

FIG. D14. Pseudocardiinae (p. N410-N411).

RV teeth have rounded transverse ridges, to which grooves in dental sockets of LV correspond; anterior laterals not extending beyond beaks. *M.Jur.* (*Allen-Bathon.*), C.Asia-E.Asia.—FIG. D14, 3a. **P. submagna*, Bajoc., E.Tien-Shan; LV int., $\times 1$ (MARTINSON, 1959).—FIG. D14, 3b. **P. carinata* (MARTINSON), Bajoc., E.Tien-Shan; RV int., $\times 0.9$ (MARTINSON, 1959).—FIG. D14, 3c. **P. jeni-seica* MARTINSON, Bajoc., Chulimo-Yenisei basin, C.Asia; LV ext., $\times 1$ (MARTINSON, 1961).
Kija LEBEDEV, 1958, p. 73 [**K. tjazhinensis*; OD]. Shell small, known species not exceeding 17 mm. in length, ovate, short to well elongated, obliquely truncated posteriorly; umbones protruding slightly; most species with posterior diagonal ridge; RV with 2 or 3 anterior and 2 or 3 posterior, transversely grooved lateral teeth, separated by sockets which receive corresponding teeth of LV; anterior laterals extending posteriorly well beyond beaks, posterior laterals distant from latter, occupying posterodorsal angle. *M.Jur.-U.Jur.*, C.Asia.—FIG. D14, 2a. **K. tjazhinensis*, U.Jur., Chulimo-Yenisei basin; RV int., $\times 3.3$ (Lebedev, 1958).—FIG. D14, 2b. **K. kibetenensis* LEBEDEV, U.Jur., same region; LV ext., $\times 3.3$ (Lebedev, 1958).
Okribella KAKHADZÉ, 1942, p. 77 [**O. elliptica*; OD]. Shell to 24 mm. long, ovate, length nearly twice height, inequilateral, inflation moderate; umbones broadly rounded, not protruding, at about anterior third of length; hinge edentulous; growth lines irregular, moderately coarse; adductor scars very dorsally placed, narrow, anterior one deep, posterior shallow. *M.Jur.* (*Bathon.*), USSR (Georgia).
 ?*Sibireconcha* LEBEDEV, 1958, p. 69 [**S. langoviensis*;

sis; OD]. Shell small, known species not exceeding 22 mm. in length, oblong, much elongated, strongly inequilateral, obliquely truncated posteriorly; umbones broad, not protruding; weak posterior diagonal ridge present; dentition unknown. *M.Jur.*, USSR (W.Sib.-E.Sib.-Transbaikal)-China.—FIG. D14, 1a. **S. langoviensis*, C.Asia (Chulimo-Yenisei basin); RV ext., $\times 1.4$ (Lebedev, 1958).—FIG. D14, 1b. **S. anodontoides* (CHERNYSHEV), same region; RV ext., $\times 1.2$ (Lebedev, 1958).

?*Tuquella* RAGOZIN, 1938, p. 106 [**T. chachlovi*; SD LUMKEVICH *et al.*, 1960, p. 99]. Shell about 10 to 20 mm. long when full-grown, ovate, subequilateral, more strongly convex than *Ferganococoncha* and with more protruding umbones; hinge line straight; dentition unknown; growth lines inconspicuous. *L.Jur.-M.Jur.*, USSR (Sib.)-C.Asia-E.Asia.—FIG. D13, 3. **T. crassa* RAGOZIN, M.Jur., Chulimo-Yenisei basin, C.Asia; LV ext., $\times 1$ (Lebedev, 1958).

?*Utchamiella* RAGOZIN, 1938, p. 138 [**U. tungusica*; SD LUMKEVICH *et al.*, 1960, p. 99]. Shell about 10-20 mm. long when full-grown, oblong, strongly inequilateral, with unprotruding, prosogyrous umbones placed near anterior end; inflation moderate; obtuse angulation commonly runs from umbo to posteroventral angle of shell; dentition unknown. *L.Jur.-M.Jur.* (mainly *Lias.*), USSR (Sib.)-C.Asia-E.Asia.—FIG. D13, 2. **U. tungusica*, L.Jur. (*Lias.*), Sib. (Tunguska basin); LV ext., $\times 1.5$ (Ragozin, 1938).

Family UNCERTAIN

?*Nyassa* HALL & WHITFIELD, 1869 [**N. arguta*; Olf.] [= *Modioconcha* HALL & WHITFIELD, 1869; non. oblit. (obj.)]. Equivalve, beaks anterior, transversely elongate or subelliptical. Beaks small, appressed; hinge long, arcuate, with numerous irregular cardinal teeth under the beak and 1 to 4 elongate lamellar teeth; ligament external. Surface with concentric growth lines and in some species obscure radii and a weak sulcus. *M.Dev.*, N.Am.-Eu. (Ger.).—FIG. D10, 4. **N. arguta*, USA (N.Y.); 4a, ext. LV, showing ornamentation, $\times 1$; 4b, hinge RV, showing dentition, greatly enl. (Hall, 1885). [Larocque]

Superfamily UNIONACEA
 Fleming, 1828

[nom. transf. THIELE, 1934 (ex Unionidae FLEMING, 1828)] [*pro* Naiadacea AUCTT. (invalid family-group lacking type genus)] [Materials for this superfamily prepared by FRITZ HAAS, except as otherwise recorded]

Shell mostly equivalve and isomyarian except where modified by attachment, mainly nacreous, with prismatic layer and heavy periostracum; beaks commonly with ornamentation; dentition, wherever present,

usually consisting of somewhat rugose cardinal and posterior lamellar teeth. [Exclusively fresh-water habitat with larval stage parasitic in fish.] ?*Perm., Trias.-Rec.*

The fresh-water bivalves classed together in the Unionacea are distinguished by the porcelain-white to bluish or purple-tinted pearly layer of their shells, rather variable nature of dentition or lack of hinge teeth, various structures of the soft parts, and characters of larval development. Variability of the shells due to ecologic modifications gives rise to many problems in classification.

SHELL CHARACTERS

Unionacean shells range in outline from nearly circular to elongate rodlike shapes and in thickness from flatly compressed forms to subglobular. Some shells are less than one inch (25 mm.) in length and others more than one foot (300 mm.). The shell is composed of three layers: a horny organic external covering of conchiolin, the **periostracum**, which is smooth, yellow-brown or black-brown, and commonly marked by color bands that radiate from the beak; a **prismatic calcareous layer**; and forming the hinge teeth and interior, a **nacreous layer** of calcium carbonate with lamellar structure consisting chiefly of aragonite. These layers together range from paper-thin to a thickness of about 15 mm. Names commonly applied to parts of unionacean shells, and not corresponding to those used by other clams, are indicated in Fig. D15. Although the surface of some shells is smooth or merely shows growth lines, that of others is partly or entirely wrinkled or ribbed, and there may be knobs, tubercles, or even spinose projections; commonly these surface features of the shell form a pattern that is fairly definite and constant within limits of an individual genus or species.

The hinge varies greatly in the Unionacea. Shells having well-defined dentition are characterized by prominent cardinals beneath and somewhat in front of the beaks accompanied by less conspicuous long, lamellar ridges (regarded by many investigators as modified cardinal teeth not homologous with the laterals of heterodonts) behind the beaks. This dentition

normally consists of two cardinals and two posterior lamellar teeth on the left valve matching sockets between the teeth of the opposed valve, but there is much deviation from this. The teeth project from a widened portion of the dorsal shell margin (**hinge plate**), which persists in the toothless space between cardinals and lamellar teeth. The cardinal teeth are relatively persistent; those which are very slender commonly are supported by a strengthening deposit (**fulcrum**). The posterior lamellar teeth tend to be reduced and in many forms to disappear. Some shells have very imperfect dentition (Alasmidontinae) or none at all (Anodontinae) other than lamellar ridges close to the dorsal margin; such ridges (termed **claustra**) are not homologous with the teeth of other Unionacea. A type of hinge found in a few genera (e.g., *Pseudodon*, *Leguminaia*) tentatively classed among Unionacea is distinguished by several short rounded projections along the dorsal margin of the shell near the beaks, but no hinge plate or fulcrum is present. Still another type, which is observed in the generally edentulous Mutelidae, is marked by crenulations along the hinge line, superficially resembling taxodont dentition.

Inside the shell, the **beak cavities** may be capacious and deep or small and shallow. Muscle impressions (anterior and posterior adductors) lack special importance, but that of the pallial muscle is marked by an entire pallial line in most shells or by one with a slight sinus in some mutelid (Fig. D15,C).

Shells belonging to genera of the Margaritiferidae, Unionidae, and Mutelidae are bilaterally symmetrical, owing to the upright (orthothetic) position in which they are held, partly embedded in bottom sediment. Among the Etheriidae, however, a free-moving early life is followed by attachment of one of the valves lying on its side (pleurothetic) like an oyster, and because the lower valve becomes larger and deeper, symmetry of the shell vanishes. Exceptionally, as in *Arconaia* and *Arcidopsis* of the Unionidae, the youthful symmetrical stage is followed by sideward bending of the valves or twisting of the shell around its axis in such manner that it can no longer stand upright but comes to rest on its side with one valve larger than the other.

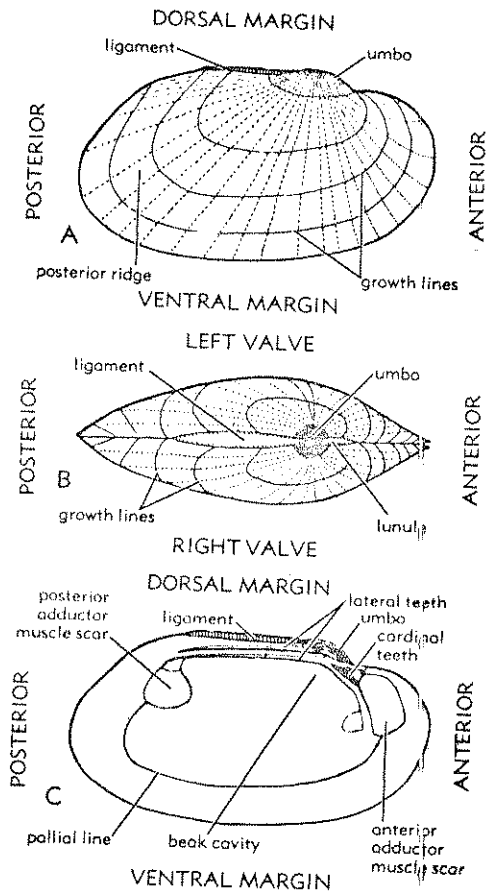


FIG. D15. Morphological features of unionacean shells (A-C, exterior, dorsal, interior) (after Baker).

LARVAL STAGE

All known Unionacea, after hatching from fertilized eggs, pass through a larval stage (generally termed glochidium, but in the Mutelidae called lasidium). First development of the larva occurs in a brood pouch (marsupium) of the parent, consisting of space between pairs of gills. The glochidia develop within their egg membranes and feed almost exclusively on the egg yolk. After a time, the larvae are expelled and further growth then becomes dependent on chance contact with a fish, to which the glochidium fixes itself by a sticky thread and by hooks on its valves. As a cyst-enclosed parasite in the flesh of

the fish, it draws nourishment from its host until it grows into a minute complete clam, when it pierces the skin of the fish and drops to the bottom of whatever stream, pond, or lake is being traversed by its free-swimming carrier. Obviously, this curious adaptation in larval development, which distinguishes the Unionacea from other pelecypods, is extremely important as means of dispersal.

ECOLOGIC INFLUENCE ON SHELL CHARACTERS

Study of unionacean assemblages living in different environments serves to demonstrate the existence of variations in shell characters that may be correlated with the nature of physical surroundings. Size, shape, and color of the surficial conchiolin layer all may be affected. The shells of members of this group living on a hard bottom generally are shorter and rounder than those found in mud or soft sand. Individuals collected from lake-bottom sediment show a tendency to have shortened and thickened anterior areas associated with produced and somewhat compressed posterior regions. Shells of Unionacea from small streams are less swollen generally than corresponding shells in rivers. Also, the same species may be represented by smooth shells in small streams and by populations with more or less strongly sculptured shells in large streams and lakes. Prevalingly, shell surfaces marked by tubercles and ridges characterize river and lake environments.

Variations that reflect ecological factors must not be overlooked in study of the classification of Unionacea, for otherwise erroneous conclusions as to the taxonomic significance of divergent or convergent shell characters are invited. Owing to the ecological plasticity and the rapidity and wide range of dispersal of these fresh-water clams by fish-borne larvae, a single generation may produce offspring that on reaching maturity differ notably from parent forms. This is strikingly illustrated by comparing the completely sculptured shells of some unionids in large eastern African lakes with tax-

nominally equivalent smooth shells in streams that empty into these lakes.

CLASSIFICATION

Arrangement of the varied hosts of Unionacea, distributed throughout the world and having a range from ?Triassic or Jurassic to Recent, offers great difficulty to the taxonomist who aspires to recognize and define phylogenetically significant assemblages of varying magnitude. Characters of the soft parts, such as union of mantle lobes, completeness of siphons, adaptation of gill spaces as marsupia, nature of the foot and musculature all aid in recognizing relationships among living forms but mostly have little value for work on fossils. Chief shell characters judged to be useful for classification include general form (with attention given to effects of sessile existence), features of the beak region (denoting nature of the immature shell), ligament, dentition, muscle scars, and pallial markings. Evidence of the high degree of developmental plasticity of the unionacean shell and the certainty that many gaps in knowledge limit the understanding of modern forms, not to mention fossils, indicate the difficulty of formulating a satisfactory natural classification not yet achieved in this group. The only all-inclusive study of fossil Unionacea so far published is by SANDBERGER (1870-75) long before most of the genera were established. Later workers have been concerned with Recent forms alone or with assemblages of various regions. The ZITTEL (1913) textbook on invertebrate fossils mentions only 13 unionacean genera, mostly without characterizations: these are divided among three families (Unionidae, Mutelidae, Etheriidae). Only very recently a system of the Unionacea for both Recent and fossil forms has been published by MODELL (1942); it lists practically all the genera and subgenera of the superfamily known at that time.

The following section of the *Treatise on Unionacea* recognizes 150 genera and 112 subgenera (223 units excluding homotypical subgenera); these are grouped in four families, one of which (Unionidae) is divided into six subfamilies.

LITERATURE ON UNIONACEA

As well may be expected, a vast literature pertains to Recent and fossil unionacean bivalves. Only a selected fraction can be cited in the general reference list. Here it may be useful to make note of more important works in a few classical groups, as follows.

Comprehensive general works on Recent Unionacea. Here may be included nos. 140, 354, 496, 497, 535, 538, 845, 846, 862-869 of the reference list.

Regional monographs on Recent Unionacea. For North America, nos. 144, 147, 328; Central America, nos. 306, 359, 588; South America, nos. 359, 694, 702; Europe, nos. 798, 969; India, nos. 389, 756; China, no. 405; Africa, nos. 142, 362, 538, 589; Australia, nos. 168, 434.

Comprehensive monograph on fossil Unionacea. No. 824.

Regional works on fossil Unionacea. For North America, no. 401; Europe, nos. 86, 87, 411, 881, 968; China, no. 686.

Family MARGARITIFERIDAE Haas, 1940

[Validated family-group name, ICZN, 1957 (Opinion 495, p. 293)] [=Margaritinae ORTMANN, 1910 (suppressed by ICZN, 1957, Opinion 495, p. 290)]

Shell equi- or sub-equivalve, mostly compressed; umbonal sculpture (if present) comprising two angular unjoined hooks; beak cavities shallow, posterior lamellar teeth tending to be reduced. Gills without water tubes, partly free posteriorly, with incomplete diaphragm, marsupium occupying all four gills. *U.Cret.-Rec.*

Margaritifera SCHUMACHER, 1816, p. 7 [valid emendation of *Margaritifera* SCHUMACHER, 1816 (ICZN, 1957, Opinion 495, p. 289)] [**Mya margaritifera* LINNÉ, 1758, p. 671; M] [=*Margaritana* SCHUMACHER, 1817, p. 123 (obj.); *Margaritifera* SCHUMACHER, 1823, p. 6 (nom. van. pro *Margaritifera*); *Damalis* LEACH, 1847, p. 272]. Characters of family. *U.Cret.-Rec.*, Eu.-N.Am.-Asia.

M. (Margaritifera). Shell heavy, thick, compressed, without posterior lamellar teeth. *U.Cret.-Rec.*, Eu.-N.Am.-E.Asia.—FIG. D16.3. **M. (M.) margaritifera* (LINNÉ), *Rec.*, Eu.; *3a,b*, LV ext., RV int., $\times 0.5$ (after 497).

M. (Cumberlandia) ORTMANN, 1912 [**Unio monodonta* SAY, 1829; OD]. Elongate-arcuate,

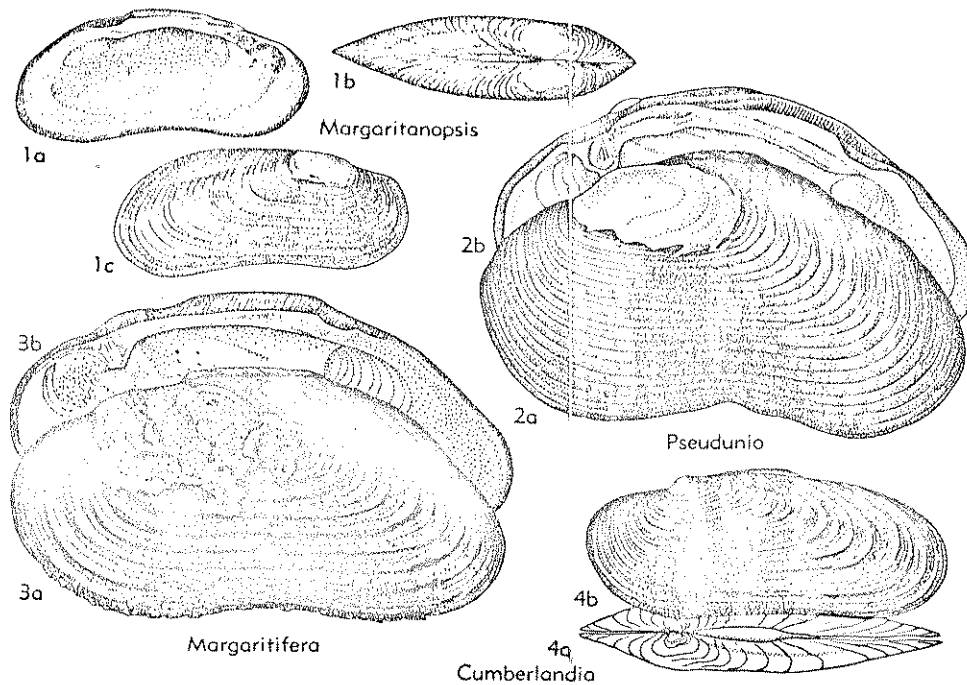


FIG. D16. Margaritiferidae (p. N414-N415).

thin; lamellar teeth weak, poorly defined. Continuous lamellar septa between gills, running obliquely forward. *Rec.*, N.Am.—FIG. D16,4. **M. (C.) monodonta* (SAY); 4a,b, both valves dorsal, LV ext., $\times 0.5$ (after 497).

M. (Margaritanopsis) HAAS, 1910 [**Unio laosensis* LEA, 1863; OD]. Elongate, compressed, kidney-shaped; cardinals and posterior lamellar teeth with long interdental area. *Rec.*, SE.Asia.—FIG. D16,1. **M. (M.) laosensis* (LEA); 1a-c, LV int., both valves dorsal, RV ext., $\times 0.5$ (after 534).

M. (Pseudunio) HAAS, 1910 [pro *Potodoma* HERRMANNSEN, 1947 (non MEEGEN, 1800)] [**Unio sinuata* LAMARCK, 1819 (=*Unio auricularius* SPENGLER, 1793); OD]. Shell ear-shaped, heavy, thick; with cardinals and posterior lamellar teeth. *Eoc.-Rec.*, Eu.-N.Am.—FIG. D16,2. **M. (P.) auricularia* (SPENGLER), *Rec.*, Eu.; 2a,b, LV ext., RV int., $\times 0.5$ (after 497).

Family UNIONIDAE Fleming, 1828

Equivalve bivalves with thick periostracum, valves generally compressed and commonly with remnant of larval shell; beak cavities deep, hinge mostly with two cardinals and two posterior lamellar teeth

in LV and single cardinal and lamellar tooth in RV. Gills with water tubes, marsupium occupying all four gills or outer pairs only, diaphragm complete. *Trias.-Rec.*

Subfamily UNIONINAE Fleming, 1828

[*nom. transl.* THIELL, 1934 (ex Unionidae FLEMING, 1828)]

Umbral sculpture mostly concentric. Marsupium occupying all four gills or outer pairs only. *Trias.-Rec.*

Unio PHILIPSSON, 1788 [**Mya pictorum* LINNÉ, 1758; SD TURTON, 1831 (ICZN, 1957, Opinion 495, p. 289)] [= *Limnaea* POLI, 1791 (obj.); *Limnaeoderma* POLI, 1795; *Unigenus* RENIER, 1807; *Lymnium* OKEN, 1815 (rejected, ICZN, Opinion 417); *Unionea* RAFINESQUE, 1815; *Mysca* TURTON, 1822; ?*Margarita* LEA, 1836 (non LEACH, 1819); *Myisca* L. AGASSIZ, 1846; *Chondrostea* GISTE, 1848; ?*Margaron* LEA, 1852; *Nodularia* CONRAD, 1853; *Nodularidia* COCKFIELD, 1901]. *Periostracum* slope generally distinct, outer edge smooth, periostracum with or without two Marsupium occupying whole length of outer gill pairs. [Fossil species of *Unio* described from North America are generally forms with complete hinge

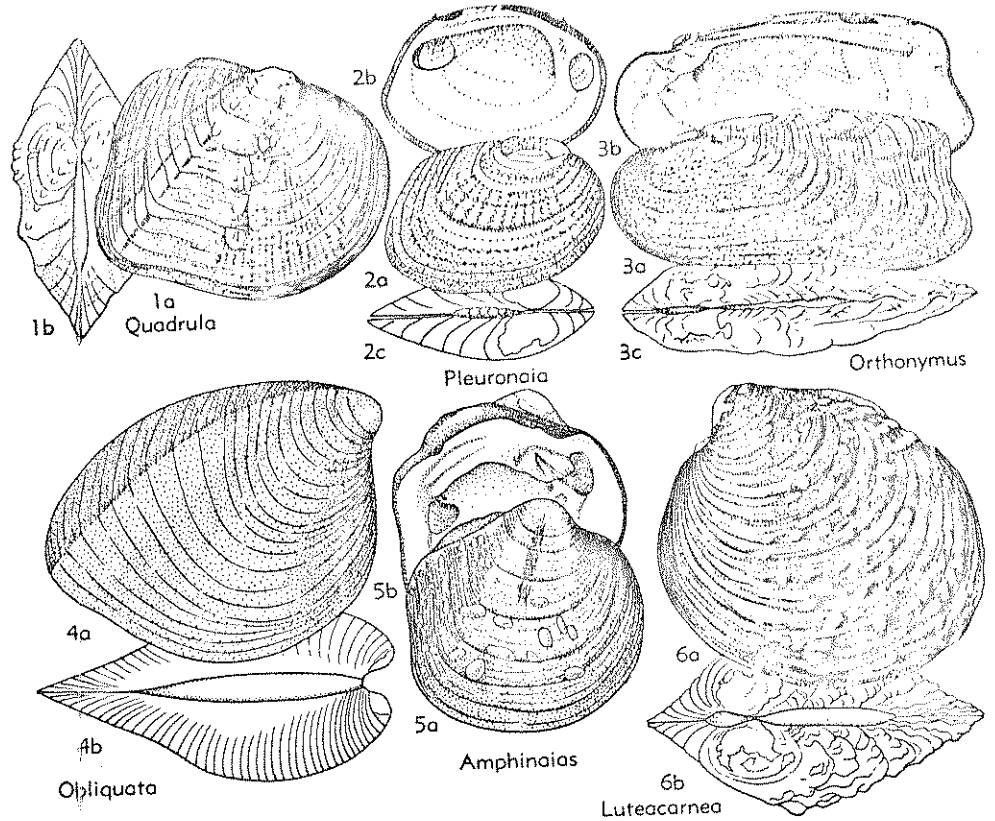


FIG. D34. Unionidae (Quadrulinae) (p. N436).

Vetuloniaia BRANSON, 1935 [*V. whitei*; OD] [= *Vetulonaea* HGLT, 1942]. Beaks nearly terminal, LV with 2 lamellar teeth, cuneiform cardinal tooth above triangular socket; RV with single lamellar tooth below triangular socket; umbonal region marked by concentric wrinkles, ventral area posterior to beaks marked by radial undulations. ?*Jur.*, N.Am.—FIG. D33,1. **V. whitei*; 1a-c, LV int., RV int., both valves dorsal, $\times 0.7$ (79).

Virgus SIMPSON, 1900 [*Unio beccarianus* TAPPERONE CANEFRI, 1883; OD]. Rather solid, elongate, compressed, rounded in front, nearly straight below; posterior slope low, smooth or sculptured; cardinals small, solid, generally 2 in each valve; interdental interval long and narrow, lamellar teeth rather long, straight. *Rec.*, N.Guinea.

V. (Virgus). Solid, sculptured with parallel folds which begin at posterior ridge and branch out over posterior slope and adjacent region of disc. *Rec.*, N.Guinea.—FIG. D33,3. **V. (V.) beccarianus* (TAPPERONE CANEFRI); 3a-c, LV ext., RV int., both valves dorsal, $\times 0.7$ (Haas).

V. (Leiovirgus) HAAS, 1912 [*Unio misoolensis* SCHEPMAN, 1896; OD] [= *Nesonia* HAAS, 1912]. Elongate, very short in front, long behind; beaks low, sculptured with radial folds; disc smooth. *Rec.*, N.Guinea (Misool I.).—FIG. D33,4. **V. (L.) misoolensis* (SCHEPMAN); 4a-d, LV ext., RV int., LV int., both valves dorsal, $\times 0.8$ (Haas).

Subfamily QUADRULINAE Haas, 1929

Shell mostly heavy, high, squarish to triangular; beaks full, ornamented with V- or W-shaped folds which commonly extend over entire disc, degenerating in some into rows of tubercles; hinge heavy, angular; shell shape commonly subject to sexual dimorphism. Marsupium occupying all four gills. *L.Cret.-Rec.*

Quadrula RAFINESQUE, 1820 [*Obliquaria quadrula* RAFINESQUE, 1820; SD HERRMANNSEN, 1847. [= *Theliderma* SWAINSON, 1840; *Telederm*

- PAETEL, 1875]. Triangular, quadrangular or rhomboid, inflated; beaks rather prominent, sculptured generally with few coarse, irregular, subparallel ridges which form knobs or tubercles where they cross posterior ridge; disc smooth or sculptured; periostracum usually dull, rayless or only feebly rayed; hinge normal, hinge plate flat, wide; cardinals heavy, ragged, lamellar teeth rather short, lower auxiliary one in some RV's. *Pleist.-Rec.*, N.Am.
- Q.** (*Quadrula*). Rounded to rhomboid, solid, pustulose, equal in both sexes; beaks sculptured with few coarse, subparallel ridges; anterior end rounded or subtruncate, base commonly arcuate, posterior end truncate, high, angled above; beak cavities rather deep. *Pleist.-Rec.*, N.Am.—FIG. D34,1. **Q.* (*Q.*) *quadrula* (RAFINESQUE), *Rec.*; *1a,b*, RV ext., both valves dorsal, $\times 0.75$ (497).
- Q.** (*Amphinaias*) CROSSE & FISCHER, 1894 [**Unio cochianus* LEA, 1860; OD] [= *Bullata* FRIERSON, 1927 (non JOUSSEAUME, 1875); *Pustulosa* FRIERSON, 1927]. Round quadrate, truncate behind, full, angled back of ligament; beaks high with few coarse ridges swollen at posterior ridge; disc mostly pustulose, but may be smooth or corrugated; periostracum commonly with broad and faint green ray; hinge massive. *Rec.*, N.Am.—FIG. D34,5. **Q.* (*A.*) *cochianus* (LEA); *5a,b*, RV ext., LV int., $\times 0.7$ (497).
- Q.** (*Luteacarne*) FRIERSON, 1927 [**Quadrula striata* RAFINESQUE, 1820; OD] [= *Striata* FRIERSON, 1927 (non O. BOETTGER, 1878)]. Oboval, thick inflated, concentrically ridged, ridges being pustulose in places. Soft parts yellow. *Rec.*, N.Am.—FIG. D34,6. **Q.* (*L.*) *striata* RAFINESQUE; *6a,b*, LV ext., both valves dorsal, $\times 0.7$ (497).
- Q.** (*Obliquata*) FRIERSON, 1927 [**Obliquaria (Scalenaria) obliquata* RAFINESQUE, 1820; OD] [= ?*Scalenaria* RAFINESQUE, 1820]. Subtriangular, rather inflated, heavy; beaks very anterior, high, full, turned forward over conspicuous lunule; truncate in front, more or less pointed behind; with radial depression behind and parallel to posterior ridge; hinge massive, cardinals radial; beak cavities deep, compressed. *Rec.*, N.Am.—FIG. D34,7. **Q.* (*O.*) *obliquata* (RAFINESQUE); *4a,b*, RV ext., both valves dorsal, $\times 0.7$ (497).
- Q.** (*Orthonymus*) L. AGASSIZ, 1852 [**Unio cylindricus* SAY, 1816; OD]. Quadrate rhomboid, with radial furrow on posterior slope; whole surface except anterior end generally pustulose, that of posterior slope commonly wrinkled; umbonal region high; periostracum lustrous, with pattern of triangular spots or chevron-shaped lines; hinge strong, in some with auxiliary 3rd lamellar tooth in RV; umbonal cavities deep, compressed. *Rec.*, N.Am.—FIG. D34,3. **Q.* (*O.*) *cylindrica* (SAY); *3a-c*, LV ext., RV int., both valves dorsal, $\times 0.5$ (497).
- Q.** (*Pleuronaia*) FRIERSON, 1927 [**Unio barnesiannus* LEA, 1838; OD]. Subtriangular to almost elliptical, solid; beaks high, full; posterior ridge strong, curved or subangular; cardinals small, including auxiliaries, also with auxiliary lamellar teeth; beak cavities shallow. *Rec.*, N.Am.—FIG. D34,2. **Q.* (*P.*) *barnesiana* (LEA); *2a-c*, RV ext., LV int., both valves dorsal, $\times 1$ (535).
- A.** (*Amblema*) RAFINESQUE, 1819 [**A. costata* RAFINESQUE, 1832; SD RAFINESQUE, 1832] [= *Bariosta* RAFINESQUE, 1832; *Crenodonta* SCHLUETER, 1838; *Baryosta* L. AGASSIZ, 1846]. Heavy, with prominent beaks; surface usually sculptured with oblique folds, posterior slope generally having smaller radial plications which curve up behind; periostracum brown to black. *L.Cret.-Rec.*, N.Am.-C.Am.
- A.** (*Amblema*). Rounded to subrhomboid; radial plications usually strong, oblique, though in some discs may be almost unornamented or slightly sculptured concentrically. *L.Cret.-Rec.*, N.Am.-C.Am.—FIG. D35,5. **A.* (*A.*) *plicata costata* RAFINESQUE, *Rec.*; *5a,b*, LV ext., both valves dorsal, $\times 0.5$ (497).
- A.** (*Plectomerus*) CONRAD, 1853 [**Unio dombeyana* VALENCIENNES, 1827; SD FRIERSON, 1927] [= ?*Gonamblyus* RAFINESQUE, 1831]. Rhomboidal, inflated with high posterior ridge; beak sculpture coarse, irregular corrugations swollen to nodules on posterior ridge; disc sculptured on posterior half with oblique ridges, which may be corrugated, and with strong corrugations on posterior slope; beak cavities moderately deep, nacre purple. *Rec.*, N.Am.—FIG. D35,3. **A.* (*P.*) *dombeyana* (VALENCIENNES); *3a,b*, LV ext., both valves dorsal, $\times 0.7$ (497).
- A.** (*Psprula*) HAAS, 1930 [**Quadrula rudis* SIMPSON, 1900; OD]. Round to rounded quadrangular, ventricose to quite compressed; beaks prominent, with deep, commonly quite compressed cavities; umbonal sculpture of many crowded, wavy, concentric wrinkles gradually passing into concentric pustulose or granular sculpture of disc on which very conspicuous, cord-like zones of growth are visible; nacre white to violet. *Rec.*, C.Am.—FIG. D35,2. *A.* (*P.*) *salinarum* HAAS; *2a-c*, LV ext., RV int., LV int., $\times 0.4$ (Haas).
- Cokeria** MARSHALL, 1916 [**C. southalli*; OD]. Subquadrangular, rather thin, ventricose, gaping in front; rounded and narrow in front, perpendicularly truncate and high behind; beaks high, incurved, sculptured with 4 concentric ridges, which become elevated posteriorly; pronounced furrow extending from beak to lower 3rd of posterior margin; in RV with 2 thin cardinals and 1 thin high lamellar tooth; 2 lamellar teeth in LV. [Based

on a unique individual, hence doubtful; perhaps an abnormality of *Quadrula (Quadrula) undulata* (BARNES).] *Rec.*, N.Am.—FIG. D35,9. **C. southalli*; 9a,b, RV ext., int., $\times 0.75$ (580).

Costanaia MACNEIL, 1935 [**C. arciformis*; OD]. Subquadrate, much inflated, posterior margin perpendicularly truncated, nearly straight, ventral margin arcuate; beaks high, anterior, with fine

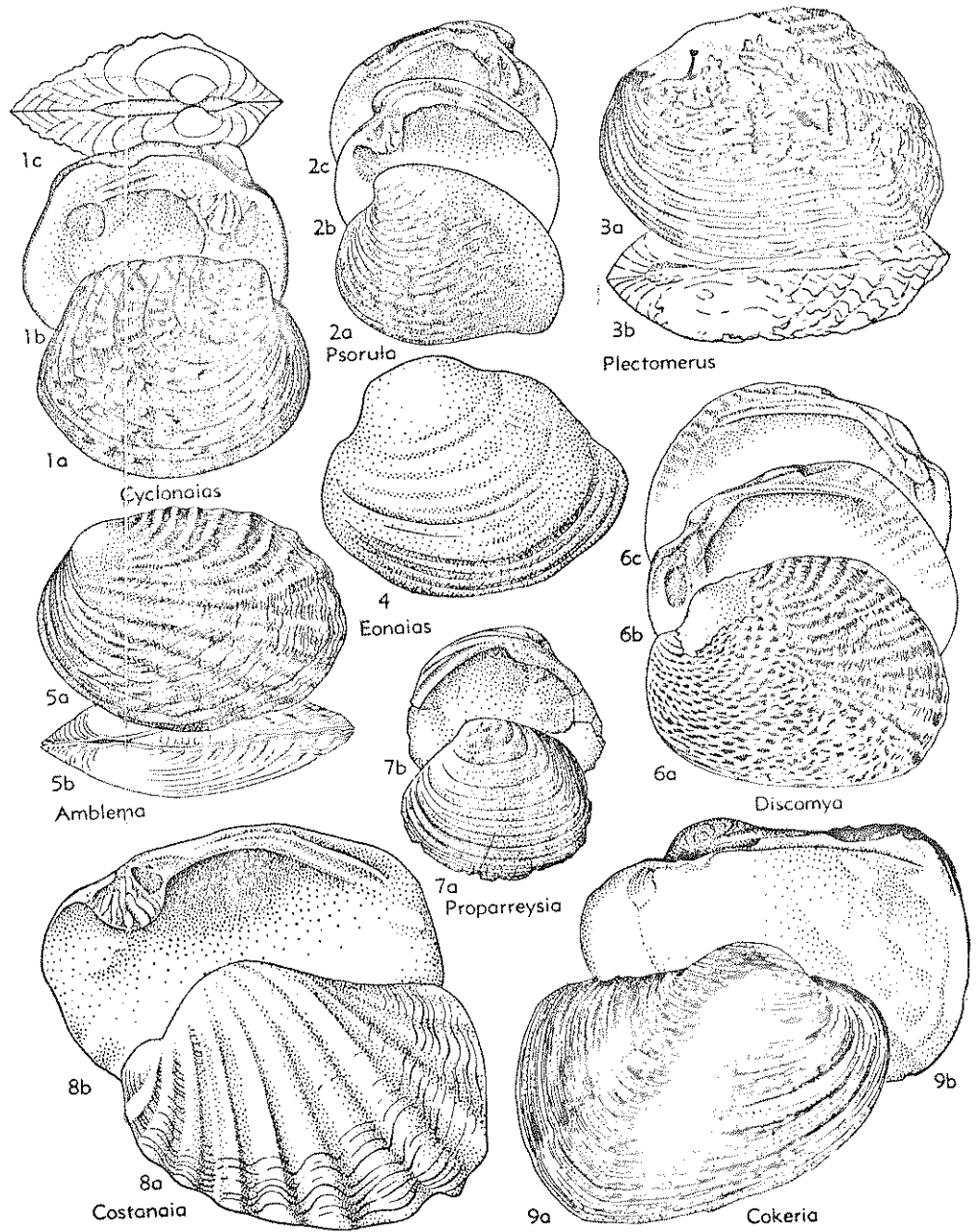


FIG. D35. Unionidae (Quadrulinae) (p. N437-N439, N441-N442).

concentric undulations, pointing down umbonal ridge as raised chevrons; surface sculptured with 12 to 15 radial ribs which intersect shell margin at deep crenulations; hinge margin long, arcuate; cardinals deeply furrowed, lamellar teeth short and feeble. *Mio.*, N.Am.—FIG. D35,8. **C. arciformis*; *Sa,b*, LV ext., RV int., $\times 0.75$ (568).

Cyclonaias PILSBRY, 1922 [**Obliquaria tuberculata* RAFINESQUE, 1820; OD] [= *Rotundaria* AGASSIZ, 1852 (*non* RAFINESQUE, 1820)]. Rounded or quadrate; beaks prominent, curved inward and forward over strongly marked lunule, their sculpture consisting of 20 to 30 fine, irregular, broken, somewhat concentric corrugations which gradually blend with regular sculpture; posterior 0.6 of shell tuberculate; beak cavities deep, compressed, nacre violet. *Pleist.-Rec.*, N.Am.—FIG. D35,1. **C. tuberculata* (RAFINESQUE), *Rec.*; *Ia-c*, RV ext., LV int., both valves dorsal, $\times 0.5$ (497).

Discomya SIMPSON, 1900 [**Unio radulosus* DROUËT & CHAPER, 1892; OD]. Round or rhomboidal, compressed, almost lens-shaped, heavy, short and narrowly rounded in front, wide and roundly truncate behind; beaks low, their sculpture unknown; posterior slope very low and compressed; shell sculpture covering entire disc, consisting on anterior half of 2 intersecting systems of elongated knobs which meet nearly at right angles to form meshwork, while on posterior half are cord-like folds which curve upward, some with bifurcation; massive hinge plate, cardinals short, heavy, lamellar teeth short, almost at right angles with cardinals from which they are separated by wide, smooth, ascending interdental interval; beak cavities deep, compressed. *Rec.*, W.Pac.(Borneo).—FIG. D35,6. **D. radulosa* (DROUËT & CHAPER); *6a-c*, LV ext., RV int., LV int., $\times 0.75$ (Haas).

Fonaias MARSHALL, 1929 [**E. reynosenica*; OD]. Beaks with numerous V-shaped loops, which are nearly regularly spaced and nested into each other, V's pointing toward ventral margin; posterior areas with fine ribs running from posterior ridge to margin. *Plio.*, N.Am.—FIG. D35,4. **E. reynosenica*; LV ext., $\times 1$ (Marshall).

Fusconaia SIMPSON, 1900 [**Unio trigonus* LEA, 1831 (=subsp. of *U. undatus* BARNES, 1823); OD] [= ?*Lyntoxia* RAFINESQUE, 1820; ?*Lyntoxia* L. AGASSIZ, 1846, *Fusconia* FRIERSON, 1927]. Rounded, elliptical, rhomboid, or triangular with beaks high and full, curved inward and forward, sculptured with few coarse, parallel ridges which curve upward behind; periostracum dark, disc not sculptured; hinge plate of moderate width, cardinals strong, nacre white, salmon or purple. *Pleist.-Rec.*, N.Am.-C.Am.—FIG. D36,2. **P. undata trigona* (LEA), *Rec.*; *2a-c*, RV ext., LV int., both valves dorsal, $\times 0.4$ (497).

Lamprotula SIMPSON, 1900 [**Chama plumbea*

CITIMNITZ, 1795; OD] [= *Gibbosula* SIMPSON, 1900]. Rounded, subquadrangular, or triangular, heavy, inflated, with high beaks; beak with few coarse, concentric ridges which form double loops; disc generally covered with coarse nodules or knobs; periostracum gray to black, lustrous; hinge massive, all teeth vertically striated, lower auxiliary lamellar tooth in RV; cavity of beaks deep, compressed. *Oligo.-Rec.*, E.Asia-Japan.

L. (*Lamprotula*). Rounded or subquadrangular, with beaks near anterior end. *Oligo.-Rec.*, E.Asia-Japan.—FIG. D37,5. **L. (L.) plumbea* (CITIMNITZ); *Sa,b*, LV ext., int., $\times 0.5$ (497).

L. (*Parunio*) PING, 1931 [**Parunio crassus*; OD]. Rounded ovoid with anterior beaks, ventrally curved; surface commonly with ridges or rows of nodules parallel to growth lines; hinge massive, lamellar teeth above and parallel to cardinals. *Plio.-Rec.*, E.Asia.—FIG. D37,2. **L. (P.) crassa* (PING), *Plio.*; *2a,b*, LV ext., int., $\times 0.5$ (738).

Loxopleurus MEEK, 1871 [**Unio belliplicatus*; OD]. Subquadrangular, very inflated, with almost central high beaks; surface sculptured with about 6 broad, subparallel folds originating at or near beaks and corresponding to crenulations of the ventral and posterior margins. *U.Cret.*, N.Am.—FIG. D36,5. **L. belliplicatus* (MEEK); LV ext., $\times 0.75$ (569).

Megalonaias UTTERBACK, 1915 [**Unio heros* SAY, 1829 (= **U. giganteus* BARNES, 1823); OD] [= *Magnonaias* UTTERBACK, 1915]. Large, heavy, subrhomboid, moderately inflated; posterior slope rather high ribbed with coarse, regular undulations originating in umbonal region; beaks low, sculptured with coarse double-looped corrugations which extend as nodules to posterior ridge and as zigzag ridges over umbonal region to upper portion of disc; periostracum black; cardinals heavy, lamellar teeth long and straight, extending near to cardinals. *Rec.*, N.Am.-C.Am.—FIG. D36,9. **M. gigantea* (BARNES), *Rec.*; LV ext., $\times 0.3$ (Conrad).

Megalonoidea MACNEIL, 1935 [**M. porcata*; OD]. Large, subquadrate, inflated; beak sculpture of semiconcentric, doubly looped undulations in youngest stage, but in adult of heavy diagonal posterior plications originating at anterior side of umbonal chevrons and smaller plications set at conspicuous angle with large ones; cardinals fairly heavy, lamellar teeth long and arcuate; ventral border of shell slightly scalloped by external ribs. *Mio.*, N.Am.—FIG. D37,1. **M. porcata*; RV ext., $\times 0.5$ (568).

Pliconaias MARSHALL, 1929 [**P. popenocci*; OD]. Subquadrate; beaks with wavy concentric undulations, each posteriorly completed by fine straight threadlike rib running across posterodorsal area

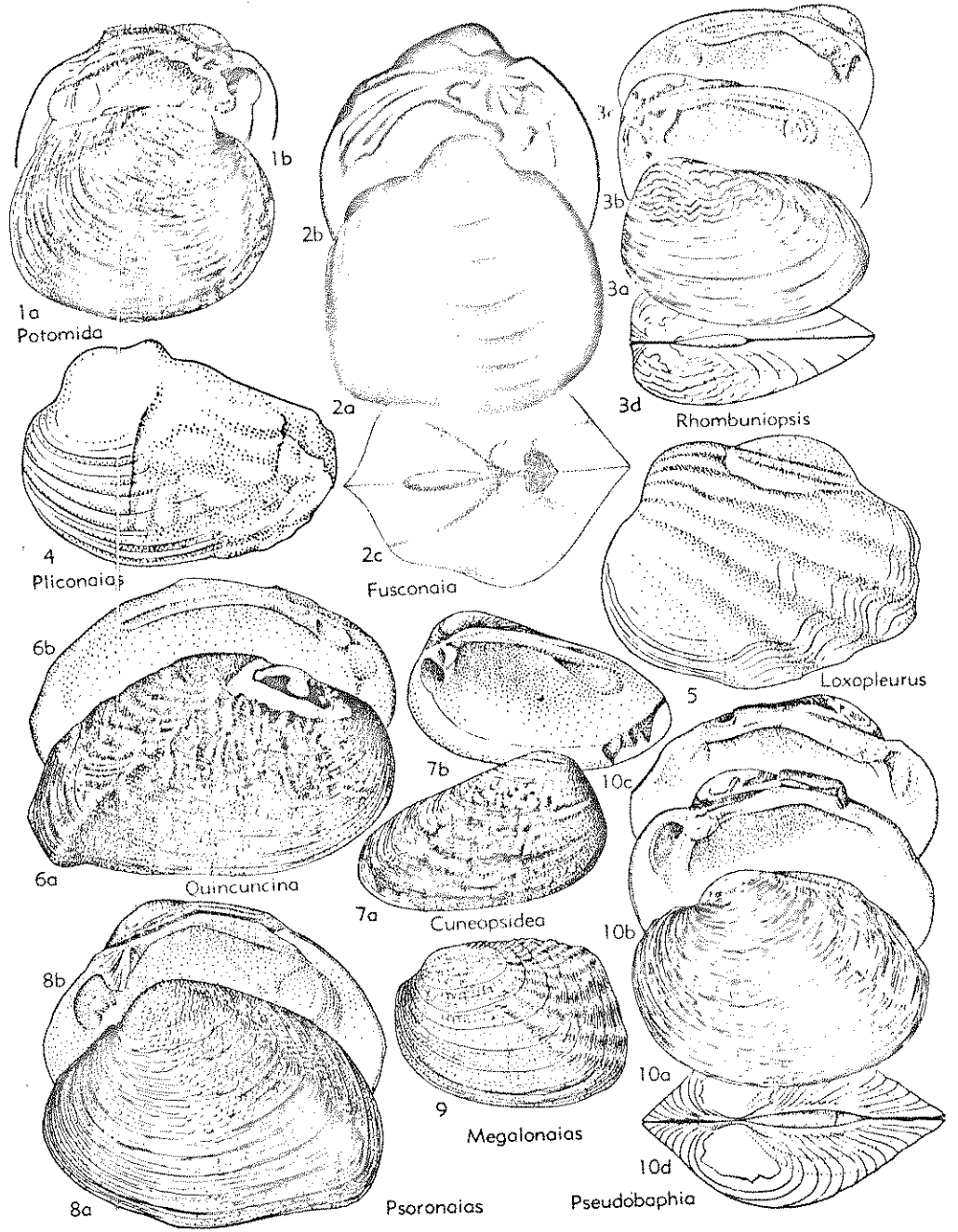


FIG. D36. Unionidae (Quadrulinae) (p. N439, N441-N442).

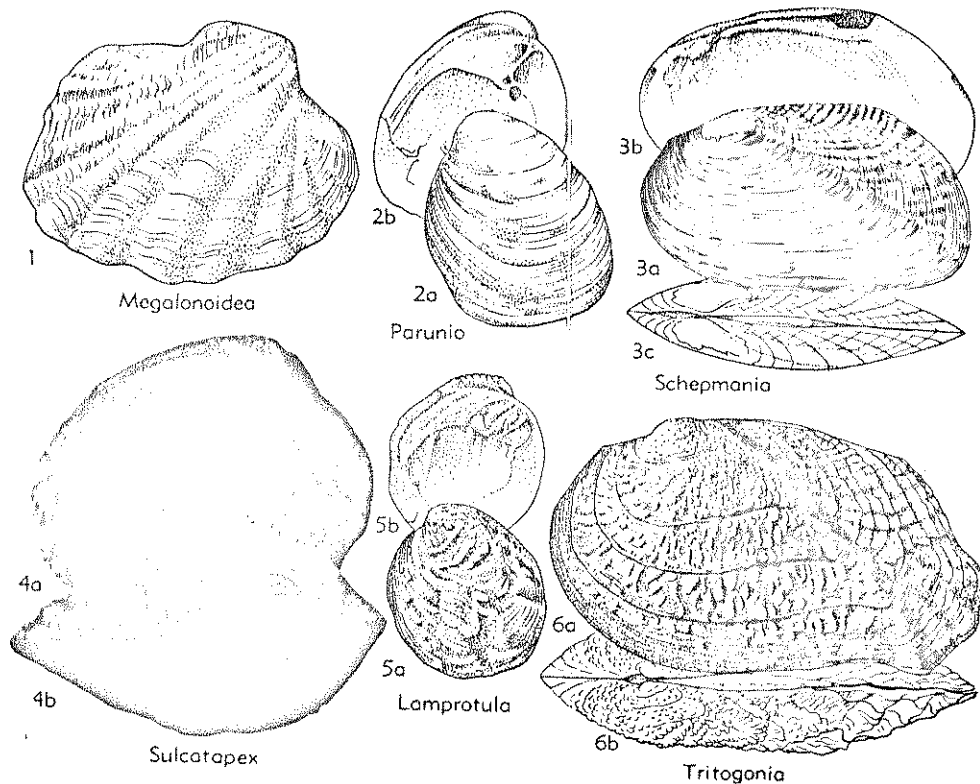


FIG. D37. Unionidae (Quadrulinae) (p. N439, N442).

toward beak; anteriorly undulations nearly fade out but are indistinctly completed by faint ribs curving toward beak; posterior portion of shell with several rude plications running obliquely across surface with pattern found in plicate North American naiads. *Plio.*, N.Am.—FIG. D36, 4. **P. popenoei*; LV ext., $\times 0.7$ (584).

Potomida SWAINSON, 1840 [**Unio corrugata* (= **Unio semirugatus* LAMARCK, 1819); OD] [= *Potamida* L. AGASSIZ, 1846; *Psilunio*, *Rytia* STEFANESCU, 1896; *Sabbaia* COSSMANN, 1897; *Rhombunio* GERMAIN, 1911; *Migranaia* HANNIBAL, 1912]. Rounded rhomboid, moderately heavy, subinflated, round and short in front, wide and roundly truncate behind; beaks high, full with numerous, fine subparallel wavy ridges which may extend well over disc as rows of knobs or nodules; cardinals moderately massive, lamellar teeth commonly curved slightly; beak cavity rather deep. [Under lacustrine conditions (e.g., Hungarian and Rumanian *Pliocene*) the shells are more elongate wedge-shaped and the beaks anterior; the cardinals and lamellar teeth may be parallel to each other, strongly remindful of American and of

East Asiatic quadruline.] *Oligo.* (*John Day*)-*Rec.*, Eu.-?E.Asia.

P. (*Potomida*). Rounded, narrow in front, wide behind; beaks submedian, covered by numerous subparallel wavy ridges, mostly not extending to disc; hinge moderately heavy. *Oligo.* (*John Day*)-*Rec.*, Eu.-?E.Asia.—FIG. D36, 1. **P. (P.) littoralis semirugata* (LAMARCK), *Rec.*, Eu.; 1a, b, RV ext., LV int., $\times 1$ (Ellis).

P. (*Cuneopsidea*) WENZ, 1928 [*pro Iridea* STEFANESCU, 1896 (non SWAINSON, 1840)] [**Unio sculptus* BRUSINA, 1874; OD]. Elongate to wedge-shaped, beaks placed well forward, anterior end steeply descending; sculpture of subparallel wavy ridges and on greater portion of disc, of knobs and nodules; hinge massive, cardinals and lamellar teeth parallel. *Pleist.*, E.Eu.—FIG. D36, 7. **P. (C.) sculpta* (BRUSINA); 7a, b, RV ext., int., $\times 0.5$ (967).

Proparqysia PILSBRY, 1921 [**Unio percorrugata* WHITFIELD, 1903; OD]. Small, quadrate; surface in younger specimens with very strong corrugation extending over half of disc, front half of shell unsculptured; hinge strong, cardinals high, lamel-

lar teeth strongly bent. *U.Cret.(Lance)*, N.Am.—Fig. D35,7. **P. percorrugata* (WHITFIELD); 7a,b, RV ext., LV int., $\times 1$ (Whitfield).

Pseudobaphia SIMPSON, 1900 [**Unio biesianus* HEUDE, 1877; OD]. Large, oval, inflated, gaping in front and behind, rather heavy, with full beaks; posterior extremity biangular; periostracum smooth, brownish, rayed; cardinal of RV large, irregular, situated behind pit and in front of beak; 2 remote lamellar teeth, poorly defined, interdental interval with numerous denticles; LV with 2 large cardinals and 2 remote, indistinct laterals; beak cavities very large and deep. *Rec.*, E.Asia.—Fig. D36,10. **P. biesiana* (HEUDE); 10a-d, LV ext., RV int., LV int., both valves dorsal, $\times 0.5$ (Haas).

Psoronajas CROSSE & FISCHER, 1893 [**Unio psoricus* MORELET, 1851; OD]. Variable in shape, oval, subtriangular, cordiform, or rather drawn out behind; disc covered with small tubercles and showing in some folds posteriorly; cardinal of RV thick and furrowed, behind thin, compressed auxiliary; lamellar teeth rather short, forming obtuse angle with cardinals and separated from them by narrow, straight interdental interval. *Rec.*, C.Am.—Fig. D36,8. **P. psorica* (MORELET); 8a,b, LV ext., RV int., $\times 0.6$ (306).

Quincuncina ORTMANN, 1922 [**Q. burkei* WALKER, 1922; OD]. Sculptured, beak sculpture subconcentric and followed on disc by zigzag ridge which becomes locally broken into quincuncially arranged nodules. *Rec.*, N.Am.—Fig. D36,6. **Q. burkei* WALKER; 6a,b, RV ext., LV int., $\times 1$ (Walker).

Rhombuniopsis HAAS, 1920 [**Unio (Cuneopsis) tauriformis* FULTON, 1906; OD]. Oval to subtriangular, heavy; beaks nearly anterior, inflated, their sculpture consisting of undulate folds; beak cavities deep; hinge consisting of heavy, low cardinals and short, strong lamellar teeth with distinct angle between these elements. *Pleist.-Rec.*, E.Asia.—Fig. D36,3. **R. tauriformis* (FULTON), *Rec.*; 3a-d, LV ext., RV int., LV int., both valves dorsal, $\times 1$ (Haas).

Schepmania HAAS, 1912 [**Unio nicuwenhuisi* SCHEPMAN, 1892; OD]. Elongate, rounded in front and behind, rather high and heavy, beaks not prominent; posterior slope crossed by parallel folds originating at posterior ridge and curving up toward dorsal margin; hinge normal for family, cardinals low and stout, lamellar teeth low and short; interdental interval long and smooth. *Rec.*, W.Pac.(Borneo).—Fig. D37,3. **S. nicuwenhuisi* (SCHEPMAN); 3a-c, LV ext., RV int., both valves dorsal, $\times 0.75$ (Haas).

Sulcatapex YEN, 1945 [**S. cretaceus*; OD]. Trapezoidal to subtriangular in outline, inflated, heavy, with prominent umbones and strong ligament trace; beaks near anterior end, slightly incurved and sculptured with broad, radiating wrinkles together with coarse, subregularly concentric ridges;

posterior slope well marked; hinge massive, with broad plate; cardinals of subrhomboidal shape, ragged and heavy; lamellar teeth moderately developed, more or less impressed; muscle scar deep and of irregular shape. *L.Cret.*, N.Am.—Fig. D37,4. **S. cretaceus*; 4a,b, LV int., both valves dorsal, $\times 1$ (1011).

Tritogonia L. ACASSIZ, 1852 [**Unio verrucosus* SAV, 1834 (= **Unio tuberculatus* BARNES, 1823); OD]. Elongate rhomboid, heavy with strong posterior slope, obliquely truncated behind in males, somewhat compressed and rounded in females; base incurved, whole disc of female, except posterior wing, covered with pustules; beaks rather low, bearing irregular, subparallel ridges posteriorly curved upward; periostracum dark olive; hinge normal, hinge plate narrow, lamellar teeth long, straight, near cardinals; cavity of beaks rather deep. *Rec.*, N.Am.—Fig. D37,6. **T. verrucosa* (SAV); 6a,b, LV ext., both valves dorsal, $\times 0.5$ (497).

Subfamily ANODONTINAE Ortmann, 1910

Shell thin to medium thick, of variable shape; hinge either toothless or with short posterior lamellar elements which cannot be homologized with those of previously treated subfamilies since they arise directly from dorsal margin of shell and not from a hinge plate, being sometimes termed "claustra," in contrast to "lamellar teeth" or "laterals." Beak sculpture consists of concentric, wavy ridges. Marsupium pad-shaped, occupying entire outer gills; fully developed glochidia kept within marsupium over winter; a special device for oxygen supply of glochidia within the gills has been developed, the so-called lateral (or Ortmann's) water tubes. *U.Cret.-Rec.*

Anodonta LAMARCK, 1799 [**Mytilus cygneus* LINNÉ, 1758, *nom. conserv.*] [= *Glochidium* RATHKE, 1797; *Anodontigenus* RENIER, 1807; *Cista* HUBNER, 1810; *Anodon* OKEN, 1815; *Anodontes* CUVIER, 1817; *Edentula*, *Lipodonta* NITZSCH, 1820; *Anodonte* FISCHER VON WALDHEIM, 1823; *Onodon* PARTINGTON, 1836-37; *Anodontina* SCHLUETER, 1853; *Colloptoperum* BOURGUIGNAT, 1881; *Pieranodon* L. FISCHER, 1886; *Euanodonta* WESTERLUND, 1890; *Nayadina* DE GREGORIO, 1914; *Anodota* PETROK, 1930; *Colloptoperum* BÉDÉ, 1932; *Euphrata* PALLARY, 1933]. Irregularly elliptical, thin, flattened to inflated, uncommonly winged slightly behind; beak sculpture consisting of parallel ridges, usually doubly looped, becoming slightly nodulose on loops; surface smooth, periostracum lustrous; hinge reduced to thin margins of shell, curved, but some in lacustrine habitats

with traces of claustra; accompanied by symphynoty of posterior wing (*Colletopterum* phase). *U.Cret.-Rec.*, worldwide in northern hemisphere.
A. (*Anodonta*). Beak subcentral, moderately strong

posterior ridge and dorsal wing, surface smooth except for growth lines. *U.Cret.-Rec.*, holarctic.
 —Fig. D38.3. **A. (A.) cygnea* (LINNÉ), Rec.; L. ext., $\times 0.25$ (497).

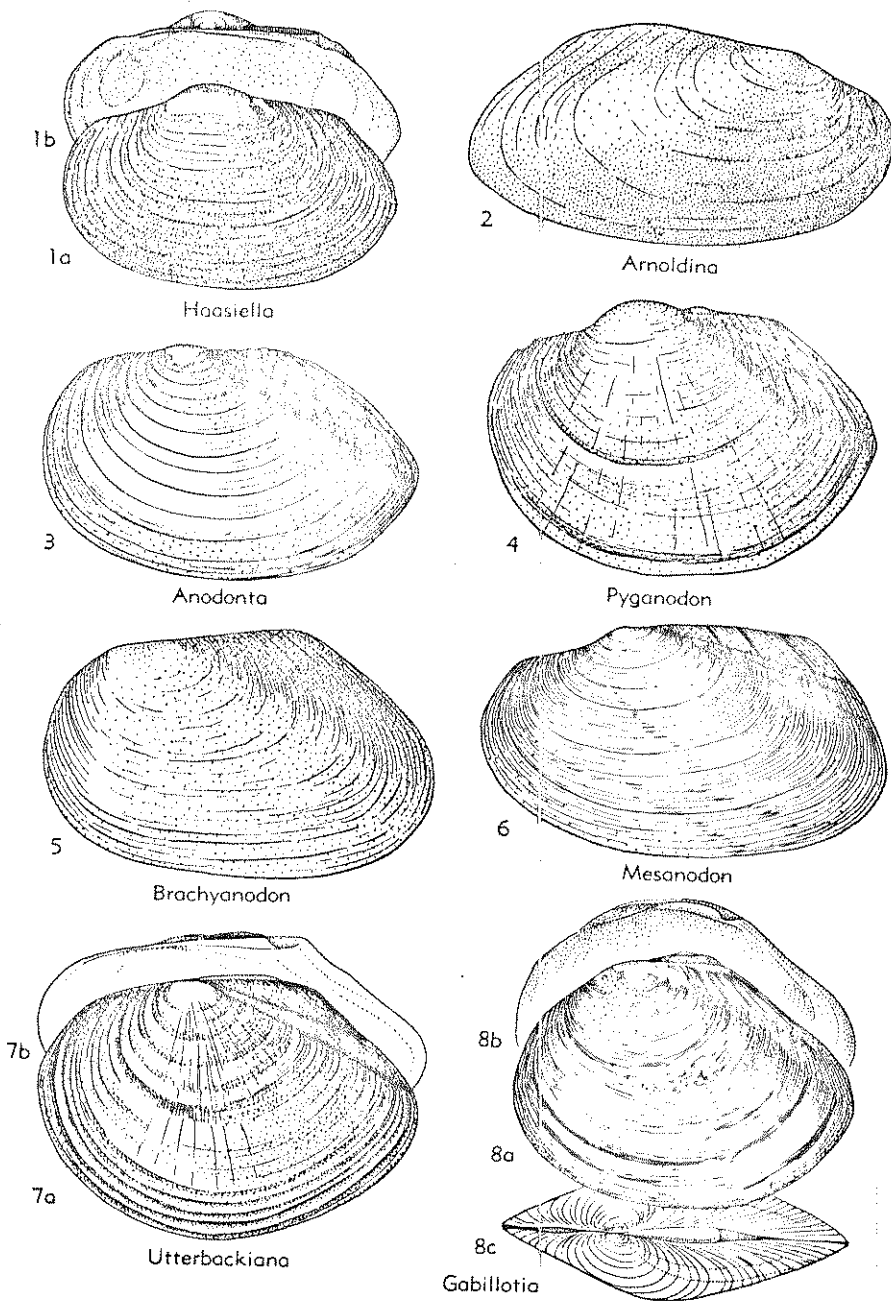


FIG. D38. Unionidae (Anodontinae) (p. N442-N444).

A. (Arnoldina) HANNIBAL, 1912 [**A. dejecta* LEWIS, 1875; OD]. Elongate-elliptical, broader behind; beaks not prominent, their sculpture consisting of numerous irregular ridges which tend to become doubly looped and nodulose. *Pleist.-Rec.*, USA (Calif.).—FIG. D38,2. **A. (A.) dejecta* LEWIS, Pleist.; RV ext., $\times 0.7$ (386).

A. (Brachyanodon) CROSSE & FISCHER, 1893 [**A. chapalensis* CROSSE & FISCHER, 1892 (= **A. coarctata* ANTON, 1839); SD THIELE, 1934]. Short, beaks anteriorly situated, not prominent, dorsal margin ascending behind beaks. *Rec.*, C.Am.—FIG. D38,5. **A. (B.) coarctata* ANTON; LV ext., $\times 1$ (497).

A. (Gabbottia) SERVAIN, 1890 [**A. pseudodopsis* LOCARD, 1883; SD SIMPSON, 1900]. Large, moderately thick, slightly compressed, subrhomboid, gaping behind; beaks low, with fine, broken, concentric sculpture; hinge line very short, edentulous, invaded by periostracum. *L.Plio.(U. Macot.)-Rec.*, SE. Eu.-SW. Asia (Syria).—FIG. D38,8. **A. (G.) pseudodopsis* LOCARD, *Rec.*; 8a-c, LV ext., RV int., both valves dorsal, $\times 0.4$ (481).

A. (Haasiella) LINDHOLM, 1925 [**A. arcaiformis* HEUDE, 1877; OD]. Very inflated, with beaks almost central. Glochidium without hook or filament. *Rec.*, E.Asia.—FIG. D38,1. **A. (H.) arcaiformis* HEUDE; 1a,b, LV ext., RV int., $\times 0.5$ (405).

A. (Jouvillea) BÉDÉ, 1932 [**A. pallaryi*; OD]. Hinge with feeble "cardinals" and 2 claustra in RV, and with single claustrum in LV [Doubtful subgenus; good figure unavailable.] *Rec.*, N.Afr.

A. (Mesanodon) CROSSE & FISCHER, 1893 [**A. lurulenta* MORELET, 1849; SD THIELE, 1934]. Subrhomboid or ovoid, thin, inflated, with well-developed low dorsal wing; beaks low, sharp, their sculpture unknown; periostracum green or olive. *Rec.*, C.Am.—FIG. D38,6. **A. (M.) lurulenta* MORELET; LV ext., $\times 1$ (306).

A. (Pyganodon) CROSSE & FISCHER, 1893 [**A. globosa* LEA, 1841; SD FRIERSON, 1927]. Large, oval, thin, inflated; beaks submedian, full and rather high, with looped and nodulose sculpture; periostracum lustrous bluish-green. *Rec.*, C.Am.—FIG. D38,4. **A. (P.) globosa* LEA; LV ext., $\times 0.4$ (306).

A. (Utterbackiana) FRIERSON, 1927 [**A. suborbiculata* SAY, 1831; OD] [= *Utterbackia*, *Utterbackia*, F. C. BAKER, 1927]. Large compressed, suborbicular, somewhat produced near middle of base, rounded in front, bluntly pointed behind; beaks flattened, bearing few irregular ridges, generally broken into nodules, or only corrugated; posterior ridge distinct; disc smooth, periostracum delicately rayed near beaks. *Rec.*, N.Am.—FIG. D38,7. **A. (U.) suborbiculata* SAY; 7a,b, LV ext., RV int., $\times 0.3$ (140).

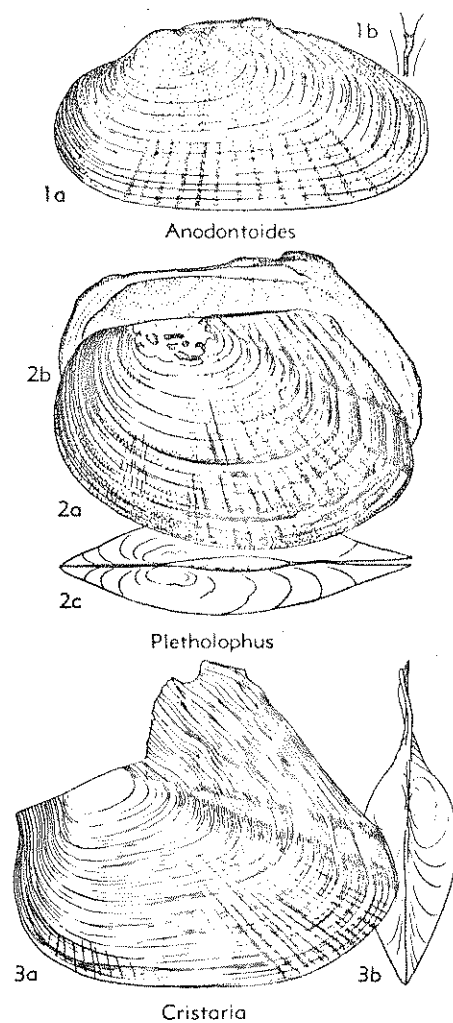


FIG. D39. Unionidae (Anodontinae) (p N444-N446).

Anodontoides SIMPSON, 1898 [pro *Anodontopsis* SIMPSON, 1898 (non M'COY, 1851)] [**Anodonta ferussaciana* LEA, 1834; OD]. Elliptical, inflated, thin, some constricted at center of base; beaks rather full, with few coarse, subparallel, concentric ridges, curved up abruptly toward rear, superimposed on fine radiating ridges; periostracum smooth, shining, commonly rayed; hinge line slightly curved in front of beaks, edentulous or with rudimentary claustra. *Pleist.-Rec.*, N.Am.—FIG. D39,1. **A. ferussacianus* (LEA), *Rec.*; 1a,b, LV ext., hinges, $\times 0.75$ (497).

Cristaria SCHUMACHER, 1817 [pro *Dipsas* LEACH,

1814 (non LAURENTI, 1768)] [*Dipsax plicatus* LEACH, 1815; OD] [=Barbala MUSEUM Callonniadum, 1797, nom. nud.; *Appius* MENKE, 1830; *Dianisotis* RAFINESQUE, 1831; *Dipsada* CUVIER,

1834; *Dipsax* VOIGT, 1834; *Dipsus* GRAY, 1835; *Dionisotis* FÉRUSSAC, 1835; *Barbata* SOWERBY, 1839; ?*Craspedodonta* KUESTER, 1842; *Cleone* GISTEL, 1848; *Dypsas* KOBELT, 1880; *Crassitesta*,

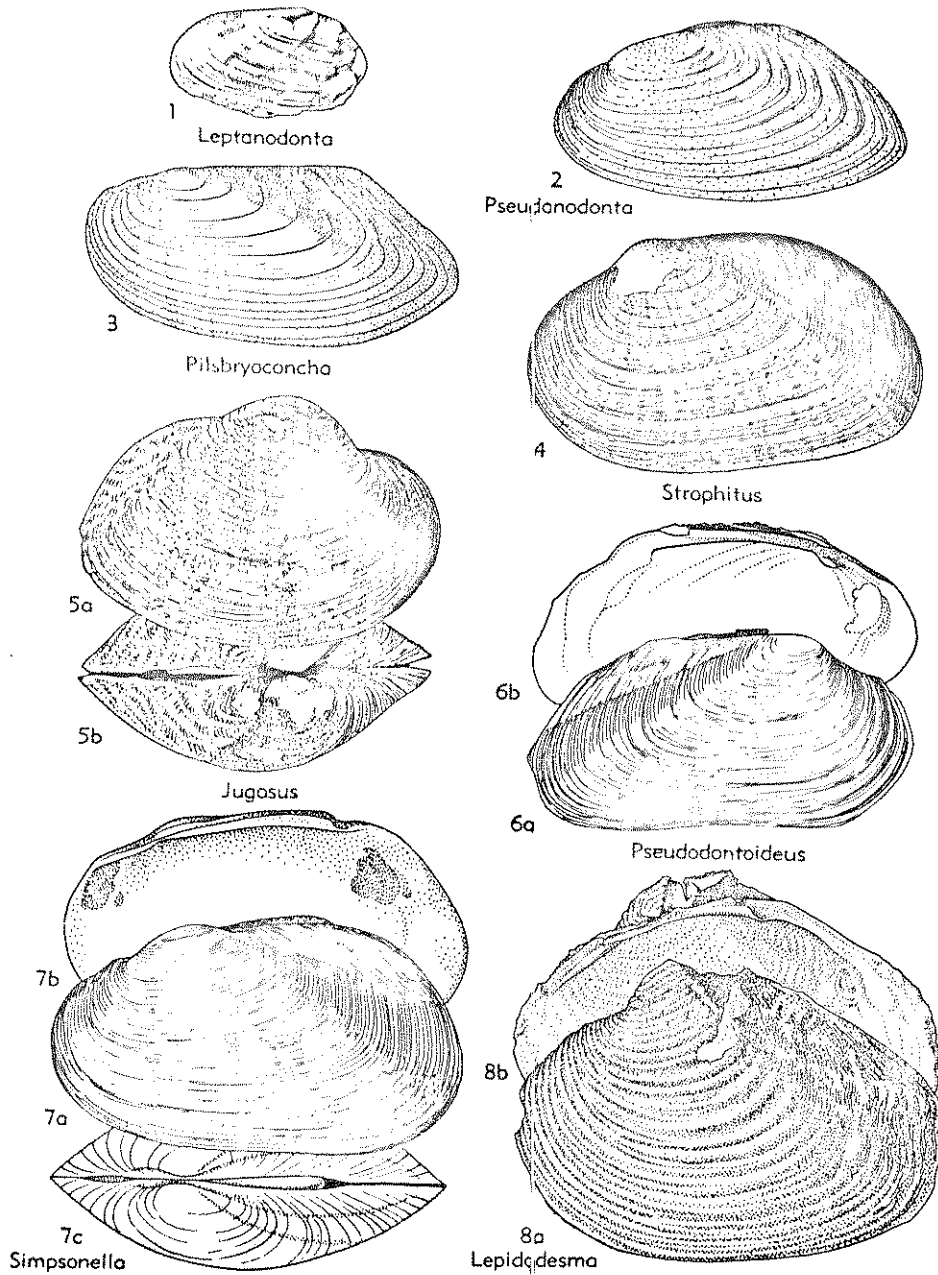


FIG. D40. Unionidae (Anodontinae) (p. N446).

Clione SIMPSON, 1900]. Mostly thin, elliptical, winged posteriorly and symphyonote; beaks rather low, sculptured with fine, somewhat doubly looped ridges at first, and later with coarse, low concentric ridges, nearly parallel with growth lines; periostracum smooth, commonly rayed; hinge with anterior claustrum wanting or vestigial and with elongate remote posterior claustrum in each valve. *Tert. (Mieken Ser.)-Rec.*, E.Asia-Japan.

C. (Cristaria). Large, thin, thicker in front, strongly winged posteriorly, with 2 rows of plications on posterior slope. *Tert.-Rec.*, E.Asia-Japan.—Fig. D39,3. **C. (C.) plicata* (LEACH), *Rec.*; 3a,b, LV ext., both valves dorsal, $\times 0.3$ (140).

C. (Pletholophus) SIMPSON, 1900 [**Symphynota discoidea* LEA, 1834; OD]. Short, elliptical, lenticular, with compressed beaks sculptured with low, wide, concentric ridges; weakly winged, pointed posteriorly; claustra very weak or wanting. *Rec.*, E.Asia-SE.Asia.—Fig. D39,2. **C. (P.) discoidea* (LEA); 3a-c, LV ext., RV int., both valves dorsal, $\times 1$ (497).

Lepidodesma SIMPSON, 1900 [**Unio languilata* HEUDE, 1874; OD]. Large, thin, inflated, with 2 high and sharp posterior ridges; beaks very high and full, with sculpture of cordlike ridges following growth lines and extending over whole shell; with row of radiating nodules on middle of disc and another stronger one on posterior ridge; ligament very large, covered with concentric scales; 2 anterior claustra in LV; 1st elongate, and with 2 long, posterior claustra, higher having edge reflexed upward; an anterior and posterior claustrum in RV; periostracum scaly, folded into hinge. *U.Plio.-Rec.*, E.Asia.—Fig. D40,8. **L. languilatum* (HEUDE), *Rec.*; 8a,b, LV ext., RV int., $\times 0.4$ (405).

Leptanodonta WENZ, 1927 [**Dreissenomya unionides* WENZ, 1927 (non FUCHS, 1870) (= **Lepianodonta rumana* WENZ, 1941); OD]. Small, thin, rounded trapezoidal, compressed with small, low beaks; dorsal margin straight, sloping anteriorly, anterior margin subangular, ventral and dorsal margins straight, almost parallel, posterior margin somewhat produced; hinge edentulous. *L.Plio. (U.Macot.)*, Eu.(Rumania).—Fig. D40,1. **L. rumana*; WENZ; RV ext., $\times 1$ (966).

Pilsbryconcha SIMPSON, 1900 [**Unio exilis* LEA, 1839; OD]. Elongate, elliptical, thin, compressed, with low posterior wing, narrow and rounded in front, pointed behind, with almost parallel dorsal and ventral margins, latter expanded posteriorly; beaks low, compressed, sculptured with coarse, irregularly concentric and doubly looped undulations; periostracum smooth, yellowish to brown, faintly rayed in some; hinge edentulous, but commonly with vestiges of faint, compressed claustrum in front of beaks. *Rec.*, SE.Asia-Indon.—Fig. D40,3. **P. exilis* (LEA); LV ext., $\times 0.6$ (Haas).

Pseudanodonta BOURGUIGNAT, 1877 [**Anodonta complanata* ROSSMAESSLER, 1835; SD WESTERLUND, 1902] [= *Pseudoanodonta* PICAGLIA, 1893; *Pseuanodonta* KENNARD & WOODWARD, 1926]. Elongate, compressed, thin, short and rounded in front, long and bluntly pointed behind, with ventral margin gently curved, expanded posteriorly, and dorsal margin almost straight, ascending posteriorly; incipient posterior wing; beaks low, sculptured with 3 to 5 tuberculate ridges; surface smooth, green, hinge edentulous. *Rec.*, Eu.—Fig. D40,2. **P. complanata* (ROSSMAESSLER); LV ext., $\times 0.7$ (798).

Simpsonella COCKERELL, 1903 [*pro Dalliella* SIMPSON, 1900 (non COSSMANN, 1895)] [**Anodonta purpurea* VALENCIENNES, 1833; OD]. Subtrapezoidal, thin, inflated, with low posterior slope and full beaks bearing sculpture of zigzag ridges which develop into angular protracted ridges on posterior slope; surface smooth; hinge generally toothless, but in some with single vestigial cardinal and equally vestigial, short, low, thin claustrum in each valve; beak cavities moderately deep. *Rec.*, Philip.—Fig. D40,7. **S. purpurea* (VALENCIENNES); 7a-c, LV ext., RV int., both valves dorsal, $\times 1$ (Haas).

Strophitus RAPINESQUE, 1820 [**Anodonta undulata* SAY, 1816; OD] [= *Strophites* DESHAYES, 1832; *Strophilus* GRAY, 1847; *Strophites* DESMAREST, 1859]. Elliptical to rhomboid, inflated, moderately heavy, pointed or biangular behind, with low posterior slope; beaks full, sculpture consisting of few strong, concentric ridges, which curve sharply upward behind; surface smooth or plicate on posterior slope; periostracum lustrous, rayed in some; hinge line incurved in front of beaks, hinge nearly edentulous except for vestigial compressed anterior claustrum in each valve; posterior claustra rarely present. *Rec.*, N.Am.

S. (Strophitus). Smooth. *Rec.*, N.Am.—Fig. D40,4. **S. (S.) undulatus* (SAY); LV ext., $\times 1$ (Sowerby).

S. (Jugosus) SIMPSON, 1914 [**S. wrightianus* WALKER, 1901; OD]. Dorsal slope strongly plicate subradially; claustra unusually strong. *Rec.*, N.Am.—Fig. D40,5. **S. (J.) wrightianus* WALKER; 5a,b, RV ext., both valves dorsal, $\times 0.9$ (Walker).

S. (Pseudodontoides) FRIERSON, 1927 [**Margaritana alabamensis* LEA, 1861; OD] [= *Pseudodontideus* THEILE, 1934]. Beak sculpture consisting of few strong ridges parallel with growth lines; general surface with irregular, concentric sculpture; anterior claustra feeble, low, smooth; posterior claustra obsolescent or absent. *Rec.*, N.Am.—Fig. D40,6. **S. (P.) alabamensis* (LEA); 6a,b, RV ext., LV int., $\times 0.5$ (140).