0	1.3	0.6
11	2.0	1.3	0.6
12	2.0	1.3	0.6

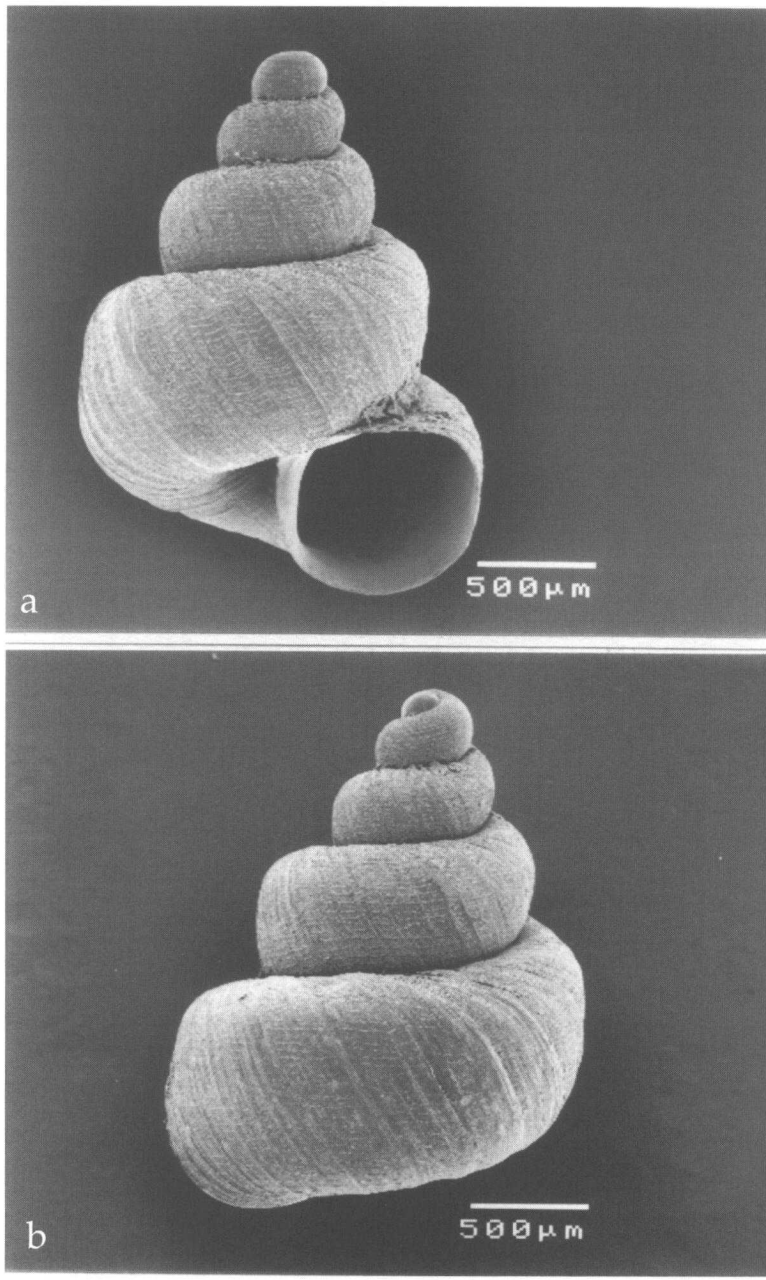

FIG. 4. *Systenostoma edentatum* n. sp. **a**, **b**, Holotype (CUIZM, Ver 022).

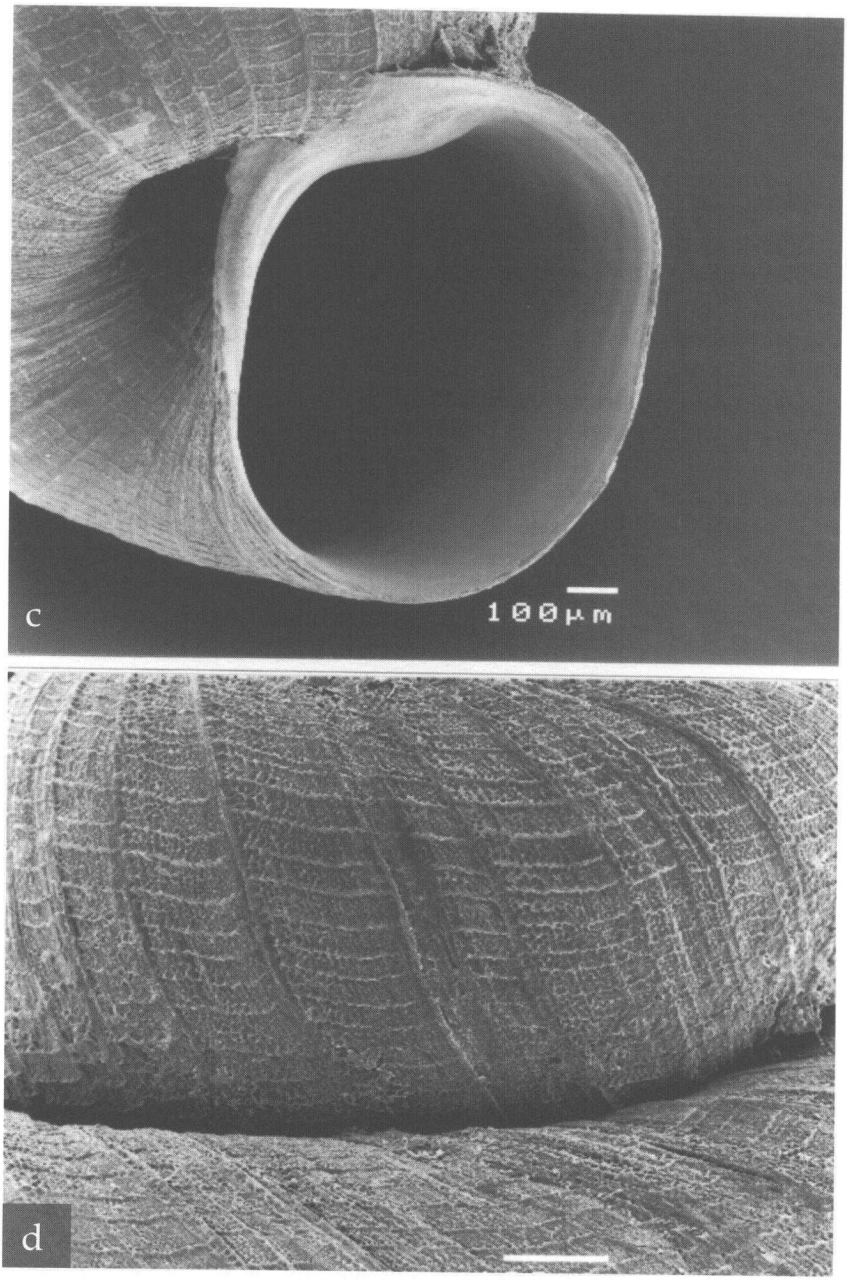

FIG. 4 (continued). **c**, Toothless aperture; **d**, axial riblets and radial striation on the shell.

last whorl has nearly flat sides. The sutures are deeply impressed. Shell dimensions of type specimens are given in Table 4.

Type locality. Tamphatai National Park (Fig. 1), Phrae Province, 18°36"20' N, 99°53"49' E, 650 meters elevation (CUIZM, Ver 022), Thailand, 1997.

Etymology. The specific epithet *edentatum* refers to the toothless aperture of the shell.

Type material. The holotype (CUIZM, Ver 022) is deposited in the Chulalongkorn University Zoological Museum together with 12 paratype shells (CUIZM, Ver 023). Another five paratype shells will be placed in the Museum of Zoology, University of Michigan, Ann Arbor. Legacy S. Panha.

Geographic distribution and Habitat. The geographic distribution of *Systenostoma edentatum* may be limited to northern Thailand. Our specimens were found in soil samples at the same habitat of *Hypselostoma khaowongensis* Panha 1997.

Diagnosis. A tiny species, 2.0-2.2 mm in diamter, with a high spired, loosely coiled, umbilicate shell. The ultimate and penultimate whorls are flat-sided. Shell sculpture of close-set, raised spiral striae and irregularly spaced transverse striae. Aperture without barriers, peristome simple, unthickened.

Discussion of the genus *Systenostoma*

Pilsbry (1917) included the genus *Systenostoma* in his *Manual of Conchology* (pp. 224-226) and figured (pl. 38, figs. 3-5, 10-12, 15-16) the three then-known species, *S. pulverea, S. pauperrima* and *S. defixa,* all taxa described by Bavay & Dautzenberg (1909a, 1912). Pilsbry added that, "My knowledge of *Systenostoma* is wholly from the writings of Bavay and Dautzenberg, ... from which I get the impression that it is closely related to *Aulacospira.* It differs by having the whorls rounded instead of keeled, and the lip less expanded, almost simple." Of the three species, one, *S. pulverea,* is "ornamented with delicate, oblique lines of growth, and very delicate spiral lines, only visible under a strong lens" (Pilsbry's translation). *Systenostoma pauperrima* was described as "without any trace of sculpture," but "all the specimens being dead and discolored." Possibly the delicate striae could not be seen because of the poor condition of the shells. No sculpture was mentioned for *S. defixa.*

Jaeckel (1950) described a species from Tonkin as *Systenostoma depressa,* and described its shell surface as follows, "Die Skulptur besteht aus radialen weit stehenden schiefen Streifchen, die die sehr feinen Spiralen kreuzen; sie beginnt am Apex und lässt sich bis auf die Unterseit

verfolgen." In the diagnosis of the species, Jaeckel said, "Die Skulptur besteht aus feinen weitstehenden Streifen und sehr feiner Spiralskulptur vom Apex bis zur Unterseite der letzten Windung."

Thompson & Upatham (1997) described two species of *Systenostoma* from Thailand, *S. concava* and *S. elevata.* They used the shell surface sculpture as a key character in delineating Southeast Asian pupilloid taxa, separating *Systenostoma* and their new genus *Acinolaemus* from other taxa by "Embryonic whorls with raised spiral threads," the minute size of the shells, and characters of the aperture. The protoconch sculpture of *S. concava* was described as "consisting of very fine reticulating granules ...; very weak spiral threads occasionally present. Teleoconch with microsculpture similar to protoconch, but spiral threads more apparent ...; superimposed on microsculpture are irregularly spaced growth wrinkles." For *S. elevata,* protoconch "microsculpture consisting of minute, low anastomosing granules; no indication of spiral threads observed in the specimens examined ... Teleoconch with similar but finer microgranules and fine raised spiral threads that are crossed by irregularly spaced oblique axial threads; base and umbilicus lacking spiral threads."

Our SEM pictures of *Systenostoma tamlod* and *S. edentatum* do not clearly show protoconch sculpture, but their teleoconch sculpture appears to be the same as described for Thompson and Upatham's two species, except that on our species the microsculpture continues on the shell base and into the umbilicus.

The species of *Systenostoma* as described by Bavay and Dautzenberg lack shell apertural dentition, as does the species described by Jaeckel. However, for *S. concava,* Thompson and Upatham describe and figure "a low ridge-like angular lamella," and a "palatal lip margin with a slight tubercular thickening." *Systenostoma elevata* lacks "any indication of dentition." For our two *Systenostoma* species, *S. edentatum,* as its name implies, lacks apertural dentition, but *S. tamlod* has the same type of apertural dentition as described by Thompson and Upatham for *S. concava.*

[It is interesting to note the similiarity of the apertural dentition of "*Hypselostoma laidlawi* Collinge" as figured by Benthem Jutting (1949b, p. 19, fig. 9) to our *Systenostoma tamlod,* and to Thompson & Upatham's (1997) *S. concava.* Actually, because of that, and the general shell shape and other characteristics, including shell sculpture, we would assign "*H. laidlawi,*" as presented by Benthem Jutting (1949b [1950]), to *Systenostoma* rather than to *Hypselostoma.* (But, while similar to our and to Thompson and Upatham's *Systenostoma* species, "*H. laidlawi*" does have its own minor specific differences – aspects of shell shape and wide umbilicus – that differentiate it from our species.)

Benthem Jutting (1949b, p. 20) explained about the specimen she figured as follows, "The specimen which I received for examination from the British Museum (Natural History) has only 2 teeth in the aperture. These probably correspond with Collinge's 'dorsal' and 'ventral' ones. Of the other, smaller, internal teeth which Collinge mentioned there is not the slightest trace in the shell now before me. Whether the two small teeth are present in the type specimen, now preserved in the University Museum of Zoology at Cambridge, will be difficult to ascertain, because the holotype is so badly broken and delicate that an examination could not be allowed."

Later Benthem Jutting (1961, p. 36) again took up the matter of Collinge's *Hypselostoma laidlawi.* "In my 1950 paper (p. 19) I referred to the fact that Collinge (1902, *Journ. Malac.* Vol. 9, p. 83) described *Hyselostoma laidlawi* as having 4 teeth in the aperture whereas the specimen in the British Museum (Natural History) which I received on loan under the name *Hypselostoma laidlawi* had only 2 teeth.

"A newly collected lot from Gua Che Yatin, Ulu Tembeling, Pahang, May 1953 now brings the clue to this riddle. The sample contained five specimens with 5 teeth (1 angular, 1 parietal, 1 basal, 1 lower and 1 upper palatal) and nine specimens having 2 teeth.

"The five first-mentioned shells correspond with Collinge's *Hypselostoma laidlawi* (fig. 2b).[1] On account of the adnate peristome and the separation of angular and parietal teeth it must now be classified as *Paraboysidia laidlawi.*

"[1]. It seems that either Collinge overlooked one tooth in the aperture, or that the specimen which he studied had indeed only four teeth. This must remain an open question as the unique shell from the "Skeat Expedition", now in the Zoological Museum at Cambridge, is in such a delapidated condition that it could not be re-investigated.

"The nine last-mentioned shells and the one in the British Museum mentioned above are a different species which I introduce here as:

"*Paraboysidia neglecta* n. sp. ..."

Benthem Jutting's (1949b) "*Hypselostoma laidlawi,*" although similar (as figured by her) to her (1961, fig. 2a) *Paraboysidia neglecta* n. sp., there are some subtle differences. The shell figured by her in 1949b is smaller, has a least one less whorl, the last whorl has a shoulder, the aperture is somewhat differently shaped, and there is a slight swelling on the subcolumellar-basal side of the peristome.

Benthem Jutting's (1961, fig. 2b) illustration of "*Paraboysidia laidlawi* (Collinge)" shows a shell aperture not very unlike Thompson & Upatham's (1997, figs. 16, 18) SEM photograph of *Acinolaemus sphinctinion.*

Incidentally, while Collinge's (1902, p. 83, pl. 5, figs. 29, 30) description of *Hypselostoma laidlawi* and his figures do not clearly show inside the shell aperture, it is hard to reconcile his figured shell which shows a strongly deflected distal part of the ultimate whorl, and a narrow umbilicus, with the shell Benthem Jutting (1961, pl. 8, fig. 21) portrayed and figured as his species.

It is obvious that the taxonomy of these pupiliod microsnails of east and southeast Asia need to receive more in-depth study, including the use of biochemical, cytological and molecular techniques, in order to understand their inter relationships.]

The shell of *Systenostoma pauperrima* is high-spired and pyramidal in outline, and the umbilicus is rather narrow. The shell of *S. pulverea* is high-spired, but not to the extent of that of *S. pauperrima,* and the spire outline on the abapertural side is somewhat concave due to the enlarged ultimate whorl. The umbilicus is narrower than that of *S. pauperrima.* The shell of *S. defixa* has a depressed spire with a concave outline on the abapertural side, also due to the enlarged ultimate whorl. Its umbilicus is larger than that of *S. pauperrima* and *S. pulverea.* The shell spire of *S. depressa* is depressed, as its name implies, but its shell shape as illustrated with the species description is more like that of *Aulacospira* or *Krobylos. Systenostoma tamlod* has a straight-sided spire and more evenly enlarged body whorl. The body whorl is more shouldered than in the other species of the genus. The most obvious characters of *S. edentatum* are its loosely coiled, high-spired shell, and the peripherally flattened body whorl.

All of the *Systenostoma* species have impressed sutures.

Krobylos n. gen.

Type species: *Krobylos pomjuk* Panha & Burch, new species.

Etymology. The name *Krobylos* is from Greek, meaning a roll or knot of hair on top of the head. The first several whorls of the shell resemble such a knot, a hair style worn by many rural Thai children.

The most distinctive characteristics of *Krobylos* are the helicoid, rimate shell with angular teleoconch whorls, the sharp, unexpanded peristome, which is unreflected, except at the columellar margin, the lack of spiral or transverse striae, and the presence of well developed, irregular growth lines that give the shell a rough appearance.

The shell of *Krobylos* differs from other southeast Asian pupilloid genera, except *Aulacospira* and *Systenostoma,* by the helicoid shape of its two species, and the rimate shell with adnate, incomplete peristome. Although *Aulacospira* species have helicoid shells, the distal part of their last whorls are free and deflected downward (except in *A. defina,* but that species has prominent apertural dentition; the two Thai species of *Aulacospira* also have apertural dentition), and the peristome is expanded. The shell of *Systenostoma* has rounded, non-angular whorls, a complete peristome, and most (perhaps all) species are spirally striate.

Krobylos pomjuk n. sp.
(Fig. 5)

Description of holotype. Shell 1.5 mm high, 2.1 mm wide, with three

and a half whorls. The whorls expand rapidly, with the last whorl being especially large and inflated. The last two whorls are weakly angular. The sutures are well defined and deep. The periostracum is dark gray in fresh specimens. Oblique, irregularly pronounced, growth lines give the shell surface a rough appearance. The protoconch contains 1.3 protruding whorls, which are smooth, lacking any apparent microsculpture. The peristome is oval in shape, sharp, not expanded or thickened and not reflected, except at the columellar margin, where it has a relatively large reflection that nearly covers the umbilicus. The aperture lacks dentition. The dimensions of type specimens are given in Table 5.

Type locality. Lod Cave (Fig. 1), Pang Ma Pa District, Mae Hong Son Province at 19°34'3" N, 98°16'41" E, 840 meters elevation (CUIZM, Ver 031), Thailand, 1997.

Etymology. *Pomjuk* is a Thai noun, here used in apposition, and refers to the shape of the shell, which resembles a knot of hair on top of the head. This hair style is used by young Thai children, especially in rural areas.

Type material. The holotype (CUIZM, Ver 031) is deposited in the Chulalongkorn University Zoological Museum together with 21 paratype specimens (CUIZM, Ver 032). Another 10 paratype shells will be placed in the Museum of Zoology, University of Michigan, Ann Arbor. Legacy S. Panha.

Geographic distribution and habitat. *Krobylos pomjuk* may be limited

TABLE 5. Holotype and paratype dimensions (in mm) of *Krobylos pomjuk*.

Type	Height	Width	Height of aperture
Holotype	1.5	2.1	0.7
Paratypes			
1	1.7	2.2	0.8
2	1.7	2.2	0.8
3	1.6	2.2	0.8
4	1.5	2.1	0.7
5	1.5	2.1	0.7
6	1.5	2.1	0.7
7	1.5	2.1	0.7
8	1.4	2.1	0.7
9	1.4	2.1	0.6
10	1.4	2.1	0.6
11	1.4	2.1	0.6
12	1.4	2.1	0.6

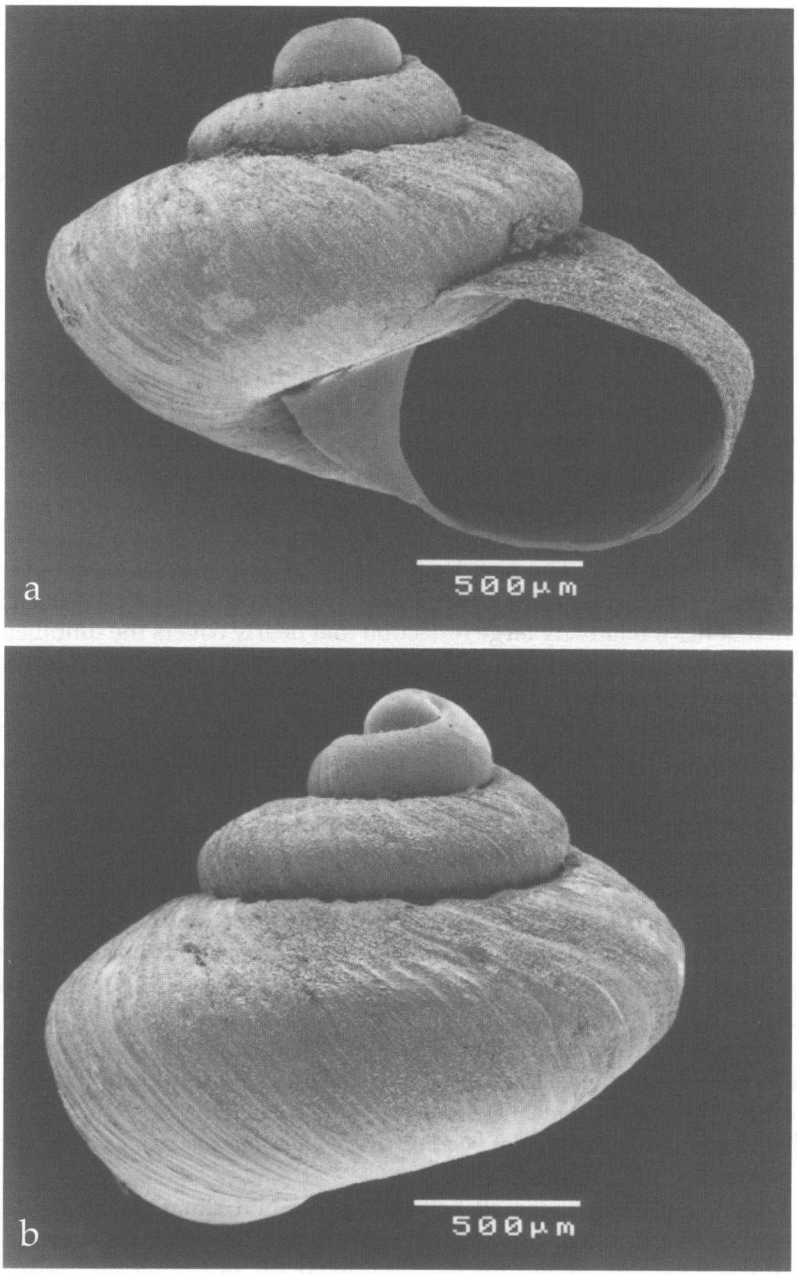

FIG. 5. *Krobylos pomjuk*. **a**, **b**, Holotype (CUIZM, Ver 031).

to northern Thailand. The snails live on limestone walls, attaching tightly to the rock surface when not active. *Hypselostoma khaowongensis* Panha was also found in this habitat.

Diagnosis. Shell very small, depressed, helicoid, rimate, with rapidly expanding whorls. Aperture lacking lamellae and plicae. Lip sharp, unexpanded, unthickened, and, except for the columellar lip, not reflected. Surface sculpture of uneven growth lines; protoconch smooth.

Krobylos maehongsonensis n. sp.
(Fig. 6)

Description of holotype. Shell 2.3 mm high, 2.0 mm wide, and with four and a half whorls. The whorls expand rather evenly. The last three whorls have a pronounced peripheral angulation. The sutures are well defined and deep. In fresh specimens, the periostracum dark gray in color. The oblique, irregular growth lines give the shell surface a rough appearance. The protoconch has 1.2-1.4 protruding, smooth whorls, lacking microsculpture. The peristome is more or less round, sharp, not expanded or thickened and not reflected, except at the columellar margin where it has a relatively large reflection that nearly covers the umbilicus. The aperture lacks dentition. The dimensions of holotype and paratype specimens are given in Table 6.

Type locality. Lod Cave (Fig. 1), Pang Ma Pa District, Mae Hong Son Province at 19°29′36″ N, 98°17′18″ E, 600 meters elevation (CUIZM, Ver 034), Thailand, 1997.

Etymology. The specific epithet *maehongsonensis* is from the name of Mae Hong Son Province, where this snail was found.

Type material. The holotype (CUIZM, Ver 034) is deposited in the Chulalongkorn University Zoological Museum together with eight paratype specimens (CUIZM, Ver 035). Another six paratype shells will be placed in the Museum of Zoology, University of Michigan, Ann Arbor. Legacy S. Panha.

Geographic distribution and habitat. *Krobylos maehongsonensis* may be limited to northern Thailand. The snails live on limestone walls, attaching the wall surface. This species was collected at a slightly lower elevation than was *Krobylos pomjuk*. *Hypselostoma khaowongensis* Panha was also found in this habitat.

Diagnosis. Shell very small, helicoid, high spired, rimate, with angulate whorls. Aperture lacking lamellae and plicae. Lip sharp, unexpanded, unthickened, and, except for the columellar lip, not reflected. Surface sculpture of uneven growth lines; protoconch smooth.

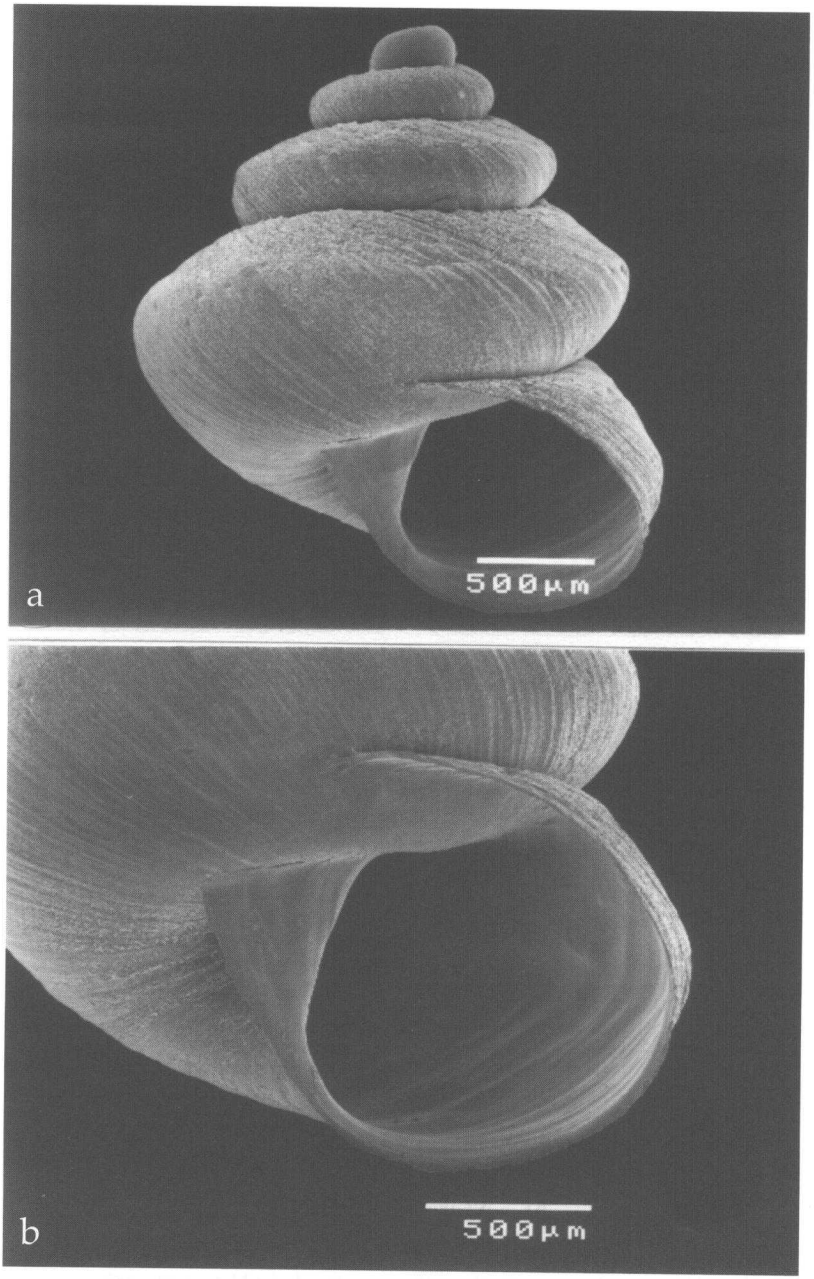

FIG. 6. *Krobylos maehongsonensis,* holotype shell, (CUIZM, Ver 034). **a**, Apertural view; **b**, higher magnification of the aperture and peristome.

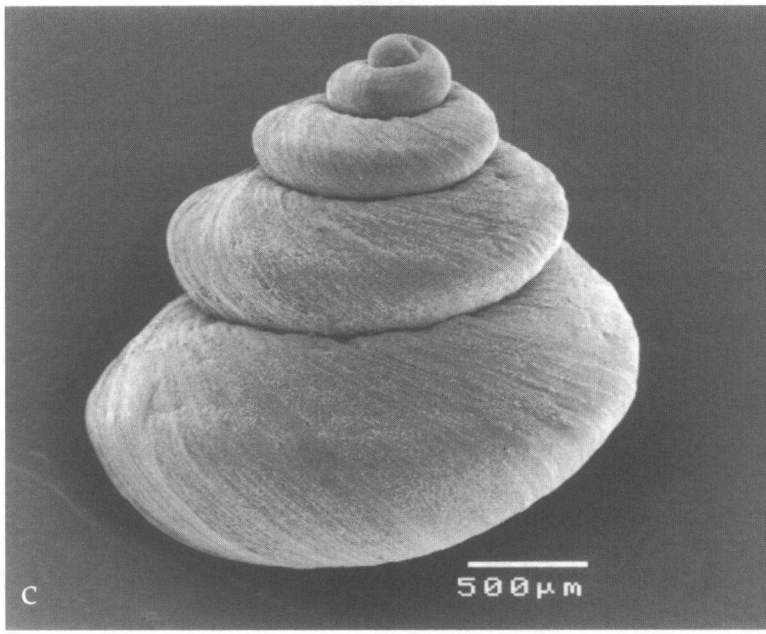

FIG. 6 (continued). **c**, Abapertural side.

TABLE 6. Holotype and paratype dimensions (in mm) of *Krobylos maehongsonensis*.

Type	Height	Width	Height of aperture
Holotype	2.3	2.0	1.2
Paratypes			
1	2.3	2.0	1.2
2	2.3	2.0	1.2
3	2.3	2.0	1.2
4	2.3	2.0	1.2
5	2.3	2.0	1.2
6	2.2	2.0	1.2
7	2.2	2.0	1.2
8	1.8	1.6	0.8

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