TREATISE ON
INVERTEBRATE PALEONTOLOGY

Prepared under Sponsorship of
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The Paleontological Society *The Society of Economic Paleontologists and Mineralogists*
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Part N
VOLUME 2 (OF 3)
MOLLUSCA 6
BIVALVIA

By †L. R. COX, N. D. NEWELL, D. W. BOYD, C. C. BRANSON, RAYMOND CASEY, ANDRÉ CHAVAN, A. H. COOGAN, COLETTE DECHASEAUX, C. A. FLEMING, FRITZ HAAS, L. G. HERTLEIN, E. G. KAUFFMAN, A. MYRA KEEN, AURÈLE LAROCQUE, A. L. MCALESTER, R. C. MOORE, C. P. NUTTALL, B. F. PERKINS, H. S. PURI, L. A. SMITH, T. SOOT-RYEN, H. B. STENZEL, E. R. TRUEMAN, RUTH D. TURNER, and JOHN WEIR

THE GEOLOGICAL SOCIETY OF AMERICA, INC.
and
THE UNIVERSITY OF KANSAS

1969

Library of Congress Catalogue Card
Number: 53-12913

Text Composed by
THE UNIVERSITY OF KANSAS PRINTING SERVICE
Lawrence, Kansas

Illustrations and Offset Lithography
THE MERIDEN GRAVURE COMPANY
Meriden, Connecticut

Binding
RUSSELL RUTTER COMPANY
New York City

Published 1969

Distributed by The Geological Society of America, Inc., P.O. Box 1719, Boulder, Colo., 80302, to which all communications should be addressed.

PART N
BIVALVIA

By †L. R. Cox, N. D. Newell, D. W. Boyd, C. C. Branson, Raymond Casey, André Chavan, A. H. Coogan, Colette Dechaseaux, C. A. Fleming, Fritz Haas, L. G. Hertlein, E. G. Kauffman, A. Myra Keen, Aurèle LaRocque, A. L. McAlester, R. C. Moore, C. P. Nuttall, B. F. Perkins, H. S. Puri, L. A. Smith, T. Soot-Ryen, H. B. Stenzel, E. R. Trueman, Ruth D. Turner, and John Weir

VOLUME 2

Subclass HETERODONTA Neumayr, 1884

[*nom. transl.* Newell, 1965 (*ex* Heterodonta Neumayr, 1884; unspecified higher category)] [Diagnosis by N. D. Newell]

Mantle lobes more or less joined and usually possessing developed siphons; cardinal area commonly present, prosodetic or divided into lunule and escutcheon; ligament opisthodetic, with or without separate resilium; without lithodesma and rarely with external accessory shelly pieces; nepionic stage usually without taxodont provinculum or adult byssus; generally possessing hinge plate and teeth differentiated into distinct cardinals and laterals; shell structure crossed lamellar, complex, or prismatic, never nacreous; gills eulamellibranchiate. *M.Ord.-Rec.*

Order VENEROIDA H. Adams & A. Adams, 1856

[*nom. correct.* Newell, 1965 (*pro* order Veneracea H. & A. Adams, 1856)] =[Heterodonta auctt. *(partim)*] [Diagnosis by N. D. Newell]

Commonly equivalve, isomyarian; dentition differentiated into standardized cardinals and laterals, or few cardinals only; posterior laterals, where present, lie entirely behind ligament; anterior laterals, if present, formed early in ontogeny by separation from cardinals of anterior part of hinge lamellae; habit active or nestling, rarely sedentary burrowers, or sessile. *M.Ord.-Rec.*

Superfamily BABINKACEA Horný, 1960

[*nom. transl.* McAlester, 1965, *ex* Babinkidae Horný, 1960]

Characters of family. *M.Ord.*

Family BABINKIDAE Horný, 1960

[Materials for this family prepared by A. L. McAlester, Yale University]

Shell anteriorly expanded, compressed; two small cardinal teeth in LV, one large cardinal tooth in RV; elongate, subequal adductor muscle scars, eight rounded pedal muscle scars in line between top of adductors; pallial line nonsinuate. *M.Ord.*

Babinka Barrande, 1881 (p. 31) [**B. prima*; OD]. Characters of family. *M.Ord.*, Eu.(Czech.).—Fig. E1,*1*. **B. prima*; Czech.(Osek); *1a*, LV int. mold, ×2.7 (Newell, n); *1b,c*, LV and RV hinges, latex casts, ×2.7 (McAlester, n).

Superfamily LUCINACEA Fleming, 1828

[*nom. transl.* Anton, 1839 (*ex* Lucinidae Fleming, 1828] [Materials for this superfamily prepared by André Chavan, Seyssel (Ain), France]

Shell generally equivalve, subcircular to oval or subtrigonal; commonly smooth externally or concentrically sculptured on internal layer of straight radial ribs, many genera with two dorsal folds which delimit anterior and posterior areas; beaks normally small, prosogyrous to orthogyrous; lunule generally more extended on RV; escutcheon ill-defined. Hinge with typical tooth formula *3a, 3b/2, 4b,* but *3a* may be obliterated, lateral laminae (if present) duplicate in LV only; integripalliate. Animal with more or less elongate to vermiform foot, rudimentary labial palps, and one or two siphonal apertures. [Marine or estuarine.] *Sil.-Rec.*

The alphabetically arranged generic descriptions in each family-group division of the Lucinacea are

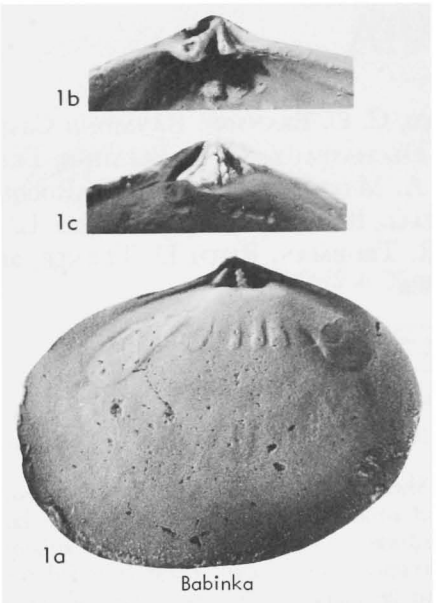


FIG. E1. Babinkidae (p. *N*491).

accompanied by numbers inclosed by square brackets. Such numbers indicate position in the sequence of generic taxa given with the respective families or subfamilies for the purpose of recording CHAVAN's arrangement, designed to reflect "natural relationships" of these taxa as inferred by him.

Family LUCINIDAE Fleming, 1828

[*nom. correct.* D'ORBIGNY, 1837 (*pro* Lucinadae FLEMING, 1828)]

Subcircular to ovate or trapezoidal in outline, shell commonly thickened, concentric sculpture tending to be irregular, strong ribs alternating with weaker ones, radial ribs (if present) stronger laterally; lunule more or less asymmetrical. Hinge with two cardinals, anterior right covered in some, lateral laminae commonly duplicate in LV; ligament marginal to inframarginal, without separated resilium; shell internally more or less punctate or grooved; anterior adductor scar with ventral extension separate from pallial line, forming moderately to strongly divergent or elongate digitation. Margin crenate or smooth. *Sil.-Rec.*

Subfamily LUCININAE Fleming, 1828

[*nom. transl.* CHAVAN, herein (*ex* Lucinidae FLEMING, 1828)]

Shell generally solid, more or less lenticular, convex, with concentric and commonly radial sculpture. Anterior scars short. *L. Jur.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Lucina.*——2. *Lucinisca.*——3. *Recurvella.*——4. *Volupia.*——5. *Here.*——6. *Herella.*——7. *Linga.*——8. *Illesca.*——9. *Pleurolucina.*——10. *Bellilucina.*——11. *Parvilucina.*——12. *Cavilinga.*——13. *Microloripes.*——14. *Callucinella.*——15. *Callucina.*——16. *Pseudolucinisca.*——17. *Striolucina.*——18. *Callucinopsis.*——19. *Barbierella.*——20. *Pillucina.*——21. *Wallucina.*——22. *Loripes.*——23. *Nevenulora.*——24. *Jagonoma.*——25. *Megaxinus.*——26. *Pteromyrtea.*——27. *Ctena.*——28. *Talocodakia.*——29. *Epicodakia.*——30. *Luciniola.*——31. *Codakia.*——32. *Epilucina.*——33. *Cavilucina.*——34. *Mesolinga.*

Lucina BRUGUIÈRE, 1797 [**Venus jamaicensis* SPENGLER, 1784; SD GRAY, 1847] [*non Lucina* LAMARCK, 1799] [=*Egraca* LEACH in GRAY, 1852 (obj.); *Dentilucina* P. FISCHER, 1887 (obj.); *Phacoides* AGASSIZ, 1845]. Medium-sized to large, subtrapezoidal, more or less flattened, with well-marked dorsal areas; sculpture of somewhat evenly spaced concentric lamellae with some areas smoother than remainder of disc. Cardinals two, straight, *3a* obsolete, *3b* and *4b* oblique and compressed, laterals with posterior ones distant; anterior scars elongate; inner shell margin with fine crenulations which tend to vanish. *U.Cret.-Rec.,* Eu.-Afr.-Asia-N.Am.

L. (Lucina) [1] [=*L. (Lepilucina)* OLSSON, 1965 (type, *L. (L.) gratis;* OD)]. Concentric lamellae well spaced, stronger posteriorly; dorsal areas clearly marked; lunule asymmetrical, elongate, narrow. Cardinals oblique, somewhat weakened; anterior scars distant from pallial line; inner margin feebly crenulate. *U.Cret.-Rec.,* Eu.-Afr.-Asia.——FIG. E2,*6*. **L. (L.) jamaicensis* (SPENGLER), Rec., USA(Fla.); *6a-c,* LV and RV hinges, LV ext., ×0.8 (*513,* Perry).

L. (Lucinisca) DALL, 1901 [2] [**L. nassula* CONRAD, 1846; OD]. Sculpture reticulate, posterior area less distinct than anterior; lunule somewhat depressed, slightly asymmetrical. Cardinals well marked; anterior scars elliptical, in part close to pallial line; inner margin strongly dentate. *Mio.-Rec.,* N.Am.-Asia(Japan-Philip.).——FIG. E2,*5*. **L. (L.) nassula* CONRAD, Rec., USA(Fla.); LV ext., ×1.5 (Perry).——FIG. E2,*8*. *L. (L.) cribraria* SAY, Mio., USA(S.Car.); *8a,b,* LV int., RV int., ×3.6 *(98)*.

Barbierella CHAVAN, 1938 [19] [**Lucina barbieri* DESHAYES, 1858;[1] OD]. Small, subtrigonal, sculpture strong, cancellate, with well-marked posterior

[1] New taxa introduced by DESHAYES in 1858 as indicated by first publication of descriptions are not correctly cited, as by some authors, as 1857, when plates alone were published. The names without accompanying descriptions used in 1857 were *nomina nuda.* Likewise, names of taxa used by DESHAYES on plates published in 1858 are correctly cited as 1860, when descriptions first were given.

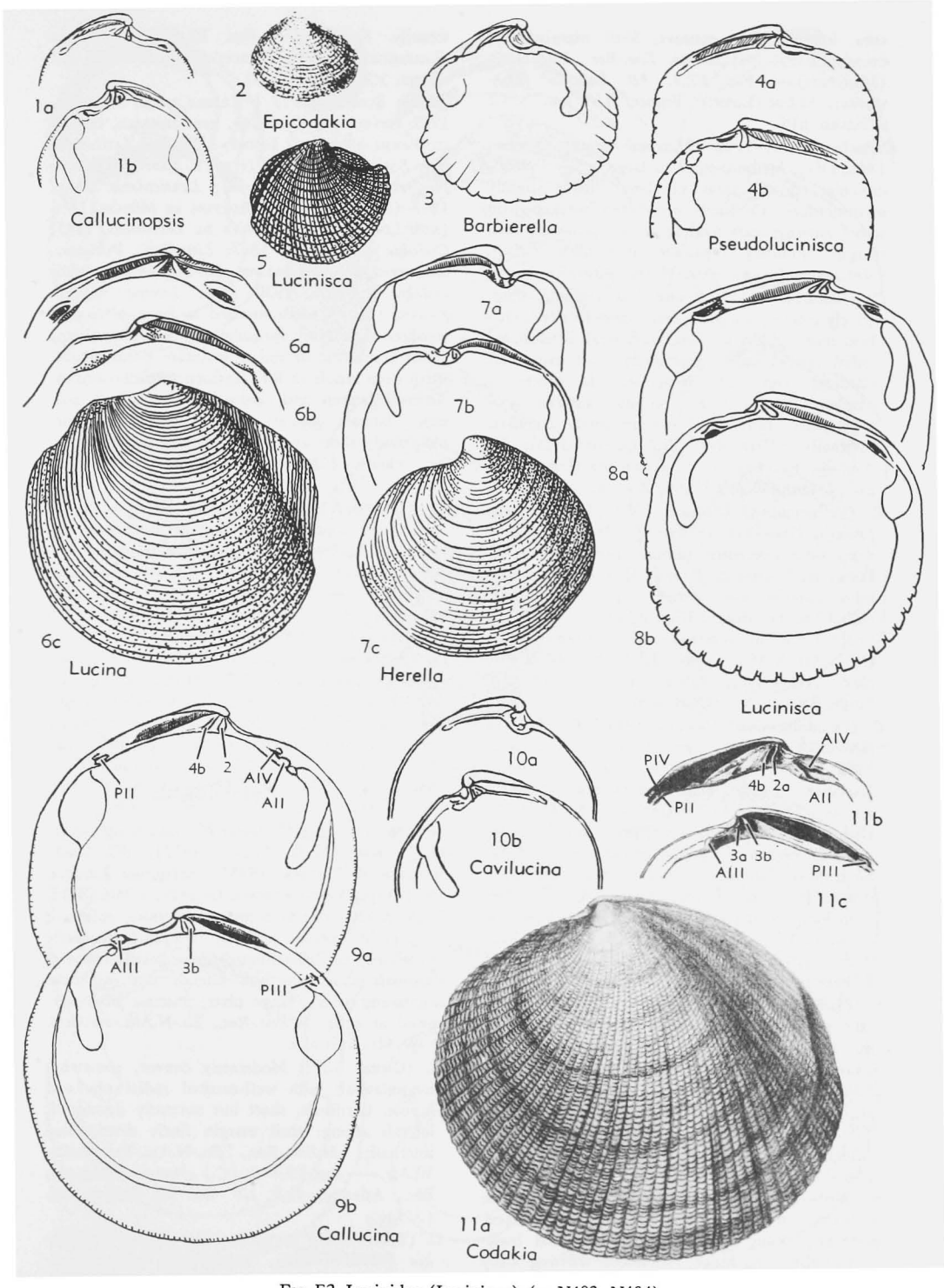


FIG. E2. Lucinidae (Lucininae) (p. *N*492, *N*494).

area; lunule deeply concave. Shell margin with broad internal undulations. *Eoc.-Rec.*, Eu.-Ind.O. (Mauritius).——Fig. E2,*3*. **B. barbieri* (Deshayes), M.Eoc.(Lutet.), France; LV int., ×3.2 (Chavan, n).

Callucina Dall, 1901 [**Lucina radians* Conrad, 1841; OD]. Medium-sized to large, generally suborbicular, dorsal areas obsolete; lunule slightly asymmetrical. Cardinals broad but weakened in some; anterior scars tending to be narrowed; shell margin minutely crenulate internally. *L.Cret.(Apt.)-Rec.*, Eu.-Afr.-Asia-N.Am.-Australia.

C. (Callucina) [15]. Rounded to trigonal, moderately convex; sculpture concentric, locally lamellose, more or less marked, with weak intercalated radial ribs; lunule asymmetrical, not excavated. Cardinals commonly weakened, *3a* practically obsolete; laterals distant, minute; anterior scars moderately short; shell margin finely crenulate internally. *L.Cret.(Apt.)-Rec.*, Eu.-Afr.-N.Am.-W. Asia.——Fig. E2,*9*. *C. (C.) hoernesi* (Deshayes), Eoc, France; *9a,b*, LV int., RV int., ×2.8 *(98)*.

C. (Callucinopsis) Chavan, 1959 [18] [**Lucina foucardi* Deshayes, 1858; OD]. Moderately convex; dense concentric ribbing; lunule excavated. Hinge teeth present, *3a* and *A1* approximate; *3b* bifid; anterior scars rather long, subparallel to pallial line but distant from it; shell margin very finely denticulate internally. *U.Cret.(Senon)-Rec.*, Eu.-N.Afr.-E.Afr.——Fig. E2,*1*. **C. (C.) foucardi* (Deshayes), Paleoc., France; *1a,b*, LV hinge, RV int., ×2 (Chavan, n).

C. (Pseudolucinisca) Chavan, 1959 [16] [**Lucina lacteola* Tate, 1897 (*pro. L. lactea* A. Adams, 1855 (*non Tellina lactea* Poli, 1795=*L. lactea* Lamarck, 1818) (=*L. concentrica* Adams & Angas, 1863, *non* Lamarck, 1806); OD]. Globose, with reticulate sculpture; lunule asymmetrical excavated, partly obliterating tooth *2*; *3b* trigonal, laterals lacking; anterior scars short, distant from pallial line; inner margin of shell with long crenulations. *Oligo.-Rec.*, Eu.-Australia. ——Fig. E2,*4*. **C. (P.) lacteola* (Tate), Rec., Australia; *4a,b*, LV and RV hinges, ×0.6 (Chavan, n).

C. (Striolucina) Sacco, 1901 [17] [**Dentilucina (S.) persolida*; OD]. Large, convex, with irregular lamellose concentric ribs; lunule elongate, ligament broad. Hinge with cardinals and feeble laterals; anterior scars long, moderately narrow; shell margin finely crenulated internally. *Eoc.-Plio.*, S.Eu.

Cavilucina P. Fischer, 1887 [33] [**Lucina sulcata* Lamarck, 1806 (1808); OD]. Rather small, rounded-oblong, thick, somewhat inflated; surface with concentric strong ribs; lunule deeply sunken, projecting below along hinge margin and backward, obliterating hinge; escutcheon wanting. Only anterior laterals developed; anterior scars short, very divergent, narrow; shell margin smooth internally. *Eoc.*, Eu.——Fig. E2,*10*. **C. sulcata* (Lamarck), M.Eoc., France; *10a,b*, LV and RV hinges, ×2.4 (Chavan, n).

Codakia Scopoli, 1777 [**Chama codak* Adanson, 1757 (*errore pro C. codok*, pre-Linnaean, invalid =**Venus orbicularis* Linné, 1758; M] [=*Lentillaria* Schumacher, 1817 (type, *L. punctata*=*Venus punctata* Linné, 1758; M); *Lenticularia* Gray, 1847 (missp.); *Chama* Martini in Mörch, 1853 (*non* Linné, 1758); *Antilla* de Gregorio, 1885; *Codokia* P. Fischer, 1887; *Lintellaria* Bucquoy, Dautzenberg, & Dollfus, 1898 (missp.); *Pexocodakia* Iredale, 1930 (type, *Lucina rugifera* Reeve, 1850)]. Medium-sized to large, lenticular, compressed, slightly inequilateral, no differentiated areas; concentric or radial sculpture predominant; small deep lunule in RV; ligament broadly sunken. Anterior laterals and cardinals well marked, posterior laterals obsolete or small; anterior scars moderately short and broad, divergent; shell margin smooth. *U.Jur.-Rec.*, Eu.-Am.-Asia-Australia-Pac.

C. (Codakia) [31]. Generally large, sculpture reticulate; lunule small, very asymmetrical, depressed; ligamentary groove broad. Posterior laterals obsolete. *Paleoc.-Rec.*, Eu.-Am.-Asia-Australia-Pac.——Fig. E2,*11*. **C. (C.) orbicularis* (Linné), Rec., W.Indies; *11a*, LV ext., ×0.8 (Reeve); *11b,c*, LV and RV hinges, ×0.5 *(513)*.

C. (Epilucina) Dall, 1901 [32] [**Lucina californica* Conrad, 1837; OD]. Medium-sized, with concentric sculpture only; lunule rather large, asymmetrical; ligamentary groove of moderate extent. Posterior laterals small. *U.Jur.-Rec.*, Eu.-N.Am.——Fig. E3,*13*. **C. (E.) californica* (Conrad), Rec., USA(Calif.); *13a,b*, LV int., RV int., ×1.7 *(98)*.

Ctena Mörch, 1861 [**Lucina pectinata* Carpenter, 1857 (*non* C. B. Adams, 1852); SD Dall, Bartsch & Rehder, 1938] [=*Jagonia* Recluz, 1869 (type, *Venus eburnea* Gmelin, 1790; OD)]. Transversely ovate to elliptical, anteriorly enlarged, compressed; beaks pointed; sculpture regularly reticulated; no differentiated areas; lunule concave. Cardinals short or thin, laterals not duplicate, originating under hinge plate; anterior scars narrowed at ends. *M.Eoc.-Rec.*, Eu.-N.Am.-Pac.-Ind. O.-W.Afr.-Australia.

C. (Ctena) [27]. Moderately convex, somewhat inequilateral, with well-marked radial ribs and lunule. Cardinals, short but normally developed, laterals strong; shell margin finely denticulated internally. *M.Eoc.-Rec.*, Eu.-N.Am.-Pac.-IndO.-W.Afr.——Fig. E3,*3*. *C. (C.) eburnea* (Gmelin), Rec., Atlantic; *3a,b*, LV and RV hinges, enl. *(513)*.

C. (Talocodakia) Iredale, 1936 [28] [**Epicodakia kennethi*; OD]. Compressed, very inequilateral, radial riblets at ends only; lunule obsolete; ligamentary groove shallow. Cardinals small,

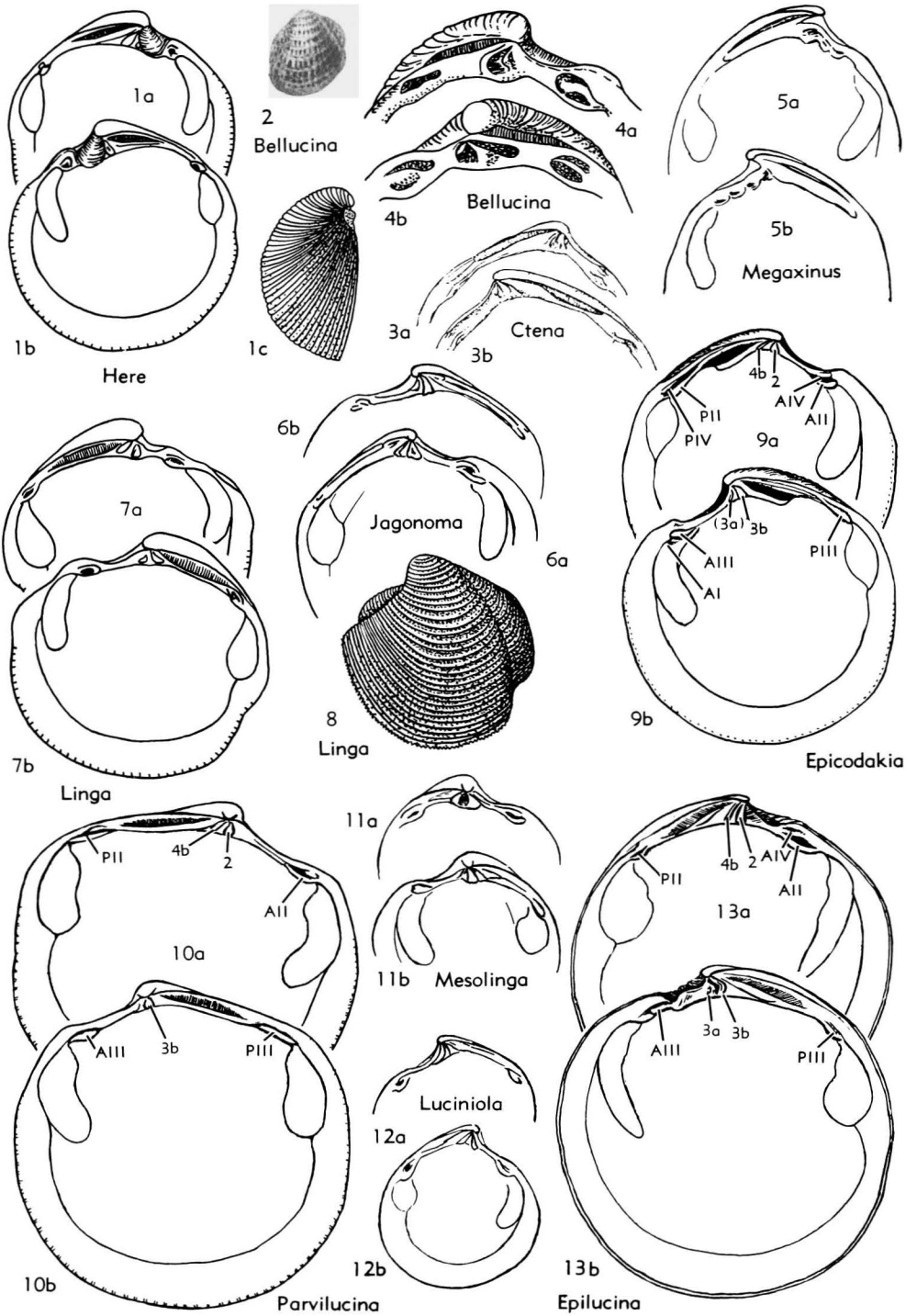


FIG. E3. Lucinidae (Lucininae) (p. *N*494, *N*496, *N*498).

laterals small, distant; anterior scars short, reniform, moderately divergent; shell margin smooth internally. *Oligo-Rec.,* Australia.

Epicodakia IREDALE, 1930 [29] [**E. consettiana* (=*Lucina minima* TENISON-WOODS, 1876, *non* ROEMER, 1836); OD]. Compressed, transversely elliptical to ovate, anteriorly enlarged; with dichotomous radial ribs predominating over concentric ribs; ligament in deep groove. Cardinals and laterals well marked, latter duplicate on LV; anterior scars elliptical, divergent, rounded at ends; marginal internal crenulations of shell almost obsolete. *Pleist.-Rec.,* Australia-N.Am.-Asia.——FIG. E3,*9*. *E. divergens* (PHILIPPI), Rec., Japan; *9a,b,* LV int., RV int., ×2.3 (*119,* mod.).——FIG. E2,*2*. **E. consettiana,* Rec., Australia; LV ext., ×1.35 (Iredale).

Here GABB, 1866 [**Lucina (H.) richtofeni* (=**Lucina excavata* CARPENTER, 1857); SD STOLICZKA, 1871]. Medium-sized to small, rounded, with weak anterior and posterior areas; concentric ribs tending to vanish; lunule deeply excavated, covering part of hinge; anterior scars somewhat short, attenuated; internal shell margin with minute denticles. *Paleoc.-Rec.,* W.Eu.-W.N.Am.-N.Afr.

H. (Here) [5]. Concentric ribs fine, but well-marked; lunule rather broadly rounded, obliterating only anterior cardinal, posterior ones well marked; anterior laterals minute, posterior laterals distant; anterior scars divergent at their ends; internal shell margin finely crenulated. *Eoc.-Rec.,* W.Eu.-W.N.Am.——FIG. E3,*1*. **H. (H.) excavata* (CARPENTER), Mio., USA(Calif.); *1a,b,* LV int., RV int., ×2.25; *1c,* LV ext., ×1.5 (*98*; Gabb, 1869).

H. (Herella) CHAVAN, 1942 [6] [**Lucina levesquei* D'ORBIGNY in DESHAYES, 1858; OD] [=*?Tuberculina* DE GREGORIO, 1882 *(nom. dub.)*]. Sculpture weakly cancellate; lunule narrow, projecting under beaks, covering obsolete RV cardinals, those of LV tuberculiform; laterals feeble; anterior scars short, wholly divergent; internal shell margin almost smooth. *Paleoc.-Oligo.,* W.Eu.-N.Afr.——FIG. E2,*7*. **H. (H.) levesquei* (D'ORBIGNY), L.Eoc.(Cuis.), France (Paris basin); *7a-c,* LV int., RV int., LV ext., ×3.6 (Chavan, n; *257*).

Linga DE GREGORIO, 1884 [**Lucina columbella* LAMARCK, 1819; SD SACCO, 1889] [=*Quasilucina* STEWART, 1930 (type, *Lucina carinifera* CONRAD, 1833; OD)]. Medium-sized, rounded, tumid; concentric ribbing more or less lamellose; lunule sunken, short, cordiform. Hinge teeth strong, short, LV laterals duplicate; anterior scars moderately short; shell margin internally denticulated. *?Paleoc., Eoc.-Rec.,* Eu.-Am.-Afr.-Asia-Australia.

L. (Linga) [7]. Rounded; concentric sculpture nearly uniform consisting of numerous equidistant lamellae; dorsal angulation rounded. Hinge teeth *3a* and *2* present; shell margin crenulated internally. *?Paleoc., Eoc.-Rec.,* W.Eu.-W. Afr.-N.Am.-C.Am. —— FIG. E3,*7,8*. **L. (L.) columbella* (LAMARCK) *basteroti* (AGASSIZ), L. Mio.(Burdigal.), France(Gironde); *7a,b,* LV int., RV int., ×1.8; *8,* LV ext., ×0.8 *(98)*.

L. (Bellucina) DALL, 1901 [10] [**Parvilucina eucosmia* DALL, 1901 (=*Lucina pisum* REEVE, Aug. 1850; *non* SOWERBY, 1836; *nec* D'ORBIGNY, 1841; *nec* PHILIPPI, Apr. 1850) (=**Lucina semperiana* ISSEL, 1869); OD] [=*Cardiolucina* SACCO, 1901 (type, *Cardium agassizi* MICHELOTTI, 1847; =*Cardita agassizi* MICHELOTTI, 1839; OD)]. Small, rounded, very tumid; sculpture of heavy concentric ribs, crossed, but not interrupted, by radiating riblets; lunule small, not immersed. Complete lucinoid hinge with *AIV* and *PIV* feebly marked; anterior scars broad, short; shell margin deeply but finely crenulated internally. *M.Eoc.-Rec.,* Eu.-Afr.-Asia(Japan)-Australia.—— FIG. E3,*2,4*. **L. (B.) semperiana* (ISSEL), Rec., Ind.O.; *2,* LV ext., ×1.4 (Reeve); *4a,b,* LV and RV hinges, enlarged *(513)*.

L. (Illesca) OLSSON, 1932 [8] [**Phacoides (Here) andersoni* OLSSON, 1930; OD]. Smaller than *L. (Linga),* with concentric sculpture of strong well-spaced folds. Hinge teeth *3a* and *2* obliterated by totally immersed lunule; anterior scars ovate, short; internal shell margin finely crenulated. *U.Eoc.,* S.Am.(Peru).——FIG. E4,*3*. *L. (I.) andersoni* (OLSSON); *3a,* LV ext., ×2.4; *3b,c,* LV int., RV int., ×3.6, ×4.8 (Olsson, 1932).

L. (Pleurolucina) DALL, 1901 [9] [**Lucina leucocyma* DALL, 1886 (1889); OD] [=*Dallucina* OLSSON & HARBISON, 1953 (type, *Lucina (Here) amabilis* DALL, 1898; OD); *L. (Paslucina)* OLSSON, 1965 (type, *L. (P.) follis*; OD)]. Smaller than *Linga,* oblong, more or less trigonal to quadrate, with sharp dorsal angulation; radial sculpture laterally strong; lunule not immersed. Cardinal *2* larger than *4b*; broadly crenulated to foliated shell margin internally. *Oligo.-Rec.,* C. Am.-N.Am.——FIG. E4,*7a*. *L. (P.) quadricostata* DALL, Mio., Jamaica; LV ext., ×6 *(1005)*.—— FIG. E4,*7b,c*. *L. (P.) undata* (CARPENTER), Rec., Mex.; *7b,c,* LV int., RV int., ×3.6 *(98)*.

Loripes POLI, 1791 [22] [**Tellina lactea* POLI, 1791 (*non* LINNÉ, 1758) (=*Amphidesma lucinalis* LAMARCK, 1818); SD GRAY, 1847] [*non Loripes* SCHWEIGGER, 1820] [=*Ligula* MENKE, 1830 (*non* MONTAGU, 1803); *Lucinida* D'ORBIGNY, 1846 (type, *L. cryptella,=L. brasiliana,=Lucina brasiliensis* PHILIPPI, 1848; OD)]. Lenticular, compressed, somewhat gibbous; sculpture feeble, concentric; areas almost obsolete; ligament internal. Hinge teeth comprising 1 RV cardinal and 2 weak LV laterals; anterior scars subelliptical; internal shell margin smooth. *Oligo.-Rec.,* Eu.-Afr.-S.Am.-Japan.——FIG. E4,*1*. **L. lucinalis* (LA-

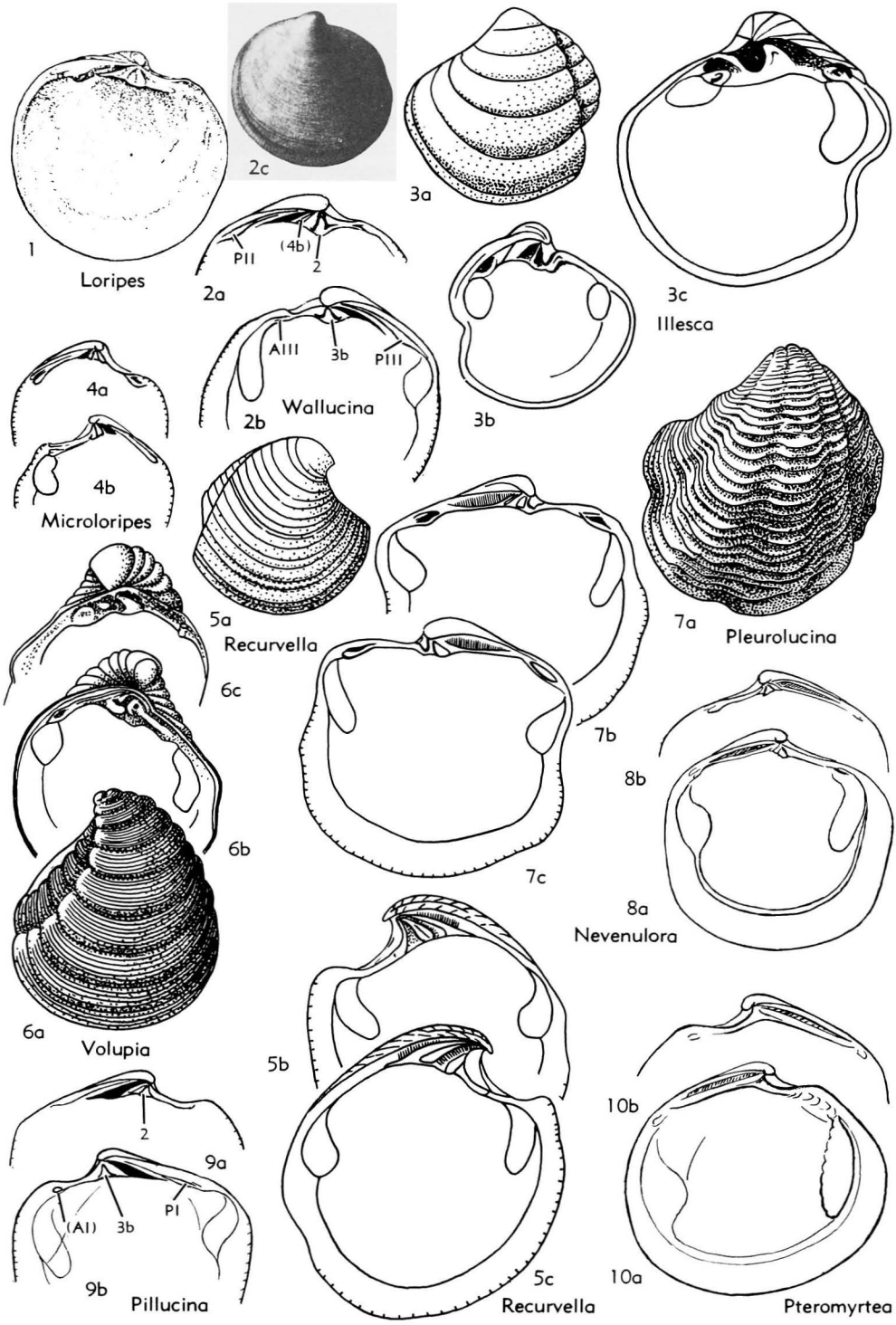


FIG. E4. Lucinidae (Lucininae) (p. *N*496, *N*498-*N*499).

MARCK), Rec., Eng.(Sussex); LV int., ×2.4 *(905a)*.

Luciniola SKEAT & MADSEN, 1898 [30] [**Venus pumila* GOLDFUSS, 1840; OD]. Small, subtrigonal, posteriorly enlarged, moderately convex, thick, with pointed beaks, with coarse concentric sculpture; lunule small. Hinge as in *Epicodakia* but with external ligament; anterior scars subparallel to pallial line. *L.Jur.(U.Lias.)*, Eu.(Ger.-Denm.). ——FIG. E3,*12*. **L. pumila* (GOLDFUSS), Denm.; *12a,b*, RV hinge, LV int., ×3.2 (Skeat & Madsen, 1898).

Megaxinus BRUGNONE, 1880 [**Lucina rostrata* PECCHIOLI, 1864; OD] [=*Stewartia* OLSSON & HARBISON, 1953 (type, *Lucina anodonta* SAY, 1824; OD)]. Irregularly lenticular to oblong compressed; hinge broad, almost edentulous, with remnants of *3b* and *4*; anterior scar broad, juxtaposed to pallial line; shell margin internally smooth. *Paleoc.-Rec.*, Eu.-Am.-N.Z.

M. (Megaxinus) [25]. Very irregular, thickened and gibbous, with ill-defined areas; lunule profoundly penetrating into broad trigonal hinge plate. Anterior scars almost continuous to pallial line. *Oligo.-Rec.*, Eu.-Am.-Red Sea.——FIG. E3, *5*. **M. (M.) rostratus* (PECCHIOLI), Plio., Italy; *5a,b*, LV int., RV int., ×1.6 (Pecchioli, 1864).

M. (Pteromyrtea) FINLAY, 1926 [26] [**Cyclina dispar* HUTTON, 1873 (=*Lucinida laevifoliata* MARSHALL & MURDOCH, 1919); OD]. Thin, rounded, with alate areas; lunule moderately depressed, obliterating anterior cardinals; posterior ones more or less marked; anterior scars wholly contiguous to pallial line. *U.Cret.-Pleist.*, N.Z. ——FIG. E4,*10*. **M. (P.) dispar* (HUTTON), Plio., N.Z.; *10a,b*, LV int., RV int., ×2.2 (Chavan, n).

Mesolinga CHAVAN, 1951 [34] [**Lucina plebeia* CONTEJEAN, 1859 (*non* GIEBEL, 1856) (=**M. typica* CHAVAN, 1952); OD]. Globose, anteriorly produced and rounded, inequilateral; with concentric approximate ribs; ligament marginal, narrow. One right cardinal, 2 left ones, and duplicate right, simple left, tuberculiform laterals; reniform anterior scars narrowed at their end; shell margin internally smooth. *U.Jur.-Cret.*, Eu.-N.Am.-?Asia. ——FIG. E3,*11*. **M. typica* CHAVAN, U.Jur. (Astart.), France(Calvados); *11a,b*, LV int., RV int., ×2.4 (Chavan, n).

Nevenulora IREDALE, 1930 [**Lucinida hilaira* HEDLEY, 1916; OD]. Moderately convex; concentric sculpture of more or less vanishing alternate distant lamellae and finer intercalated striae; lunule well marked. Hinge with cardinals and laterals, both evanescent in some forms; anterior scars moderately short; shell margin smooth internally. *U.Jur.(Raurac.)-Rec.*, Eu.-Australia-N.Z.

N. (Nevenulora) [23]. Irregularly striated, almost smooth, anteriorly angular, posteriorly rounded; lunule moderately concave. Teeth small; anterior scars somewhat divergent. *L.Eoc.-Rec.*, Eu.-Australia.——FIG. E4,*8*. **N. hilaira* (HEDLEY), Rec., Australia; *8a,b*, LV int., RV hinge, ×2 (Chavan, n).

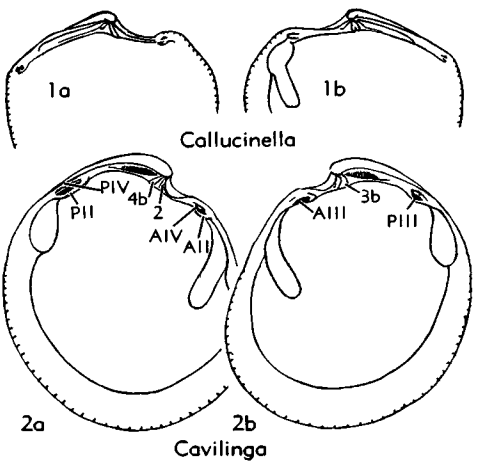


FIG. E5. Lucinidae (Lucininae) (p. *N*498-*N*499).

N. (Jagonoma) CHAVAN, 1946 [24] [**Lucina circumcisa* ZITTEL & GOUBERT, 1861; OD] [=*Dilora* MARWICK, 1948 (type, *D. lorea*; OD)]. Rounded at both ends; sculpture of alternate stronger and smaller concentric fine ribs. Hinge teeth well developed, *3b* narrow, not bifid; anterior scars not widely diverging. *U.Jur.(Raurac.)-Plio.*, Eu.-N.Z.——FIG. E3,*6*. **N. (J.) circumcisa* (ZITTEL & GOUBERT), Astart., France; *6a,b*, LV int., RV hinge, ×1.6 (Chavan, n).

Parvilucina DALL, 1901 [**Lucina tenuisculpta* CARPENTER, 1864; OD]. Rather small, rounded, inflated, with finely concentric sculpture, radial striae weakening medially, anterior and posterior areas feebly marked. Thin, but almost complete hinge, with *3a* but *AIV* and *PIV* obsolete; anterior scars more or less broad and short. *U.Cret.(Senon.)-Rec.*, Eu.-Afr.-N.Am.-Australia.

P. (Parvilucina) [11]. Sculpture finely reticulate; ligament marginal. Hinge teeth comprising short *3b* and distant laterals; internal shell margin very finely crenulated. *U.Cret.(Senon.)-Rec.*, W.Eu.-N.Am.——FIG. E3,*10*. **P. (P.) tenuisculpta* (CARPENTER), Rec., USA(Calif.); *10a,b*, LV int., RV int., ×4.4 *(98)*.

P. (Callucinella) CHAVAN, 1961 [14] [**Lucina albella* LAMARCK, 1806]. Lenticular, depressed; with fine irregular superficial concentric sculpture; areas obsolete; lunule long; ligament marginal. Hinge teeth comprising broad and bifid *3b* and distant laterals; anterior scars rather narrow, short; internal shell margin feebly crenulated to smooth. *M.Eoc.-Plio.*, W.Eu.-Australia.

——Fig. E5,*1*. **P. (C.) albella* (Lamarck), M. Eoc.(Lutet.), France; *1a,b*, LV and RV hinges, ×2 (Chavan, n).

P. (Cavilinga) Chavan, 1937 [12] [**Lucina trisulcata* Conrad, 1841; OD]. Rounded, trigonal, high, inequilateral, with approximate concentric close ribs and some annular rings; ligament inframarginal; lunule deep. Cardinal *3b* curved, laterals approximate; anterior scars divergent, somewhat elongated. *U.Cret.-Rec.*, W.Eu.-S.Afr.-N.Am.——Fig. E5,*2*. **P. (C.) trisulcata* (Conrad), Mio., USA(Md.); *2a,b*, LV int., RV int., ×6.5 *(98)*.

P. (Microloripes) Cossmann, 1910 (1912) [13] [**Lucina dentata* Defrance, 1823; OD]. Rounded, globose, small; sculpture irregularly concentric; ligament internal, oblique. Anterior scars short; shell margin strongly dentated internally. *?U. Cret.(Senon.), Paleoc-Rec.*, Eu.-W.Afr.——Fig. E4,*4*. **P. (M.) dentata* (Defrance), L.Mio. (Burdigal.), S.France; *4a,b*, LV int., RV int., ×4 (Chavan, n).

Pillucina Pilsbry, 1921 [20] [**P. spaldingi*; OD]. Rounded, moderately convex; sculpture of concentric and radial lines laterally strengthened, medially evanescent. Hinge short, with *2* and *3b* trigonal and one almost obsolete right anterior lateral; anterior scars moderately short; internal margin of shell undulated. *Plio.-Rec.* Australasia-Pac.-Asia-Red Sea.

P. (Pillucina). Lateral tooth *AIII* small; anterior scar rather elongate. *Plio.-Rec.*, Pac.-Asia-Red Sea. ——Fig. E4,*9*. *P. fischeriana* (Issel), Rec., Red Sea; *9a,b*, LV int., RV int., ×5.6 *(98)*.

P. (Sydlorina) Iredale, 1930 [**S. symbolica* (=**Codakia pisidium* Hedley, 1914, *non* Dunker, 1860); OD]. Sculpture stronger than in *P. (Pillucina)*, anterior scar shorter and more rounded, *AIII* rather stout. Rec., Australia-Japan.

Recurvella Chavan, 1937 [3] [**Lucina dolabra* Conrad, 1833; OD]. Small, subtrigonal, compressed, with high, recurved beaks; areas well marked; lunule symmetrical. Hinge high, without laterals; anterior scars short, divergent. *M.Eoc.-Oligo.* or *?Plio.*, W.Eu.-N.Am.-?Asia.——Fig. E4, *5*. **R. dolabra* (Conrad), M.Eoc.(Claiborn.), USA (Ala.); *5a*, RV ext., ×2.4; *5b,c*, RV int., LV int., ×4.8 (*98*; Harris, 1919).

Volupia Defrance, 1829 [4] [**V. rugosa*; OD] [=*Gradilucina* Cossmann, 1902 (type, *Lucina tabulata* Deshayes, 1858; OD)]. Small, oblong, tumid, with prominent curved beaks; sculpture of strong annular rings; areas deep. Cardinals strong, tuberculiform; anterior scars short, ovate-oblong; internal margin of shell crenate. *M.Eoc.-U.Eoc.*, Eu.(France).——Fig. E4,*6*. *V. tabulata* (Deshayes), Eoc.(Barton.), France(Paris basin); *6a*, LV ext., ×6; *6b,c*, LV int., RV int., ×6 *(257)*.

Wallucina Iredale, 1930 [21] [**Lucina jacksoniensis* Smith, 1885; OD]. Rounded, inflated; sculpture of almost uniform concentric and radial lines. Hinge with cardinals broader than in *Pillucina*, 1 right anterior and 2 marked, posterior laterals; anterior scars broad, short; finely denticulated internal shell margin. *Mio.-Rec.*, Australia-Pac.-Asia-W.Afr.——Fig. E4,*2a,b*. *W. erythraea* (Issel), Red Sea; *2a,b*, LV int., RV int., ×3.2 (Chavan, n).——Fig. E4,*2c*. **W. jacksoniensis* (Smith), Australia; RV ext., ×2.4 *(852)*.

Subfamily MYRTEINAE Chavan, new subfamily

Thin, more or less quadrangular or transverse, moderately compressed shell with concentric sculpture; anterior scars medium-sized. *L.Jur.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Mesomiltha*.——2. *Monitilora*.——3. *Prophetilora*. ——4. *Gonimyrtea*.——5. *Myrtea*.——6. *Myrteopsis*.——7. *Perampliata*.——8. *Gardnerella*.——9. *Milthona*.——10. *Lucinoma*.——11. *Discomiltha*.

Myrtea Turton, 1822 [**Venus spinifera* Montagu, 1803; M] [=*Cyrachaea* Leach, 1819 (obj.); *Eulopia* Dall, 1901 (type, *Lucina sagrinata* Dall, 1886; OD); *?Notomyrtea* Iredale, 1924 (type, *Myrtea botanica* Hedley, 1918,=*Tellina brazieri* Sowerby, 1883, *non* 1869; OD)]. Transversely elliptical to quadrangular, flattened; areas obsolete; sculpture of concentric, posteriorly elevated ribs with intercalated vermiculate radials in some; beaks pointed; lunule and escutcheon narrow and straight. Cardinals narrow, with *3b, 2*, and *4b;* RV laterals very long (those of LV on margin), originating from under plate; reniform short scars; internal shell margin smooth. *?U.Cret., Oligo.-Rec.*, Eu.-Australia-N.Z.-Asia-N.Am.

M. (Myrtea) [5] [=*Myrtaea* Dall, 1901]. Concentrically ribbed; ligament external. Teeth well developed; laterals of same length anteriorly and posteriorly. *?U.Cret.*, N.Z.; *Oligo.-Rec.*, Eu.-N. Am.-Asia-Australia. —— Fig. E6,*1;* E7,*1*. **M. spinifera* (Montagu), Rec., Medit.; E6,*1*, RV ext., ×0.7 (*513*, Reeve); E7,*1a*, RV int., ×1 *(905a);* E7,*1b,c*, LV and RV hinges, ×1 *(513)*.

M. (Myrteopsis) Sacco, 1901 [6] [**M. taurolaevis* (=*M. magnotaurina*); OD]. Finely striated. Ligament semi-internal. Teeth minute, *AI* shorter than *PI*. *Mio.*, S.Eu.

Discomiltha Chavan, 1952 [11] [**D. oehlerti* Bigot in Chavan, 1952; OD]. Moderately large, suborbicular, flattened, thin; sculpture of well-spaced feeble, concentric ribs and finer striae; posterior area well marked; lunule very asymmetrical, narrow, long, projecting ligament inframarginal. Hinge teeth comprising only 2 weak cardinals

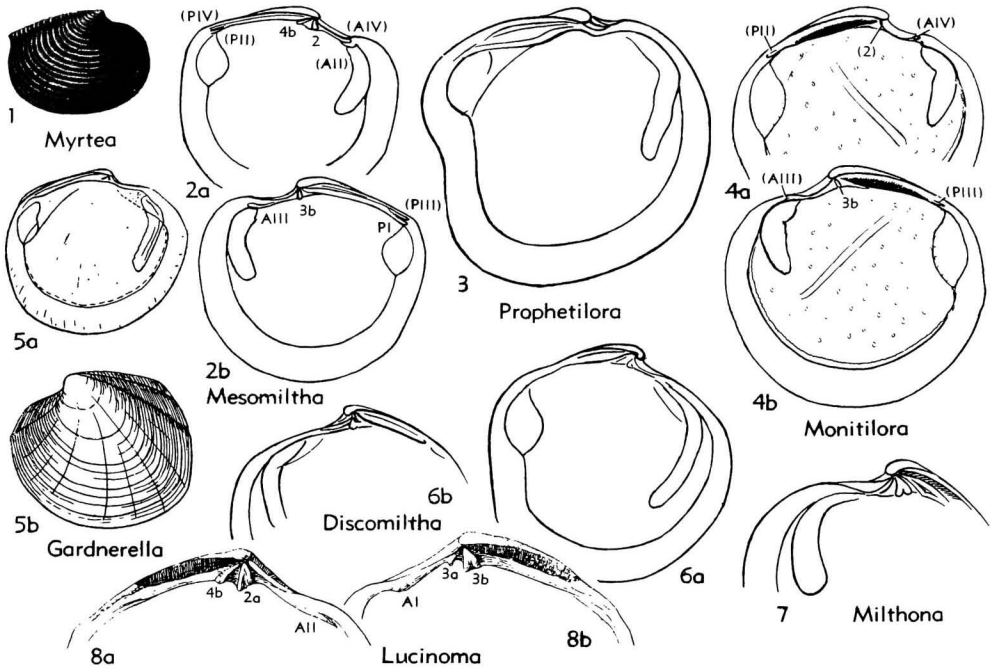


FIG. E6. Lucinidae (Myrteinae) (p. *N*499-*N*501).

partly covered by lunular expansion; shell internally punctate and grooved; anterior scars elongate, narrow, distant from pallial line; shell margin smooth internally. *U.Jur.*, Eu.——FIG. E6,*6*. **D. oehlerti* BIGOT, Astart., France(Calvados); *6a,b*, LV int., RV int., ×1 (Chavan, n).

Gardnerella CHAVAN, 1951 [8] [**Myrtaea waltonensis* GARDNER, 1926; OD]. Large, inequilateral, more or less produced anteriorly, truncated or rounded posteriorly; moderately compressed; sculpture of irregular weak concentric ribs; lunule long. Cardinals thin, 1 right, 2 left, and right laterals; anterior scars rather broad, only slightly divergent; shell internally punctate, with smooth margin. *L.Eoc.-Mio.*, Eu.-N.Afr.-N.Am.——FIG. E6,*5*. *G. cossmanni* (CHAVAN), L.Eoc., France; *5a,b*, LV int., ext., ×0.9 (Chavan, 1941).

Gonimyrtea MARWICK, 1929 [4] [**Loripes concinnus* HUTTON, 1885 (=*L. icterica* LAMY, 1920; *non Lucina concinna* ADAMS, 1870; *nec L. icterica* REEVE, 1850); OD] [=*Alucinoma* HABE, 1958 (type, *A. soyoae;* OD]. Small, subquadrangular, compressed, sculpture fine, concentric; lunule depressed, asymmetrical. Hinge tooth *2* more or less adherent to its edge, *3a* lacking, *3b* present, *AI* small; anterior scars reniform, short; shell margin internally smooth. *Paleoc.-Rec.*, Eu.-N.Afr.-N. Am.-C. Am.-N. Z.-Australia-Japan. —— FIG. E7,*3*. *G. galeottiana* (NYST), Eoc.(Barton.), Belg.; *3a,b*, LV ext., int., ×4 (Glibert, 1936).

Lucinoma DALL, 1901 [10] [**Lucina filosa* STIMPSON, 1851; OD] [=*Triodonta* GRAY, 1851 (*non* BORY, 1827; *nec* MULSANT, 1842; *nec* AGASSIZ, 1846) (obj.); *Thiatira* LEACH, 1819]. Medium-sized to large, lenticular, moderately convex, posterior margin rectilinear; with regularly spaced annular ribs and intercalated finer ones; lunule lanceolate, long, not sunken or bent. Two compressed teeth in each valve, *2* and *3b* bifid, and feeble laminar *AI*; anterior scars narrow, long, diverging; shell margin internally smooth. *Oligo.-Rec.*, Eu.-Red Sea-N.Am.-Pac.-Australia-Japan.—— FIG. E6,*8*. *L. borealis* (LINNÉ), Rec., Eu.; *8a,b*, LV and RV hinges, ×1 *(513)*.

Mesomiltha CHAVAN, 1938 [1] [**Lucina pulchra* ZITTEL & GOUBERT, 1861; OD]. Medium-sized, transversely ovate-rounded, posteriorly depressed; with fine, regular equidistant concentric ribs and very fine intercalated radial lines; lunule lanceolate projecting below in dentiform elongation; long ligament. Hinge teeth comprising 1 RV, 2 LV cardinals, and thin distant laterals; anterior scars curved, detached at their ends; shell margin internally smooth. *L.Jur.(Lias.)-U.Jur., ?Cret.*, Eu. ——FIG. E6,*2*. **M. pulchra* (ZITTEL & GOUBERT), U.Jur.(Astart.), France(Calvados); *2a,b*, LV int., RV int., ×2 (Chavan, n).

Milthona MARWICK, 1931 [9] [**M. glomerosa*; OD]. Moderately large, inequilateral, anteriorly rounded, posteriorly enlarged, with concentric

coarse, wide-spaced ribs; not differentiated posterior area; lunule somewhat depressed, cordiform. Hinge teeth *2* and *3b* bifid, *4b* strong, laterals lacking; anterior scars narrowly linguiform, divergent; shell margin smooth internally. *Mio.*, N.Z.——Fig. E6, *7*. **M. glomerosa*; RV int., ×0.9 *(595)*.

Monitilora Iredale, 1930 [**Lucina ramsayi* Smith, 1885 (=*Loripes icterica* Angas, 1867, *non Lucina icterica* Reeve, 1850)]. Rounded, with concentric regularly spaced ribs and radial intercalated lines; lunule lanceolate, its edge forming ridge along hinge plate; ligament elongated, inframarginal. Single weak cardinal in each valve, RV lateral obsolete; anterior scars narrow, distant from pallial line; internal rugosities present, margin smooth. *Paleoc.-Rec.*, Eu.-Australia-Asia.

M. (Monitilora) [2]. Medium-sized, circular to elliptical in outline, relatively tumid, dorsal area not distinguished; lunule straight-edged; scars moderately long; shell internally punctate. *Paleoc.-Rec.*, Eu.-Australia-Asia.——Fig. E6,*4*. *M. elegans* (Defrance), Eoc., France; *4a,b*, LV int., RV int., ×2.7 *(98)*.

M. (Prophetilora) Iredale, 1930 [3] [**P. arizela*; OD]. Large, ovate, enlarged backward, compressed, with faint dorsal area; lunule bent inward. Hinge almost obsolete; scars linguiform, relatively long; shell internally pustulose. *Paleoc.-Rec.*, Eu.-Australia.——Fig. E6,*3*. **M. (P.) arizela*, Rec., Queensl.; LV int., ×1 (Iredale, 1930).

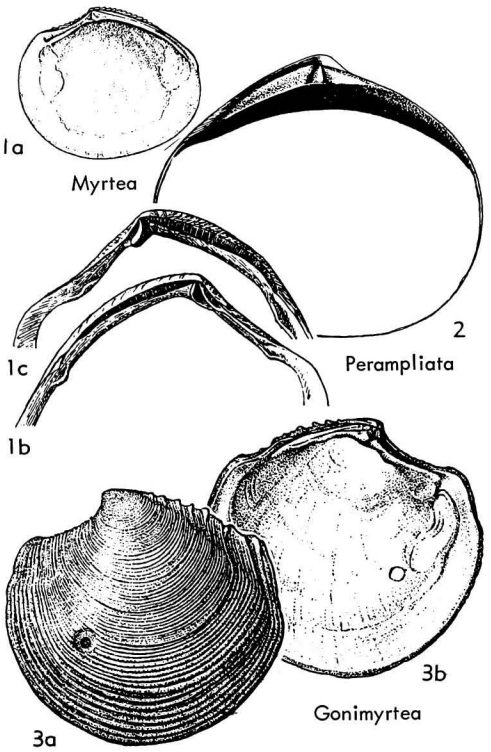


Fig. E7. Lucinidae (Myrteinae) (p. *N*499-*N*501).

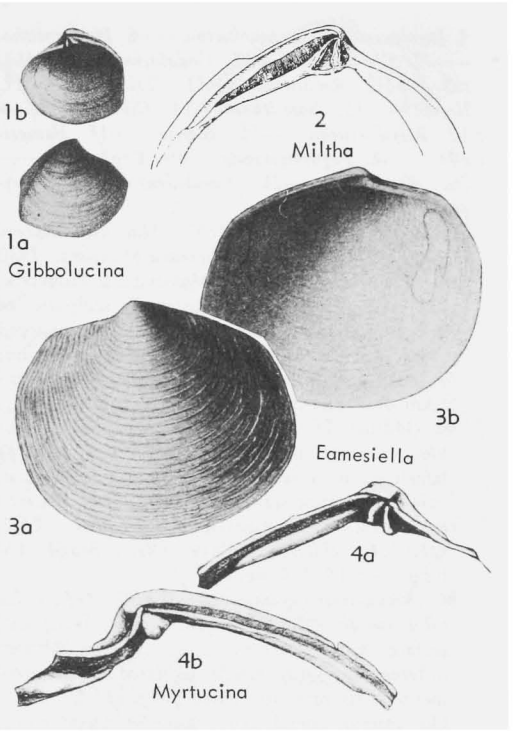


Fig. E8. Lucinidae (Milthinae) (p. *N*502, *N*504).

?**Perampliata** Arkell, 1936 [7] [*pro Ampliata* Arkell, 1934, p. 282 (*non* Wagner, 1907)] [**Tellina ampliata* Phillips, 1829, p. 324; OD]. Large, compressed, with close-spaced concentric ribs; beaks small; lunule lacking, escutcheon broad. Stout short hinge plate with 1 RV and 2 LV cardinals; pallial line and anterior scars unknown. *Jur.*, Eu.(G.Brit.-France).——Fig. E7,*2*. **P. ampliata* (Phillips), U.Jur.(Corall.), Eng.; LV int., ×0.7 (Arkell, 1936).

Subfamily MILTHINAE Chavan, new subfamily

Shell relatively solid, generally compressed. Sculpture concentric, faint, irregular to vanishing; anterior scars long. *Sil.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Phenacocyclas*.——2. *Pterolucina*.——3. *Myrtucina*.

4. *Jagolucina.*——5. *Saxolucina.*——6. *Plastomiltha.*——7. *Claibornites.*——8. *Codalucina.*——9. *Miltha.*——10. *Recticardo.*——11. *Trinitasia.*——12. *Ilionia.*——13. *Eomiltha.*——14. *Gibbolucina.*——15. *Pseudomiltha.*——16. *Zorrita.*——17. *Eamesiella.*——18. *Pegophysema.*——19. *Eophysema.*——20. *Anodontia.*——21. *Cavatidens.*——22. *Loripinus.*

Miltha H. & A. ADAMS, 1857 [**Lucina childreni* GRAY, 1825; OD] [=*Miltheoidea* MARWICK, 1930 (type, *Miltha neozelandica* MARSHALL & MURDOCK, 1921; OD)]. Discoidal, flattened; sculpture of unequal concentric striae; ligament on enlarged nymph. Hinge teeth *3b* and *2* somewhat bifid; shell margin smooth internally. *U.Cret.-Rec.,* Eu.-N.Am.-Australia-N.Z.

M. (Miltha) [9]. Large, subcircular to ovate-oblong, slightly inequivalve; surface smooth or lamellose, with faint areas; lunule asymmetrical, striated. Anterior scars long, club-shaped. *U.Cret.-Rec.,* Eu.-N.Am.-Australia-N.Z.——FIG. E8,*2*. **M. (M.) childreni* (GRAY), Rec., Brazil; LV hinge, ×1 *(513,* Sowerby).

M. (Recticardo) COSSMANN, 1908 [10] [**Phacoides (R.) rutoti*; OD]. Medium-sized, subelliptical; surface with concentric dense striation without differentiated areas; lunule depressed, almost symmetrical, its projecting edge prolonged by ridge-like anterior lateral tooth, posterior lateral weak; anterior scars relatively short, penetrating upward between lunular edge and anterior lateral. *U.Cret.-Paleoc.,* Eu.-N.Am.——FIG. E9,*3*. **M. (R.) rutoti* (COSSMANN), Paleoc., Belg.; *3a,b,* LV and RV hinges, ×2 *(98)*.

Anodontia LINK, 1807 [**A. alba* (=**Venus edentula* LINNÉ, 1758); OD]. Rounded, tumid, slightly inequilateral; sculpture of irregular growths and very fine radial striae; anterior area more or less marked, posterior area obsolete; beaks prosogyrous; lunule ill-defined; ligament oblique, sunken. Hinge edentulous except for faint tuberculiform cardinal; anterior scars broad, short, very divergent; shell margin internally smooth. *Eoc.-Rec.,* Eu.-Asia-N.Am.-Pac.-Australia-Afr.

A. (Anodontia) [20]. Medium-sized to large, globose, rounded in front, slightly truncate posteriorly; surface with concentric and radial lines, anterior area ill-defined; lunule depressed; ligament sunken but inserted upon cardinal elongation. *Eoc.-Rec.,* Eu.-Asia-N.Am.-Pac.O.-Australia.——FIG. E9,*6*. **A. edentula* (LINNÉ), Rec., Ind. O.; RV int., ×1.3 *(98)*.

A. (Cavatidens) IREDALE, 1930 [21] [**C. omissa*; OD]. Small, globose, laterally truncate, with concentric sculpture only, dorsal area distinct; beaks high; ligament sunken on cardinal process. *Rec.,* Australia.

A. (Loripinus) DE MONTEROSATO, 1883 [22] [**Lucina fragilis* PHILIPPI, 1836; SD VON MARTENS, 1884]. Small, very globose, thin, anteriorly rounded, not depressed; ligament strongly depressed, without cardinal elongation or process. Hinge tooth *3b* directed backward. *Eoc.-Rec.,* S. Eu.-Afr.-Asia-Japan-?N.Am.

Claibornites STEWART, 1930 [**Lucina rotunda* LEA, 1833; OD]. Medium-sized, lenticular, flattened; sculpture of concentric striae, dorsal areas obsolete; lunule lanceolate. Hinge with narrow cardinals and strong anterior laterals; anterior scars elongate, narrow; shell margin internally smooth. *Paleoc.-Oligo.,* Eu.-N.Am.

C. (Claibornites) [7]. Thick; sculpture coarsely concentric; areas weak; ligament on large depressed nymph, gibbous internally. Hinge as in *Saxolucina,* but with *3a* less obsolete and *3b* only obscurely bifid, *AI* stronger; anterior scars long. *Eoc.,* N.Am.——FIG. E9,*1*. **C. (C.) rotunda* (LEA), M.Eoc., USA(Ala.); *1a,b,* LV int., RV hinge, ×0.9 (Harris, 1919).

C. (Codalucina) STEWART, 1930 [8] [**Lucina uncinata* DEFRANCE, 1823; OD]. Thin, sculpture finely concentric; no areas; ligament deeply sunken, in broad groove. Hinge with well-marked cardinals and anterior laterals, weak posterior laterals; scars relatively long, linguiform. *Paleoc.-Oligo.,* Eu.-N.Am.——FIG. E9,*2*. **C. (C.) uncinata* (DEFRANCE), Paleoc., France; LV int., ×1.3 *(98)*.

Eamesiella CHAVAN, 1951 [17] [*pro Pseudolucina* CHAVAN, 1947 (*non* WILCKENS, 1909)] [**Lucina corrugata* DESHAYES, 1843; OD]. Subquadrangular, rather inflated; surface with distant concentric lamellose waves. Edentulous; stout nymph; shell margin smooth internally. *?Eoc.* or *Oligo., Rec.,* Afr.-Australia-Eu.——FIG. E8,*3*. **E. corrugata* (DESHAYES), Rec., Pac.; *3a,b,* LV ext., int., ×2 (Alcock & Anderson, 1897).

Gibbolucina COSSMANN, 1904 [**Venus callosa* LAMARCK, 1806; OD] [=*?Elathia* ISSEL, 1869 (type, *E. arconatii;* OD) *(gen. dub.)*]. Irregularly compressed; sculpture of coarse lamellae or ribs, with narrow deep areas; lunule concave, short, broad. Trigonal hinge plate with *3a* thin, *3b,* strongly bilobate, *2, 4b* present, laterals lacking; short stout nymph; fine radial internal threads; anterior scars elongate, narrow, subparallel to pallial line; shell margin internally smooth. *Cret.-Rec.,* Eu.-Am.-Australia-Afr.

G. (Gibbolucina) [14]. Small, moderately convex, subtrigonal, gibbose; lunule depressed, partly covering ill-defined cardinals, *3a* obsolete; short scars. *L.Eoc.-Rec.,* Eu.-Afr.-Australia-?Red Sea.——FIG. E8,*1;* E10,*2*. **G. (G.) callosa* (LAMARCK), M. Eoc., France; E8,*1a,b,* RV ext., int., ×1 *(257);* E10,*2a,b,* RV ext., int., ×1 *(257)*.

G. (Eomiltha) COSSMANN, 1910 (1912) [13]. [**Lucina contorta* DEFRANCE, 1823; OD]. Medium-sized, almost flat, transversely subrhomboidal; with more or less elevated concentric lamellae; lunule not sunken. Cardinals well defined;

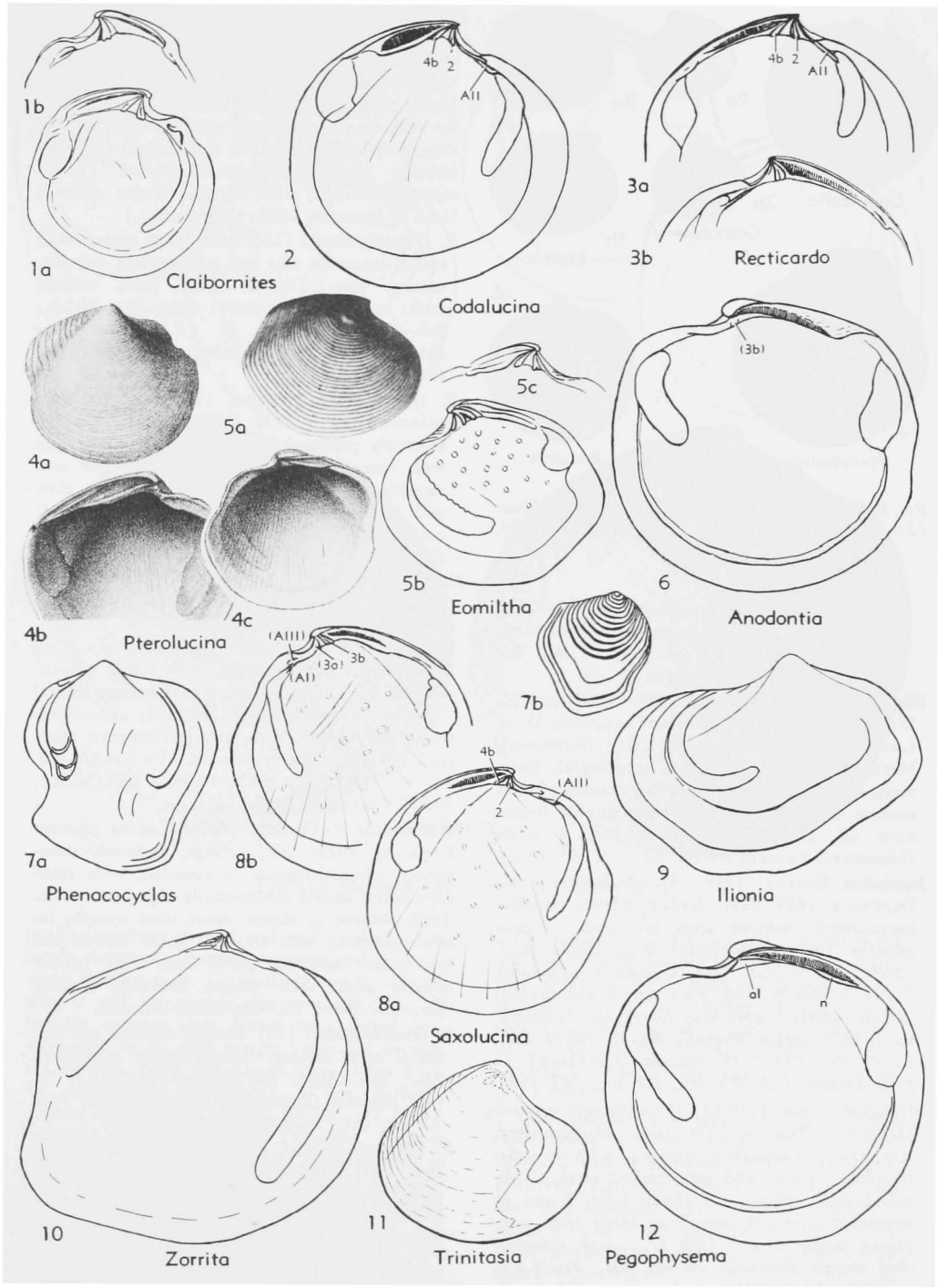


FIG. E9. Lucinidae (Milthinae) (p. *N*502, *N*504-*N*506).

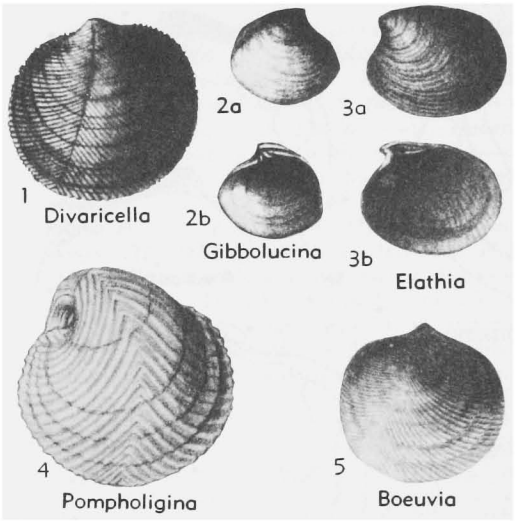


FIG. E10. Lucinidae (Milthinae) *(2);* Divaricellinae *(1,4-5);* (Genus Uncertain) *(3)* (p. *N*502, *N*504, *N*506, *N*508).

scars relatively long. *Cret.-Rec.,* Eu.-Am.-E.Afr. ——FIG. E9,*5*. **G. (E.) contorta* (DEFRANCE), Paleoc., France; *5a,* RV ext., ×0.7; *5b,c,* RV int., LV hinge, ×1 (Chavan, n).

Illionia BILLINGS, 1875 [12] [**I. canadensis;* SD WHITEAVES, 1884] [=*Prolucina* DALL, 1896 (type, *Lucina prisca* HISINGER, 1837; OD); *Platymermis* NOETLING, 1883]. Irregularly rhomboidal, transverse, compressed, with postumbonal sulcus; lunule concave, long. Anterior scars long, narrow, linguiform. *Sil.,* N.Eu.-N.Am.——FIG. E9,*9*. *I. prisca* (HISINGER), Sweden; LV int. mold, ×0.7 *(1026)*.

Jagolucina CHAVAN, 1939 [4] [**Lucina concava* DEFRANCE, 1823; OD]. Rather inflated, rounded, inequilateral, without areas but with irregular growths; beaks prosogyrous; large lunule moderately asymmetrical. Two cardinals in each valve, *2* and *3b* clearly bifid, with distant well-marked laterals; anterior scars very divergent, attenuated, short; shell margin internally smooth. *Paleoc.-Eoc.,* Eu.——FIG. E11,*1*. **J. concava* (DEFRANCE), L. Eoc., France; *1a,b,* RV int., LV int., ×2 *(98)*.

Myrtucina VOKES, 1939 [3] [**Lucina roseburgensis* HENDON in TURNER, 1938; OD]. Medium-sized, compressed, transversely rounded, with irregular lamellose growths and well-marked areas. Cardinals broadly trigonal, *3b* almost bifid, *2* and *4b* somewhat divergent, laterals on hinge plate comprising strong *AI* and faint *PI*; nymph elongate; shell margin internally smooth. *Eoc.,* Eu.-N.Am. ——FIG. E8,*4*. **M. roseburgensis* (HENDON), USA(Ore.); *4a,b,* LV and RV hinges, ×3 (Vokes, 1939).

Pegophysema STEWART, 1930 [**Lucina schrammi* CROSSE, 1876; OD]. Rounded, tumid, slightly inequilateral; sculpture of irregular growths, with well-marked anterior area, posterior area obsolete; lunule narrow, depressed. Cardinal plate triangular without protuberances; anterior scars scarcely divergent, long and narrow; shell margin internally smooth. *Eoc.-Rec.,* N.Am.-N.Afr.-Eu. [=*Lissophaira* OLSSON, 1961 (type, *Lucina spherica* DALL & OCHSNER, 1928; OD) (subj.).]

P. (Pegophysema). [18]. Subcircular; surface with coarse concentric ribs and well-marked, subalate, anterior area. Trigonal hinge plate, without teeth; anterior scars narrow. *Oligo.-Rec.,* N.Am.-Eu.——FIG. E9,*12*. *P. (P.) chrysostoma* (MEUSCHEN), Rec., W.Indies; RV int., ×0.9 *(98)*.

P. (Eophysema) STEWART, 1930 [19] [**Lucina subvexa* CONRAD, 1832 (1846); OD]. Subovate, anteriorly produced, posteriorly enlarged; surface with concentric and radial striae, anterior area vanishing at adult stage. Elongate hinge plate with ill-defined transverse small tooth and left posterior lateral; relatively broad anterior scars. *Eoc., ?Oligo.,* N.Am.-N.Afr.-Eu.

Phenacocyclas LA ROCQUE, 1950 [1] [**P. pohli;* OD]. Irregularly rhomboidal, oblong, compressed; surface only concentrically striated, anteriorly plicate and with deep posterior area corresponding to notch in ventral margin; lunule small; escutcheon narrow. Probably one small anterior lateral and two presumably small cardinals; sigmoid internal groove; falciform, enlarged anterior scars; shell margin internally smooth. *Dev.,* N.Am.-Eu. ——FIG. E9,*7*. **P. pohli,* M.Dev., USA(Mich.); *7a,b,* RV int., ext., ×0.7 *(530)*.

Pseudomiltha P. FISCHER, 1887 [**Lucina gigantea* DESHAYES, 1825; OD]. Large, flattened, transversely subquadrangular to rounded, with small erect beaks; surface concentrically ribbed or smooth. Teeth obsolete or absent; short stout nymph; interior punctate, with also fine radial threads and low flange bordering pallial line; long, narrow anterior scars; shell margin internally smooth. *?Jur., Eoc.-Mio.,* Eu.-Asia-S.Am.-W.Indies.

P. (Pseudomiltha) [15]. Broadly elliptical to ovate; dorsal areas lacking. Hinge totally edentulous. *?Jur., Eoc.-Oligo.,* Eu.-Asia.——FIG. E11,*3*. **P. (P.) gigantea* (DESHAYES), M.Eoc., France; *3a,b,* RV int., ext., ×0.7 (Deshayes, 1825).

P. (Zorrita) OLSSON, 1932 [16] [**P. (Z.) petersoni*; OD]. Transversely subquadrangular, with deep posterior area. Unequal faint internal ribs. Remnants of *3b* and *4b* present. *Eoc.-Mio.,* Peru-Jamaica-Eu.——FIG. E9,*10*. **P. (Z.) petersoni;* LV int., ×0.9 (Chavan, n).

Pterolucina CHAVAN, 1942 [2] [**Lucina coeloprocta* COSSMANN, 1887; OD]. Medium-sized to large, rounded trigonal, relatively compressed, with

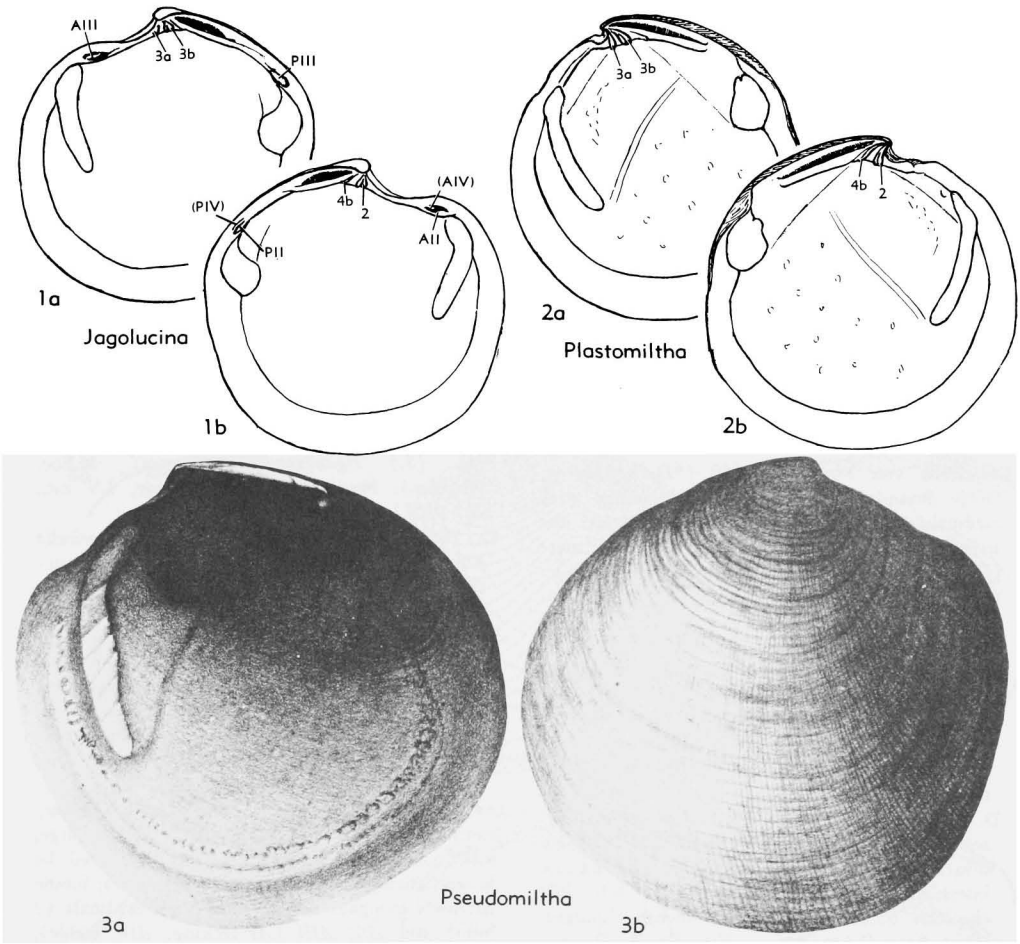


FIG. E11. Lucinidae (Milthinae) (p. *N*504-*N*505).

locally lamellose growths and well-marked areas; lunule depressed; ligament semi-internal on relatively short nymph. Cardinal *3b* weak, oblique, thin, *2* and *4b* scarcely divergent, *AI* faint, *PI* lacking; anterior scars distant from pallial line, subparallel to it; shell margin internally smooth. *U.Cret.-Mio., ?Plio.*, Eu.-Asia-N.Afr.——FIG. E9,*4*. **P. coeloprocta* (COSSMANN), U. Eoc. (Barton.), France; *4a-c*, RV ext., LV int., RV int., ×1 *(160)*.

Saxolucina STEWART, 1930 [**Lucina saxorum* LAMARCK, 1806 (1808); OD]. Medium-sized to large, discoidal to subtrigonal, flattened, anteriorly somewhat acuminate, posteriorly truncate; sculpture consisting of lamellose concentric ribs or outgrowths; areas narrow, anterior marked by lines of punctuations, posterior obsolete; lunule projecting backward. Anterior scars very narrow, long; shell margin internally smooth. *?U.Cret., Paleoc.-Plio., ?Rec.*, Eu.-Afr.-Am.-Eu.

S. (Saxolucina) [5]. Medium-sized; lunule covering part of teeth, but not really excavated. Cardinals *3b* and *2* partly bifid, *4b* present, *3a* and laterals more or less obsolete; nymph curved; shell commonly pustulose internally. *Eoc.*, Eu.; *?Rec.*, Afr.——FIG. E9,*8*. **S. (S.) saxorum* (LAMARCK), Eoc., France; *8a,b*, LV int., RV int., ×1.7 *(98)*.

S. (Plastomiltha) STEWART, 1930 [6] [**Cyclas claibornensis* CONRAD, 1865; OD] [=*Armiltha* OLSSON & HARBISON, 1953 (type, *Lucina disciformis* HEILPRIN, 1886; OD)]. Large, lamellose, with depressed lunule. Straight nymph. Cardinals *3b* and *2* strongly bifid, *3a* well marked, shell internally punctate. *?U.Cret., Paleoc.-Plio.*, C.Am.-N.Am.-Eu.——FIG. E11,*2*. **S. (P.) claibornensis* (CONRAD), Eoc., USA(Ala.); *2a,b*, RV int., LV int., ×1 *(98)*.

?Trinitasia MAURY, 1928 [11] [**Thyasira sancti-*

andreae MAURY, 1925; OD]. Trigonal, subequilateral, convex, ventral margin rounded; surface smooth, posterior area marked by angulation. Cardinals 3 (incompletely known), strong, 1 on RV, 2 on LV; scars apparently not detached, linguiform, and curved. *Mio.,* Trinidad.——FIG. E9,*11*. **T. sanctiandreae* (MAURY); LV int., ×0.75 (Chavan, n).

Subfamily DIVARICELLINAE Glibert, 1967

Shell convex, rounded, with divaricate or undulating external sculpture. *L.Eoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Divalinga.*——2. *Viaderella.*——3. *Stchepinskya*——4. *Paralucinella.*——5. *Lucinella.*——6. *Divalucina.*——7. *Boeuvia.*——8. *Divaricella.*——9. *Egracina.*——10. *Pompholigina.*——11. *Eodivaricella.*

Divaricella VON MARTENS, 1880 [**D. angulifera*; OD]. Rounded, with small lunule. Hinge with cardinals and incomplete or obsolete laterals; anterior scars flexuous, narrowly elongate; shell margin internally smooth but incised or exceeded by terminations of ribs. *Plio.-Rec.,* Afr.-Ind.O.-Asia-Australia-C.Am.

D. (Divaricella) [8]. Solid, divaricated by angular ribs. Lateral teeth, *AII, PII,* and *PIII* obsolete; terminations of ribs exceeding margin. *Plio.-Rec.,* Asia-Australia-E.Afr.——FIG. E12,*1*; E10,*1*. **D. (D.) angulifera,* Rec., Ind.O.(Mauritius); E12, *1a,b,* RV hinge, LV int., ×2 *(107);* E10,*1,* RV ext., ×1 (von Martens).

D. (Egracina) CHAVAN, 1951 [9] [**Tellina dentata* WOODS, 1815; OD]. Relatively flattened, divaricated by large flattened ribs, with narrow interspaces. Hinge with *3a, AI, AII, PII, PIII* obsolete; terminations of ribs incising margin. *Pleist.-Rec.,* C.Am.-Afr.——FIG. E12,*5*. *D (E.) dentata collignoni* CHAVAN, Afr.; *5a-c,* LV ext., RV hinge, LV int., ×2.5 *(107)*.

Boeuvia CHAVAN, 1948 [7] [**Lucina pulchella* AGASSIZ, 1845; OD] [=*?Bourdotia* DALL, 1901 (type, *Lucina bourdoti* COSSMANN, 1882; OD) *(nom. dub.)*]. Not much inflated; divaricated by numerous flattened ribs with narrow interspaces. Incomplete hinge without *AI* and *PI*; *3a, 4b, AIV, PII* and *PIV* all obsolete or lacking; ligament partly internal; anterior scars strongly divergent from pallial line; shell margin internally smooth. *L.Eoc.-Oligo.,* N.Afr.-Eu.——FIG. E12,*3*; E10,*5*. **B. pulchella* (AGASSIZ), M.Eoc.(Lutet.), France; E12, *3a,b,* RV hinge, LV int., ×2 *(107)*; E10,*5,* RV ext., ×1 (Deshayes).

Divalinga CHAVAN, 1951 [**Lucina quadrisulcata* D'ORBIGNY, 1846; OD]. Orbicular, inflated; divaricated by broad flattened ribs with narrow interspaces; lunule slightly depressed, dissymmetric; ligament external. Hinge with well-developed cardinals and laterals but no *AI* and *PI*; anterior scars short; shell margin internally denticulate. *L.Eoc.-Rec.,* Eu.-N.Am.-C.Am.-Afr. [=*Cyclas* MÖRCH, 1853 (*non* LAMARCK, 1799) (type, *Lucina quadrisulcata* D'ORBIGNY, 1846; SD CHAVAN, herein).]

D. (Divalinga) [1]. Hinge teeth *3a* and *AIV* feeble; anterior scars slightly divergent from pallial line. *Oligo.-Rec.,* W.Eu.-N.Am.-C.Am.——FIG. E12,*9*. **D. (D.) quadrisulcata* (D'ORBIGNY), Rec., USA(Fla.); *9a,b,* RV hinge, LV int., ×2 *(107)*.

D. (Stchepinskya) CHAVAN, 1951 [3] [**Lucina rigaultiana* DESHAYES, 1858; OD]. Inflated; lunule elongate. Hinge teeth *3a* and *PIV* feeble, anterior and posterior laterals both distant; anterior scars short, acutely diverging from pallial line; shell margin weakly crenulate internally. *L.Eoc.-U.Eoc.,* W. Eu.-?N. Afr.——FIG. E12,*11*. **D. (S.) rigaultiana* (DESHAYES), M.Eoc. (Auvers.), France; *11a,b,* RV hinge, LV int., ×3 *(107)*.

D. (Viaderella) CHAVAN, 1951 [2] [**Divaricella perparvula* DALL, 1901 (=*Lucina pisum* PHILIPPI, 1857; *non* SOWERBY, 1836; *nec* D'ORBIGNY, 1841; *nec* REEVE, 1850)]. Inflated; sculpture obsolete on angle of divergence, posterior lamellae distant. Hinge teeth *PIV* feeble, *PI* lacking (also *AI*); anterior scars short, acutely pointed and diverging. *Mio.,* W.Eu.; *Rec.,* N.Am.-S.Afr.-W. Eu.——FIG. E12,*10*. **D. (V.) perparvula* (DALL), USA(Calif.); *10a,b,* RV hinge, LV int., ×2 *(107)*.

Divalucina IREDALE, 1936 [6] [**Lucina (Cyclas) cumingi* ADAMS & ANGAS, 1863; OD]. Large, solid, moderately inflated; surface divaricated by broad flattened ribs with narrow interspaces; lunule narrowly elongate. Hinge with large cardinals (2 bifid) and *AII, AIII* (*AI* lacking, *AIV* feeble), posterior laterals obsolete; anterior scars narrowly elongate, not divergent from pallial line; shell margin smooth internally. *Oligo.-Rec.,* Asia (Ceylon-Japan)-Australia-N.Z.——FIG. E12,*4*. **D. cumingi* (ADAMS & ANGAS), Rec., N.Z.; *4a,b,* RV hinge, LV int., ×1.5 *(107)*.

Lucinella DI MONTEROSATO, 1883 [5] [**Tellina divaricata* LINNÉ, 1758 (=*Lucina commutata* PHILIPPI, 1836); OD]. Relatively small, solid, with posterior area, sculpture undulated. Hinge with cardinals and laterals, *3a* and *PII* feeble, *AI* and *PI* lacking; ligament deeply internal; anterior scars not much divergent from pallial line; shell margin crenulate internally. *Mio.-Rec.,* W.Eu.-S. Eu.-Ind.O.(Mauritius).——FIG. E12,*7*. **L. divaricata* (LINNÉ), Rec., France; *7a,b,* RV hinge, LV int., ×4 *(107)*.

Paralucinella CHAVAN, 1951 [4] [**Lucina undulata* LAMARCK, 1806; OD]. Relatively small; sculpture undulated. Hinge narrow, dentition as in *Stchepinskya,* but *3a* lacking; ligament elongated; anterior

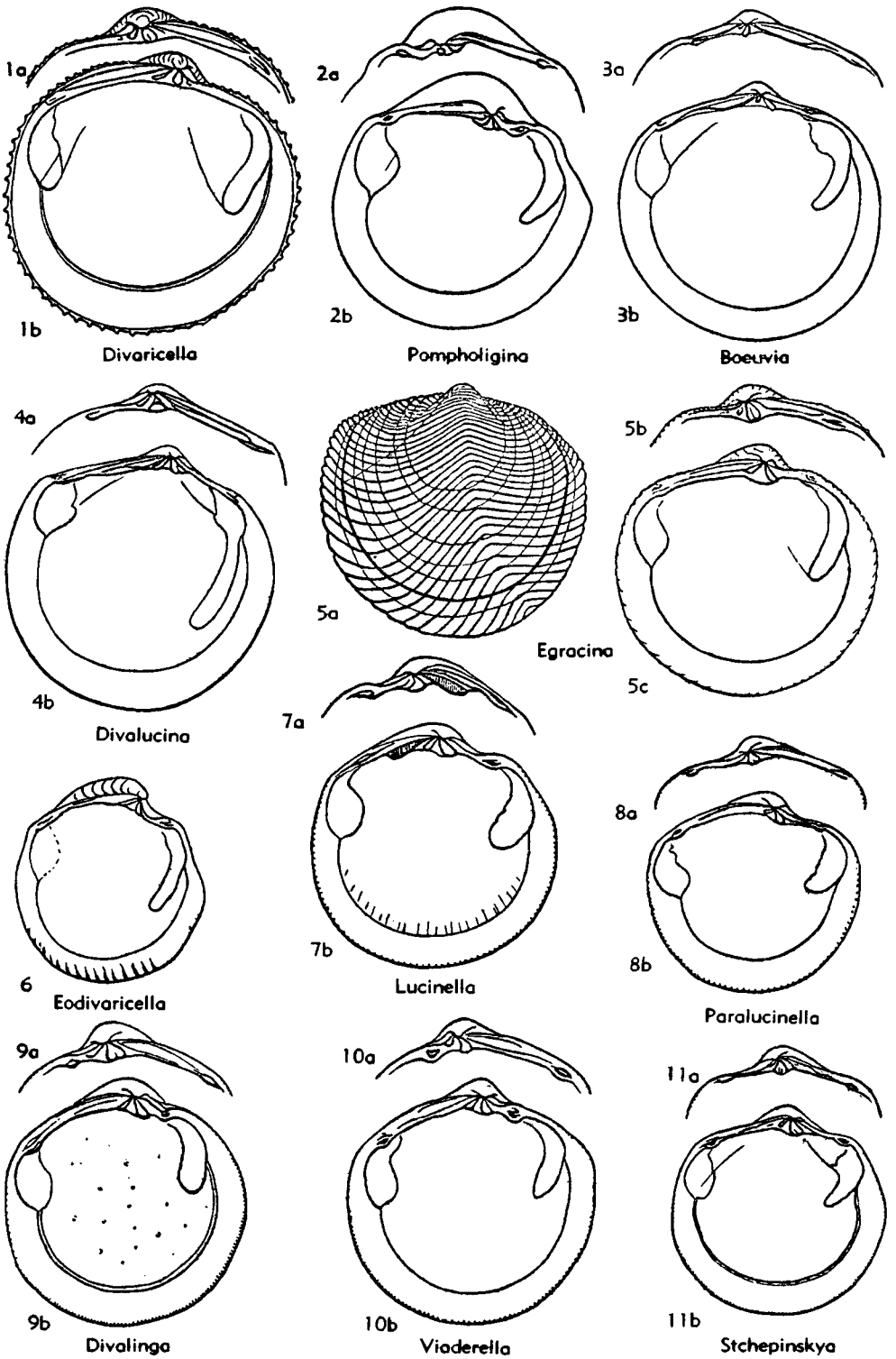


FIG. E12. Lucinidae (Divaricellinae) (p. *N*506, *N*508).

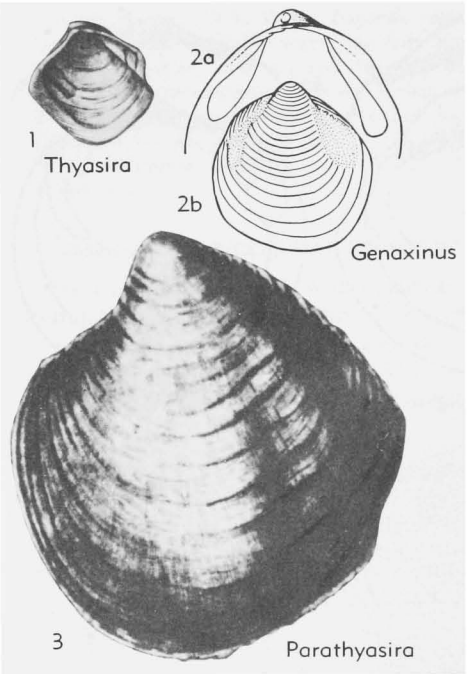


FIG. E13. Thyasiridae (p. N508).

scars short, rounded; shell margin crenulated internally. *Oligo.*, W.Eu.——FIG. E12,*8*. *P. undulata* (LAMARCK), Stamp., France; 8*a,b*, RV hinge, LV int., ×4.5 *(107)*.

Pompholigina DALL, 1901 [**Lucina gibba* GRAY, 1825; OD]. Tumid, with subspiral beaks; surface divaricated by elevated rounded ribs with wide interspaces. Hinge apparently cyclodont, with cardinals and several laterals. *M.Eoc.-Rec.*, W.Afr.

P. (Pompholigina) [10]. Hinge with *3a* and *4b* well developed; anterior scars short, pointed, divergent from pallial line; shell margin smooth internally. *Rec.*, W.Afr.——FIG. E12,*2*; E10,*4*. **P. (P.) gibba* (GRAY); E12,*2a,b*, RV hinge, LV int., ×2 *(107)*; E10,*4*, LV ext., ×1 (Reeve, 1850).

P. (Eodivaricella) CHAVAN, 1951 [11] [**Divaricella oppenheimi* NEWTON, 1923; OD]. Lunule excavated; nepionic sculpture concentric, then divaricate. Anterior scars narrow; middle part of internal shell margin undulated. *M.Eoc.*, W.Afr. (Nigeria).——FIG. E12,*6*. **P. (E.) oppenheimi* (NEWTON); LV int., ×3.3 *(107)*.

LUCINIDAE GENERA DUBIA

Austriella TENISON-WOODS, 1881 [**A. sordida*; OD]. Like *Eamesiella* but with an inconspicuous arcuate tooth and a falciform scar. [May be an eroded form, possibly an edentulous ungulinid.] *Rec.*, Australia.

Elathia ISSEL, 1869 [**E. arconatii*; OD]. *Rec.*, Red Sea [See *Gibbolucina.*]——FIG. E10,*3*. **E. arconatii*; *3a,b*, LV ext., RV int., ×1 (Issel).

?Freila DE GREGORIO, 1930.

Jagonella SELLI, 1944 [**J. gortanii*; OD]. *(Nom. nud.)*

Levimyrtaea OLSSON, 1965 [**Myrtaea (L.) inconspicua*; OD]. Possibly equivalent of *Gonimyrtea* or *Myrteopsis. Mio.*, Ecuador.

Lucinigenus RENIER, 1894 [Rejected, ICZN].

Family THYASIRIDAE Dall, 1901

[=Cryptodontidae DALL, 1895]

Trigonal to subquadrangular or obliquely rounded, thin, with dorsal anterior depression and more or less well-marked posterior area; beaks small, acute, prosogyrate; ligament and resilium juxtaposed, united, former inframarginal, latter deeply sunken in ill-defined depression or socket; no nymph. Surface concentrically ribbed or smooth. Hinge with protruding right lunular edge forming one or two small ill-defined tuberosities, with intermediate left and corresponding sockets; muscle scars elongate, superficial. *M.Trias.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Thyasira.*——2. *Conchocele.*——3. *Philis.*——4. *Maorithyas.*——5. *Tauraxinus.*——6. *Mendicula.*——7. *Axinulus.*——8. *Parathyasira.*——9. *Axinopsida.*——10. *Adontorhina.*——11. *Leptaxinus.*——12. *Genaxinus.*——13. *Storthodon.*

Thyasira LEACH in LAMARCK, 1818 [**Amphidesma flexuosa* LAMARCK, 1818 (=**Tellina flexuosa* MONTAGU, 1803); OD] [=*Axinus* SOWERBY, 1821 (type, *A. angulatus;* OD); *Cryptodon* TURTON, 1822; *Bequania* LEACH in BROWN, 1827; *Ptychina* PHILIPPI, 1836 (obj.); *Prothyasira* IREDALE, 1930 (type, *P. peroniana*; OD) (obj.)]. Obliquely trigonal, with sharp dorsal folds and well-marked posterior area. Concentrically sculptured. *Cret.-Rec.*, Eu.-N.Am.-Pac.-Australia.

T. (Thyasira) [1]. Small, oblique, with lunular margin only slightly curved, protruding in right valve, followed by resilium in moderately short, broadly trigonal depression. A minute pseudocardinal on left valve. *Cret.-Rec.*, Eu.-Pac.-Australia.——FIG. E13,*1*; E14,*8*. **T. (T.) flexuosa* (MONTAGU), Rec., Medit.; E13,*1*, RV int., ×1 *(305)*; E14,*8*, RV hinge, ×1 *(513)*.

T. (Conchocele) GABB, 1866 [2] [**C. disjuncta*; OD]. Very oblique, enlarged backward; lunular margin nearly straight, followed by resilium in long narrow depression; anterior muscle scar broad. *Oligo.-Rec.*, N.Am.-N.Pac.——FIG. E14,*4*.

***T. (C.) disjuncta* (GABB), Rec., USA(Calif.); *4a,b,* RV ext., int., ×0.7 (Keen, 1939).

T. (Philis) P. FISCHER, 1861 [3] [**P. Cumingi;* OD]. Small, somewhat oblique; deeply excavated lunule in spoon-shaped socket under beak, its edge U-shaped in front of ill-defined depression. *Rec.,* Australasia-Japan.——FIG. E14,*6*. **T. (P.) cumingi,* Moluccas; LV int., enl. (Chavan, n).

Adontorhina BERRY, 1947 [10] [**A. cyclia*; OD]. Small, resembling *Axinopsida* but hinge teeth replaced by indefinite ridges and denticles on somewhat reflected lunular and escutcheonal margins. Anterior pseudocardinals tuberculiform. *Pleist.-Rec.,* W.N.Am.——FIG. E14,*11*. **A. cyclia,* Pleist., USA(Calif.); *11a,b,* LV int., ext., ×10 (Berry, 1917).

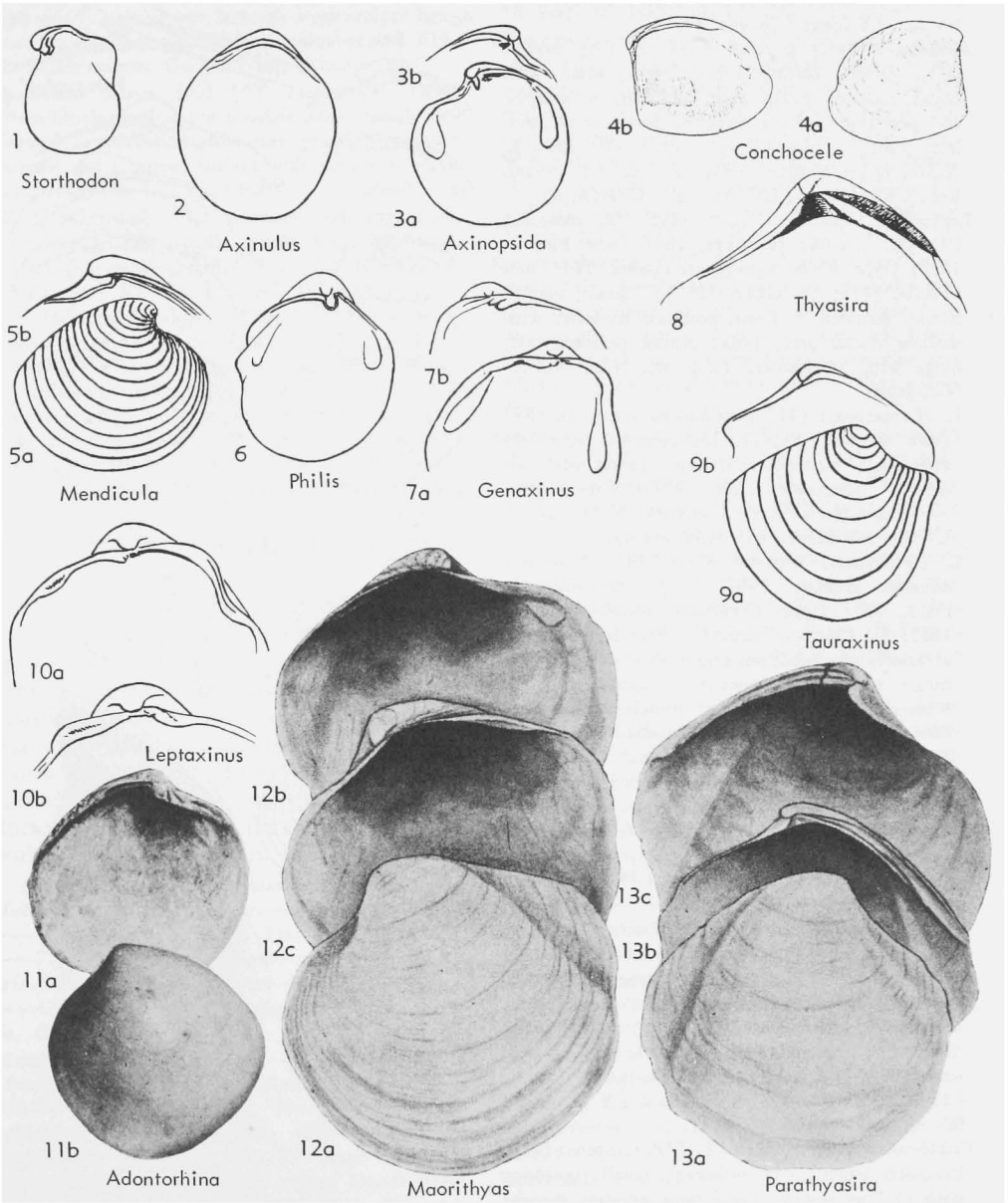


FIG. E14. Thyasiridae (p. *N*508-*N*511).

Axinopsida KEEN & CHAVAN in CHAVAN, 1951 [9] [*pro Axinopsis* SARS, 1878 (*non* TATE, 1868)] [**Axinopsis orbiculata* G. O. SARS, 1878; OD]. Suborbicular, slightly inequilateral; lunular margin concave, ventral and posterior margins rounded; hinge with pointed projecting pseudocardinal; muscle scars ovately elongate. *U.Plio.-Rec.,* N.Eu.-N. Atl.-W.N. Am.-W. Pac.(Japan)-Medit.——FIG. E14,*3*. **A. orbiculata* (SARS), Rec., Norway; *3a,b,* RV int., LV hinge (Chavan, n).

Axinulus VERRILL & BUSH, 1898 [7] [**A. brevis*; OD]. Ovately oblong, subequilateral, small, with broad rounded beaks and long narrow anterior and posterior cardinal margins, dorsal areas obsolete; posterior adductor scar small. *Plio.-Rec.,* E. N.Am.-W.Eu.-Medit.——FIG. E14,*2*. **A. brevis,* Rec., USA(Maine); LV int., enl. (Chavan, n).

Leptaxinus VERRILL & BUSH, 1898 [**L. minutus*; OD][=*Clausina* JEFFREYS, 1847 (*non* BROWN, 1827) (type, *Kellia ferruginosa* FORBES, 1843, *non* MORRIS, 1843; SD GRAY, 1847)]. Small, inequilateral, rounded in front, posterior truncate, with shallow dorsal area; beaks almost opisthogyrate; hinge with tuberosities. *Plio.-Rec.,* N.Eu.-N.Am.-N.Z.-Japan.

L. (Leptaxinus) [11] [=*Clausina* JEFFREYS, 1847 (*non* BROWN, 1827)]. Inequilateral, anteriorly attenuated, posteriorly sinuate; hinge with ill-defined tuberosities. *Rec.,* N.Eu.-N.Am.-Japan. ——FIG. E14,*10*. **L. (L.) minutus,* N.Atl.; *10a,b,* LV and RV hinges, enl. (Chavan, n).

L. (Genaxinus) IREDALE, 1930 [12] [**Thyasira albigena* HEDLEY, 1907; OD] [=*?Vaticinaria* DALL, 1901 (type, *Cryptodon moseleyi* SMITH, 1885; SD CHAVAN, herein)]. Very inequilateral, anteriorly produced, posteriorly short and straight; hinge with subhorizontally elongate toothlike tuberosities in each valve; muscle scars large. *Plio.-Rec.,* Japan-SW.Pac.-Australia-N.Z.——FIG. E13,*2*. **L. (G.) albigenus* (HEDLEY), Plio., N.Z.; *2a,b,* RV int., LV ext., ×15, ×10 (Hedley, 1907).——FIG. E14,*7*. *L. (G.) cookianus* FLEMING, Plio., N.Z.; *7a,b,* LV int., RV hinge, ×30 (Chavan, n).

Maorithyas FLEMING, 1950 [4] [**M. marama* (=*Thyasira flexuosa* SUTER, 1913, *non Tellina flexuosa* MONTAGU, 1803); OD]. Rounded, oblong, globose, with obtuse dorsal folds; escutcheon narrowly crescentic; surface with irregular growth lines; hinge thin, its posterior part excavated in ligamentary groove, bounded below by ridge; inner shell surface with radiating lirae, anterior muscle scar 8-shaped. *Rec.,* N.Z.-Australia-Japan.——FIG. E14,*12*. **M. marama,* N.Z.; *12a-c,* LV ext., int., RV int., ×1 (Fleming, 1950).

Parathyasira IREDALE, 1930 [8] [**P. resupina*; OD]. Rounded trigonal, inequilateral, small, posterior with shallow double angulation; anterior margin concave; surface with fine radial lines; hinge with lunular pseudocardinals and very faint posterior

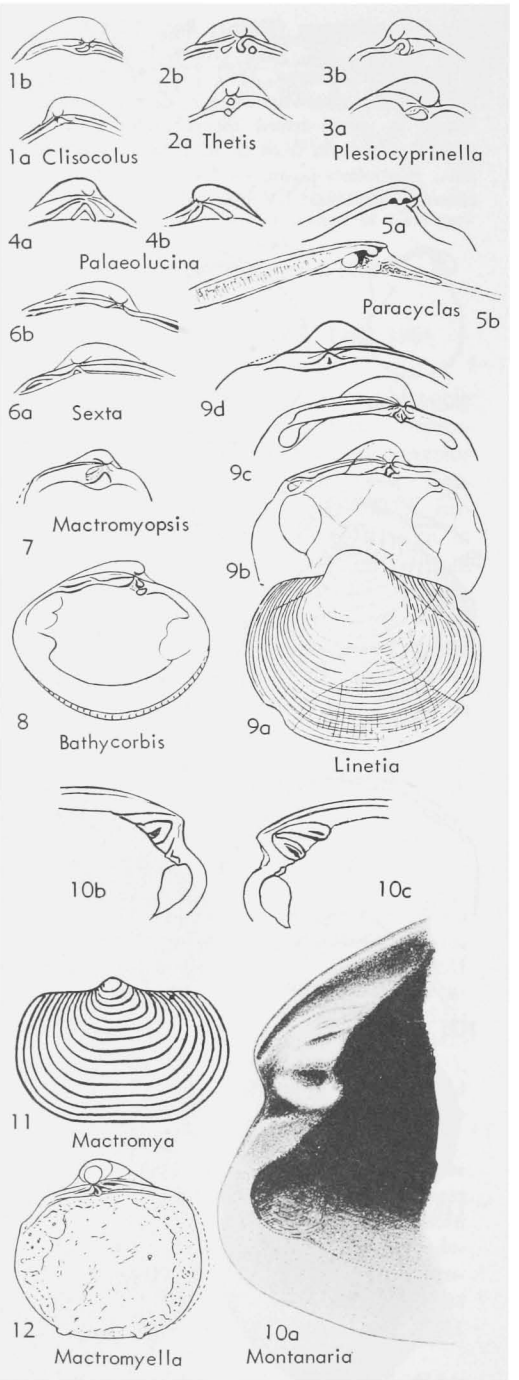


FIG. E15. Mactromyidae (p. *N511-N513*).

laterals. *Pleist.-Rec.,* Australia-N.Z.-Japan.——Fig. E13,*3*; E14,*13. P. resupina neozelandica* Iredale, N.Z.; E13,*3,* LV ext., ×5 (Iredale, 1930); E14, *13a-c,* RV ext., int., LV int., ×1 (Fleming, 1950).

Storthodon Giebel, 1856 [13] [**S. liscaviensis;* OD]. Oblong, gibbous, with well-marked posterior area, beaks pointed, prosogyrous; hinge with pyramidal quadrangular tooth under beaks and nearly similar one beneath it; marginal ligament in flattened area. *M.Trias.,* Eu.——Fig. E14, *1. *S. liscaviensis,* Ger.; RV int. (Chavan, n).

Tauraxinus Sacco, 1901 [**T. miorugosus*; OD]. Flabelliform, with quite obsolete areas, lunule depressed or sunken, ligamentary groove somewhat narrow and elongate; surface with concentric wavy sculpture. *Mio.-Rec.,* Eu.-S.Pac.

T. (Tauraxinus) [5]. Anterior end attenuated, produced; beaks small; lunule long, depressed. *Mio.,* Eu.——Fig. E14,*9. *T. (T.) miorugosus,* Italy; *9a,b,* RV ext., int., enl. (Chavan, n).

T. (Mendicula) Iredale, 1924 [6] [**M. memorata* (=*Lucina induta* Hedley, 1907, *non* Stoliczka, 1887); OD]. Anterior end rounded, beaks prominent, prosogyrate; lunule not defined but corresponding anterior margin projecting backward behind beaks. *Rec.,* S.Pac.-Australia.——Fig. E14,*5. *T. (M.) memorata* (Iredale), Australia; *5a,b,* RV ext., hinge, enl. (Chavan, n).

Family MACTROMYIDAE Cox, 1929

[=Mactromyacidae Cox, 1935]

Globose, outline trigonal to elliptical, commonly elongate transversely; beaks more or less prominent, prosogyrous; lunule ill-defined, ligament in broadened, distinctly marginal groove with somewhat sunken resilium; surface with predominant concentric sculpture. Hinge with primitive laminae in cyclodont pattern; anterior adductor scars ovate, not digitate; some shells with shallow pallial sinus. *Dev.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Mactromya.*——2. *Clisocolus.*——3. *Macromyopsis.*——4. *Mactromyella.*——5. *Linetia.*——6. *Thetis.*——7. *Sexta.*——8. *Bathycorbis.*——9. *Plesiocyprinella.*——10. *Palaeolucina.*——11. *Montanaria.*——12. *Paracyclas.* [Insert above, 1a. *Unicardium;* 6a. *Cordiula.*]

Mactromya Agassiz, 1843 [1] [**M. rugosa* (=**Lutraria concentrica* Münster in Goldfuss, 1840; SD Herrmannsen, 1847]. Transversely elliptical, nearly equilateral, with strong subequidistant concentric ribs; RV hinge with anterior thickening and shallow socket. *Jur.(Bathon.-Portland.),* Eu.-E.Afr.——Fig. E15,*11. *M. concentrica* (Münster), U.Jur., Ger., LV ext., ×1.25 (Chavan, n, after Goldfuss).

Bathycorbis Iredale, 1930 [8] [**Chione despecta* Hedley, 1904; OD]. Transversely trigonal, small, nearly equilateral; surface with strong concentric ribs, laciniate, intercalated striae; LV hinge with 2 superposed tuberculiform teeth and posterior thickening in front of ligament, RV hinge with single rounded tooth and laminar processes in inverted V above it. *Rec.,* Australia.——Fig. E15,*8. **B. despecta* (Hedley); LV int., ×12 *(119).*

Clisocolus Gabb, 1869 [2] [**Loripes dubia* Gabb, 1864; OD]. Trigonal to rounded, somewhat inequilateral, beaks high, with lamellar striae; resilium sunken; hinge with ill-defined virguliform cardinal and anterior lateral in each valve. *Cret.,* W.N.Am.-Eu.——Fig. E15,*1;* E16,*1. *C. dubius* (Gabb), Chico Gr., USA(Calif.); E15,*1a,b,* RV and LV hinges *(119);* E16,*1a,b,* RV and LV hinges, ×1.5; E16,*1c,* LV ext., ×1.5 *(333).*

Cordiula Meyer, 1887 [6a] [**Unicardium? eocenense;* OD]. Similar to *Thetis* in outline and sculpture, but without oblique internal rib; three faint mediposterior pallial sinuosities. One left tubercular cardinal and obsolete laterals. Anterior scar elliptical, posterior elliptical-cordate. *Oligo.,* USA (Miss.).

Linetia Chavan, 1959 [5] [**Mactromya Caumonti* Chavan, 1959 (*ex* Agassiz, MS, 1845) (=*Mactromya calliope* Rollier, 1913, *non* Thévenin, 1909, *ex* d'Orbigny, 1850); OD]. Large, rounded ovate, very inequilateral, with irregular concentric ribbing and radial striation laterally; hinge with *AIII-3* in inverted V with triangular *2* and distinct *4b* below. *Jur.(Aalen.-Callov.),* Eu.——Fig. E15,*9. **L. caumonti* (Agassiz), Bajoc., W.France; *9a-d,* LV ext., int., LV and RV hinges, ×0.8 *(119).*

Mactromyopsis Chavan, 1959 [**Unicardium hemirhytideum* Cossmann, 1905; OD]. Subquadrate to subcirculate, rather thick, with strong concentric ribbing; hinge with single cardinal in each valve attached to its anterior lamina, elevated posterior muscle scar. *Jur.(Charmouth.-Callov.),* Eu.

M. (Mactromyopsis) [3]. Subquadrate; RV hinge with well-developed cardinal *3. Jur.(Bajoc.-Callov.),* Eu.——Fig. E15,*7. *M. (M.) hemirhytidea* (Cossmann), Bajoc., W.France; LV hinge, ×1.25 *(119).*

M. (Mactromyella) Chavan, 1959 [4] [**Unicardium inflatum* Thévenin, 1909 (*ex* d'Orbigny, 1850); OD]. Subcircular, with rather regular ribbing; RV hinge with evanescent cardinal *3,* overhanging well-developed *AI. Jur.(Charmouth.-Bajoc.),* Eu.——Fig. E15,*12. *M. (M.) inflata* (Thévenin), Bajoc., W.France; RV int., ×1.25 *(119).*

Montanaria Spriestersbach, 1909 [11] [**M. ovata* (=**Pleurophorus devonicus* Beushausen, 1884); SD Haffer, 1959]. Rounded oval to elongate, very inequilateral, beaks small, anterior, surface

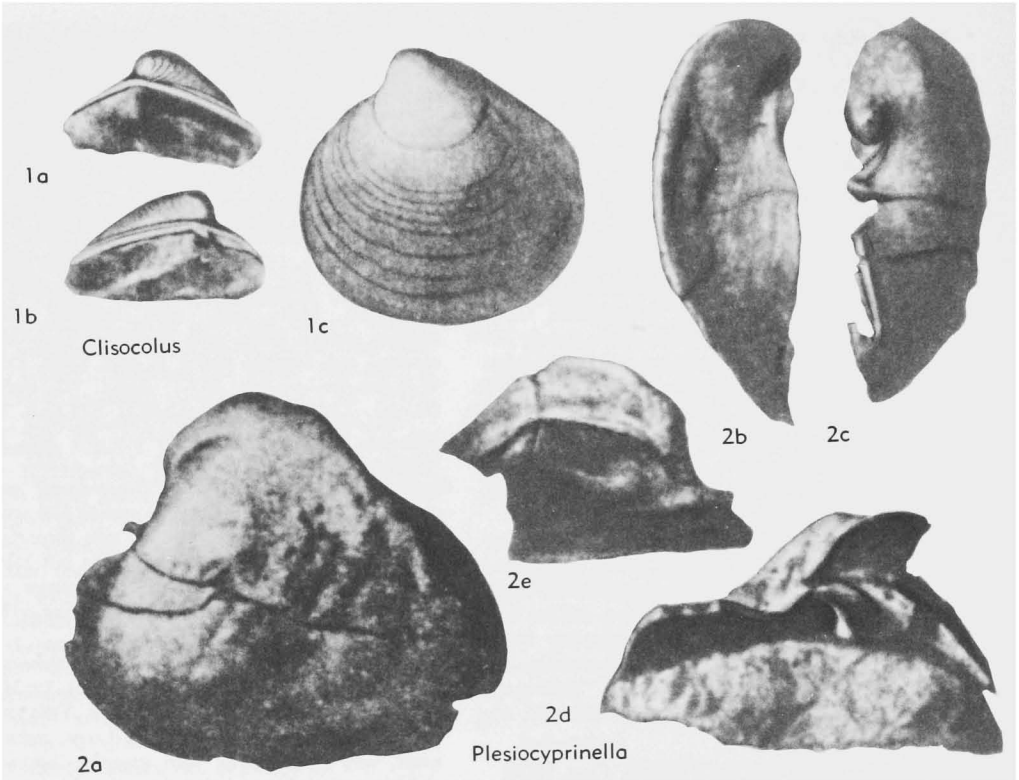


FIG. E16. Mactromyidae (p. *N*511-*N*512).

with fine concentric growth lines only; hinge with *AIII, 3a-3b/4a, 2, (4b); 2* and *3* grooved to bifid, some shells with *AIII* and *4a* weak or lacking; anterior scars ovate. *Dev.*, Eu.——FIG. E15,*10*. **M. devonica* (BEUSHAUSEN), Remscheider beds, Ger.; *10a,* RV hinge (Beushausen); *10b,c,* RV and LV hinges (Chavan, n).

?**Palaeolucina** CHAO, 1927 [10] [**P. carbonaria;* OD]. Mostly elliptical, with somewhat low beaks, distinct ovate lunule, and long narrow escutcheon; surface with lamellose concentric ribs; hinge with 3 teeth in LV, median one bifid; 2 oblique teeth and marginal anterior lamella in RV; muscle scars unknown. *Carb.*, China.——FIG. E15,*4*. **P. carbonaria; 4a,b,* LV and RV hinges, enl. (Chavan, n, after Chao).

Paracyclas HALL, 1843 [12] [**P. elliptica* (=*Lucina proavia* GOLDFUSS, 1840); OD]. Ovate, beaks low, surface with concentric ribs; RV hinge apparently with *2* oblique superposed rounded tubercles separated by sockets, superior one smaller than inferior, flat area in front of them and possibly linear anterior lateral; broad and long ligament depression; anterior muscle scars elliptical. *Dev.*, N. Am. - Eu. —— FIG. E15,*5*. *P. marginata* (MAURER), Ger.; *5a,b,* LV hinges, enl. (Chavan after Maurer).

Plesiocyprinella HOLDHAUS, 1918 [9] [**P. carinata;* OD]. Cordate, rounded, beaks prominent; RV hinge with *AIII, 3a, 3b* hooked, LV hinge with large, low, subtrigonal 2 and thinner, oblique *4b*. *Perm.*, S.Am.——FIG. E15,*3*; E16,*2*. **P. carinata,* Brazil; E15,*3a,b,* LV and RV hinges, ×0.8 *(119)*; E16,*2a-e,* LV ext., ant., RV ant., hinge, LV hinge, all ×1.5 (Holdhaus).

Sexta STEPHENSON, 1954 [7] [**S. navicula*; OD]. Rounded, convex, relatively low beaks, no lunule, ligament external; surface nearly smooth; hinge with anterior laterals, median depression, faint posterior laterals, RV with minute cardinal; adductor scars small, subequal. *U.Cret.(Cenoman.)*, N.Am.——FIG. E15,*6*. **S. navicula,* USA(Tex.); *6a,b,* RV and LV hinges, ×2 *(119)*.

Thetis J. DE C. SOWERBY, 1826 [6] [**T. major;* M (=*Corbula laevigata* SOWERBY, 1818, *non Thetis* OKEN, 1815, inval., *nec* C. B. ADAMS, 1845, *nec* H. ADAMS & A. ADAMS, 1856)] [=*Thetironia* STOLICZKA, 1870 (obj.); *Fimbriella* STOLICZKA, 1871 (obj.)]. Subcircular, tumid, with prominent nearly orthogyrous beaks; surface with concentric

and laterally radial sculpture; ligament thin; hinge with *AIV* continued above and behind tubercular *2* as hooked tooth, RV with 2 superposed tuberculiform cardinals. Oblique internal rib resembling pallial sinus. *Cret.(Alb.-Cenoman.),* Eu.-N.Am. ——Fig. E15,*2*. **T. laevigata* (Sowerby), L.Cret., Eng.; *2a,b,* RV and LV hinges, ×1.25 *(119)*.

[The American species, known as *Thetiopsis* Meek, shows a venerid hinge.]

Unicardium d'Orbigny, 1850 (1849) [1a] [**Corbula cardioides* Phillips, 1829; SD Stoliczka, 1871]. Like *Mactromya* but more tumid, rounded; broadly inflated prosogyrous beaks; irregular lamellose concentric ribbing. Hinge with right faint cardinal tubercle; long straight nymph. *Jur.,* W.Eu.

Family FIMBRIIDAE Nicol, 1950

[=Corbidae Dall, 1895]

Transversely elliptical or ovate, beaks rounded; lunule and escutcheon generally well marked; surface bearing primary radial ribs superposed by smooth or concentrically sculptured external layer; marginal ligament on nymph. Hinge with massive, trigonal or tubercular, generally entire medial teeth in more or less cyclodont pattern, anterior laterals commonly and posterior laterals generally developed; muscle scars ovate to reniform, short, without digitation. *Carb.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Fimbria.*——2. *Scaldia.*——3. *Schafhaeutlia.*——4. *Sphaeriola.*——5. *Haastina.*——6. *Cyclopellatia.*——7. *Sphaera.*——8. *Mutiella.*——9. *Parvicorbis.*

Fimbria Megerle von Mühlfeld, 1811 [1] [**F. magna* (=*Venus fimbriata* Linné, 1758); OD] [*non Fimbria* Bohadsch, 1761 (invalid)] [=*Corbis* Cuvier, 1817 (obj.); *Idothea* Schumacher, 1817 (*non* Fabricius, 1796) (obj.)]. Transversely elliptical, subequilateral, thick, beaks prosogyrous; lunule small, lanceolate, ligament external but partly sunken; surface with strong reticulate sculpture, concentric ribs medially dominant; hinge with 2 cardinals in each valve, *3b* grooved, anterior laterals near, posterior laterals remote; interior with very small pallial sinus and crenulate margin. *M.Jur.(Bathon.)-Rec.,* Eu.-N.Am.-Pac.-India-Australia.——Fig. E17,*1*. **F. fimbriata* (Linné), Rec., Eu.; *1a-c,* RV ext., int., LV int., ×1 *(674)*.

Cyclopellatia Cossmann, 1907 [6] [**C. acrodonta*; OD]. Rounded, nearly equilateral, low prosogyrous beaks; surface with close-spaced radial ribs crossed by concentric striations which predominate posteriorly; hinge broad, thick, LV with marginal anterior approximate to upper lateral *(AIV),* strong trigonal *2,* oblique *4b,* strong *PII* not very remote; ligament marginal. *L.Jur. (Barrem.),* Eu.——Fig. E18,*4*. **C. acrodonta,* S. France; *4a,b,* LV ext., ×1.25, hinge, ×2.5 (Chavan, n, after Cossmann).

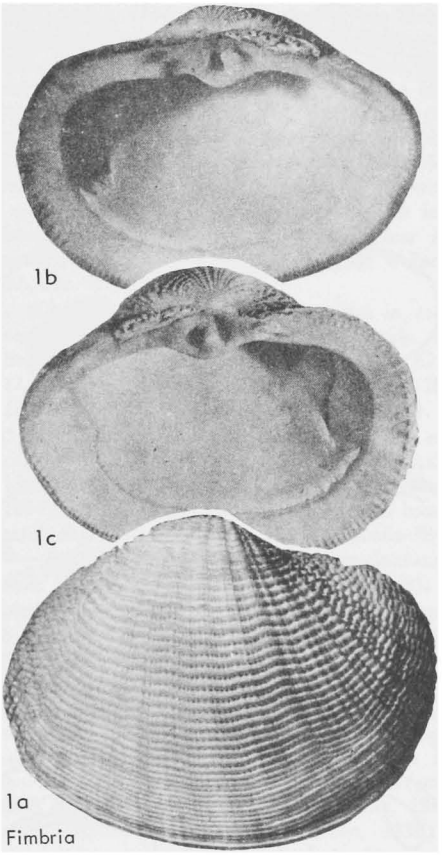


Fig. E17. Fimbriidae (p. *N*513).

Haastina Marwick, 1953 [5] [**Heminajas? haastiana* Wilckens, 1918; OD]. Transversely elliptical, slightly inequilateral, beaks high, prosogyrous; surface with concentric striation; hinge with 3 diverging cardinals, median bifid, posterior weak on RV, posterior laterals strong; muscle scars ovate. *U.Jur.(Oxford.),* N.Z.——Fig. E18,*3*. **H. haastina* (Wilckens); RV int., ×1.5 (Chavan, n, after Marwick).

Mutiella Stoliczka, 1871 [8] [**Corbis rotundata* d'Orbigny, 1843; OD]. Globose, high, ovate, beaks broad, nearly orthogyrous, with long marginal ligament; surface finely reticulate; LV hinge with *AIV* marginal, elongate and small remote tubercular *AII, 2* deeply bifid, *4b* long and stout. *U.Cret.,* Eu.-S.Asia(India).——Fig. E18,*5*. **M. rotundata* (d'Orbigny), Senon., France; LV hinge, ×1.5 (Chavan, n, after d'Orbigny).

Parvicorbis Cossmann, 1892 [9] [*pro Bernayia* Cossmann, 1887 (*non Bernaya* Jousseaume, 1884)] [**Bernayia subarata* Cossmann, 1887; SD Chavan,

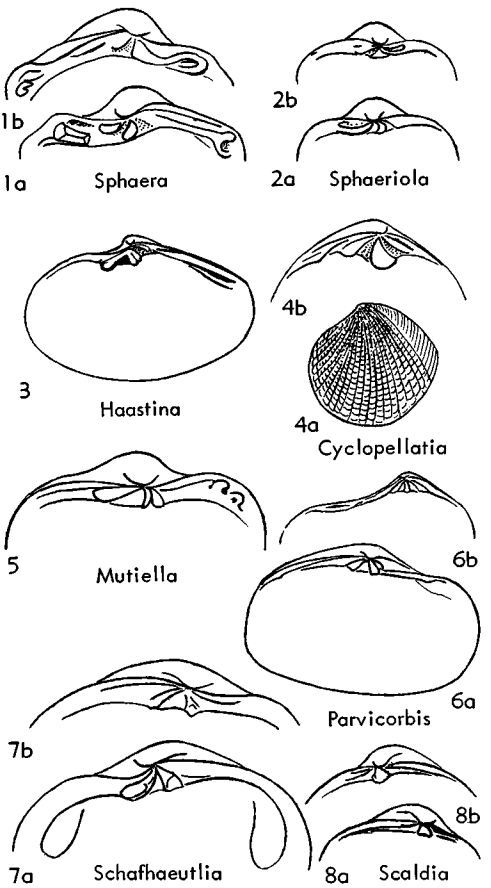


FIG. E18. Fimbriidae (p. *N*513-*N*514).

herein]. Small, transversely elliptical, slightly gaping at both ends; lunule narrow, escutcheon well impressed, nymph short; surface with concentric to reticulate sculpture; hinge with small pointed cardinals, bilobate *2*, remote anterior and posterior laterals; inner shell margin smooth. *Eoc.*, Eu.——FIG. E18,*6a*. **P. subarata* (COSSMANN), France (Paris Basin); *6a*, LV int., ×4.5 (Chavan, n, after Cossmann).——FIG. E18,*6b*. *P. goodallina* (COSSMANN), France (Paris Basin); *6b*, RV hinge, ×8 (Chavan, n, after Cossmann).

Scaldia DE RYCKHOLT, 1847 [2] [**S. lambotteana*; SD STOLICZKA, 1871]. Rounded, short, slightly inequilateral, somewhat prosogyrous prominent beaks; escutcheon narrow, nymph elongate; surface concentrically striate; hinge with 2 cardinals in each valve, *2* and *3b* strong, *3a* laminar, *4b* weak; inner shell margin smooth. *Carb.*, Eu.——FIG. E18,*8*. **S. lambotteana*, Belg.; *8a,b*, LV and RV hinges, ×1.25 (Chavan, n).

Schafhaeutlia COSSMANN, 1897 [3] [*pro Gonodon* SCHAFHAEUTL, 1863 (*non* HELD, 1837)] [**Gonodon ovatum* SCHAFHAEUTL, 1863; OD]. Broadly elliptical, short, very thick, slightly inequilateral; surface with concentric sculpture; hinge with cyclodont conical cardinals and irregular anterior lateral; anterior muscle scar small. *U.Trias.*, Eu.-S.Am.——FIG. E18,*7*; E19,*1*. *S. mellingi* (HAUER); E18,*7a,b*, RV and LV hinges, ×1 (Chavan, n, after Hauer); E19,*1a-c*, LV int., RV int., both valves ant., ×1 (Schafhaeutl, 1863). [=*Gonodus* MUSKETOV, 1913 (missp.).]

Sphaera SOWERBY, 1822 [7] [**S. corrugata*; SD STOLICZKA, 1871] [=*Palaeocorbis* CONRAD, 1869 (obj.)]. Rounded, inflated, solid, subequilateral, with inflated nearly orthogyrous beaks; surface with corrugated concentric ribs; hinge strong, cyclodont, RV with strong anterior lateral, subhorizontal anterior cardinal, and arcuate posterior lateral, LV with anterior lateral fused with anterior cardinal and ill-defined posterior lateral, each valve with 2 remote posterior laterals. *L. Cret.*, Eu.——FIG. E18,*1*. **S. corrugata*, Neocom., France; *1a,b*, RV and LV hinges, ×2 (Chavan, n, after d'Orbigny & Woods).

Sphaeriola STOLICZKA, 1871 [4] [**S. madridi* (=*Cardium madridi* D'ARCHIAC, 1843); OD]. Globose, rounded, subequilateral, with prominent nearly orthogyrous rounded beaks, ligament short, broad; hinge with 2 teeth in each valve, anterior one (*AIV, AIII -3a*) subhorizontal and elongate, posterior one *(2, 3b)* trigonal, arcuate, stout, inner shell margin with denticles not corresponding to apparent ribs; sculpture of concentric sulci on radial internal ribs. *Jur.(Domer.-Bathon.)*, Eu.-N.Z.-Japan.——FIG. E18,*2*. **S. madridi* (D'ARCHIAC), Bathon., Eng.; *2a,b*, RV and LV hinges, ×1.25 (Chavan, n, after Morris & Lycett).

Family UNGULINIDAE
Adams & Adams, 1857

[=Diplodontidae DALL, 1895]

Outline subtrigonal to oblong, rounded or obliquely ovate, beaks generally low, dorsal angulations weak or absent, ligament and resilium marginal; surface smooth, punctate, or with fine concentric sculpture; hinge with two cardinals, medial one bifid, and incomplete or evanescent laterals; muscle scars irregular, anterior scar elongate and not detached from pallial line, posterior scar large. *U.Cret.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Ungulina*.——2. *Numella*.——3. *Felania*.——4. *Brachymeris*.——5. *Microstagon*.——6. *Diplodonta*.——7. *Zemysina*.——8. *Felaniella*.——9. *Zemysia*.

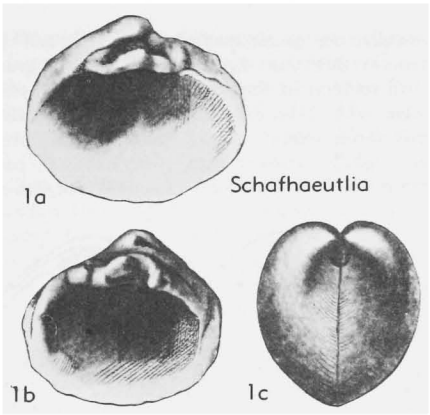


FIG. E19. Fimbriidae (p. *N*514).

——10. *Bruetia.*——11. *Phlyctiderma.*——12. *Timothynus.*——13. *Cycladicama.*——14. *Toralimysia.*

Ungulina ROISSY, 1805 [1] [**U. rubra* (=*Tellina cuneata* SPENGLER, 1782); SD GRAY, 1847] [=*Unguline* DAUDIN in BOSC, 1801 (vernac.); *Clotho* BASTEROT, 1825 (*non* WALCKENAER, 1805, *nec* FAUJAS, 1808) (type, *C. unguiformis;* OD)]. Oblong, thick, irregular; lunule lacking, external ligament extended backward, with groove adjacent to shorter socket occupied by broad resilium which partly covers nymph and obliterates *4b*; large oblong subequal muscle scars. *Oligo.(Aquitan.)-Rec.,* Eu.-W.Afr.——FIG. E20,*8*. **U. cuneata* (SPENGLER), Rec., Senegal; *8a,b,* LV int., RV hinge, enl. *(121)*.

Brachymeris CONRAD, 1875 [4] [**B. alta*; OD] [=*Arene* CONRAD, 1875 (*non* ADAMS & ADAMS, 1854)]. Obliquely oblong, nearly orthygyrous beaks; lunule lacking, narrow marginal ligament and resilium in short groove; hinge with generally bifid *2* and *3b,* and oblique *3a* and *4b,* anterior laterals moderately developed, posterior ones weak; anterior muscle scar very broad. *U.Cret.,* N.Am. ——FIG. E20,*7*. **B. alta,* USA(N.Car.); *7a,b,* RV int., LV hinge, ×3 (Chavan, 1960).

Bruetia CHAVAN, 1962 [10] [**Lucina radians* MELLEVILLE, 1843 (*non* CONRAD, 1841) (=*L. subradians* D'ORBIGNY, 1850); OD]. Subtrigonal to subquadrate, somewhat thick; narrow resilium and flat nymph in front and resting on short ligament; hinge with 2 bifid cardinals in each valve, anterior laterals and *AIV-4a* developed marginally; internal radial lines generally well marked; anterior muscle scar falciform, posterior scar shorter and ovate. *Paleoc.-Mio.,* Eu.-C.Am.——FIG. E20, *5. B. subradians* (D'ORBIGNY), L.Eoc., France (Paris Basin); *5a,b,* LV int., RV hinge, ×3 (Chavan, 1960).

Cycladicama VALENCIENNES in ROUSSEAU, 1854 [**C. luciniformis* (=*Cyrenoida oblonga* HANLEY, 1844 *(nom. nud.)*, 1856); OD] [=*Joannisiella* DALL, 1895 (*pro Joannisia* DALL, 1895, *non* MONTEROSATO, 1884, *nec* KIEFER, 1894) (obj.)]. Transversely subovate, attenuate forward, somewhat angular and truncate rearward, with external flattened area defined by medioposterior weak angulation; ligament in groove adjacent to shorter resilium in broader socket; surface concentrically striate; hinge with 2 cardinals in each valve and single more or less distinct anterior lateral; anterior muscle scar irregularly extended and doubles, elongate. *U.Eoc.-Rec.,* Pac.-W.Afr.-Japan-?Eu.

C. (Cycladicama) [13]. Broad, normal in convexity; hinge with laminar anterior laterals. *U. Eoc.-Rec.,* Pac.-W.Afr.-Japan-?Eu.——FIG. E20, *11. *C. (C.) oblonga* (HANLEY), Rec., Philip. Is.; *11a,b,* RV int., LV hinge, ×2 (Chavan, 1960).

C. (Toralimysia) IREDALE, 1936 [14] [**T. excentrica* (=*Joannisiella sphaericula* HEDLEY, 1906, *non Cyrenella sphaericula* DESHAYES, 1854); OD]. Strongly convex; hinge with broad cardinals and obsolete laterals. *Rec.,* Australia-?Eu. ——FIG. E20,*3*. **C. (T.) excentrica* IREDALE; *3a,b,* RV and LV hinges, enl. (Chavan, 1960).

Diplodonta BRONN, 1831 [**Venus lupinus* BROCCHI, 1814 (*non* LINNÉ, 1858) (=**Tellina rotundata* MONTAGU, 1803) (=*D. rotundata* var. *aequilateralis* CERULLI, 1909); SD HERRMANNSEN, 1846] [=*?Taras* RISSO, 1826 (type, *T. antiquatus*; OD) *(nom. dub.)*; *Mysia* LEACH in BRONN, 1827 (*non* LAMARCK, 1818) (obj.); *Glocomene* LEACH in GRAY, 1852 (type, *Tellina rotundata* MONTAGU, 1803; SD CHAVAN, 1962); *?Mittrea* GRAY, 1864 (type, *Diplodonta brasiliensis* MITTRE, 1850)]. Suborbicular, convex, inequilateral, beaks prosogyrous; ligament on medium-sized flattened nymph with narrow resilium on its anterior extremity; hinge with 2 well-developed oblique cardinals in each valve and weak *5b*; anterior muscle scars sinuate, narrower than posterior scars. *Paleoc.-Rec.,* Eu.-N.Am.-Pac.-W.Afr.

D. (Diplodonta) [6]. Moderately convex; hinge with somewhat narrow short teeth; anterior muscle scars not elongate. *Paleoc.-Rec.,* Eu.-N. Am.-Pac.——FIG. E20,*10*. **D. (D.) rotundata* (MONTAGU), Rec., Medit.; *10a,b,* LV int., RV hinge, ×3 (Chavan, 1960).

D. (Zemysina) FINLAY, 1926 [1927] [7] [**Zemysia (Z.) globus* FINLAY, 1927; OD]. Very convex; hinge with longer and more bifid teeth and more elongate muscle scar than in *D. (Diplodonta). Eoc.-Rec.,* Eu.-N.Am.-Pac.——FIG. E21, *3. D. (Z.) walli* (WOODRING), Mio., Jamaica; *3a,b,* RV ext., int., ×4 *(1005)*.

Felania RECLUZ, 1851 [3] [**Venus diaphana* GMELIN, 1790; OD]. Sublenticular, thin, medium-sized; lunule small, external ligament adjacent to long resilium lying in groove; hinge with 2 cardi-

nals and single anterior lateral in each valve; anterior muscle scars less elongate than posterior scars. *Rec.,* W.Afr.——Fig. E20,*2*. **F. *diaphana* (Gmelin), Senegal; *2a,b,* LV int., RV hinge, enl. (Chavan, 1960).

Felaniella Dall, 1899 [**Mysia (Felania) usta* Gould, 1861; OD]. Subquadrangular to rounded, inequilateral, posteromedially enlarged and flattened, rather thin; ligament in marginal groove, small resilium in elliptical socket at top of nymph; hinge with 2 subvertical or oblique cardinals in each valve; anterior muscle scars somewhat irregular, slightly narrower than posterior scars, pallial line doubled. *U.Cret.-Rec.,* N.Am.-W.Pac.-Eu.-Afr.

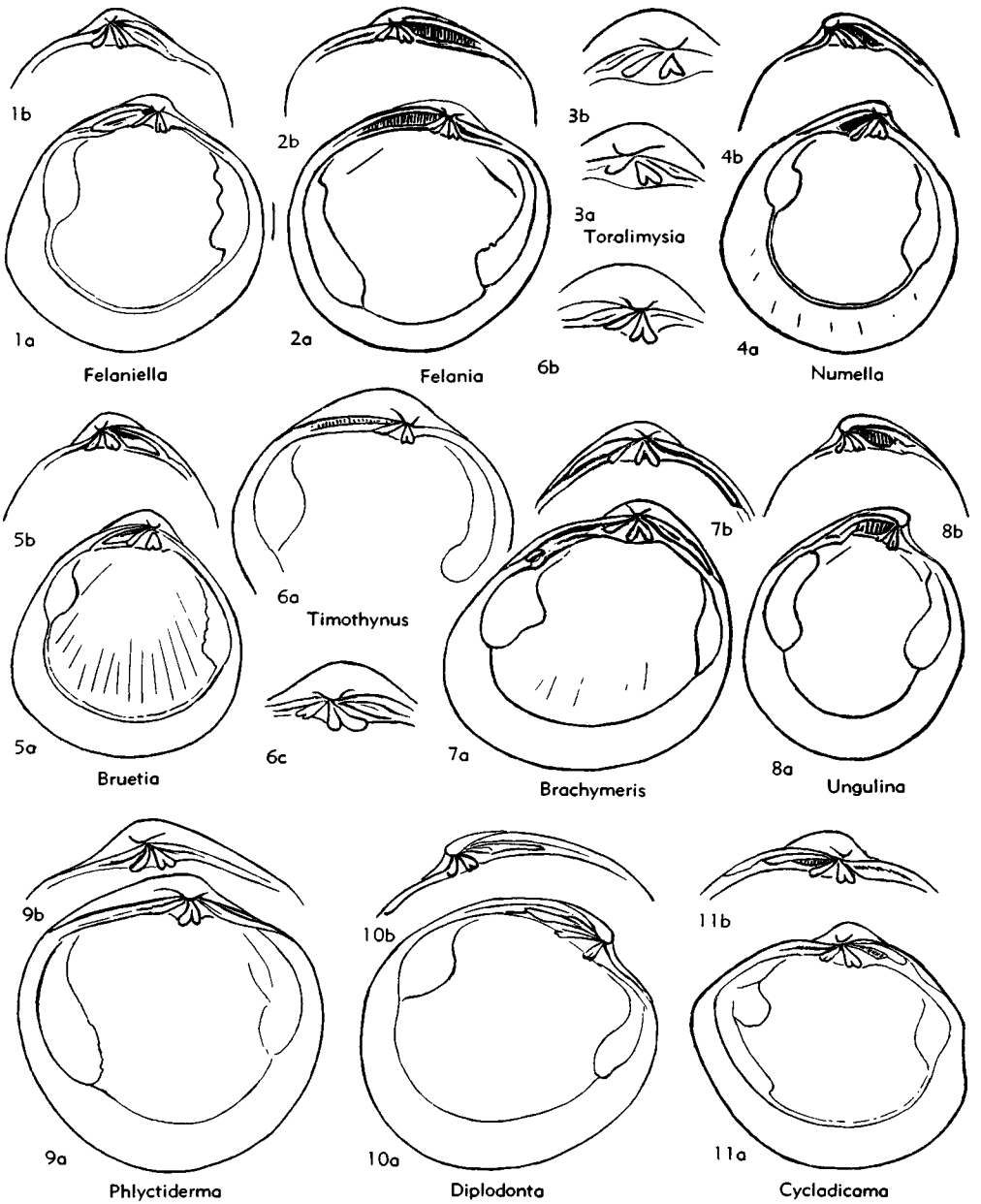


Fig. E20. Ungulinidae (p. *N515-N517*).

F. (Felaniella) [8]. Ligament almost external, resilium restricted; hinge with somewhat oblique teeth; muscle scars rather narrow. *Paleoc.-Rec.*, N.Am.-Pac.-Eu.——Fig. E20,*1*. **F. (F.) usta* (Gould), Rec., Japan; *1a,b*, LV int., RV hinge, ×2 (Chavan, 1960).

F. (Zemysia) Finlay, 1926 [1927] [**Lucina zelandica* Gray, 1835; OD]. Broader and more rounded than *F. (Felaniella)*; ligament somewhat sunken, resilium extended, partly covering long nymph; hinge with nearly vertical teeth; muscle scars relatively broad. *U.Cret.-Rec.*, S.Pac.-S.Afr.-N.Am.-Eu.——Fig. E21,*1*. *F. (Z.) acclinis* (Conrad), Mio., USA(Md.); *1a,b*, RV int., LV hinge, enl. *(121)*.

Microstagon Cossmann, 1896 (1899) [5] [*pro Goodallia* Deshayes, 1860 (*non* Turton, 1822)] [**Goodallia herouvalensis* Deshayes, 1860; SD Dall, 1903]. Small, very obliquely oblong, anteromedially elongated; ligament narrow and long, on nymph adjacent to shorter resilium lying in groove; hinge with thick *2* and oblique *3b*, oblique *3a, AIII, 4b*, and obsolete *PII;* anterior muscle scars well marked, irregularly elongate, enlarged. *L. Eoc. - Rec.*, Eu.-C. Am.-N. Am.-Japan. —— Fig. E21,*2*. *M. miliare* (Lamarck), Eoc., France(Paris Basin); *2a,b*, LV, RV int., ×2 *(121)*. [=*Minipisum* Yabe, 1961 (type, *M. japonicum;* M) (subj.).]

Numella Iredale, 1924 [2] [**Mysia (Felania) adamsi* Angas, 1867; OD]. Ovately oblong, concentrically striate; ligament next to deep resilium, extended narrowly forward and broadly rearward; hinge with elongate *4b*; anterior muscle scars longer and narrower than others. *Mio.-Rec.*, Australia.——Fig. E20,*4*. **N. adamsi* (Angas), Rec.; *4a,b*, LV int., RV hinge, ×3 (Chavan, 1960).

Phlyctiderma Dall, 1899 [11] [**Diplodonta semiaspera* Philippi, 1836; OD]. Globose, rounded, inequilateral, posteriorly enlarged, externally punctate, pustulose, or reticulate; ligament long, in groove, resilium narrow; hinge with somewhat projecting bifid *2* and *3b*, and oblique *3a, 4b, AIII*; posterior muscle scars very broad. *Mio.-Rec.*, N. Am.-W.Pac.-Japan.——Fig. E20,*9*. **P. semiaspera* (Philippi), Rec., USA(Fla.); *9a,b*, LV int., RV hinge, ×4 (Chavan, 1960).

Timothynus Harris & Palmer, 1946 [12] [**Sphaerella bulla* Conrad, 1865; OD] [=*Sphaerella* Conrad, 1838 (*non* Sommerfelt, 1834) (type, *S. subvexa;* OD)]. Very globose, rounded, inequilateral, posteriorly enlarged; ligament and resilium adjacent, with long rounded nymph; surface smooth; hinge with *2* and *3b* deeply bifid and projecting strongly *(2* subvertically, posterior half of *3b* almost horizontally), *3a* and *4b* oblique; anterior muscle scars narrow, much elongated. *L. Eoc.-Rec.*, N.Am.-?Eu.——Fig. E20,*6a*. *T. subvexus* (Conrad), Mio., USA(Md.); LV int., enl. (Chavan, 1960).——Fig. 20,*6b,c*. **T. bulla* (Conrad), Mio., USA(Md.); *6b,c*, LV and RV hinges, enl. (Chavan, 1960).

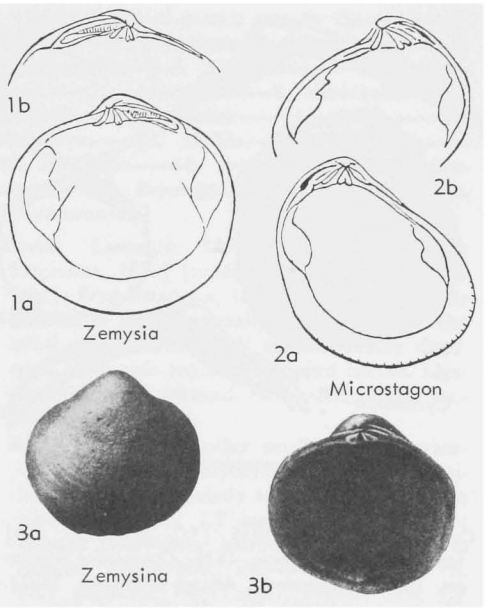


Fig. E21. Ungulinidae (p. *N515*, *N517*).

GENUS DUBIUM

Pegmapex Berry, 1960 [**P. phoebe;* M]. Thin, smooth, orbicular; true hinge plate continued posteriorly with flat expansive shelf formed by narrow, sharply angular, deeply sunken escutcheon. Two cardinals in each valve, posterior right and anterior left larger and bifid. *Rec.*, N.Am.(Mex.).

Family CYRENOIDIDAE
Adams & Adams, 1857

[=Cyrenellidae Fischer, 1882]

Suborbicular, posteriorly enlarged, inequilateral, thin, inflated, with rounded prosogyrous beaks; lunule lacking, escutcheon present or absent, ligament and resilium developed marginally; surface concentrically striate; hinge with anterior LV and RV cardinals forming posterior bent part of their original anterior lateral, elongate, forming pattern *AI-1, AIII-3, AII-2*, with *4b* simple and minute, posterior laterals lacking; muscle scars large, elongate, without digitation. *Rec.*

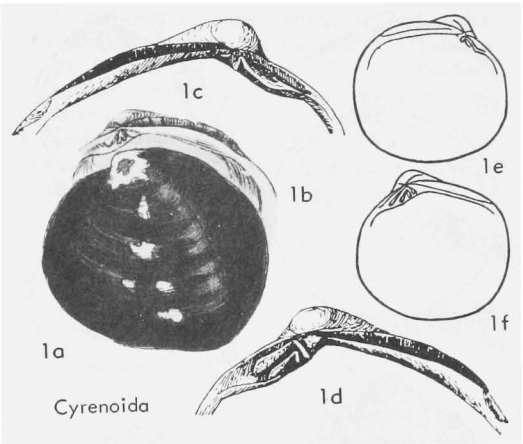


FIG. E22. Cyrenoididae (p. *N*518).

Cyrenoida JOANNIS, 1835 [**C. dupontia*; OD] [=*Cyrenella* DESHAYES, 1835; *Cyrenoides* SOWERBY, 1839; *Cyrenodonta* ADAMS & ADAMS, 1857]. Characters of family. *Rec.*, Afr.-N.Am.-C.Am.——FIG. E22,*1a-d*. **C. dupontae* [=*C. dupontia (lapsus)*], W.Afr.; *1a,b*, LV ext., RV hinge, ×1.25 (Sowerby, 1852); *1c,d*, LV and RV hinges, enl. (Lamy).——FIG. E22,*1e,f*. *C. rhodopyga* VON MARTENS, Congo; *1e,f*, LV and RV int., ×0.8 *(114)*.

Superfamily CHAMACEA Lamarck, 1809

[*nom. correct.* ICZN, 1957, Opinion 484 (*pro* Camacea DE BLAINVILLE, 1825) (=camacées LAMARCK, 1809)] [Chamacea MENKE, 1830, not recognized by ICZN] [Materials for this superfamily prepared by MYRA KEEN]

Sculpture normally well developed, concentric or radial or both; shell cemented to substrate by one valve, at least temporarily; beaks prosogyrate, ligament parivincular; hinge degenerate in appearance, with at least one large cardinal tooth in either valve, two cardinals and weak laterals in some; muscle scars two, large, subequal; pallial line entire. *?U.Cret., Paleoc.-Rec.*

Family CHAMIDAE Lamarck, 1809

[*nom. transl.*, BRODERIP, 1839 (*ex* Camacea DE BLAINVILLE, 1825) (=camacées LAMARCK, 1809)] [Chaminae GRAY, 1823, not recognized by ICZN]

Characters of superfamily. *?U.Cret., Paleoc.-Rec.*

Chama LINNÉ, 1758 [**C. lazarus*; SD CHILDREN, 1823 (ICZN, Opinion 484, 1957)] [=*Jataronus* BRUGUIÈRE, 1792, AUCTT. *(nom. nud.)*; *Maceris* MODEER, 1793 (obj.); *Cameola* RAFINESQUE, 1815 *(nom. null.)*; *Lacinea* SOWERBY, 1842 (obj.); *?Hellia* SCHAFHÄUTL, 1863 (type, *H. gryphus*; Cret., Ger.; M)]. Attached by LV throughout life; ornamentation foliaceous. *?U.Cret., Paleoc.-Rec.*, tropics-Eu.-N.Am.

C. (Chama). Concentric ornamentation of distinctive flattened spines in irregular radial rows. *L.Eoc.-Rec.*, Eu.-Am.-SW.Pac.——FIG. E23,*1*. **C. (C.) lazarus*, Rec., E.Indies; *1a-c*, RV ext., LV int., RV hinge, ×0.5 *(124b, 684)*.

C. (Cipliacella) VINCENT, 1928 [**Chama pulchra* RAVN, 1902; M] [=*Ciplyella* VINCENT, 1930 (obj.); *Cipleyella (nom. null.)*]. Attachment scar obscure; otherwise as in *C. (Chama)*. *Paleoc. (Dan.)*, Eu.

C. (Psilopus) POLI, 1795 [**Chama gryphoides* LINNÉ, 1758; M] [=*Psilopoderma* POLI, 1795 (obj.); *Psilotus, Psilopododerma (nom. null.)*]. Concentric sculpture of small, even, flat scales. *Rec.*, IndoPac.

Arcinella SCHUMACHER, 1817 [**Chama arcinella* LINNÉ, 1767; T] [not preoccupied by *Arcinella* OKEN, 1815, rejected ICZN, Opinion 417] [=*Echinochama* FISCHER, 1887 (obj.)]. Shell attached in early growth stages only; ornamentation spinose. *Mio.-Rec.*, SE.USA-C.Am.-S.Am.——FIG. E23,*2*. **A. arcinella* (LINNÉ), Rec., Carib., *2a-c*, RV ext., LV, RV int., ×0.7 *(675, 684)*.

Pseudochama ODHNER, 1917 [**Chama cristella* LAMARCK, 1819; SD GARDNER, 1923]. Shell attached by RV. *Oligo.-Rec.*, tropics.

P. (Pseudochama). No *PII* in adult; nepionic shell with concentric sculpture only. *Oligo.-Rec.*, Medit.-C.Am.-SW.Pac.——FIG. E23,*3*. **P. (P.) cristella* (LAMARCK), Rec., E.Indies; LV ext., ×0.5 (Reeve, 1847).

P. (Eopseuma) ODHNER, 1919 [**P. (E.) pusilla*; M]. Small; nepionic shell with concentric and radial sculpture; *PII* persisting in adult. *Rec.*, E. Indies.

Superfamily LEPTONACEA Gray, 1847

[*nom. transl.* DALL, 1900 (*ex* Leptonidae GRAY, 1847)] [=Erycinacea FISCHER, 1887] [Materials for this superfamily prepared by ANDRÉ CHAVAN]

Marine, byssiferous, with three apertures in mantle—anterior (buccal), median (pedal), and posterior (anal); shell equivalve, commonly thin and more or less covered by mantle, with small resilium, indenting hinge plate or not, rarely with marginal ligament. Cardinal teeth commonly tubercular, contrasting with elongated laterals and partly atrophied by incomplete individualization of tooth *1;* hinge, therefore, para-

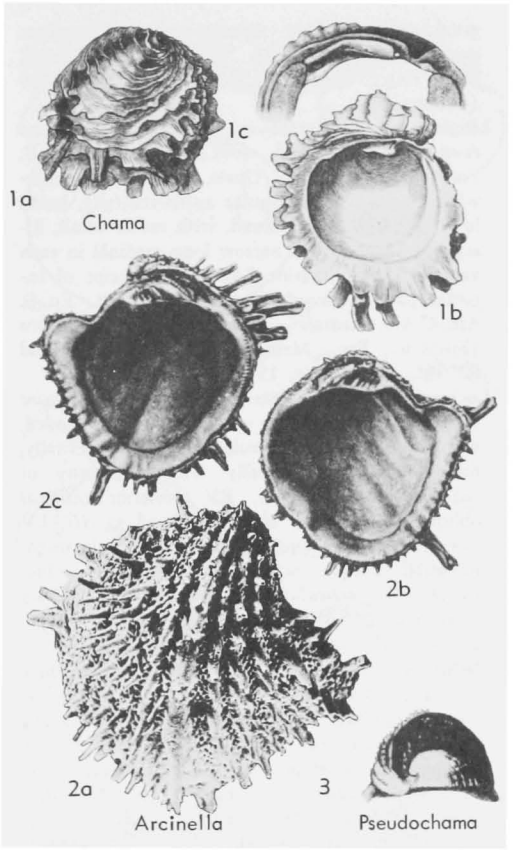


FIG. E23. Chamidae (p. *N*518).

cyrenoid *(114)*. [Burrowing.] *?Cret., Paleoc.-Rec.*

The alphabetically arranged generic descriptions in each family-group division of the Leptonacea are accompanied by numbers inclosed by square brackets. Such numbers indicate position in the sequence of generic taxa given with the respective families or subfamilies for the purpose of recording CHAVAN's arrangement, designed to reflect "natural relationships" of these taxa as inferred by him.

Family ERYCINIDAE Deshayes, 1850

[=Laseadae GRAY, 1847]

Shell somewhat flattened; hinge plate indented under beaks, small, lucinoid; cardinals and laterals present on both valves, duplicate on RV in some; internal ligament in triangular, rather ill-bounded socket, its adjacent marginal part on small nymph in some forms. *Paleoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Erycina.*——2. *Hemilepton.*——3. *Scacchia.*——4. *Austroscintilla.*——5. *Lucinaxinus.*——6. *Goodalliopsis.*——7. *Amerycina.*——8. *Parvikellia.*——9. *Litigiella.*——10. *Lasaea.*——11. *Pythina*——12. *Melliteryx.*——13. *Myllita.*——14. *Zemyllita.*——15. *Myllitella.*——16. *Arthritica.*——17. *Semierycina.*——18. *Erycinopsis.* [Insert above, 12a. *?Clathroconcha.*]

Erycina LAMARCK, 1805 [**E. pellucida;* SD STOLICZKA, 1871] [=*Migonitis* RAFINESQUE, 1815 (obj.); *Eryx* SWAINSON, 1840 (obj.)]. Transversely elliptical or ovate, externally smooth or with faint radial striae. Anterior RV cardinal faintly developed, other ones trigonal; elongated laterals. Ligament extended backward. *Paleoc.-Plio., ?Rec.,* Eu.-?S.Afr.-N.Am.-C.Am.

E. (Erycina) [1]. Rather small and thin, transversely ovate to elliptical, commonly subequilateral, smooth or faintly striated radially. Hinge narrow; posterior LV cardinal small, but not minute, lamelliform narrow laterals parallel to margin. *Paleoc.-Mio.,* Eu.——FIG. E24,*1*. **E. (E.) pellucida,* Eoc.(Lutet.), France; *1a,b,* LV and RV hinges, ×4.8 (Chavan, n).

E. (Hemilepton) COSSMANN, 1911 (1912) [2] [**H. longifossula;* OD]. Subelliptical, smooth. Hinge

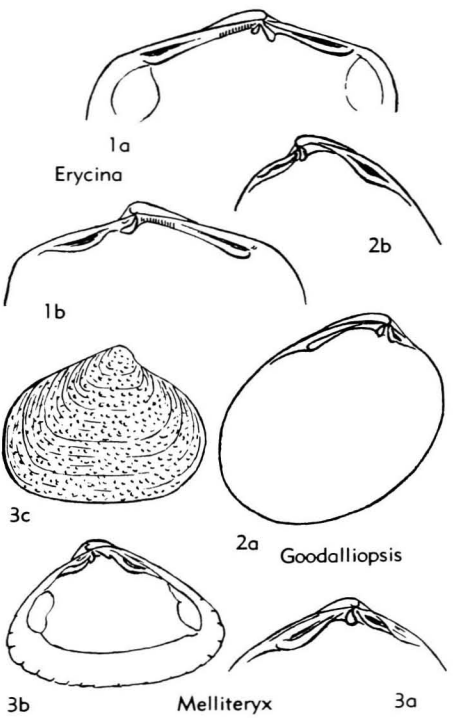


FIG. E24. Erycinidae (p. *N*519-*N*520).

stout, anterior RV cardinal in direct prolongation of elongated *AIII;* posterior RV and anterior LV obliquely trigonal; posterior LV very minute; posterior lateral stout and distant from ligament, much extended backward. *Eoc.-Plio., ?Rec.,* Eu.-N.Am.-C.Am.-?S.Afr.——Fig. E25,*8*. *E. (H.) longifossula,* Mio. (Aquitan.), France; *8a,b,* LV and RV hinges, much enl. (Cossmann, 1913).

Amerycina Chavan, 1959 [7] [**Erycina colpoica* Dall, 1913; OD]. Transversely elliptical, very inequilateral, wtih opisthogyrous beaks and anterior side by far longest, concentrically furrowed. Long anterior laterals; short posterior; in each valve, one trigonal somewhat bilobate cardinal; anterior right quite indistinct and posterior left narrow against well-defined resilium. *?Eoc., Mio.-Rec.,* N. Am.(Gulf Calif.)-W.C.Am.-S.Am.——Fig. E25,*7*. **A. colpoica* (Dall), Gulf Mexico; *7a,b,* RV and LV hinges, ×6 (Chavan, n).

Arthritica Finlay, 1927 [16] [**Kellia bifurca* Webster, 1908; OD]. Ovate, moderately flattened, smooth. Anterior RV and posterior LV cardinals indistinct; *2, 3b,* angular, small, in front of moderately short ligamentary hollow; laterals simple, remote, 2 diverging internal furrows. *Mio.-Rec.,* N.Z.——Fig. E25,*13*. **A. bifurca* (Webster); Rec., *13a,b,* LV int., RV hinge, ×7.2 (Chavan, n).

?Clathroconcha Coen, 1934 (12a) [**C. istriensis;* OD]. Small, slightly convex, inequilateral, anteriorly elongated; minute prosogyrous beaks. Sculpture of strong radial ribs, without any dichotomy, but crossed by concentric lamellae. RV hinge with elongate straight laterals and 2 median sockets, anterior one virguliform and deeper, posterior one trigonal, in front of both is one acute thin tooth (or socket's margin). Pallial line broadened; inner margin crenate. *Rec.,* Adriatic.

Goodalliopsis de Raincourt & Munier-Chalmas, 1863 [6] [**G. orbignyi* =*Erycina terminalis* Deshayes, 1860; M]. Obliquely oblong, small; finely striated, very inequilateral, posterior side broadest. Anterior cardinals in prolongation of *AII* and *AIII*; *AI* rather long, posterior cardinals narrow, in front of oblique socket; posterior laterals strong, more elongate than anterior ones. *M.Eoc.,* Eu.——Fig. E24,*2*. **G. terminalis* (Deshayes), Lutet., France; *2a,b,* LV int., RV hinge, ×16 (Cossmann, 1913; *259*).

Lasaea Brown, 1827 [10] [**Cardium rubrum* Montagu, 1803; M] [=*Cycladina* Cantraine, 1835 (type, *C. adansoni*; SD Gray, 1847) (*non* Berthold in Latreille, 1827); *Lasea* Gray, 1842 (*nom. van.*) (obj.); *Anapa* Gray (type, *Poronia petitiana* Récluz, 1847); *Poronia* Récluz, 1843 (type, *P. adansoniana*; OD)]. Transversely rounded, minute, inflated, inequilateral, smooth, anterior side longest, beaks straight. Cardinals small, all (except *4b*) partly fused to anterior laterals, which duplicate on both valves; ligament interno-marginal, with minute narrow socket. *Eoc.-Rec.,* cosmop.——Fig. E25,*12*. **L. rubra* (Montagu), Rec., Eng.; *12a,b,* LV int., RV hinge, ×10 (Chavan, n).

Litigiella di Monterosato, 1909 [9] [**Erycina cuenoti* Lamy, 1908 (=*Lepton glabrum* P. Fischer, 1873); OD]. Ovate, inequilateral, somewhat produced and angular anteroventrally, beaks low, hinge plate flat, broad, with rather small, ill-separated laterals and narrow long cardinal in each valve in front of wide hollow for receipt of internal part of broad ligament. *Mio.-Rec.,* Eu.-S. Am.-C.Am.-Australia.——Fig. E25,*11*. **L. glabra* (Fischer), Rec., Medit.; *11a,b,* LV hinge and RV int., enl. (Lamy, 1908). [*?Eoc.,* S.Afr.]

Lucinaxinus Cerulli-Irelli, 1909 [5] [**Thyasira (L.) reticulata*; OD]. Subequilateral rounded, with high but not prominent beaks; externally, finely reticulated, laterally with dichotomy of radials. Hinge narrow, RV posterior cardinal oblique, LV anterior angularly fused to *AII,* LV posterior obscure; long marginal laterals; ligament in small oblique socket. *Mio.-Plio.,* Eu.——Fig. E25,*4*. **L. reticulatus* (Cerulli-Irelli), Italy (Calabr.); *4a,b,* LV hinge and RV int.; *4c,* LV ext., enl. (Cerulli-Irelli, 1909).

Melliteryx Iredale, 1924 [12] [**Erycina acupuncta* Hedley, 1909; OD]. Transversely trigonal; externally punctate. Small cardinals and strong laterals, posterior ones larger and duplicate; narrow ligamentary socket and marginal flattening. *Plio.-Rec.,* Japan-Australia.——Fig. E24,*3*. **M. acupuncta* (Hedley), Rec., Australia; *3a,b,* LV hinge and RV int.; *3c,* RV ext., ×3.2 (*365*; Hedley, 1909).

Myllita d'Orbigny & Récluz, 1850 [13] [**Erycina deshayesii* Récluz; OD]. Transversely subelliptical, rather broad, thick; divaricate strong curved ribs, small beaks. Cardinals well defined, RV anterior in prolongation of *AIII*; well-marked subparallel laterals, duplicate on RV, anterior ones longest; ligament internomarginal, with both socket and nymph. *Plio.-Rec.,* SW.Pac.-Australia.

M. (Myllita). Moderately transverse, thick, beaks not inflated. Both valves with well-developed cardinals and strong elongate laterals. *Plio.-Rec.,* SW.Pac. - Australia. —— Fig. E25,*9*. **M. (M.) deshayesii* d'Orbigny & Récluz, Rec., Australia; *9a,b,* LV int., RV hinge; *9c,* all ×4 (Chavan, n).

M. (Zemyllita) Finlay, 1927 [14] [**Pythina stowei* Hutton, 1877; OD]. Very transverse, with rounded beaks. Curved cardinals, only 1 well developed on each valve and short bent laterals. *Plio.-Rec.,* N.Z.-Australia.——Fig. E25,*6*. **M. (Z.) stowei* Hutton, N.Z.; *6a,b,* LV and RV hinges, ×5.2; *6c,* LV juv. ext., ×2.4 (Chavan, n).

Myllitella Finlay, 1927 [15] [**M. vivens*; OD]. Circular, with undulated divaricate ribs and con-

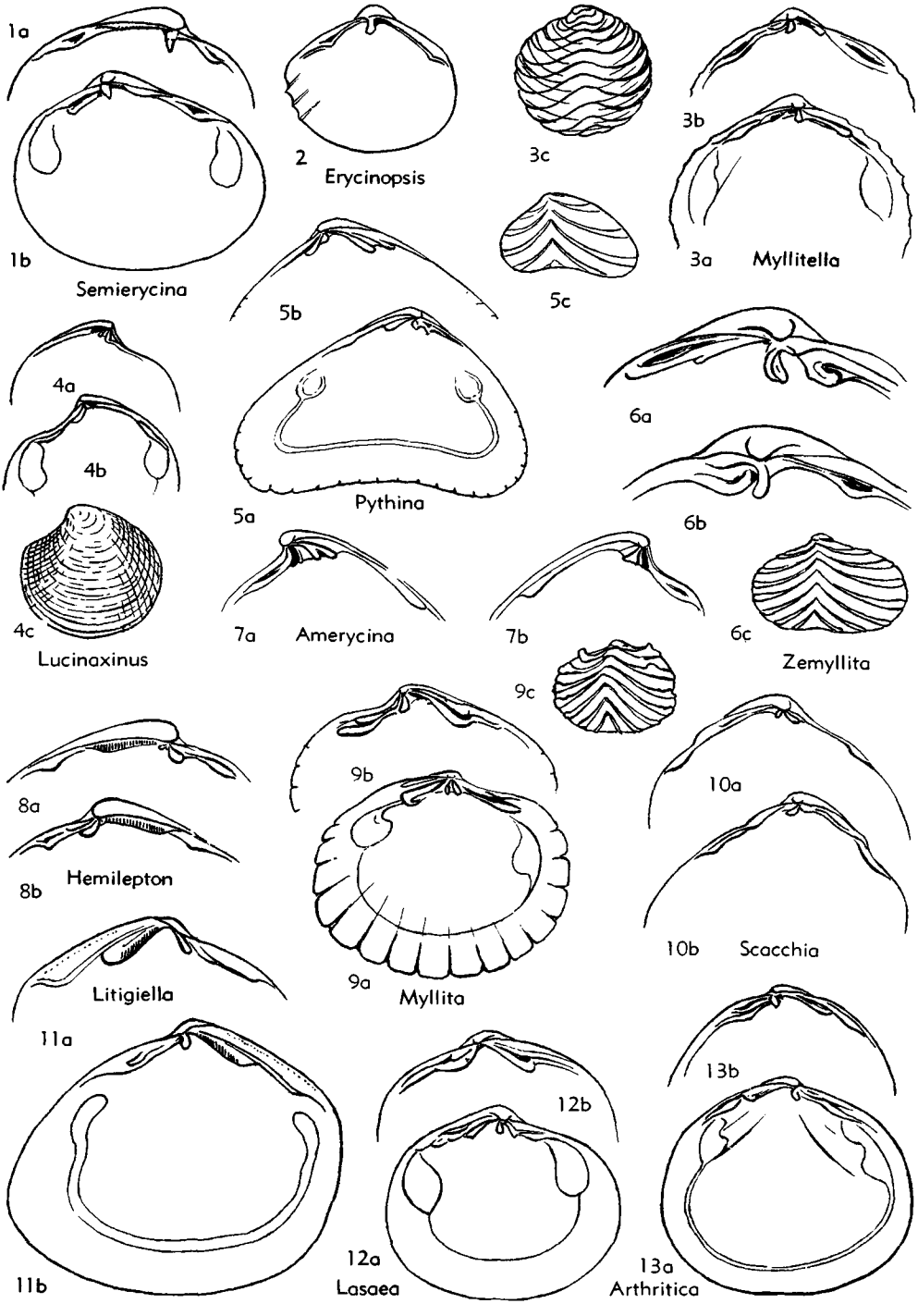


FIG. E25. Erycinidae (p. *N*519-*N*520, *N*522).

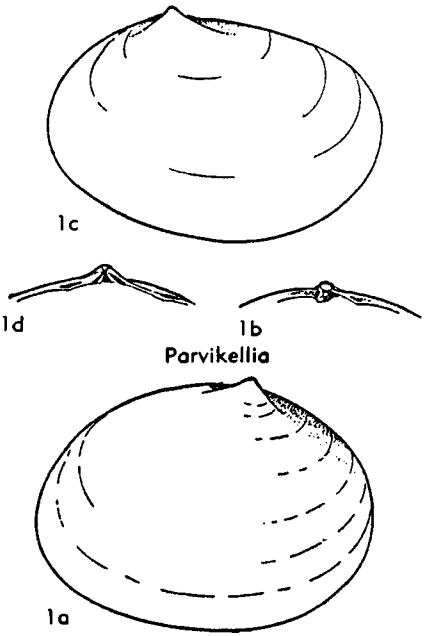


FIG. E26. Erycinidae (p. *N522*).

centric growths. Small cardinals and somewhat remote well-marked elongate laterals; hinge plate scarcely indented by internal part of ligament. *Oligo.-Rec.*, N.Z.——FIG. E25,*3*. **M. vivens*, Rec., N.Z.; *3a,b*, LV int., RV hinge, ×11; *3c*, LV ext., ×6.4 (Chavan, n).

Parvikellia LASERON, 1956 [8] [**P. isolata*; OD]. Oval, thin, polished, inflated; with faint growths. RV hinge with subumbonal resilifer, simple cardinal in front with slight hook, faint marginal anterior laterals, prominent posterior; LV hinge *(P. depressa)* with 2 narrow cardinals and 2 laterals, anterior one ascending toward beak as 3rd anterior cardino-lateral. *Rec.*, Australia.——FIG. E26,*1a,b*. **P. isolata; 1a,b*, RV ext., hinge, enl. (Laseron, 1956).——FIG. E26,*1c,d*. *P. depressa* LASERON; *1c,d*, LV ext., hinge, enl. (Laseron, 1956).

Pythina HINDS, 1844 [11] [**P. deshayesiana;* OD]. Transversely but irregularly trigonal, with divaricate ribs. Very small cardinals and somewhat strong short laterals, posterior ones duplicate on RV; narrow ligamentary hollow and marginal flattening. *U.Eoc.-Rec.*, Eu.-Asia.——FIG. E25,*5*. **P. deshayesiana*, Rec., Philip. Is.; *5a,b*, LV int., RV hinge; *5c*, LV ext., ×3.2 (Chavan, n).

Scacchia PHILIPPI, 1844 [**Tellina elliptica* SCACCHI, 1833 (*non* BROCCHI, 1814) (=**Loripes ellipticus* SCACCHI, 1836); SD GRAY, 1847]. Somewhat trigonal, smooth, inequilateral; anterior side longest. Cardinals rather small *(3b, 2, 4b)*, laterals simple, one on each side, rising apparently from under side of plate; ligament in oblong socket adjacent to well-marked nymph. *Eoc.-Rec.*, Eu.

S. (Scacchia) [3] Lateral teeth rather narrow and remote, cardinals small. *Eoc.-Rec.*, Eu.——FIG. E25,*10*. **S. (S.) elliptica* (SCACCHI), Rec., Medit.; *10a,b*, LV and RV int., ×6 (Cerulli-Irelli, 1909; Cossmann, 1913).

S. (Austroscintilla) KAUTSKY, 1939 [4] [**A. meieri*; OD]. Broad flat laterals, strong right posterior cardinal. *Mio.*, Eu.

Semierycina DE MONTEROSATO in COSSMANN, 1911 (1912) [**Lepton prismaticum* DI MONTEROSATO, 1878; OD]. Small, translucent, transversely subelliptical. Hinge with 1 cardinal developed on each valve, its lower part pointed; anterior approximate and posterior remote laterals. *Paleoc.-Rec.*, W.Eu.

S. (Semierycina) [17]. Shell more ovate and beaks farther forward than in *Erycinopsis*. *Mio.-Rec.*, Eu.——FIG. E25,*1*. **S. (S.) prismatica* (DI MONTEROSATO), Rec., Medit.; *1a,b*, LV and RV int., ×14.5 (Chavan, n).

S. (Erycinopsis) CHAVAN, 1959 [18] [**Erycina semipecten* COSSMANN, 1887; OD]. Trigonal-rounded, concentrically ribbed except on anterior radiated area. RV with strong laterals and 1 vertically projecting cardinal, in front of deep oblique cut. *Paleoc.-Eoc.*, Eu.(France).——FIG. E25,*2*. **S. (E.) semipecten* (COSSMANN), Eoc., France; RV int., ×5.5 *(160)*.

Family KELLIIDAE
Forbes & Hanley, 1848

[*nom. correct.* SOWERBY, 1862 (pro Kelliadae FORBES & HANLEY, 1848)]

Shell variable in convexity. Hinge plate indented under more or less prominent beaks, hinge paracyrenoid with obliquely trigonal cardinals, RV with *1* strongest, which is almost entirely differentiated from its origin, obliterating *3b*, LV with generally two unequal pointed cardinals, the anterior one *(2)* upward, posterior one downward; no distinctly elongate anterior laterals, but strong remote posteriors present. *Paleoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Kellia*.——2. *Pseudolepton*.——3. *Pseudokellya*.——4. *Aligena*.——5. *Radobornia*.——6. *Paraborniola*.——7. *Diplodontina*.——8. *Lasaeokellya*.——9. *Kaneoha*.——10. *Micropolia*.——11. *Cicatellia*.——12. *Pseudopythina*.——13. *Bornia*.——14. *Lionelita*.——15. *Borniola*.——16. *Byssobornia*.——17. *Scintillula*.——18. *Nesobornia*.——19. *Marikellia*.——20. *Mioerycina*. [Insert above, 4a. *Odontogena*.]

Kellia TURTON, 1822 [1] [**Mya suborbicularis* MONTAGU, 1803; SD RÉCLUZ, 1844] [=*Chironia* DESHAYES, 1839 (type, *C. laperousii*; M); *Oronthea* GRAY (*ex* LEACH, MS) 1852 (obj.)]. Ovate, slightly angular and strongly convex, with concentric striation. Cardinal *3a* in prolongation of *AIII, 1* stout and oblique, *2a* angular, curved, *2b* conical, pointed; strong posterior laterals; *PI, PII* and faint *PIII;* wide cut for ligament. *Eoc.-Rec.,* cosmop.——FIG. E27,*5*. **K. suborbicularis* (MONTAGU), Rec., Spain; *5a,b,* LV int., RV hinge, ×4 (Chavan, n).

Aligena LEA, 1846 (1843, *nom. nud.*) [**Amphidesma aequata* CONRAD, 1843 (=*A. striata* LEA, 1846); SD DALL, 1900]. Irregularly trigonal to quadrangular rounded, high, smooth. Hinge with small *3a,* stout *1,* curved *2a* in prolongation of anterior lateral, with small *2b* behind it; wide oblique ligament and single strong remote posterior lateral on each valve. *Mio.-Rec.,* Eu.-Afr.-N.Am.

A. (Aligena) [4]. Subvertically pointed, more or less virguliform right cardinal; posterior laterals of moderate strength. *Mio.-Rec.,* Eu.-?Afr.-N.Am. ——FIG. E27,*7*. **A. (A.) aequata* (CONRAD), Mio., USA(Va.); *7a,b,* LV and RV int., ×4 (Chavan, n).

A. (Odontogena) COWAN, 1964 [4a] [**A. (O.) borealis;* OD]. Oblique right cardinal, stronger posterior laterals. *Rec.,* N.Am.(W.Can.).

Bornia PHILIPPI, 1836 [**B. corbuloides* (=*Erycina corbuloides* BIVONA MS. in PHILIPPI); SD STOLICZKA, 1871 (=*Cyclas sebetia* COSTA, 1836)] [=?*Ceratobornia* DALL, 1899 (type, *B. (C.) longipes*=*Lepton longipes* STIMPSON, 1855; OD)]. Transversely trigonal to trapezoidal, slightly inequilateral, flattened, shining, smooth or with faint infra-externally placed radials, crenulating inner margin. *Paleoc.-Rec.,* cosmop.

B. (Bornia) [13]. Hinge with narrow oblique well-marked *1, 2a, 2b,* and traces of *AIII, AII* in front of them; short well-defined resilium and moderately strong *PI,* strong *PII,* traces of *PIII,* all closely behind ligament. *Paleoc.-Rec.,* Eu., N.Am.-S.Ind.O.——FIG. E27,*6*. **B. (B.) sebetia* (COSTA), Rec., Italy; *6a,b,* LV int., RV hinge, ×6.8 (Chavan, n).

B. (Borniola) IREDALE, 1924 [15] [**B. lepida* HEDLEY, 1906; OD]. Transversely elliptical, striated, inequilateral, with pointed beaks. *Rec.,* Australia.

B. (Byssobornia) IREDALE, 1936 [16] [**B. filosa* HEDLEY, 1902; OD]. Radial striae conspicuous on entire surface. Oblique cardinals and very short posterior laterals. *Rec.,* Australia.

B. (Lionelita) JOUSSEAUME, 1888 [14] [**L. lionelita* (=*Erycina denticulata* DESHAYES, 1855, var. *lionelita* JOUSSEAUME, 1888, in CHAVAN, 1953); OD]. Tooth *1* almost straight, terminating at right angle to its origin in *AI*; *3a* minute, but discernible; *2b* trigonal pointed; resilium oblique, with strong laterals behind it. *Rec.,* Ind.O.—— FIG. E27,*10*. **B. (L.) denticulata lionelita* (DESHAYES, 1855), Obock; *10a,b,* LV and RV int.; *10c,* RV ext., ×2.4 *(114)*.

Cicatellia LASERON, 1956 [11] [**C. indenta*; OD]. Transversely oval, small, somewhat inequilateral; ventral margin flexuous; broad, prosogyrous, inflated beaks; surface microscopically wrinkled. LV with conical median cardinal and 2 rather faint laterals, rounded protuberant prodissoconch. *Rec.,* Australia, *?Mio.-Rec.,* USA(Fla.).——FIG. E28,*3*. **C. indenta; 3a,b,* LV ext., hinge, enl. *(531)*.

Diplodontina STEMPELL, 1899 [7] [**D. tumbesiana;* M]. Transversely ovate, moderately broad, with concentric striae. LV showing trigonal bilobate cardinal, its posterior part smaller than on *Kellia;* short anterior lamina and broad oblique resilium with parallel thickening above it; posterior margin enlarged. *Rec.,* W.S.Am.——FIG. E27,*3*. **D. tumbesiana,* Peru; LV int., ×4 (Stempell, 1899).

Kaneoha DALL, BARTSCH & REHDER, 1938 [9] [**K. rosea*; OD]. Very small, rounded, smooth, somewhat inflated. *AI-1* and *3b* coalescent under marginal *AIII*; *2* hooked with long *AII,* not detached from it; stout resilium and rather long posterior laterals (duplicate on RV). *Rec.,* Hawaii.—— FIG. E27,*1*. **K. rosea*; *1a,b,* LV and RV hinge, ×32 (Dall, Bartsch & Rehder, 1938).

Lasaeokellya COSSMANN & PEYROT, 1911 (1912) [8] [**Kellia (L.) cestasensis*; OD]. Orbicular, subequilateral, slightly convex, with lamellar growths. RV with oblique *1,* fused to anterior side of *3b* into bifid inequilateral unit; resilium oblique, scarcely indenting inferior margin of plate; posterior laterals toothlike. *Mio.,* Eu.(France).—— FIG. E29,*2*. *L. cestasensis,* Burdigal, France; RV int., ×6.4 *(165)*.

Marikellia IREDALE, 1936 [19] [**Kellia solida* ANGAS, 1877; OD]. Transversely subquadrangular, solid, rather inflated, with irregular concentric lines, small beaks. Hinge broad, with stout trigonal *1* and *2b,* oblique ill-defined *2a* and *3a;* also somewhat oblique long resilium indenting hinge plate, posterior laterals strong. *Rec.,* E.Afr.-Australia. ——FIG. E27,*4*. **M. solida* (ANGAS), Australia; *4a,b,* LV and RV int., ×4 (Chavan, n).

Micropolia LASERON, 1953 [10] [**M. typica*; OD]. Minute, translucent, subtrigonal and subequilateral, smooth. LV hinge with tooth pointed backward and 2 bow-shaped laterals; RV with 2 elongated laterals. *Rec.,* Australia.——FIG. E28,*2*. **M. typica*; *2a-c,* LV ext., LV and RV hinges, enl. *(531)*.

Mioerycina KAUTSKY, 1939 [20] [**Erycina letochai* HOERNES, 1859; OD]. Transversely elliptical, sinuous in middle, almost equilateral. Hinge with short *1* and *2b; AIII-3a* and *2a-AII* being undifferentiated from margin while very small *3b* occurs behind top of *1;* oblique spoon-shaped resilium and long posterior laterals. *Mio.,* Eu.(Austria).

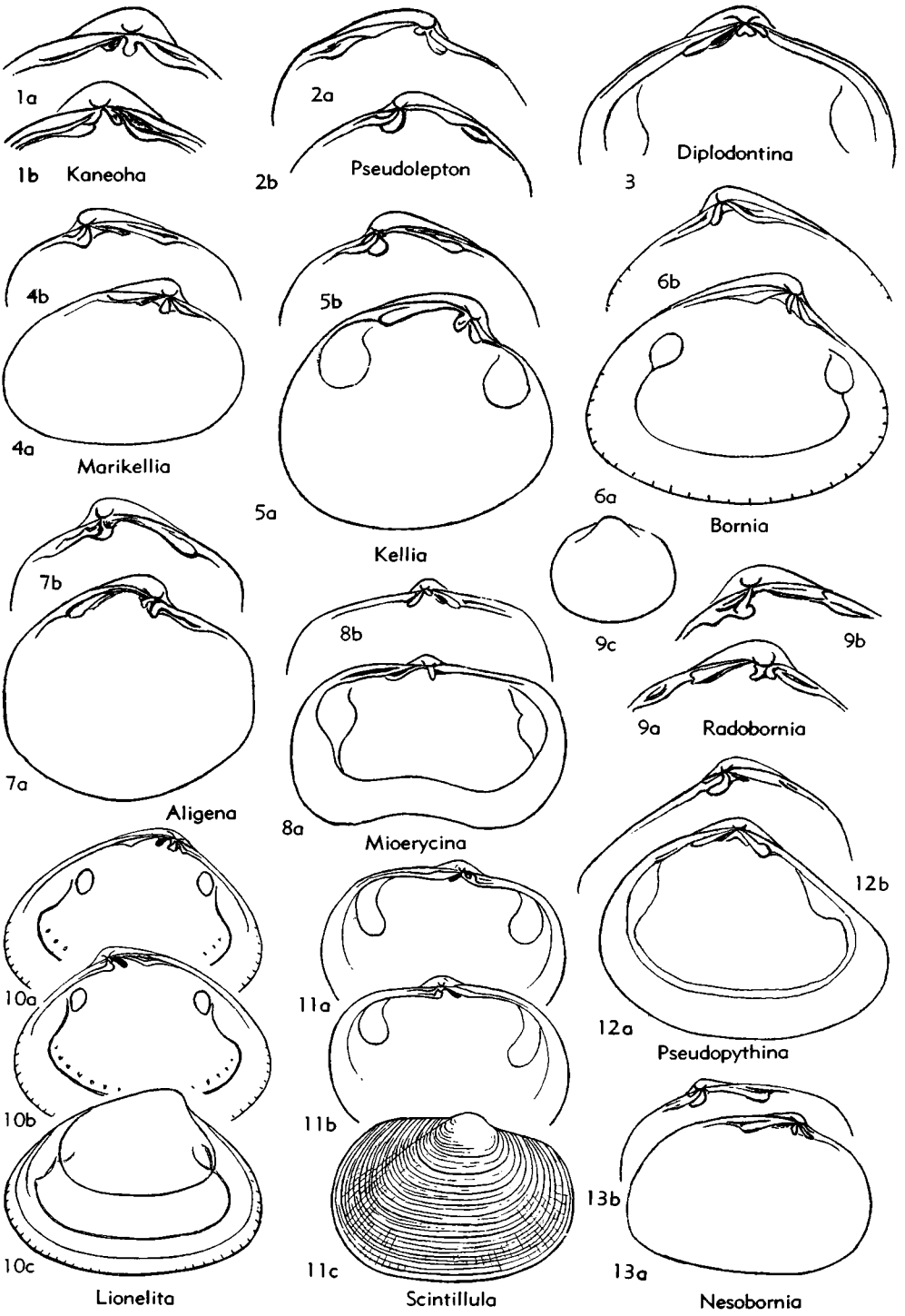


FIG. E27. Kelliidae (p. *N*523, *N*525-*N*526).

——Fig. E27,*8*. **M. letochai* (Hoernes), M.Mio., Austria; *8a,b*, LV int. and RV hinge, enl. *(456)*.

Nesobornia Dall, Bartsch & Rehder, 1938 [18] [**N. bartschi* Chavan, herein (*pro Erycina (Poronia) ovata* Gould, 1850, *non* Gray, 1825, *nec* Philippi, 1836)]. Subtrapezoidal rounded, somewhat inequilateral, obliquely elongated backward, shining and smooth; beaks pointed with 2 small cardinals on each valve: *3a, 1, 2a, 2b*, with faint short anterior prolongations of the former and somewhat backward produced resilium, posterior laterals well-marked. *?M.Eoc.-Rec.*, Hawaii-E.Afr. ——Fig. E27,*13*. **N. bartschi* Chavan, Rec., Hawaii; *13a,b*, LV int. and RV hinge, ×3.2 (Chavan, n).

Pseudokellya Pelseneer, 1903 [3] [**Kellia cardiformis* E. Smith, 1885; OD]. Globular, high, thin, with radial riblets; beaks inflated. Hinge very narrow, LV with 2 small cardinals in prolongation of short anterior lateral thickening and RV with single cardinal, then ligamentary cut and posterior thickening. *Rec.*, Antarctic.——Fig. E29,*1*. **P. cardiformis* (Smith); LV int., ×4.8 *(852)*.

Pseudolepton Cossmann, 1895 [2] [**Lepton insigne* Mayer in Hörnes, 1864; OD]. Subquadrangular to ovate, with diverging striae or granular laminae. Hinge with *3a, 3b*, oblique *2a, 2b* poorly developed; remote posterior laterals *PI, PII. Mio., ?Rec.*, Eu.-?S.Afr.——Fig. E27,*2*. **P. insigne* (Mayer), Mio., Aus.; *2a,b*, LV and RV hinges, enl. (Cossmann, 1913; *456*).

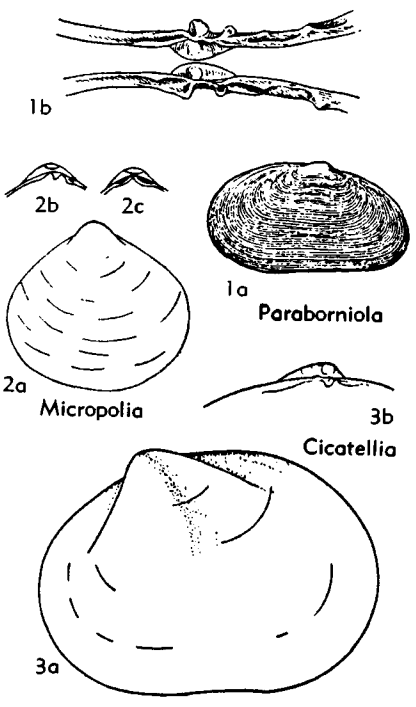


Fig. E28. Kelliidae (p. *N523*, *N525*).

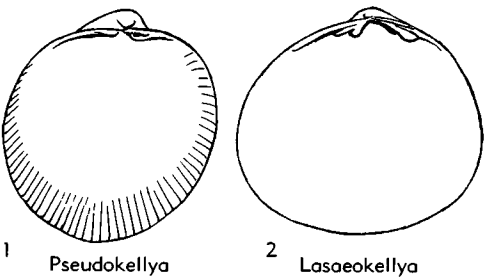


Fig. E29. Kelliidae (p. *N523*, *N525*).

Pseudopythina P. Fischer in di Monterosato, 1884 [12] [**Kellia macandrewi* Fischer, 1867 =*Coralliophaga setosa* Dunker, 1864; M] [=*?Borniopsis* Habe, 1959 (type, *B. tsurumaru;* OD)]. Transversely trigonal, very inequilateral, anteriorly attenuated and elongate; enlarged and rounded backward, smooth. No anterior prolongation of *1, 2* oblique and well marked; *3a* small, *2b* minute; with oblique short resilium and nymph; posterior laterals just behind them, short, placed marginally. *Plio.-Rec.*, W.Eu.-NW.Pac.——Fig. E27,*12*. **P. setosa* (Dunker), Rec., Portugal; *12a,b*, LV int. and RV hinge, ×6.8 (Chavan, n).

Radobornia Dall, Bartsch & Rehder, 1938 [**R. araia*; OD]. Transversely rounded, inequilateral, beaks rather prominent; RV with small laminar *3a* and strong hooked *1*, LV with curved *2a-AII* and curved approximate *2b*, each valve with one remote lamellar posterior lateral; long internal resilium and marginal nymph. *Rec.*, Hawaii.

R. (Radobornia) [5]. Transversely ovate, thin, externally punctate; ventral margin rounded. *Rec.*, Hawaii.——Fig. E27,*9*. **R. (R.) araia* Dall, Bartsch & Rehder; *9a,b*, LV and RV hinges, ×2.8; *9c*, LV ext., ×1.6 (Dall, Bartsch, and Rehder, 1938).

R. (Paraborniola) Habe, 1958 [6] [**P. matsumotoi*; OD]. Transversely elongate, ventral margin straight. Hinge as in *R. (Radobornia)* with *2a* thinner and *2b* strongly trigonal. *Rec.*, Japan. ——Fig. E28,*1*. **R. (P.) matsumotoi* (Habe); *1a,b*, RV ext., hinges, ×1 *(388)*.

Scintillula Jousseaume, 1888 [17] [**S. scintillula*; OD]. Transversely subelliptical almost equilateral, inflated, slightly enlarged backward, finely striated. Hinge with marginal *3a*, slightly continued by *3b* above and behind hooked trigonal *1*, itself in prolongation of *AI*; similarly hooked *2a-AII* followed by tubercular small *2b* on opposite valve; and, perhaps, also minute *4b*; oblique short re-

silium and much elongated faint posterior laterals. *Rec.*, Ind.O.——Fig. E27,*11*. **S. scintillula*, Obock; *11a,b*, LV and RV int.; *11c*, RV ext., ×4 *(114)*.

Family LEPTONIDAE Gray, 1847

Shell commonly compressed; hinge plate not or scarcely indented by resilium, under very small beaks. Paracyrenoid hinge of nepionic appearance, oblique strongest cardinals (right *1* and left *2a*) being not separated from their anterior original lamellae *(AI, AII)*, elongating in front of them. Posterior laterals only slightly longer than anteriors. Pallial line irregular and distant from ventral margin. *?Cret., Paleoc.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Lepton*.——2. *Planikellia*.——3. *Divarikellia*.——

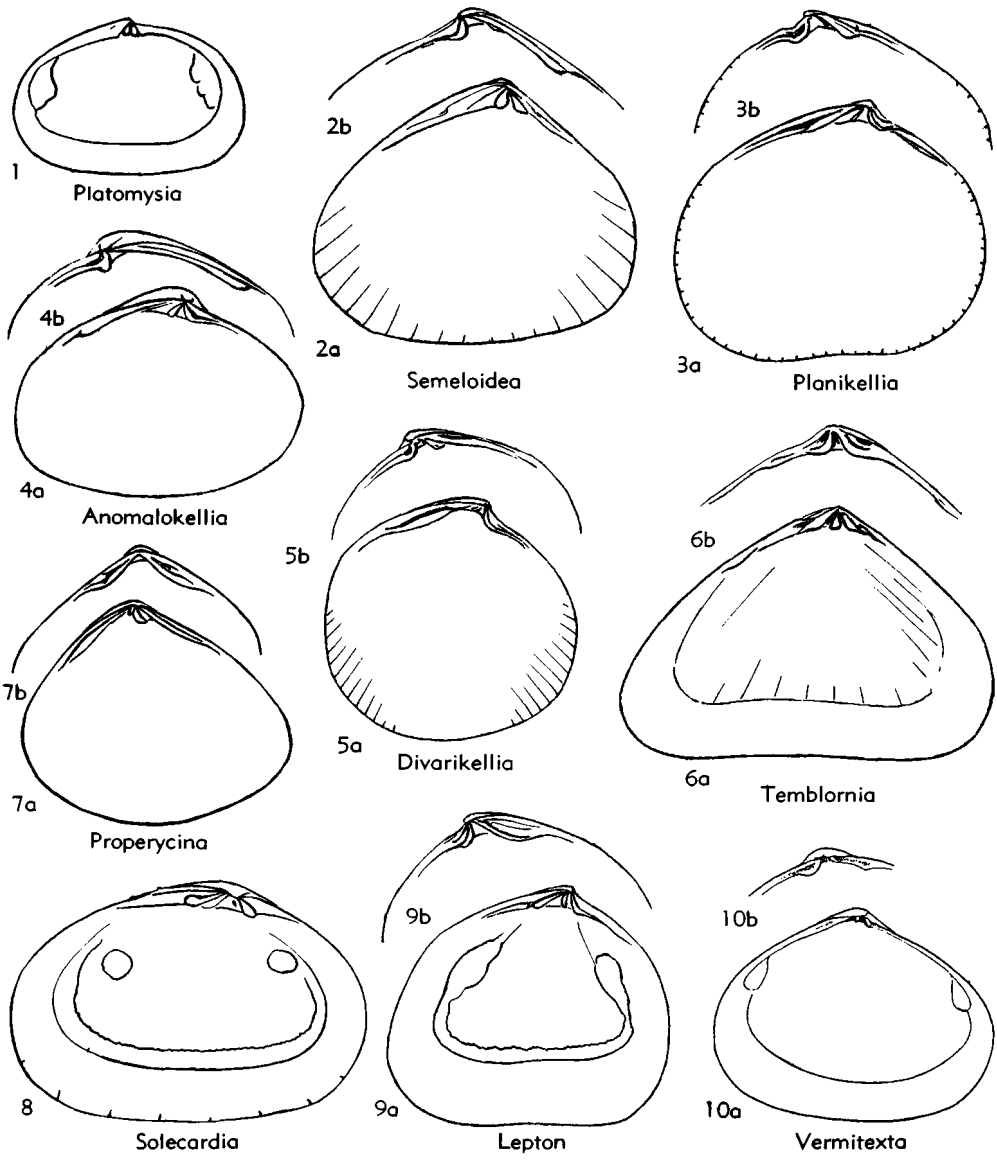


Fig. E30. Leptonidae (p. *N527*).

4. *Vermitexta.*——5. *Anomalokellia.*——6. *Platomysia.*——7. *Semeloidea.*——8. *Temblornia.*——9. *Solecardia.*——10. *Properycina.*——11. *Potidoma.*

Lepton TURTON, 1822 [**Solen squamosus* MONTAGU, 1803; SD HERRMANNSEN, 1846] [=*Eupoleme* GRAY (*ex* LEACH, MS), 1852 (obj.)]. Ovate-subquadrangular, flattened. Hinge with 2 narrow cardinals on each valve, of which anterior ones *(1, 2a)* are gradually strengthened straight from anterior small crest; *3a* very oblique; *4b* narrow, both small and thin; resilium broad and trigonal; posterior laterals (duplicate on right) just behind and above it, lamellar. *?Cret., Eoc.-Rec.,* W.Eu.-W.N.Am.

L. (Lepton). [1]. Ovate, with slight oblique truncation; punctate. Hinge with elongate laterals and *4b* almost vertical. *?Cret., Eoc.-Rec.,* Eu.——FIG. E30,9. **L. (L.) squamosum* (MONTAGU), Rec., Ireland; *4a,b,* LV int. and RV hinge, ×4 (Chavan, n).

L. (Divarikellia) COSSMANN, 1887 [3] [**Erycina nitida* CAILLAT, 1834; OD]. Ovate-rounded, with divaricate riblets. Anterior laterals inflexed, but moderately long, *4b* obscure, elongate posterior laterals. *Eoc.,* W.Eu.——FIG. E30,*5*. **L. (D.) nitidum* (CAILLAT), Lutet., France; *5a,b,* LV int. and RV hinge, ×6.4 (Chavan, n).

L. (Planikellia) COSSMANN, 1887 [2] [**Erycina radiolata* LAMARCK, 1805; OD]. Ovate-rounded, with radial striae. Short anterior laterals, inflexed at their strengthening into cardinals, *4b* oblique backward; stouter posterior laterals. *Eoc.,* W.Eu.——FIG. E30,*3*. **L. (P.) radiolatum* (LAMARCK), Lutet., France; *3a,b,* LV int. and RV hinge, ×4.8 (Chavan, n).

Anomalokellia COSSMANN, 1887 [5] [**Erycina catalaunensis* COSSMANN, 1883; M]. Transversely ellipticotrigonal, small, with concentric striae. Hinge with marginal faint *AIII-3a,* stout angular *AI-1,* thinner angular *AII-2a* and subsymmetric oblique *4b*. Stout angular resilium; remote laterals. *Paleoc.,* Eu.(France).——FIG. E30,*4*. **A. catalaunensis* (COSSMANN), Thanet., France; *4a,b,* LV int. and RV hinge, ×6.4 (Cossmann, 1913).

Platomysia HABE, 1951 [6] [**P. rugata*; OD]. Transversely subelliptical, with concentric regular undulations; 2 small cardinals, anterior one prolonged by marginal small crest. *Rec.,* Japan-N.Atl.-?N.Sea.——FIG. E30,*1*. **P. rugata*; LV int., ×0.8 *(365)*.

Properycina CERULLI-IRELLI, 1908 [**P. mariana;* OD]. Subtrigonal to ovate, with small beaks. Long subsymmetrical anterior laterals and only 1 oblique cardinal *(4b)* distinct from anterior and posterior laterals (both duplicate on right valve). Tooth *1* almost undifferentiated from *AI. M.Eoc.-Rec.,* W. Eu.-Atl.-Medit.

P. (Properycina) [10]. Anterior and posterior margins oblique; *4b* quite distinct, laterals almost straight. *U.Eoc.-U.Plio.,* W.Eu.——FIG. E30,*7*. **P. (P.) mariana,* Calabr., Italy; *1a,b,* LV int. and RV hinge, enl. (Cerulli-Irelli, 1909).

P. (Potidoma) DEROUX, 1961 [11] [**Lepton subtrigonum* FOLIN & PERRIER (*ex* JEFFREYS MS), 1873; OD]. Anterior and posterior margins nearly horizontal, *4b* appressed against anterior cardinolateral *2-AII;* laterals sinuate. *M.Eoc.-Rec.,* W. Eu.-Atl.-Medit.

Semeloidea BARTRUM & POWELL, 1928 [**S. donaciformis*; M]. Trigonal to subquadrangular, thin, with laterally, several radial riblets; LV with 2 well-marked cardinals, posterior one passing above top of anterior one, obliquely attenuated onward; 1 on RV prolonged angularly into small crest under elevated margin; curved, posterior laterals. *Eoc.-Rec.,* Medit.-N.Z.-C.Eu.

S. (Semeloidea) [7]. Hinge plate arched under resilium, *4b* posteriorly curved, *2* rather strong. Posterior laterals long. *Oligo.-Rec.,* Eu.-N.Z.——FIG. E30,*2a*. **S. (S.) donaciformis* BARTRUM & POWELL, Rec., N.Z.; LV int., enl. (Bartrum & Powell, 1928).——FIG. E30,*2b*. **S. (S.) geoffroyi* (PAYRAUDEAU), Rec., Medit.; RV hinge, ×4 (Chavan, n).

S. (Temblornia) KEEN, 1943 [8] [**Donax triangulatus* ANDERSON & MARTIN, 1914; OD]. Short cardinals and shallow small resilium, so that posterior laterals, just behind it, look like cardinals; hinge plate straight under resilium. *Eoc.-Plio.,* N.Am.-S.Am.——FIG. E30,*6*. **S. (T.) triangulata* (ANDERSON & MARTIN), Mio., USA (Calif.); *6a,b,* LV int. and RV hinge, ×7.8 (Chavan, n).

Solecardia CONRAD, 1849 [9] [**S. eburnea*; M]. Medium-sized, transversely elliptical, moderately convex, punctate, with crenulated margin, hinge with oblique cardinals, anteriorly differentiated from short anterior crest; trigonal resilium and oblique short posterior laterals just above and behind it. *Plio.-Rec.,* N.Am.-E.Afr.——FIG. E30,*8*. **S. eburnea,* Rec., Mex.; LV int., ×2.4 (Chavan, n).

Vermitexta LASERON, 1956 [4] [**V. garrardi*; OD]. Nearly equilateral, small, slightly elongated anteriorly; translucent, thin, moderately inflated; sculpture of faint growths and of microscopic short radially arranged broken corrugations. Ligament small; small median cardinal and anterior one, prolonged into long marginal lateral; moderately long laminar posterior laterals. *?Eoc.,* Eu.; *Rec.,* Australia.——FIG. E30,*10*. **V. garrardi,* Rec., Australia; *10a,b,* LV int., RV hinge, enl. *(531)*.

Family MONTACUTIDAE Clark, 1855

Shell more or less convex, rounded, inequilateral; resilium in large defined hollow

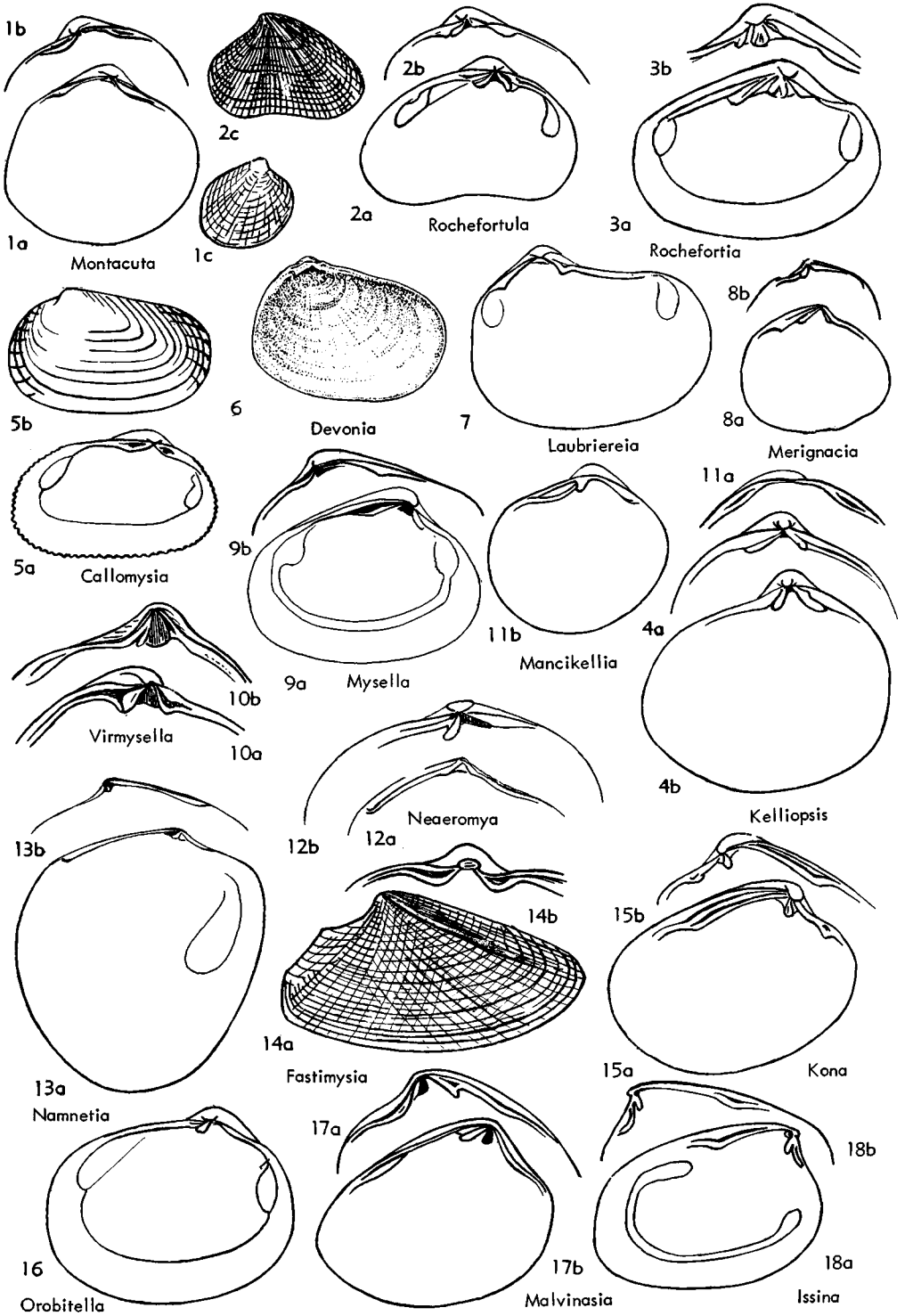


FIG. E31. Montacutidae (p. *N*529-*N*533).

or socket under beaks. Hinge with no true separated cardinals, but only thickened, generally subsymmetrical laterals, commonly bent up at their umbonal end so as to form distant toothlike hook, therefore no more than one pseudocardinal on each valve; posterior laterals commonly duplicate on one valve. *Eoc.-Rec.*

Generic arrangement by CHAVAN.——1. *Montacuta.*——2. *Devonia.*——3. *Entovalva.*——4. *Scioberetia.*——5. *Pythinella.*——6. *Tellimya.*——7. *Nipponomysella.*——8. *Laubriereia.*——9. *Namnetia.*——10. *Decipula.*——11. *Kelliopsis.*——12. *Fronsella.*——13. *Neaeromya.*——14. *Isorobitella.*——15. *Orobitella.*——16. *Axinodon.*——17. *Merignacia.*——18. *Montacutona.*——19. *Issina.*——20. *Kona.*——21. *Lasaeoneaera.*——22. *Virmysella.*——23. *Rochefortula.*——24. *Mysella.*——25. *Rochefortia.*——26. *Malvinasia.*——27. *Curvemysella.*——28. *Sphaerumbonella.*——29. *Mancikellia.*——30. *Pileatona.*——31. *Nipponomontacuta.*——32. *Fastimysia.*——33. *Thecodonta.*——34. *Pristes.* 35. *Barrimysia.*——36. *Callomysia.* [Insert above, 3a. *Conchentopyx;* 31a. *Tahunanuia.*]

Montacuta TURTON, 1822 [1] [**Ligula substriata* MONTAGU, 1808; SD HERRMANNSEN, 1846] [=*Sphenalia* S. WOOD, 1874 (obj.); *Coriareus* HEDLEY, 1907 (type, *C. vitreus;* OD); *Montaguia* BRONN, 1848 (obj.)]. Small, subquadrangular, rounded in front, truncated backward, inflated; with radial striae or distant riblets and concentric lamellar growths. Rounded prosogyrous beaks. Elongate laterals, more or less duplicate on right valve (upper margin scarcely differentiating into *AIII* and *PIII*); anterior ones stronger. Small resilium. *Eoc.-Rec.,* Eu.——FIG. E31,*1. **M. substriata* (MONTAGU), Rec., Britain; *1a,b,* LV int. and RV hinge, ×8; *1c,* RV ext., ×4 (Chavan, n).

Axinodon VERRILL and BUSH, 1898 [16] [**A. ellipticus* (=*Kellia symmetros* JEFFREYS, 1876); OD] [=*Kelliola* DALL, 1899 (obj.)[1]]. Ovately transverse, rounded, orthgyrous; LV hinge with rounded *2,* RV with tuberculiform ill-defined *1;* chondrophore oblique. *Rec.,* N.Am.-N.Atl.——FIG. E32,*7. *A. symmetres* JEFFREYS, USA(Mass.); *7a,b,* LV and RV hinges (Chavan, n).

[1] Identity of *K. symmetros* with *A. ellipticus* established by Dr. K. OCKELMANN.

Barrimysia IREDALE, 1929 [**Rochefortia excellens* HEDLEY, 1912; OD]. Very transverse, with striae crenulating inner margin. Two well-marked laterals, subsymmetrical on both sides of deep somewhat oblique resilium. *Rec.,* Australia-Japan.

B. (Barrimysia) [35]. Outline trigono-elliptical, nearly equilateral. *Rec.,* Australia.

B. (Callomysia) HABE, 1951 [36] [**C. matsuii*; OD]. Subquadrangular transverse, inequilateral, with concentric lines; also oblique riblets at lateral ends. *Rec.,* Japan.——FIG. E31,*5. *B. (C.) matsuii* (HABE); *5a,b,* LV int., ext., ×1.6 *(365).*

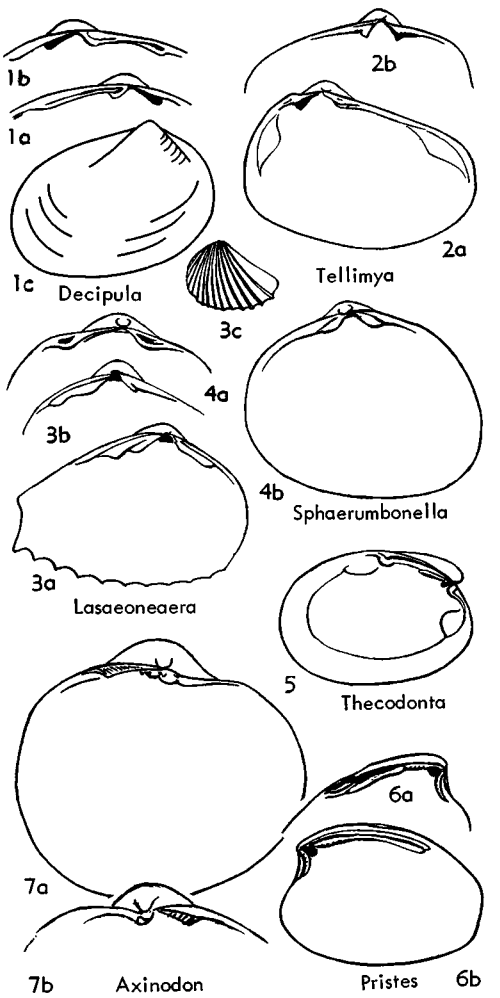


FIG. E32. Montacutidae (p. *N529-N530, N532-N533*).

Conchentopyx BARNARD, 1964 (3a) [**C. granulosa;* M]. Shell internal, semiovate, thin; umbo at anterior quarter; prodissoconch prominent, circular. Coarse growth lines and faint radial striae; inner margin smooth; hinge edentulous; no anal siphon. *Rec.,* S.Afr.

Curvemysella HABE, 1959 [27] [**Mysella paula* (=*Pythina paula* A. ADAMS, 1856); OD]. Transversely elongated, obliquely sloping at each end, with interior and posterior dorsal angulation; medially depressed. Hinge narrow, with lateral lamina on each side of resilial depression. *Rec.,* N. Australia-New Guinea-Japan.——FIG. E33,*1. *C. paula* (A. ADAMS), Japan; *1a,b,* RV ext., int., ×1 (Habe, 1959).

Decipula FRIELE, 1875 [10] [**D. ovata* (=**Montacuta tenella* LOVÉN, 1846); OD]. Transversely oval, thin, inequilateral; beaks low, orthogyrous; anterior side elongated. Long narrow anterior laterals, obliquely modified into right toothlike and left enlarged termination; triangular oblique resilium. *Plio.-Rec.,* Atl.-Medit.——FIG. E32,*1. *D. tenella* (LOVÉN), Rec., N.Sea; *1a,b,* RV and LV hinges; *1c,* LV ext., all enl. *(829).*

Devonia WINCKWORTH, 1930 [2] [*pro Synapticola* MALARD, 1904 (*non* VOIGHT, 1892)] [**Synapticola perrieri* MALARD, 1904; OD]. Transversely subquadrangular, very inequilateral, elongated onward and truncated at both sides. Hinge with a marginal ill-defined *AII* and, behind a broad resilial hollow, a strong *PII. Eoc.-Rec.,* W.Eu.——FIG. E31,*6. *D. perrieri* (MALARD), Rec., Britain (Devon); LV int., ×8.8 *(905a).*

?Entovalva VÖLTZKOW, 1890 [3] [**E. mirabilis;* M] [*?=Cycladoconcha* SPAERCK, 1932 (type, *C. amboinensis*; M)]. Like *Devonia* but shell completely internal, with more distinct teeth. *Rec.,* Zanzibar.

Fastimysia IREDALE, 1929 [32] [**Rochefortia viastellata* HEDLEY, 1909; OD]. Trigono-elliptical, very transverse, inequilateral, shortly sloping under beaks, then obliquely truncated; strongly acuminate at opposite side. Deep resilium in semielliptical socket just under beaks. Almost subsimilar elongated flexuous laterals on both sides. *Rec.,* Australia.——FIG. E31,*14. *F. viastellata* (HEDLEY); *14a,b,* LV ext., hinge, ×11.5 *(433).*

Fronsella LASERON, 1956 [12] [**F. adipata*; OD]. Transversely subquadrangular, to ovately transversal, moderately inflated, anterior side longer. Hinge narrow, bearing in each valve small anterior conical teeth, anterior margin somewhat laminar, and, after broad ligamentary indentation of plate, lamellar rather strong posterior lateral. *Rec.,* Australia-Japan.——FIG. E33,*4b,c. *F. adipata,* Australia; *4b,c,* LV ext. and hinge, enl. (Laseron, 1956).——FIG. E33,*4a. F. oshimai* HABE, Japan; LV hinge, enl. (Habe, 1958).

Issina JOUSSEAUME, 1898 [19] [**I. issina;* OD]. Subquadrangular, small, very inequilateral, posterior side much elongated. On each valve, 2 anterior laterals, marginal one curved, internal one shorter and pointed; and one long curved posterior lateral. Very narrow, but well-marked resilium. *Rec.,* Red Sea.——FIG. E31,*18. *I. issina; 18a,b,* LV int. and RV hinge, ×8 (Melvill & Standen, 1914).

Kelliopsis VERRILL & BUSH, 1898 [11] [**Montacuta elevata* STIMPSON, 1851; OD] Ovately rounded, inequilateral, anterior side longest. On each valve, anterior and posterior toothlike short stout lateral, prolonged by thickening of margin with small subtrigonal resilium between them. *Rec.,* Am.——FIG. E31,*4. *K. elevata* (STIMPSON), USA; *4a,b,* LV and RV int., enl. *(937).*

Kona DALL, BARTSCH & REHDER, 1938 [20] [**K. bucki*; OD]. Subelliptical, small inequilateral. Resilium stout and short, on well-developed shelf. On each valve single short subperpendicular cardinal-like process and 2 (anterior and posterior) unequal true laterals, both well marked. *Rec.,* Hawaii. ——FIG. E31,*15. *K. bucki*; *15a,b,* LV and RV int., ×8 (Dall, Bartsch, & Rehder, 1938).

Lasaeoneaera COSSMANN, 1913 [21] [**Corbula radiata* DESHAYES, 1824; M]. Moderately small, anteriorly rounded, posteriorly acuminated. Regular radial ribs, of which, on each valve, is an irregularly thick anterior lateral and, backward, an obliquely divided posterior one. *Eoc.,* Eu.(France). ——FIG. E32,*3. *L. radiata* (DESHAYES), Lutet., France; *3a,b,* LV and RV int., ×3.3; *3c,* LV ext., ×2.7 (Deshayes, 1837).

Laubriereia COSSMANN, 1887 [8] [**Erycina emarginata* DESHAYES, 1860; OD]. Small, trigonal-rounded to subquadrangular, very inequilateral, concentrically striated, anterior side much elongated. Narrow hinge with, on each valve, marginal long anterior lateral enlarged and bent into short, toothlike, additive one under the beak; also marginal posterior lateral. Between them, semicircular socket for resilium. *Eoc., ?Plio.,* W.Eu.——FIG. E31,*7. *L. emarginata* (DESHAYES), Lutet., France; LV int., enl. *(259).*

Malvinasia COOPER & PRESTON, 1910 [26] [**M. arthuri*; M]. Subtrigonal, small inequilateral, posterior side produced. On each valve, anterior long marginal lateral, accompanied by shorter oblique one, toothlike on right valve, hooklike and joined to marginal on left. Subperpendicular trigonal resilium and one sinuate posterior lateral. *Rec.,* Falkland Is.——FIG. E31,*17. *M. arthuri; 17a,b,* RV hinge and LV int., enl. (Chavan, n).

Mancikellia DALL, 1899 [29] [*pro Zoe* MONTEROSATO, 1878 (*non* PHILIPPI, 1840)] [**Zoe pumila* DI MONTEROSATO, 1878 (=*Montacuta pumila* S. WOOD, 1840); OD]. Small convex inequilateral rounded shell, anteroventrally enlarged. Hinge with well-marked laterals, anterior ones separated by broad socket from thickened margin and completed, under beak (in right valve only) by a stout toothlike termination; posterior laterals slightly shorter than anterior and separated from them by large oblique hollow resilifer. *Plio.-Rec.,* W.Eu.-Medit.——FIG. E31,*11. *M. pumila* (WOOD), Rec., S.Sea; *11a,b,* LV hinge and RV int., ×8 (Friele, 1886).

Merignacia COSSMANN, 1914 [17] [**Pseudolepton (M.) pleurodesmatoides* COSSMANN & PEYROT, 1914; OD]. Small, ovate-rounded, flattened, inequilateral, little longer anteriorly. Marginal sinuous anterior lateral on each valve and a toothlike hook appressed to it (stouter on the right). Superficial resilial socket. Moderately flat posterior lateral. Very dissymetric scars. *Mio.,* Eu.(France). ——FIG. E31,*8. *M. pleurodesmatoides* (Coss-

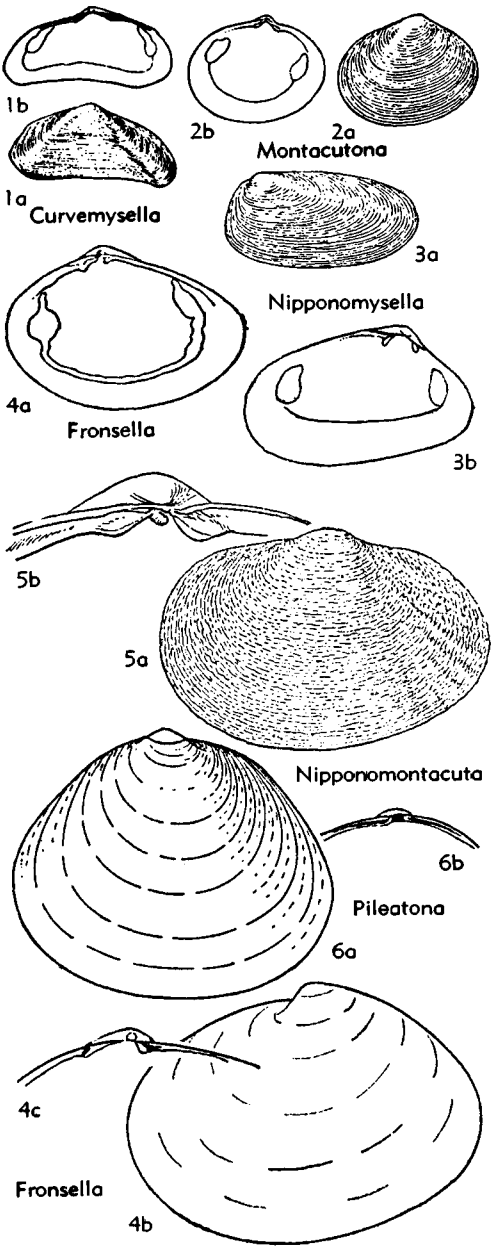


FIG. E33. Montacutidae (p. *N*529-*N*532).

MANN & PEYROT), Burdigal., France; *8a,b,* LV int. and RV hinge, enl. (Cossmann & Peyrot, 1914).

Montacutona YAMAMOTO & HABE, 1959 [18] [**M. mutsuwanensis*; OD]. Suborbicular, compressed, with polished surface, marked only by weak growths. Two solid diverging teeth and a resilial gap between them. Lateral hinge margins more or less thickened and lamellar. *Rec.,* Japan.——FIG. E33,*2*. **M. mutsuwanensis*; RV ext., int., ×4 (Habe & Yamamoto, 1959).

Mysella ANGAS, 1877 (Aug.) [**M. anomala*; OD] [=*Petricola* GRAY, 1825 (*non* LAMARCK, 1801) (type, *Mya bidentata* MONTAGU, 1803; SD GRAY, 1847, subj.)]. Transversely trigono-elliptical, inequilateral, shortened in front, obliquely elongate backward. Approximate concentric ribs. Well-marked laterals, posterior right strongest, anterior right marginal, *1* minute bordering it, *2* oblique and long. Prominent long chondrophore[1] and trigonal resilium. *Mio.-Rec.,* cosmop.

M. (Mysella) [24]. Resilium without crests; chondrophore obliquely elongate, *2* long under *fAI, 1* long, very thin and oblique more or less truncate at both ends. *Mio.-Rec.,* cosmop.——FIG. E31,*9*. **M. anomala,* Rec., Vict.; *9a,b,* LV int. and RV hinge, ×8 (Chavan, n).

M. (Rochefortia) [25] VÉLAIN, 1877 (post-Nov.) [?1878] [**R. australis*; M]. Resilium with crests as bifid tooth; chondrophore stouter and shorter, with minute crest at its top on RV; *I* subvertical and *AI* attenuated, thin; *2* almost marginal. More or less rounded at both ends. *Plio.-Rec.,* Ind.O.(St.Paul Is.)-Australia-N.Am.——FIG. E31, *3*. **R. australis* (VÉLAIN), Rec., St. Paul Is.; *3a,b,* LV int., RV hinge, much enl. (Vélain, mod.).

Namnetia COSSMANN, 1905 [9] [**N. discoides;* M]. Oblong-ovate, smooth, with flattened beaks and very small hinge plate. Marginal left curved and 2 right marginal and minute, infraumbonal anterior laterals. Restricted short resilium and, on each valve, long marginal posterior lateral. No nymph. Anterior adductor clublike. *Eoc.,* Eu. (France).——FIG. E31,*13*. **N. discoides,* Lutet., France; *13a,b,* LV int. and RV hinge, ×2.7 (Cossmann, 1905).

Neaeromya GABE, 1873 [**N. quadrata*; M]. Transversely subquadrangular to trigonal, finely striated. Right strong anterior laminar tooth and oblique posterior enlarged margin; oblique resilium between them; left thinner oblique anterior. *Mio.-Rec.,* C.Am.-N.Am.-Eu.

N. (Neaeromya) [13]. Subquadrangular, anterior side elongate, inequilateral. Right anterior tooth long, left anterior prolonged into margin. *Mio.-Rec.,* USA (Calif.)-C. Am.-Eu.——FIG. E31,*12*. **N. (N.) quadrata* GABB; *12a,b,* LV and RV hinges, ×2 (Pilsbry, 1921).

N. (Isorobitella) KEEN, 1962 [14] [**N. (I.) singularis*; OD]. Ovate-trigonal, subequilateral. Resilium less oblique than in *Orobitella,* being

[1] In such shells, the chondrophore (usually cited as *PI, PII*) functions also as posterior laterals, with its edge laminar and posterior part depressed (*PI, fPII*) in RV, the contrary in LV (*fPI, PII*) so that the other, remote, marginal true laterals may be given as *PIII* and *PIV*.

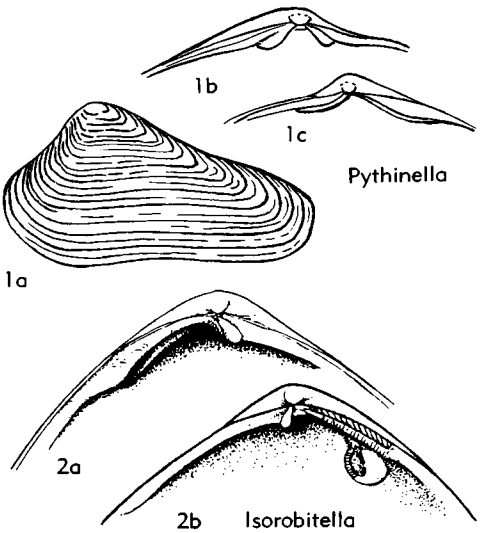


FIG. E34. Montacutidae (p. *N*531-*N*532).

almost parallel to the hinge margin, and showing a median ridge. No gap between the cardinal and the resilifer. *Rec.*, W.Mex.——FIG. E34, *2*. **N. (I.) singularis*; *2a,b*, LV, RV hinges, ×10 (Keen, 1962).

N. (Orobitella) DALL, 1900 [15] [**Montacuta floridana* DALL, 1899; OD]. Anterior margin broadly rounded, elongate, thus very inequilateral. Right laminar tooth rather small. *Mio.-Rec.*, N. Am.——FIG. E31,*16*. **N. (O.) floridana* (DALL), Rec., USA(Fla.); RV int., enl. (Dall, 1900).

Nipponomontacuta YAMAMOTO & HABE, 1961 [31] [**N. actinariophila*; M]. Transversely ovate, subequilateral, anterior end shorter and narrower; moderately convex. Sculpture of growth lines and of several anteroventral radial cords. LV hinge with 2 diverging teeth, posterior one stouter, resilifer between them; lateral margins enlarged, posterior groove for *PIII*. Rec., Japan.——FIG. E33,*5*. **N. actinariophila; 5a,b*, RV ext., LV hinge, enl. (Habe & Yamamoto, 1961).

?**Nipponomysella** HABE, 1959 [7] [**Montacuta oblongata* YOKOYAMA, 1922; OD]. Quite transversely inequilateral, donaciform, with growth lines. Looks like *Tellimya*, but hinge said to be edentulous in right valve and with two unequal cardinals in left. *Rec.*, Japan.——FIG. E33,*3a*. **N. oblongata* (YOKOYAMA); RV ext., ×3 (Habe, 1959). ——FIG. E33,*3b*. *N. obesa* HABE; LV int., ×7.5 (Habe, 1960).

Pileatona LASERON, 1956 [30] [**P. compressa*; OD]. Small, thin, translucent, subtrigonal, with nearly erect beaks and fine growths. Hinge with narrow subumbonal resilifer and 2 obscure subsymmetric laterals. *Rec.*, Australia.——FIG. E33,*6*. **P. compressa; 6a,b*, LV ext., hinge, enl. (Laseron, 1956).

Pythinella DALL, 1899 [5] [**Montacuta cuneata* VERRILL & BUSH, 1898; OD]. Transversely subtrigonal, very inequilateral, elongated posteriorly and attenuated at both sides. Orthogyrous beaks. Hinge with rather long and narrow right, shorter and stouter left, laterals. Resilium restricted to the upper part of a wide arch under the beaks. *Rec.*, N.Am.——FIG E34,*1*. **P. cuneata* (VERRILL & BUSH), Cape Hatteras; *1a-c*, LV ext., hinges, ×11.3 *(937)*.

Rochefortula FINLAY, 1927 [23] [**Rochefortia reniformis;* SUTER, 1909; OD]. Transversely subtrigonal, rounded and sinuate ventrally, ornamented by concentric ribs, regularly crossed by concentric striae. Prosogyrous moderately high beaks. Trigonal well-defined resilium; left anterior and posterior laterals subsymmetric; right anterior oblique, the posterior somewhat remote. *Mio.-Rec.*, Australia-N.Z.-S.Atl.——FIG. E31,*2*. **R. reniformis* (SUTER), N.Z.; *2a,b*, LV int. and RV hinge, ×11.5; *2c*, LV ext., enl. (Chavan, n).

?**Scioberetia** BERNARD, 1895 [4] [**S. australis*; M]. Subcircular, inequilateral, very minute; several crenulations on margin before and behind resilial socket. *Rec.*, S.Am.-Antarctica.

Sphaerumbonella COEN, 1933 [28] [**S. brunellii*; OD]. Ovate, globose, thick, slightly truncated laterally. Rounded beaks. Two short strong subsymmetric right laterals, anterior and posterior, on enlarged margin and on both sides of oblique deep socket. On left valve more internally placed laterals under sockets of right ones. *Rec.*, Red Sea. ——FIG. E32,*4*. **S. brunellii*; *4a,b*, LV and RV int., both enl. (Coen, 1933).

Tahunanuia POWELL, 1952 [31a] [**T. alata;* OD]. Thin, trapezoidal, very inequilateral, anteriorly short and rounded, posteriorly broadened and truncated. Irregular distant concentric waves. Hinge with single tooth in each valve, right one subvertically projecting, left one subhorizontally curved. Oblique broad resiliifer. Slight radial ridge bordering inner margin of both scars. *Rec.*, N.Z.

Tellimya BROWN, 1827 [6] [**Mya ferruginosa* MONTAGU, 1808; SD GRAY, 1847] [=*Tellinomya* AGASSIZ, 1846 *(emend.)*]. Shell subelliptical, very inequilateral, elongated and attenuated onward, shortly truncated backward. Externally striated. Slightly opisthogyrous beaks, under which lies small deep resilial socket. Oblique anterior laterals, right one long, attenuated, subhorizontal, left one shorter and more oblique. Short, strong, almost vertical resilium. *Mio.-Rec.*, W.Eu.-Am.—— FIG. E32,*2*. **T. ferruginosa* (MONTAGU), Rec., USA(Mass.); *2a,b*, LV int. and RV hinge, ×4 (*937* mod., and Chavan, n).

Thecodonta A. ADAMS, 1864 [**T. sieboldi*; M]. Transversely rounded, convex, very inequilateral, posterior part much elongated. Beaks prosogyrous. Sculpture concentric. Anterior left lateral curved,

gradually increasing subparallel to margin, then straightened along oblique resilium. Posterior laterals remote, thickened. *Rec.*, W.Pac.-E.Pac.

T. (Thecodonta) [33]. Obliquely elongate, with projecting beaks. Anterior LV lateral strengthened at right angle along small resilium, posterior laterals unequally remote. *Rec.*, W.Pac.——Fig. E32,*5*. **T. (T.) sieboldi* Adams, Japan; LV int., ×4.5 (Chavan, n).

T. (Pristes) Carpenter, 1864 (*non Pristis* Latham, 1794) [34] [**Pristes oblonga* Carpenter, 1864; OD] [=*Pristiphora* Carpenter, 1866 (*non* Blanchard, 1835); *Serridens* Dall, 1899]. More transverse than oblique, with scarcely projecting beaks and arcuate anterior, transversely serrated, laterals; duplicate subparallel left posteriors. *Rec.*, E.Pac.——Fig. E32,*6*. **T. (P.) oblonga* (Carpenter), USA(Calif.); *6a,b*, LV hinge and RV int., ×9 (Chavan, n).

Virmysella Iredale, 1930 [22] [**V. spernax*; M]. Trigono-elliptical, rather flattened, solid, inequilateral, small. Externally sculptured by alternating concentric lines and growths. A deep trigonal socket bordered anteriorly by laminar bent left and hooklike right lateral; posteriorly, by single right and 2 left ones. *Rec.*, Australia-Alaska-N.Eu.——Fig. E31,*10*. **V. spernax*; *10a,b*, LV and RV hinges, ×6 (Iredale, 1930).

Family GALEOMMATIDAE Gray, 1840

[*nom. correct.* Dall, 1899 (*pro* Galeommidae Gray, 1847)] [=Galeommidii Gray, 1840]

Shell slightly convex or flattened, commonly transverse, irregular or gaping. Resilium ill-defined, accompanied by marginal ligament. Hinge irregular, with small to quite minute, tuberculiform cardinals, hooking or projecting at termination of flexuous somewhat obscure laterals, and crossing themselves from one valve to another around resilium, in more or less cyclodont disposition. *U.Eoc.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Galeomma*.——2. *Paralepida*.——3. *Amphilepida*.——4. *Galeommella*.——5. *Libratula*.——6. *Ephippodonta*.——7. *Ephippodontoana*.——8. *Ephippodontina*.——9. *Thyreopsis*.——10. *Levanderia*.——11. *Lactemiles*.——12. *Scintilla*.——13. *Cymatioa*.——14. *Ambuscintilla*.——15. *?Scintillorbis*.——16. *Spaniorinus*.——17. *Scintillona*.——18. *Barclaya*.——19. *Leiochasmea*.——20. *Achasmea*.——21. *Passya*.——22. *Phlyctaenachlamys*.——23. *Turquetia*.——24. *Cyamionema*.——25. *Vasconiella*.——26. *Divariscintilla*. [Insert above, 3a. *?Uncidens;* 9a. *Aclistothyra;* 9b. *Coleoconcha;* 27. *Tryphomyax*.]

Galeomma Sowerby in Turton, 1825 [1] [**G. turtoni* Sowerby, 1825; SD Gray, 1847] [=*Parthenope* Scacchi, 1833 (type, *P. formosa*; OD); *Hirudinaria* Scacchi, 1833 (type, *H. alba*; M)]. Irregularly quadrangular-transverse, thin, moderately inequilateral, gaping, externally finely radiated or smooth. Hinge margin straight or nearly so; beaks low with lateral thickenings on both sides, raised up at their infraumbonal junction, there crossed with tubercular very minute cardinal. Resilium inframarginal, oblique, small. *Rec.*, W.Eu.-Medit.

G. (Galeomma). Distorted, ventrally gaping; fine external ribs crenulating inner margin. Long narrow hinge plate with cardinals not distinctly separated from lateral thickenings. *Rec.*, W.Eu.-Medit.-W.Afr.——Fig. E35,*4*. **G. (G.) turtoni* Sowerby, Spain; *4a,b*, LV and RV int., ×4.8 (Chavan, n).

G. (Amphilepida) Dall, 1899 [3] [**G. politum* Deshayes, 1855; OD]. Transversely subelliptical, smooth, gaping. Dental process forming oblique T on right valve *(3a, 1, 3b)* and oblique M on left *(2b, 2a, All)*, set apart from enlarged laterals. Oblique resilium under sinuous nymph. *Rec.*, Ind.O.——Fig. E35,*11*. *G. (A.) obockense* Jousseaume, Obock; *11a,b*, LV and RV int.; *11c*, RV ext.; all ×4 *(114)*.

G. (Paralepida) Dall, 1899 [2] [**G. formosum* Deshayes, 1855; OD] [=*Lepirodes* P. Fischer, 1887 (obj.) (*non Lepyrodes* Guénée, 1854)]. Largely gaping, with faint radial riblets. Dental process on both sides of ligament, distinctly separated from lateral thickenings. *Rec.*, Australia-Japan.

Aclistothyra McGinty, 1955 [9a] [**A. atlantica;* OD]. Thin, nearly flat, broadly gaping; transversely semiovate, rounded at both ends. Minute granulations, no radial ornament. Hinge plate straight, slightly thicker medially, without developed teeth. External ligament. *Rec.*, USA(Fla.).

Ambuscintilla Iredale, 1936 [14] [**A. praemium*; M]. Short, broadly and ovately rounded, somewhat transverse, smooth. Small cardinal developed on each valve and short oblique resilium and nymph. Lateral processes thickened but not separated from margin. *Rec.*, Australia-?Ind.O.——Fig. E35,*5*. **A. praemium;* LV int., enl. *(436)*.

Barclayia A. Adams, 1875 [18] [**Scintilla incerta* Deshayes, 1863; M] [=*Barclaya* ?auctt., 1874, Zool. Rec., p. 184; *Barclaya* P. Fischer, 1887 *(err.)*]. Subtrapezoidal, almost subrectangular, somewhat inequilateral, ventrally moderately rounded. Sculptured by concentric lines and numerous radial riblets. On the left valve, 2 long laterals with sockets above them, subparallel to margin, separated by resilium and 2 minute tuberculiform cardinal teeth. *Rec.*, E.Afr.——Fig. E35, *8*. **B. incerta* (Deshayes), Réunion; *8a*, LV int., ×3.6; *8b*, RV ext., ×2.1 (Deshayes, 1863).

Coleoconcha Barnard, 1964 (9a) [**C. opalina;* M].

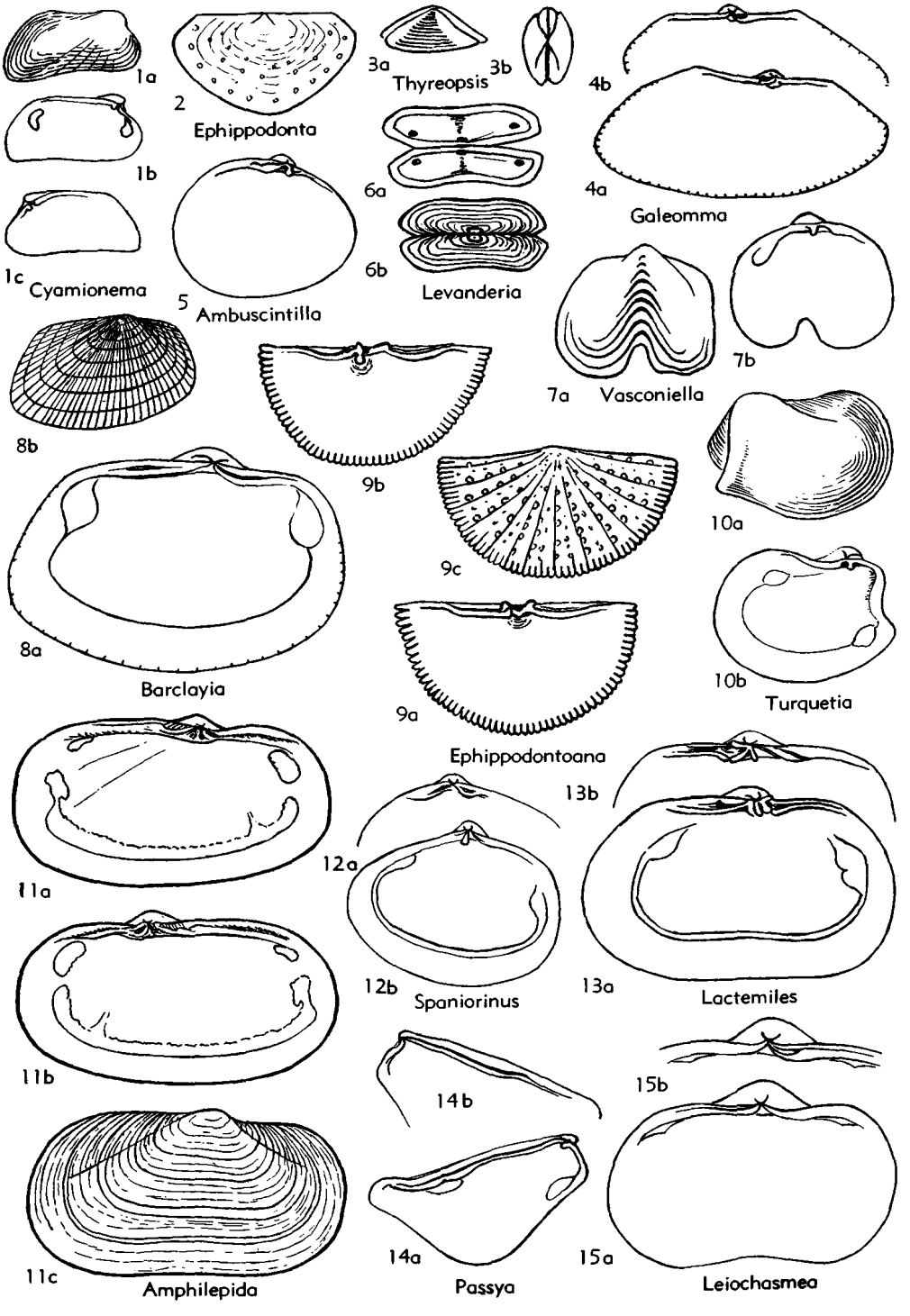


FIG. E35. Galeommatidae (p. *N533*, *N535-N537*).

Shell internal, transversely, rather narrowly semiovate, thin, translucent; umbo slightly in front of middle; prodissoconch prominent, subcircular. Concentric grooves only; tiny granules at both ends corrugating lateral surfaces and crenulating margins. Hinge line straight, very slightly thickened, edentulous; no adductors. *Rec.*, S.Afr.

Cymatioa BERRY, 1964 [13] [*pro Crenimargo* BERRY, 1963 (*non* COSSMANN, 1902)] [**Crenimargo electilis* BERRY, 1963; OD]. Shell resembling *Solecardia* in outline but surface microscopically punctate, with several low, ripple-like radial ribs making ventral margin gently crenate; adductor scars high, pallial line interrupted or dotlike, showing through shell; hinge in RV with small pointed cardinal tooth and long posterior lateral, ligament socket large; hinge of LV with thin anterior laterals, 2 small cardinals and pustular *PII*. *Rec.*, W. C. Am.-Red Sea.——FIG. E36,*6*. **C. electilis* (BERRY); *6a,b*, RV and LV hinges, ×8 (Berry, 1964); *6c*, *C.* sp., Red Sea; LV int., ×3.3 (Chavan, n).

?Cyamionema MELVILL & STANDEN, 1914 [24] [**Cyamiun (C.) decoratum*; M]. Papyraceous, quadrangular, upper and ventral margins subparallel; anterior side short and rounded, posterior end obliquely truncated. Lirate on ventral region. Two minute conical right teeth, one more prominent left, and no separated laterals. Ligament external, elongate. *Rec.*, S.Atl. (Falkland Is.).—— FIG. E35,*1*. **C. decoratum*; *1a*, RV ext.; *1b,c*, LV and RV int., all ×2.8 (Melvill & Standen, 1914). [?Sportellid.]

Ephippodonta TATE, 1889 [**Scintilla? lunata* TATE, 1887; SD MITCHELL, 1890]. Semielliptical, laterally angular, most extended not far from straight hinge margin, ventrally rounded. Externally striated, papillose or reticulated. Ligament bounded on each side by obtuse tooth with bifid crown and long laterals. *Rec.*, Australia.

E. (Ephippodonta) [6]. Almost semielliptical in outline, with symmetric sides. Hinge margin only slightly shorter than oblique diameter. Radial papillae only developed toward external margin. Inner margin plain. *Rec.*, Australia.——FIG. E35, *2*. **E. (E.) lunata* (TATE); RV ext., ×2.4 (Tate, 1889).

E. (Ephippodontina) KURODA, 1945 [8] [**E. (E.) murakamii*; OD]. Irregularly semielliptical hinge margin straight, noticeably shorter than angular diameter. Surface finely reticulated, hinge almost edentulous, with well-marked thickened laterals only. *Rec.*, Japan.——FIG. E36,*4*. **E. (E.) murakamii;* LV int., ×3.1 (Kuroda, 1945).

E. (Ephippodontoana) HABE, 1951 [7] [**E. macdougalli* TATE, 1889; OD]. Almost semicircular, hinge margin diametral. Radial papillae on whole surface, radial riblets indenting ventral margin deeply. *Rec.*, Australia.——FIG. E35,*9*. **E. (E.) macdougalli* TATE; *9a,b*, LV and RV int.; *9c*, RV ext., all ×4 (Chavan, n).

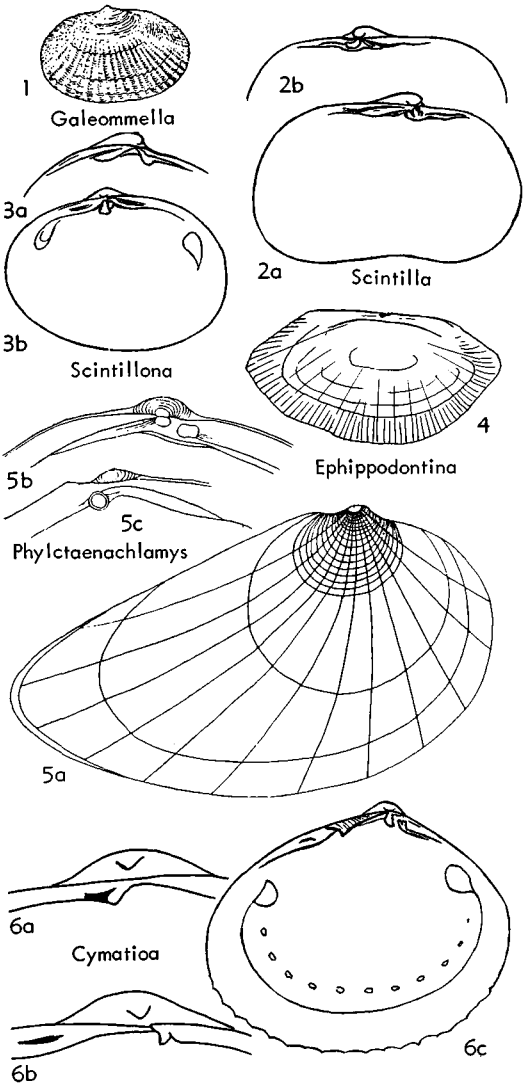


FIG. E36. Galeommatidae (p. *N535-N536*).

Galeommella HABE, 1958 [4] [**G. utinomii*; OD]. Ellipsoidal, moderately convex, not gaping; beaks small, elevated; radial ribs distinct, laterally weakened and less widely spaced than medially. Inner margin crenulated. *Rec.*, Japan.——FIG. E36,*1*. **G. utinomii;* RV ext., ×5 (Habe, 1958).

Lactemiles IREDALE, 1931 [11] [**Scintilla strangei* DESHAYES, 1856; OD]. Medium-sized, elliptical, thin, with shining surface ornamented only by faint striae. Tubercular short crossed cardinals: *3a, I, 3b*, forming T; *2a, 2b*, making inverted V,

prolonged by somewhat short lateral, parallel to margin. Oblique nymph and resilial socket. *Rec.*, Australia-Pac.——Fig. E35,*13*. **L. strangei* (Deshayes), Pac.; *13a,b*, LV and RV int., ×2.8 (Chavan, n). [Beaks prosogyrous.]

Leiochasmea Dall, Bartsch & Rehder, 1938 [**Solecardia (Scintilla) chascax* Pilsbry, 1921; OD]. Small, elliptical, thin, smooth or with coarse growths. Beaks pointed. Hinge line straight. Two marginal thickenings separated by resilium in trigonal depression and by external support of ligament. *Rec.*, Hawaii.

L. (Leiochasmea) [19]. Ventrally gaping. *Rec.*, Hawaii.——Fig. E35,*15*. **L. (L.) chascax* (Pilsbry); *15a,b*, RV int. and LV hinge, ×5.1 (Dall, Bartsch, & Rehder, 1938).

L. (Achasmea) [19] Dall, Bartsch & Rehder, 1938 [**Solecardia (Scintilla) thaanumi* Pilsbry, 1921; OD]. Without ventral gape. *Rec.*, Hawaii-?Japan.

Levanderia Sturany, 1905 [10] [**L. erythraensis*; M]. Narrowly transverse, hinge margin straight, almost diametral; angular at lateral ends, almost straight and somewhat concave ventrally. Externally sculptured with zigzag striae. No teeth developed. *Rec.*, Red Sea.——Fig. E35,*6*. **L. erythraensis*; *6a,b*, both valves int., ext., ×1.6 (Sturany, 1925).

Libratula Pease, 1865 [5] [**L. plana*; M]. Smooth, semilunar, flat, with straight serrate cardinal margin and median ligament. Not gaping. *Rec.*, Pac.

?Passya Deshayes, 1858 [21] [**P. eugenii*; OD]. Subquadrangular, flat, very irregular in outline and inequilateral. Beaks small, pointed, anterior side angular, very short; posterior side sloping down, its end strongly acuminate and somewhat rostrate. Ventral margin very convex in middle. Hinge margin thickened in long sinuate curved lamellae. Ligament external. *U.Eoc.*, Eu.(France).——Fig. E35,*14*. **P. eugenii*; *14a,b*, LV int. and RV hinge, ×4.8 *(258)*.

Phlyctaenachlamys Popham, 1939 [22] [**P. lysiosquillina*; OD]. Very inequilateral, rounded in front, medioposteriorly much acuminated, angular. Regularly sculptured. Hinge with tuberculiform cardinals and elongate lateral. *Rec.*, Australia.——Fig. E36,*5*. **P. lysiosquillina*; *5a*, RV ext., ×9; *5b,c*, LV and RV hinges, ×16.5 (Popham, 1928-29).

Scintilla Deshayes, 1856 [12] [**S. philippinensis*; SD Stoliczka, 1871]. Largely subelliptical, somewhat straightened on hinge margin. Surface granular, nacreous. Sinuous faint anterior and posterior laterals. Two ill-defined unequal cardinals on right valve and one, more or less obscure, on left. *?Eoc.*, W.Eu.; *Rec.*, Pac.-Ind.O.——Fig. E36, *2*. **S. philippinensis*, Penang; *2a,b*, LV int. and RV hinge, enl. (Chavan, n).

Scintillona Finlay, 1927 [17] [**Spaniorinus zelandicus* Odhner, 1924] [=*?Varotoga* Iredale, 1931 (subj.) (type, *Solecardia cryptozoica* Hedley, 1917)]. Transversely ovate, rounded at both ends. Right tubercular prominent small cardinal, left, slightly prominent, oblique one, prolonged into obscure lamella (fitting in socket of opposite valve). Resilium followed by marked nymph. *L.Mio.-Rec.*, Australia-N.Z.——Fig. E36,*3*. **S. zelandica* (Odhner), N.Z.; *3a,b*, LV hinge and RV int., ×4.6 (Chavan, n).

?Scintillorbis Dall, 1899 [15] [**Scintilla crispata* P. Fischer, 1873; OD]. Orbicular, inequilateral, compressed, very thin. Radial and concentric sculpture. External obsolete ligament and stouter resilium. Small tooth on each valve. *Rec.*, Atl.

Spaniorinus Dall, 1899 (1900) [16] [**Solecardia (S.) cossmanni* Dall, 1900; OD]. Transversely subovate, compressed; beaks median; anterior side gradually narrowing, posterior side remaining broad and somewhat truncated. Subvertical tooth in RV, in front of oblique resilium, with traces of shorter teeth on each side; oblique tooth on LV, no distinct laterals on enlarged margins. *Eoc.-Plio.*, W.Eu.-N.Am.——Fig. E35,*12*. **S. cossmanni* (Dall), USA(Va.); *12a,b*, LV hinge and RV int., ×3.6 (Dall, 1900).

Thyreopsis A. Adams, 1868 [9] [**T. coralliophila*; M]. Trigonal, angular dorsally and at extremities, slightly inequilateral. Valves widely gaping. Hinge apparently edentulous. *Rec.*, Ind.O.(Mauritius).——Fig. E35,*3*. **T. coralliophila*; *3a,b*, LV ext., dorsal, ×1.2 (H. Adams, 1868).

Tryphomyax Olsson, 1961 (27) [**T. lepidoformis*; OD]. Small, thin, flat, subovate, somewhat enlarged posteriorly and with more or less pronounced ventral notch. Sculpture of low radial riblets, cancellated by minute concentrics. RV cardinal knoblike; LV with 2 cardinals, anterior one larger. Internal ligament, in small resilifer. *Rec.*, Panama.

?Turquetia Vélain, 1877 [23] [**T. fragilis* Vélain, 1876 (1877); M] [=*Turquetia* Vélain, 1876 *(nom. nud.)*]. Convex, very inequilateral, transversely ovate, rounded and enlarged anteriorly, shortened, obliquely truncated and folded posteriorly. Beaks orthogyrous. Hinge margin thickened on anterior elongation, then showing small tubercular tooth separated by 2 sockets. Ligament external. *Rec.*, S.Atl. (St.Paul Is.).——Fig. E35,*10*. **T. fragilis; 10a,b*, RV ext., int., enl. (Chavan, n). [?Sportellid.]

?Uncidens Coen, 1934 (3a) [**U. arupinensis*; OD]. Small, thin, slightly convex, equivalve, subequilateral, subelliptical, with slight posterior truncation; no lunule or escutcheon. Sculpture of coarse concentric ribs and faint radial lines. RV hinge with anterior lateral, strong median cardinal with rounded median deep concavity and oblique posterior cardinal; semiinternal ligament. LV with 2 rounded, anterior and median cardinal processes,

located in concavities in front of and in RV tooth; and posterior oblique cardinal. Inner margin smooth. *Rec.*, Adriatic.

Vasconiella DALL, 1899 [**Vasconia jeffreysiana* P. FISCHER, 1873; OD] [*pro Vasconia* FISCHER, 1875, *partim*]. Irregularly rounded, ventrally lobated by deep concave sinuosity. Sculpture of unequal lamellar growths. Small conical tooth under submedian beak, followed by resilium and ligamentary attachment. *Rec.*, Atl.-Medit.-N.Z.

V. (Vasconiella) [25]. Slightly oblique, with rather strong rounded tooth. *Rec.*, Atl.-Medit.—— FIG. E35,7. **V. (V.) jeffreysiana* (FISCHER), Cape Breton Is.; *7a,b*, RV ext., int., ×3.2 (Fischer, 1875).

V. (Divariscintilla) POWELL, 1932 [26] [**D. maoria*; OD]. Strongly oblique; with smaller, angular tooth. *Rec.*, N.Z.

GENERA DUBIA

Autonoe LEACH, 1852 (*non* RAFINESQUE, 1815) (*nom. nud.*).

Bilobaria PELSENEER, 1911. Shell undescribed. Type lost.

Hyalokellia HABE, 1960 [**H. polita*; OD]. Described as bean-shaped, posteriorly produced; hinge narrow, with RV small cardinal and long posterior lateral, LV very weak anterior cardinal and posterior lateral. Unfigured. ?Erycinid. *Rec.*, Japan.

Soyokellia HABE, 1958 [**S. compressa;* OD]. Unfigured. Said to be oblong and inequilateral, rounded at both ends, hinge with single anterior and 2 posterior teeth on right valve, resilium narrow. ?Erycinid. *Rec.*, Japan.

Superfamily CHLAMYDOCONCHACEA Dall, 1884

[*nom. transl.* KEEN, herein (*ex* Chlamydoconchidae DALL, 1884)] [Materials for this superfamily prepared by MYRA KEEN]

Shells internal, without pallial or adductor scars or hinge teeth; enclosed in two sacs within the mantle, umbones loosely joined by an abortive ligament; prodissoconchs prominent, persistent, at dorsal ends of valves; animal sluglike, ovoid, covered by tough, papillose mantle, foot protruding anteriorly through orifice, a second orifice posteriorly for anal opening. *Rec.*

Family CHLAMYDOCONCHIDAE Dall, 1899

Characters of superfamily. *Rec.*

Chlamydoconcha DALL, 1884 [**C. orcutti*; OD]. Characters of superfamily. *Rec.*, N.Am.——FIG. E37,*1*. **C. orcutti*, USA(Calif.); *1a*, animal, valve visible dorsally through transparent mantle, ×1.5; *1b-e*, shell, showing RV ext., LV int., LV ext., RV int., all ×10 (*1a*, Williams, 1949; *1b-e*, Los Angeles County Museum specimens, Keen, n).

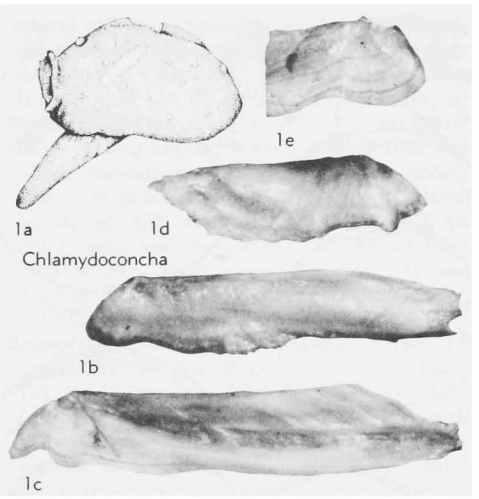


FIG. E37. Chlamydoconchidae (p. *N*537).

Superfamily CYAMIACEA Philippi, 1845

[*nom. transl.* THIELE, 1934 (*ex* Cyamiidae PHILIPPI, 1845)] [Materials for this superfamily prepared by ANDRÉ CHAVAN]

Shell equivalve, commonly somewhat thickened, mostly with resilium adjacent to nymph, slightly hollowing hinge plate; upper hinge elements distinct, elongate and hooked at their termination above inferior ones; laterals distinct, *AI* (or *1*) and *AII* (or *2*) present. Marine; foot with a byssal gland; two posterior apertures in mantle. *Jur.-Rec.*

The alphabetically arranged generic descriptions in each family-group division of the Cyamiacea are accompanied by numbers inclosed by square brackets. Such numbers indicate position in the sequence of generic taxa given with the respective families or subfamilies for the purpose of recording CHAVAN's arrangement, designed to reflect "natural relationships" of these taxa as inferred by him.

Family CYAMIIDAE Philippi, 1845

[=Perrierinidae MARWICK, 1927]

Shell small, more or less angular, with broad hinge plate scarcely or not at all hollowed by oblique well-defined resilium;

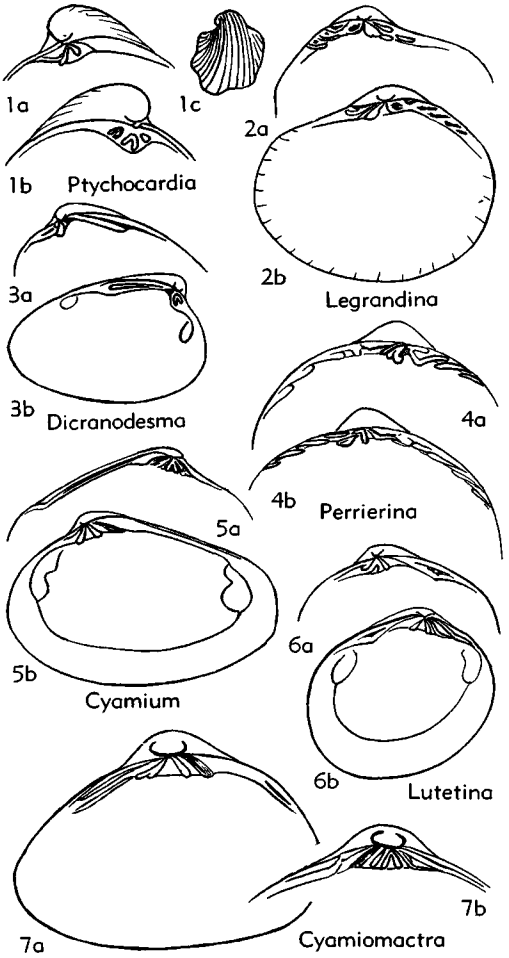


FIG. E38. Cyamiidae (p. *N538-N539*).

cardinals narrowly elongate, diverging, some (commonly *2b*) bilobate; laterals remote, some with taxodont tendency. *Mio.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Cyamium*.——2. *Cyamiomactra*.——3. *Reloncavia*.——4. *Cyamiocardium*.——5. *Perrierina*.——6. *Legrandina*.——7. *Ptychocardia*.——8. *Dicranodesma*.——9. *Lutetina*.

Cyamium PHILIPPI, 1845 [1] [**C. antarcticum*; M]. Transversely elongate, inequilateral, rounded in front, somewhat obliquely extended and faintly truncated backward. Left hinge with remnants of *AII, 2a,* bifid *2b,* and obsolete *4b*; right with remnants of *3a, 1, 3b;* posterior laterals remote, more or less indistinct. *Rec.,* S.Am.-Antarctica.—— FIG. E38,*5*. **C. antarcticum,* S.Am.(Patag.); *5a,b,* LV hinge, RV int., ×5 (Chavan, n).

Cyamiocardium SOOT-RYEN, 1951 [4] [**Cyamium denticulatum* SMITH, 1907; M]. Rounded, with inflated beaks, radiating sculpture. Hinge as in *Cyamiomactra* but without elongate well-developed laterals and with broader *3a,* shorter *2a,* and *3b* obscurely bifid. Denticulated inner margin. *Rec.,* Antarctica-Chile-?N. Z.-?Australia.—— FIG. E39,*1*. **C. denticulatum* (SMITH); *1a,* LV int., ×20; *1b,c,* RV and LV hinges, ×10 *(858)*.

Cyamiomactra BERNARD, 1897 [2] [**C. problematica*; M] [=*Heteromactra* LAMY, 1906 (type, *Mactra (H.) laminifera*)]. Subtrigonal, short, slightly inequilateral; angular in front, enlarged and somewhat obliquely sloping backward; surface smooth. Hinge with 2 well-developed long parallel anterior laterals in each valve, coalescent *3a, 1, 3b,* curved *AII,* largely bifid *2, 4b,* and faint remote posterior lateral; very oblique narrow resilium. *?Pleist., Rec.,* ?Australia-?N.Z.-Antarctica.——FIG. E38,*7*. **C. problematica,* Stewart Is.; *7a,b,* RV int., LV hinge, ×10 (Chavan, n).

Dicranodesma DALL, 1899 (1900) [8] [**Mysella calvertensis* GLENN in DALL, 1900]. Transversely and very obliquely trigonal, inequilateral, shortly rounded in front, acuminate backward; beaks prosogyrous. Hinge moderately stout, RV with anterior lateral and trigonal *1* having remnants of *3* around its top, LV with oblique inverted V *(2-AII),* all in front of oblique resilium, moderately broad, long posterior lateral. *Mio.,* N.Am. (Md.).——FIG. E38,*3*. **D. calvertensis* (GLENN); *3a,b,* RV hinge, LV int., ×4 (Chavan, n).

Legrandina TATE & MAY, 1901 [6] [**L. bernardi;* OD]. Largely ovate, somewhat inequilateral, anteriorly attenuated, posteriorly enlarged; radially ribbed. Hinge with *I, 3a-b, AII* in prolongation of *2,* scarcely bifid, *4b* and several oblique, subparallel, taxodont-like laterals, RV with only 2 right anterior but 4 posterior ones, LV with 1 to 3 laterals; crenulated margin; resilium in spoonlike pit. *Rec.,* S.Pac.(Tasmania).——FIG. E38,*2*. **L. bernardi; 2a,b,* LV hinge, RV int., ×20 (Chavan, n).

Lutetina VÉLAIN, 1876 (1877) [9] [**L. antarctica;* OD]. Largely subovate, relatively thick, anterior side shorter and narrower than broadened posterior; ventral margin convex, shining surface with faint concentric ribs; beaks small. Hinge with narrow oblique cardinals and lamellar anterior lateral; *AIII-3a* obsolete, *1* on inferior margin of plate, *3b, AIV, AII, 2a, 2b* well separated, oblique resilium and each valve with strong posterior lateral. *Rec.,* Atl.(St.Paul Is.).——FIG. E38,*6;* E39,*2*. **L. antarctica*; E38,*6a,b,* RV hinge, LV int., enl. (Chavan, after Vélain, 1876); E39,*2a,b,* LV and RV hinges, ×32 (Bernard).

Perrierina BERNARD, 1897 [5] [**P. taxodonta;* M]. Transversely ovate, very inequilateral, anterior side much shorter than posterior. Hinge with *1, 3a-b,* curved *AII, 2a* coalescent with *2b, 4b* present, and

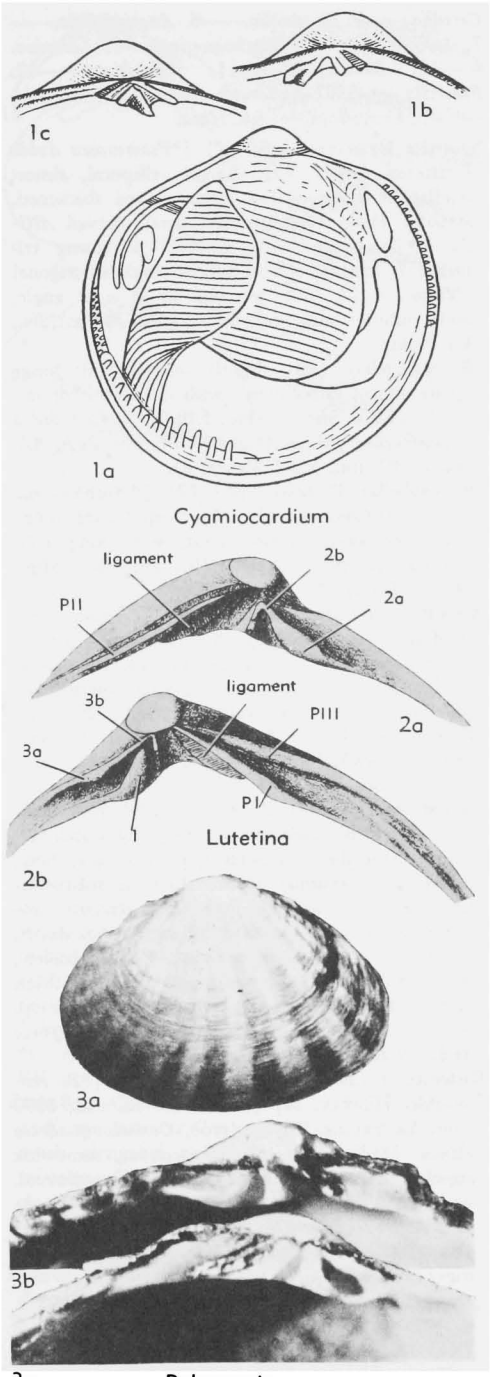


FIG. E39. Cyamiidae (p. *N538-N539*).

several oblique, subparallel, taxodont-like laterals; oblique narrow resilium. *Plio.-Rec.*, N.Z.-Antarctica.——FIG. E38,*4*. **P. taxodonta*, Rec., Stewart Is.; *4a,b*, LV and RV hinges, ×10 (Chavan, n).

Ptychocardia THIELE, 1912 [7] [**P. vanhöffeni*; OD]. Oblong-angular, convex, with 3 radial folds which undulate margin, also concentric ribbing; prominent prosogyrous beaks. Hinge with lamellar curved *AIII*, and tubercular *AIV*, *AI-1* and *AII-2*, each one in inverted V; rounded deep resilium. *Rec.*, Antarctica.——FIG. E38,*1*. **P. vanhoeffeni*; *1a-c*, RV and LV hinges, LV ext., much enl. (Chavan, n).

Reloncavia SOOT-RYEN, *nom. subst.* herein [3] [*pro Kingiella* SOOT-RYEN, 1957 (*non* SEGUY, 1937)] [**Kingiella chilenica* SOOT-RYEN, 1957; OD]. Ovate, radial sculpture distinct, ventral margin crenate. Outer ligament conspicuous and resilium in oblique groove. Two RV cardinals, *3b* grooved; central triangular, not bilobate, *2* and *4a, 4b*. Elongate laterals. *Rec.*, S.Am.(Chile). ——FIG. E39,*3*. **K. chilenica; 3a*, LV ext., ×0.7; *3b,c*, RV and LV hinges, ×24 (Soot-Ryen, 1959).

Family TURTONIIDAE Clark, 1855

Small, prosogyrous, very inequilateral; with rather narrow hinge plate bearing tubercular cardinals and both anterior and posterior laterals; ligament external. Four mantle folds and no outer demibranchs. *Mio.-Rec.*

Turtonia ALDER, 1848 [**Venus minutus* FABRICIUS, 1780; OD]. Anteriorly short, convex, posteriorly acuminate; LV hinge with subhorizontal *AII* adjacent to feebly bifid tubercular *2*, laminar *AIV* and minute *4b* above and behind it; RV with *AI* and *AIII* prolonged by *1* and *AIII-3a* by tubercular *3b*, hinge plate hollowed backward, posterior laterals very distant and minute. *Mio.-Rec.*, N.Eu.-Greenl.-Alaska-Japan.——FIG. E40,*3*. **T. minuta* (FABRICIUS), Rec., North Sea; *3a,b*, RV hinge, LV int., ×10 (Chavan, n).

[This genus has been placed in the Veneracea by K. OCKELMANN (Ophelia I, no. 1, p. 121-145, 1964) but, apart of several anatomical differences, its hinge is not cyrenoid (with hollowed plate, *4b* minute, *AIV* developed, and tubercular cardinals).]

Family SPORTELLIDAE Dall, 1899

[=Basterotidae WOODRING, 1925]

Small to medium-sized, shell commonly thickened, more or less rounded in outline; hinge plate broad, scarcely or not at all hollowed by internal part of ligament, which is principally marginal, lying on nymph; cardinals differently developed, *1* trigonal and strong, obliterating *3*, tooth *2* oblique, *4b*

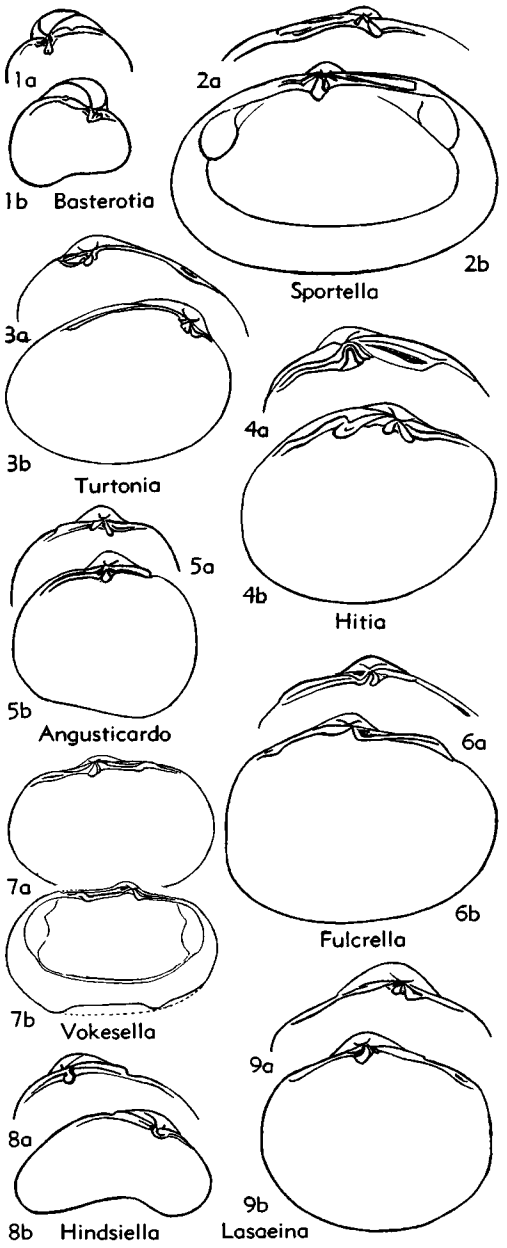


FIG. E40. Turtonidae *(3);* Sportellidae *(1-2,4-9)* (p. *N*539-*N*541).

obsolete in some, laterals incomplete. *Jur.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Sportella.*——2. *Fabella.*——3. *Vokesella.*——4. *Cerullia.*——5. *Hindsiella.*——6. *Angusticardo.*——7. *Isoconcha.*——8. *Benthoquetia.*——9. *Lasaeina.*——10. *Grundensia.*——11. *Anisodonta.*——12. *Fulcrella.*——13. *Basterotia.*——14. *Basterotella.*——15. *Ensitellops.*——16. *Hitia.*

Sportella DESHAYES, 1858 [1] [**Psammotea dubia* DESHAYES, 1824; OD]. Largely elliptical, almost equilateral, more or less flattened and thickened, smooth. Hinge with laminar narrow curved *AIII-3a-3b,* latter posteriorly adjacent to strong trihedral *1;* laminar *AII* at inferior angle of trigonal oblique *2a, 2b* at its top and *4b* at right angle, both minute; long callous nymph. *Paleoc.-Plio.,* Eu.-N.Am.

S. (Sportella). Only slightly inequilateral; hinge plate almost unhollowed, with short anterior laterals. *Paleoc.-Mio.*——FIG. E40,*2.* **S. (S.) dubia* (DESHAYES), M.Eoc.(Lutet.), France; *2a,b,* LV hinge, RV int., ×2 (Chavan, n).

S. (Fabella) CONRAD, 1863 [2] [**Amphidesma constricta* CONRAD, 1841; M]. Inequilateral; hinge plate hollowed, broad, stout, with long subparallel anterior laterals *(AIII, AI, AII). Mio.-Plio., ?Rec.,* N.Am.-SW.Eu.-Medit.

Angusticardo COSSMANN, 1887 [6] [**Poromya rotundata* DESHAYES, 1857; SD COSSMANN, 1913]. Short ovate, with distinct *3a* and *2b,* trigonal *1,* moderately strong posterior *4b,* long anterior laterals, short nymph; no ventral sinuosity. *Eoc.,* W. Eu.——FIG. E40,*5.* **A. rotundata* (DESHAYES), M.Eoc.(Lutet.), France; *5a,b,* LV hinge, RV int., ×6 (Chavan, n).

Anisodonta DESHAYES, 1858 [11] [**A. complanatum*; M]. Subquadrangular, narrowly transverse, anterior side short, attenuated, posterior area long, broad, and vertically truncated; with mediposterior external carina. Hinge with irregular anterior laterals, partly fused to anterior cardinals, trigonal broad *1,* oblique *2,* other ones obsolete, posterior laterals long; with very narrow resilium and short flat broad nymph. *Paleoc.-Rec.,* cosmop.——FIG. E41,*3.* **A. complanatum,* Paleoc., France; *3a,b,* LV int., RV hinge, ×3.7 (Chavan, n).

Basterotia C. MAYER in HÖRNES, 1859 [**B. corbuloides* HÖRNES; M] [=*Eucharis* RÉCLUZ, 1850 (*non* LATREILLE, 1804) (type, *Corbula quadrata* HINDS, 1843; OD)]. Strongly convex, somewhat angular, short, subtrapezoidal, very inequilateral, with very prominent beaks; ventral margin convex, slightly concave in middle. Hinge with one projecting cardinal on each valve, *2* hooklike, *1* trigonal; *3a* oblique, faint; with short nymph and enlarged posterior margin. *Mio.-Rec.,* cosmop.

B. (Basterotia) [*13*]. Dorsally angular. *Mio.-Rec.,* cosmop.——FIG. E40,*1.* **B. (B.) corbuloides* HÖRNES, Helvet., Aus.; *1a,b,* RV hinge, LV int., enl. (Chavan, n).

B. (Basterotella) OLSSON & HARBISON, 1953 [14] [**Pleurodesma floridana* DALL, 1903; OD]. Scarcely angular, irregularly striated; RV coarsely

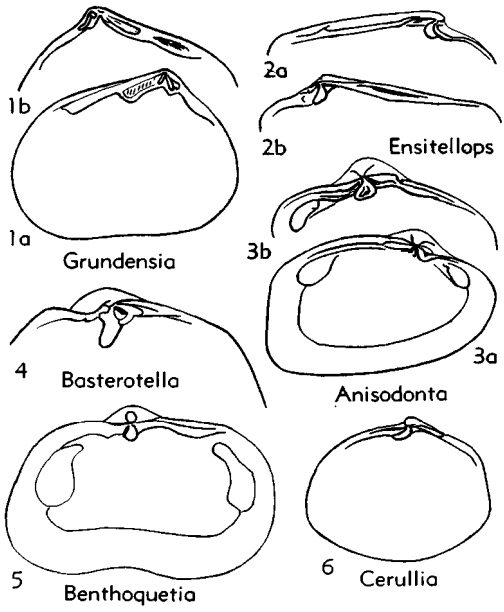


FIG. E41. Sportellidae (p. *N*540-*N*541).

granular. Hinge with distinct resilium beneath nymph. *Mio.-Rec.*, Eu.-Am.——FIG. E41,*4*. **B. (B.) floridana* (DALL), Plio., USA(Fla.); RV hinge, ×3.3 (Chavan, n).

Cerullia CHAVAN, 1953 [4] [*pro Scintillula* CERULLI-IRELLI, 1909 (*non* JOUSSEAUME, 1888)] [**Solecardia (Scintillula) intermedia* CERULLI-IRELLI, 1909; SD CHAVAN, 1953]. Subovate to subelliptical, acuminate forward, slightly truncated backward, somewhat inequilateral. Hinge with long marginal *AIII*, strong oblique curved *1* and *2*, others more or less obsolete, moderately short resilium and nymph; faint left posterior lateral. *Paleoc.-Plio., ?Rec.*, Eu.-?N.Am.——FIG. E41,*6*. **C. intermedia* (CERULLI-IRELLI), U.Plio., Italy; RV int., enl. from ×7 orig. (Chavan, n).

Ensitellops OLSSON & HARBISON, 1953 [15] [**Amphidesma protexta* CONRAD, 1841; OD]. Solenoid, much elongated posteriorly, externally somewhat pustular. Strong curved *AII*, *2* and *1* trigonal, elongated posterior lateral. *Mio.-Rec.*, Am.——FIG. E41,*2*. **E. protexta* (CONRAD), Mio., USA (Va.); *2a,b*, LV and RV hinges, ×4 (Chavan, n).

Fulcrella COSSMANN, 1886 [12] [**Poromya paradoxa* DESHAYES, 1857; OD]. Broadly ovate-transverse, slightly inequilateral. Very long regular anterior laterals, fused to anterior cardinals; well-marked narrow posterior right cardinal and resilial hollow under maginal ligament; remote faint posteriors. *Eoc.-Rec.*, Eu.-N.Am.-Pac.——FIG. E40, *6*. **F. paradoxa* (DESHAYES), L.Eoc., France; *6a,b*, RV hinge, LV int., ×5.3 (Chavan, n).

Grundensia KAUTSKY, 1939 [10] [**G. adametzi*; OD]. Subquadrangular, inequilateral, with broad flat hinge, narrowed in its middle, no detached anteriors, *AII-2a* bifid, *2b* short, *3a*, *1*, small, obsolete *3b*, all small and narrow; long posterior laterals; broad resilium and marginal ligament. *Mio.(Helvet.)*, Austria.——FIG. E41,*1*. **G. adametzi*; *1a,b*, LV int., RV hinge, enl. (Chavan, n).

Hindsiella STOLICZKA, 1871 [5] [*pro Hindsia* DESHAYES, 1858 (*non* H. & A. ADAMS, 1853)] [**Modiola arcuata* LAMARCK, 1807; OD]. Moderately small, inequilateral, transversely elongated, arcuate in middle and rounded at lateral ends. Hinge with long *AIII* and *AII* grooves, rounded tuberculiform *1*, curved *2*; nymph relatively elongate. *Paleoc.-U.Eoc.*——FIG. E40,*8*. **H. arcuata* (LAMARCK), M.Eoc. (Lutet.), France; *8a,b*, RV hinge, LV int., ×4 (Chavan, n).

Hitia DALL, BARTSCH & REHDER, 1938 [16] [**H. ovalis*; OD]. Transversely elliptical, inflated, smooth. Knoblike cardinals; with *1*, *2a* and *2b* and *3a* and *3b* in an inverted V, latter in prolongation of *AIII*, above top of *1*; marginal *AII* and broad ligament, resilium and nymph; remote faint marginal left lateral. *Rec.*, Hawaii.——FIG. E40,*4*. **H. ovalis*; *4a,b*, RV hinge, LV int., ×6 (Chavan, n).

?Isoconcha DAUTZENBERG & FISCHER in PELSENEER, 1911 [**I. sibogai*; SD PRASHAD, 1932]. Transversely elliptical, almost subequilateral, concentrically striated, inflated, small. Hinge with one developed cardinal on each valve and corresponding socket, under beak; ligament external, no distinct resilium. *Rec.*, Australasia.

I. (Isoconcha) [7]. Regularly elliptical, sinuated in middle, subequilateral *(755)*. *Rec.*, Australasia.

I. (Benthoquetia) IREDALE, 1930 [8] [**Turquetia integra* HEDLEY, 1907; OD] [=*Austroturquetia* COTTON, 1930]. Irregularly elliptical, somewhat inequilateral. *Rec.*, N.Z.-Australia.——FIG. E41, *5*. **I. (B.) integra* (HEDLEY); RV int., enl. (Chavan, n). [May be an erycinid with faintly marked laterals.]

Lasaeina COSSMANN, 1910 [1912] [9] [* *Lasaea saucatsensis* COSSMANN, 1896; OD]. Ovately rounded, rather broad, smooth. Hinge with 2 cardinals on each valve; *3a* faint, *3b* strong, *AII-2*, *4b*. Faint anterior and posterior lateral; narrow resilium, moderately long nymph. *Mio.*, Eu.——FIG. E40,*9*. **L. saucatensis* (COSSMANN), Burdigal., France; *9a,b*, LV hinge, RV int., ×7.4 (Chavan, n).

Vokesella CHAVAN, 1952 [3] [**V. inopinata*; OD]. Subelliptical, thin, slightly inequilateral, with distinct right anterior *AI-1-3b* trigonal, oblique, right-angled *AII-2*, a faint *4b*; small oblique resilium and prominent long nymph. *Jur.*, Eu.(W.France). ——FIG. E40,*7*. **V. inopinata*; *7a,b*, RV int., LV int., ×4.7 (Chavan, n).

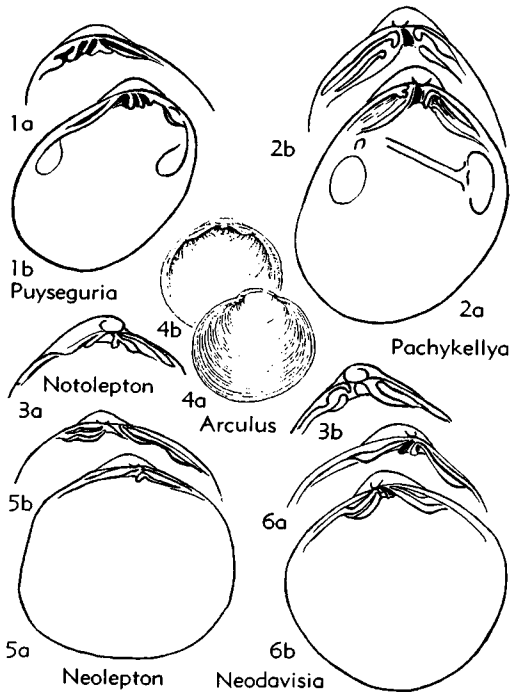


FIG. E42. Neoleptonidae (p. N542-N543).

Family NEOLEPTONIDAE Thiele, 1934

Shell minute, rounded, with more or less broad hinge plate, arched under internal ligament. Hinge without completely developed cardinals or with one, but with long laminar anterior and posterior arched, commonly hooked laterals on both sides. *Plio.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Neolepton.*——2. *Neodavisia.*——3. *Notolepton.*——4. *Pachykellya.*——5. *Puyseguria.*——6. *Calvitium.*——7. *Jousseaumiella.*——8. *Epilepton.*——9. *Arculus.*

Neolepton DI MONTEROSATO, 1875 [1] [**Lepton sulcatulum* JEFFREYS, 1859; SD CROSSE, 1884]. Suborbicular, somewhat truncated backward, almost equilateral. RV hinge with well-developed duplicate right anterior and successive posterior laterals, LV hinge with *2-AII* angular, *AIV* marginal, also *PII. Plio.-Rec.*, Eu.——FIG. E42,*5*. **N. sulcatulum* (JEFFREYS), Rec., Medit.; *2a,b,* RV hinge, LV int., enl. (Chavan, n).

Arculus DI MONTEROSATO, 1909 [9] [**Lepton sykesi* CHASTER, 1895; M]. Oval, subrhomboidal, rather convex, inequilateral, concentrically striated. Each valve with extremely minute erect cardinal and anterior and posterior laterals. *Rec.*, G.Brit.(Guernsey).——FIG. E42,*4*. **A. sykesi* (CHASTER); *4a,b,* RV int., LV ext., ×18 *(905a)*.

Calvitium LASERON, 1953 [6] [**C. glabra*; OD]. Minute, thin, inequilateral, smooth, with large dome-shaped prodissoconch. Internal ligament; LV with small rounded anteriorly placed cardinal with large fold of hinge, bearing hardly a tooth behind it and prominent lateral, RV with 2 prominent laterals. *Rec.*, Australia.——FIG. E43,*3*. **C. glabrum,* New S.Wales; *3a,* RV ext., enl.; *3b,c,* LV and RV hinges, ×12 *(531)*.

Epilepton DALL, 1899 [8] [**Lepton clarkiae* CLARK, 1852; M]. Broadly ovate, pellucid, inequilateral; anterior side twice length of posterior. Hinge with well-marked laterals, duplicate on RV and single distinct oblique tooth in front of resilium. *Rec.*, Eu.(N.Sea-Medit.).——FIG. E43,*2*. **E. clarkiae* (CLARK), Eng.; RV int., much enl. (Chavan, n).

Jousseaumiella BOURNE, 1907 [7] [*pro Jousseaumia* BOURNE, 1906 (*non* SACCO, 1894)] [**Jousseaumia heterocyathi* BOURNE, 1906; SD CHAVAN, herein]. Trigonal, inequilateral, concentrically ribbed. Hinge with duplicate laterals and single vertical slightly inequilateral cardinal on RV, 2 narrow cardinals and marginal successive laterals on LV. *Rec.*, India (Andaman I.).——FIG. E43,*1*. **J. heterocyathi* (BOURNE); *1a,b,* LV and RV hinges, much enl. *(76)*.

Neodavisia CHAVAN, *nom. subst.*, herein [2] [*pro Davisia* COOPER & PRESTON, 1910 (*non* DEL GUERCIO, 1909; *nec* BARNES & MACDUNNOUGH, 1913)] [**Davisia cobbi* COOPER & PRESTON; M]. Rounded, somewhat angular in front, slightly inequilateral. Hinge with strong laterals, duplicate on RV, subparallel, *AI* and *AII* continued by short *3a* and *2*; resilium small, scarcely oblique, submedian. *Rec.*, SW.Atl.(Falkland Is.).——FIG. E42,*6*. **N. cobbi* (COOPER & PRESTON); *6a,b,* LV hinge, RV int., much enl. (Chavan, n).

Notolepton FINLAY, 1927 [3] [**Kellia antipoda* FILHOL, 1880; OD]. Trigonal-rounded, scarcely inequilateral, concentrically striated, with duplicate successive anterior and posterior laterals, *AI* short. *?Mio., Rec.*, Australasia-S.Atl.——FIG. E42,*3*. **N. antipodum* (FILHOL); *3a,b,* LV and RV hinges, much enl. (Chavan, n).

Pachykellya BERNARD, 1897 [4] [**P. edwardsi*; M]. Somewhat obliquely oblong, thick, with prominent beaks and broad hinge, central resilium on both sides of which 2 laterals on each valve are hooked, curved or bifid at their termination. *Pleist.-Rec.*, N.Z.(Stewart Is.).——FIG. E42,*2*. **P. edwardsi* BERNARD; *4a,b,* RV hinge, LV int., ×33 (Chavan, n).

Puyseguria POWELL, 1927 [5] [**P. cuneata*; OD]. Very oblique and inequilateral, ovately rounded, anteriorly produced, posteriorly shortened; beaks

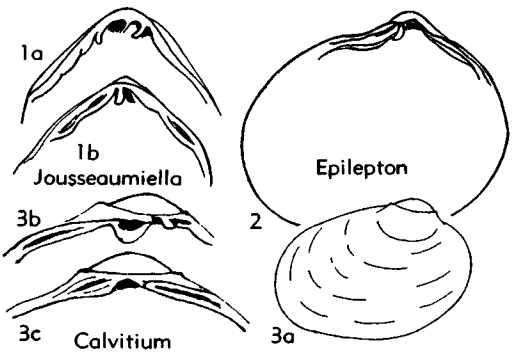


FIG. E43. Neoleptonidae (p. *N*542).

opisthogyrous. Hinge with long anterior laterals and 2 cardinals (2 bifid) of which anterior one is in prolongation of lateral, short posterior laterals. *Plio.-Rec.*, N.Z.——FIG. E42,*1*. *P. wanganuica* (POWELL), U.Plio.; *1a,b*, LV hinge, RV int., ×27 (Chavan, n).

Superfamily CARDITACEA Fleming, 1820

[*nom. transl.* MENKE, 1830 (*ex* Carditidae FLEMING, 1820)]
[Materials for this superfamily prepared by ANDRÉ CHAVAN]

Shell trigonal to cordiform, trapezoidal, or mytiliform, with radial external sculpture predominating at least locally over concentric and with internal layer of straight radial riblets, which invariably crenulate margin if relatively strong; with more or less marked medioposterior rib or angulation; lunule small, commonly depressed; escutcheon somewhat ill-defined; beaks prosogyrate, tending to be rounded. Hinge of curved lucinoid type with two unequal teeth *(2, 4b)* in LV, *3b* oblique; *5b* very thin, if present; *PI* and *AIV* lacking, other laterals tuberculiform or remote, producing in some shells hinge of cyrenoid aspect; ligament internal or external, latter type inserted on well-marked nymph; shell integripalliate; pedal scars distinct. Animal byssiferous, with open mantle lacking communication between branchial aperture and pedal slitlike outlet; gills large, unequal, united posteriorly. [Marine.] *?Ord., Dev.-Rec.*

The alphabetically arranged generic descriptions in each family-group division of the Carditacea are accompanied by numbers inclosed by square brackets. Such numbers indicate position in the sequence of generic taxa given with the respective families or subfamilies for the purpose of recording CHAVAN's arrangement, designed to reflect "natural relationships" of these taxa as inferred by him.

Family PERMOPHORIDAE van de Poel, 1959 (1895)

[*pro* Pleurophoridae DALL, 1895 (Code, 1961, Art. 40)]
[=Kalenteridae MARWICK, 1953; Redoniidae BABIN, 1966]

Medium-sized to large, trapezoidal to modioliform, very inequilateral; radial ribs tending to be obsolete on anterior part of surface, internal margin smooth; with marginal ligament and long nymph. Cardinals partly obsolete, tuberculiform, or much elongated; *5b* and anterior laterals lacking in most, posterior laterals remote, that of LV strongest; anterior and pedal scars on thickened buttress. *?Ord., ?Dev., L.Carb.-U.Cret.*

Subfamily PERMOPHORINAE van de Poel, 1959 (1895)

[*nom. transl.* CHAVAN, herein (*ex* Permophoridae VAN DE POEL, 1959) (=Pleurophoridae DALL, 1895)]

Anterior margin more or less rounded, posterior truncate, with medioposterior angulation and generally several posterior ribs. Hinge with moderately elongate *3b*, trigonal *2*, narrow *4b* appressed in some shells to inferior edge of nymph. *?Ord., ?Dev., L.Carb.-L.Jur.*

Arrangement of generic taxa by CHAVAN.——1. *Permophorus*.——2. *Curionia*.——3. *Pseudopermophorus*.——4. *Celtoides*.——5. *Triaphorus*.——6. *Kalentera*.——7. *Redonia*.——8. *Netschajewia*.——9. *Rimmyjimina*.——10. *Pleurophorella*.

Permophorus CHAVAN, 1954 [1] [*pro Pleurophorus* KING, 1844 (*non* MULSANT, 1842)] [**Arca costata* BROWN, 1841; M]. Subrectangular, solid, with low beaks near anterior end; sculpture rugose concentric, with several posterior radial riblets; lunule and escutcheon well developed. LV hinge with broadly tuberculiform *2*, weak, but distinct, *4b* and 2 broad, distant, oblique, posterior laterals; RV hinge with *3a* as rounded obsolescent tubercle, *3b* oblique, strong, sharply defined and posterior lateral submarginal; deep reniform anterior scar in front of myophoric buttress and shallow pedal scar just below *2*. *L.Carb.-Perm.*, cosmop.——FIG. E44,*1*. *P. albequus* (BEEDE), L.Perm., USA(Tex.); *1a,b*, RV int., LV int., ×2, ×3 *(665)*.——FIG. E45,*3*. **P. costatus* (BROWN), Perm. (Upper Magnesian Ls.), Souter Point, Durham, Eng.; *3a*, latex cast int. RV, ×3.3 (Logan, 1964, fig. 8); showing two cardinal teeth; *3b*, latex cast LV,

×3.3 (Logan, 1964, fig. 9), showing two cardinal teeth (Newell, n).[1]

[1] The type specimens of *P. costatus* are lost and there has been uncertainty about the characteristics and limits of the genus *Permophorus* (Logan, 1964, *548*). Unpublished studies by NEWELL suggest that more than one species of *Permophorus* may occur in the British faunas and that the genus is highly variable in American faunas. Fig. E45,*3a*, above (613.62, Hancock Mus., Newcastle upon Tyne) is here designated as neotype. [NEWELL]

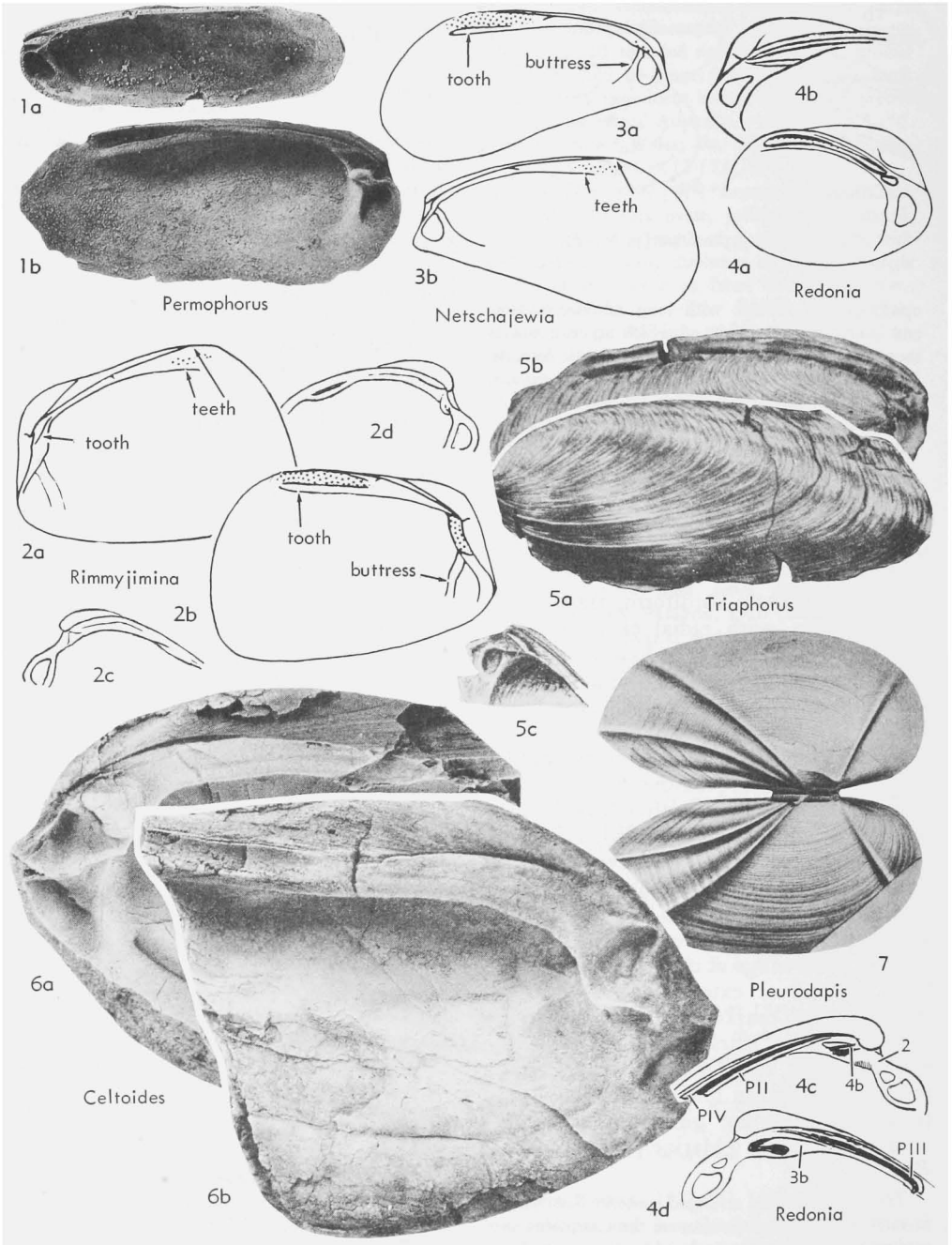


FIG. E44. Permophoridae (Permophorinae) (p. *N*543-*N*547).

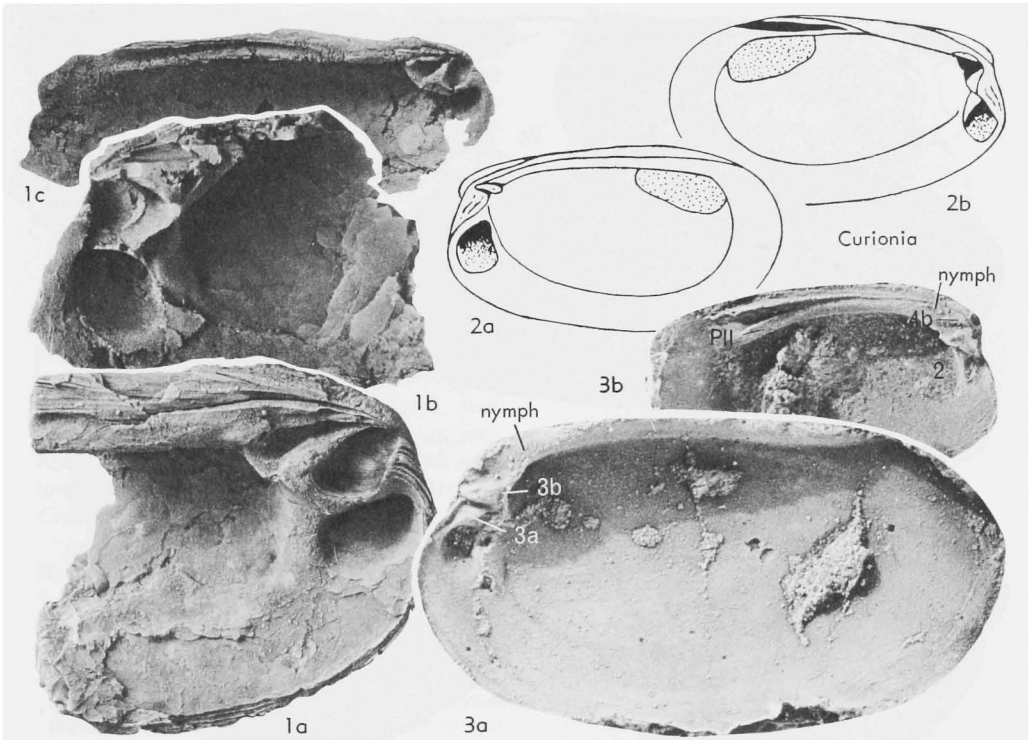


FIG. E45. Permophoridae (Permophorinae) (p. *N*543-*N*545).

Celtoides NEWELL, 1957 [4] [**C. unioniformis*; OD]. Transversely elongate, large, thick-shelled, inequilateral, surface unornamented; lunule small, escutcheon broad. Hinge with broad *3b*, stronger than *2* and bearing radial furrow, both trigonal, *4b* obsolete, *PII* long; with myophoric buttress of moderate size. *Perm.*, N.Am.——FIG. E44,*6*. **C. unioniformis*, USA(Wyo.); *6a,b*, RV int., LV int., ×1 *(669)*.

Curionia ROSSI RONCHETTI, 1965 [2] [**Myoconcha curionii* HAUER, 1857; OD]. Subovate, very inequilateral, with rounded beaks; lunule broadly developed, covering anterior side of cardinal *2*; ornament of concentric striae. Hinge with trigonal oblique *2* and *3b*, very oblique narrow *4b*, distant posterior laterals, that of RV quite marginal. Ovate anterior scar on buttress, broad posterior scar superficial. *Trias.(Carn.-Rhaet.)*, Eu.(Italy-Switz.-Ger.).——FIG. E45,*2*. **C. curionii* (HAUER), Carn., Italy; *2a,b*, RV int., LV int., ×2 (Rossi Ronchetti & Allesinaz, 1965).

Kalentera MARWICK, 1953 [6] [**K. mackayi*; OD]. Transversely suboval, large, beaks near front end; sculpture concentric, posterior radial lines vanishing. Hinge with short conical *2*, deeply oblique *3b*, curved *4b*, and remote, very strong, broad posterior laterals; anterior adductor on buttress extending backward to hinge, beneath which is very deep pedal scar bounded above by toothlike ridge resembling branch of *3b* on RV. *L.Jur.*, N.Z.——FIG. E46,*4*. **K. mackayi*; *4a,b*, RV int., LV int., ×1 *(599)*.

Netschajewia YAKOVLEV, 1925 [8] [**Mytilus pallasi* DE VERNEUIL, 1845 (=*Pleurophorus modioliformis* KING, 1844); OD]. Medium-sized, trapezoidal, relatively narrow, convex, front end angular, produced, rear end acuminate; sculpture of irregular growth lines; lunule and escutcheon lacking. Hinge with obscure *3b* and quite remote posterior laterals, stronger on LV. *Perm.*, Eu.-Greenl.——FIG. E44,*3*. **N. modioliformis* (KING), USSR; *3a,b*, LV int., RV int., ×2 *(669)*.

?**Pleurodapis** CLARKE, 1913 [**P. multicincta*; OD]. Elongate ovate, beaks subanterior, umbones low; hinge line straight, ligament external; dentition unknown; surface with strong rounded ridge from beaks to anterior margin, ending in marginal notch; 4 or 5 divergent radial ridges of varying strength from beaks to posterior margin, delimiting shallow indentations of shell margin. *Dev.*, S.Am.

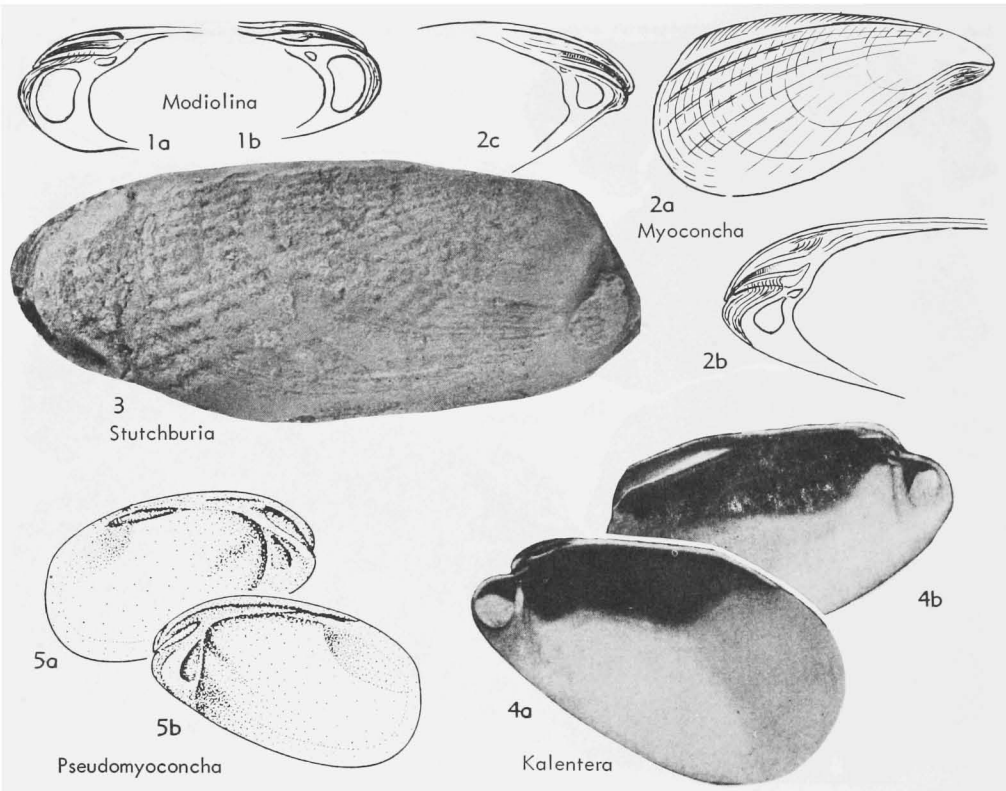


FIG. E46. Permophoridae (Permophorinae) *(4);* (Myoconchinae) *(1-3,5)* (p. *N*545, *N*547-*N*548).

(Ponta Grossa & Santa Cruz, Brazil).——FIG. E44, *7*. **P. multicincta,* Ponta Grossa, Brazil; ×1 *(138)*. [LAROCQUE]

?Pleurophorella GIRTY, 1904 [10] [**P. papillosa*; OD]. Externally like *Permophorus* but somewhat less inequilateral, thin, ornamented only by minute papillae and weak concentric lines; lunule and escutcheon sharply defined. Interior unknown. *U. Penn.*, N.Am.(Tex.).

Pseudopermophorus CIRIACKS, 1963 [3] [**P. annettae*; OD] [?=*Protrete* GIRTY, 1908 (type, *P. texana*; OD)]. Shell heavy, slightly inequivalve, RV more convex than LV, subquadrate, tapering slightly posteriorly; ventral margin gently indented medially at the termination of a broad medial sulcus; posterior and anterior margins broadly rounded; escutcheon deep, elongate, more prominent on the RV; lunule deeply invaginated as an ovoid cavity (brood pouch?) immediately above the anterior adductor; shell surface ornamented with coarse, rounded concentric fila, devoid of radial ornamentation; dentition *3b, (5b), (PIII)/2, 4b, PII* with *5b* barely distinguishable from the ligament nymph. *Perm.(Park City)*, USA(Mont.)-Japan.——FIG. E45,*1*. **P. annettae*; *1a,b,* LV int., RV int., ×2; *1c,* LV int., ×1 *(132)*. [NEWELL]

?Redonia ROUAULT, 1851 [7] [**R. deshayesiana;* SD P. FISCHER, 1886]. Subelliptical, with prominent beaks relatively far forward. Hinge with arcuate subhorizontal *2*, subelliptical *3b*, very long curved and transversely striated, *4b* and *5b* parallel to margin; posterior laterals fused together, anterior adductor on broad buttress. [Doubtfully belongs in Modiomorphidae.] *Ord.*, Eu.(France).——FIG. E44,*4*. **R. deshayesiana,* Brittany; *4a,b,* LV int., RV int., ×1; *4c,d,* LV and RV hinges, enl. (Chavan, n).

Rimmyjimina CHRONIC, 1952 [7] [**R. arcula*; OD]. Small, trapezoidal, relatively broad, convex, front more or less rounded, rear truncate; sculpture of irregular growth lines; lunule small, oval, well defined; narrow escutcheon bearing fine ligament groove. Hinge with narrow *3b,* posterior LV lateral long and broad. *Perm.*, N.Am.-Eu. (Aus.).——FIG. E44,*2*. **R. arcula,* USA(Ariz.); *2a,b,* RV int., LV int., ×5; *2c,d,* RV and LV hinges, ×3.5 *(669)*.

Triaphorus MARWICK, 1953 [3] [**Pleurophorus zelandicus* TRECHMANN, 1918; OD]. Transversely oval, prosogyrous beaks almost terminal; irregular concentric sculpture, radial ridges only on posterior surface; lunule deep, escutcheon well de-

fined. Hinge with very weak oblique *3a*, strong oblique *2* and *3b*, long, weak *4b* welded to long nymph; strong posterior laterals remote; anterior adductor on buttress below anterior cardinals, shallow pedal scar on their lower side. *U.Trias.*, N.Z.——Fig. E44,*5*. **T. zelandicus* (Trechmann), Otamitan; *5a-c*, RV ext., LV ext., RV hinge, ×1 *(599)*.

Subfamily MYOCONCHINAE Newell, 1957

[*nom. transl.* Chavan, herein (*ex* Myoconchidae Newell, 1957)]

Acuminate anteriorly, regularly enlarged posteriorly, mytili- to modioliform, angulated posterodorsally, surface with many fine radial threads, at least toward rear. Hinge with elongate *3b*, extremely narrow, linear *2* and *4b*, rather faint, *4b* fused with lower edge of nymph. *?M.Dev., Perm.-U. Cret.*

Arrangement of generic taxa by Chavan.——1. *Myoconcha*.——2. *Modiolina*.——3. *Daharina*.——4. *Pseudomyoconcha*.——5. *Stutchburia*.——6. *Pleurophorina*. [Insert above, 4a. *?Pseudosanguinolites*.]

Myoconcha J. de C. Sowerby, 1824 [**M. crassa*; M]. Modioliform, with long, narrow submarginal angulation bordered by furrow, surface with very fine numerous riblets. Cardinals *2* and *4b* thin, *3b* stronger, *PII* well developed, behind long nymph; myophoric buttress broad. *?Perm., L.Jur. (Lias.)-U.Cret.(Senon.)*, cosmop.

M. (Myoconcha) [1] [=*?Labayophorus* Likharev, 1939 (type, *L. magnus*; M]. Large, with terminal beaks, ribs vanishing toward anterior side. Cardinals nearly straight, those of LV very thin, low, *3b* generally trigonal; myophoric buttress low, moderate in extent. *?Perm., L.Jur.(Lias.)-U.Cret.(Senon.)*, cosmop.——Fig. E46,*2*. **M. (M.) crassa*, M.Jur.(Bajoc.), France; *2a-c*, RV ext., hinge, LV hinge, ×1 (Chavan, n).

M. (Modiolina) J. Müller, 1851 [2] [**M. bosqueti* (=*Lithodomus discrepans* Müller, 1847); OD]. Small, beaks not quite terminal, whole surface with fine radial and concentric riblets. Cardinals thin, *2* sinuate, *3b* somewhat curved; nymph relatively narrow; myophoric buttress broad. *U.Cret.(Senon.)*, Eu.——Fig. E46,*1*. **M. (M.) discrepans* (Müller), Campan., Neth.; *1a,b*, RV and LV hinges, ×1 (Chavan, n).

Daharina Dubar, 1948, p. 170 [3] [**Myoconcha (Daharina) gentili*; M]. Large, gibbose, thick-shelled, oval, obliquely elongated, smooth, with anterior, terminal beaks; posterodorsal region rather flattened, winglike; anteroventral margins with byssal gape; umbonal angle occupied in each valve by broad, thick hinge plate, posterior part of which bears in RV broad, elongate cardinal tooth, received in socket adjacent to nymph in LV; no lateral teeth; anterior adductor scar deep, on shell wall below hinge plate. *L.Jur.(U.Pliensb.)*, Afr.(Morocco).——Fig. E47,*1*. **D. gentili*; *1a,b*, LV ext., LV int. (broken post. region restored), ×0.4 (Dubar, 1948). [Cox]

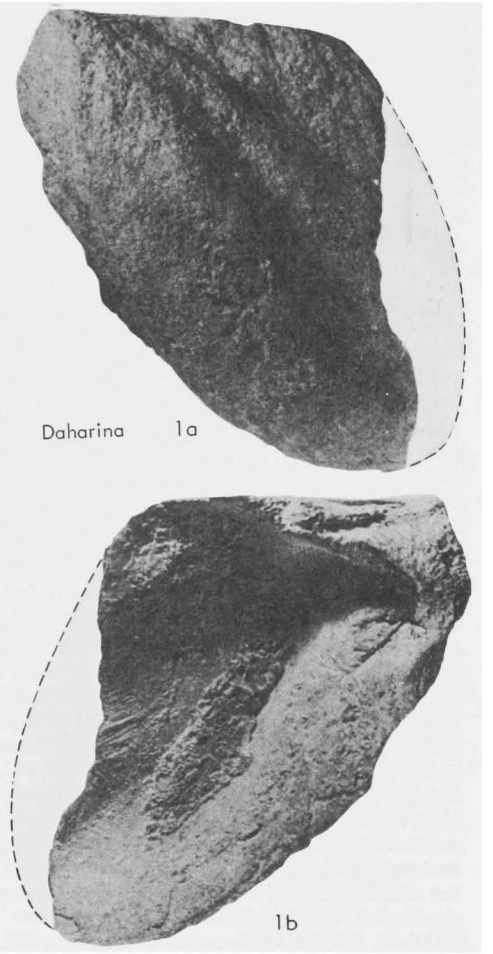


Fig. E47. Permophoridae (Myoconchinae) (p. *N*547).

?Modiella Hall, 1883, p. 4 [**Pterinea pygmaea* Conrad, 1842; M]. Similar externally to *Myoconcha* Sowerby (1824), *Modiolina* Müller (1851), and *Netschajewia* Yakovlev (1925); hinge details unknown. *M.Dev.*, USA(N.Y.). [Newell]

?Pleurophorina Likharev, 1925 [6] [**Pleurophorus simplex* Likharev, 1925 (=*Modiola simplex* Keyserling, 1846); M]. Externally like *Permophorus* but reported to lack cardinal *2*. *Perm.*, USSR.

Pseudomyoconcha Rossi Ronchetti, 1966 (1967) [4] [**Myoconcha lombardica* Hauer, 1857; OD].

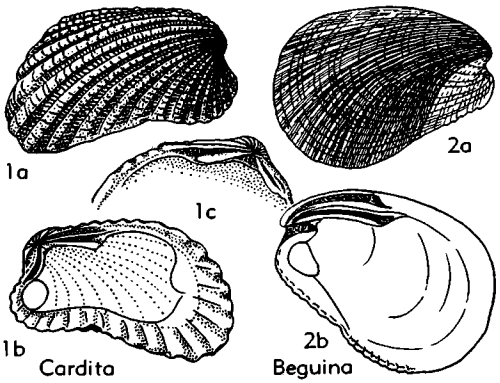


FIG. E48. Carditidae (Carditinae) (p. *N*548).

Very inequilateral, modioliform, more or less sinuate ventrally, strongly convex dorsally. Terminal curved beaks. External concentric irregular growths and radial lines. Broad anterior buttress. LV with *2*, *PII*, no developed *4b*; RV with *3b*, well marked *PIII*. *M.Trias.-U.Trias.*, Eu.(Italy-Ger.-Hung.)-Japan.——FIG. E46,*5*. **P. lombardica* (HAUER), U.Trias., Italy; *5a,b*, LV, RV int., ×1 (Rossi Ronchetti & Allasinaz, 1966).

?**Pseudosanguinolites** PATTE, 1929 (4a) [**P. douvillei*; M]. Transversely much elongated and curved, anterior side angular, posterior side more or less rounded; shell thick, with almost terminal, anterior beaks. Trapezoidal striated area above hinge plate, which in RV bears long posterior cardinal parallel to upper margin; external long narrow ligament; anterior part of hinge unknown, but elliptical anterior scar and ogival posterior one can be seen. *Dev.*, IndoChina.

?**Stahlia** E. FISCHER, 1915, p. 219 [**S. persica*; M]. Rectangular, elongate, not oblique; umbones terminal; evenly and rather strongly inflated; ornament of radial ribs, most prominent on dorsal part of shell, and concentric folds; anterior adductor scar moderately large, below beak; dentition unknown; said to gape posteriorly, but appearance of gape possibly due to imperfect preservation of type. [Possibly synonym of *Myoconcha*.] *L.Jur.(Toarc.)*, SW.Asia(Iran). [Cox]

Stutchburia ETHERIDGE, JR., 1900 [5] [**Orthonota? costata* MORRIS, 1845; OD]. Large, transversely subquadrate, ornamented posteriorly by coarse ribs; lunule and escutcheon developed. Cardinals *2* and *3b* obsolescent, likewise laterals *PI* and *PIII* but *PII* well marked. *Perm.*, cosmop.——FIG. E46, *3*. **S. costata* (MORRIS), Artinsk., Australia; RV ext., ×1 *(669)*.

Family CARDITIDAE Fleming, 1828

[*nom. correct.* COSSMANN, 1914 (*pro* Carditadae FLEMING, 1828]

Small to large, trapezoidal or rounded, with strong radial ribs and shell margin invariably crenulated internally; ligament external. Hinge with faint *3a* and thin *5b*, anterior laterals tuberculiform; anterior scars set on platform. *Dev.-Rec.*

Subfamily CARDITINAE Fleming, 1828

[*nom. transl.* CHAVAN, herein (*ex* Carditidae FLEMING, 1828)]

Mytiliform, with long *3b* and obsolete laterals. *Paleoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Cardita*.——2. *Jesonia*.——3. *Beguina*.

Cardita BRUGUIÈRE, 1792 [**Chama calyculata* LINNÉ, 1758; SD GRAY, 1847].[1] Transversely inequilateral, trapezoidal or modioliform, with nodulose radial ribs. Hinge with obliquely trigonal divergent cardinals in LV and faint anterior laterals. *Paleoc.-Rec.*, cosmop.

C. (Cardita) [1] [=*Arcinella* OKEN, 1815 (rejected by ICZN, 1956, Opinion 417, as nonbinominal) (*non* SCHUMACHER, 1817) (obj.); *Mytilicardita* ANTON, 1839 (obj.)]. Relatively small, short; lunule not depressed. Cardinal *3b* elongated backward-inward. *Paleoc.-Rec.*, Eu.-Afr.-Asia-Australia.——FIG. E48,*1*. **C. (C.) calyculata* (LINNÉ), Rec., Medit.; *1a-c*, RV ext., RV int., LV hinge, ×1 (*7*; Chavan, n).

C. (Jesonia) GRAY, 1847 [2] [**Perna jeson* ADANSON, 1757, p. 217 (invalid, pre-Linnaean) (=*Cardita senegalensis* REEVE, 1843); OD] [=*Mytilicardes* DE BLAINVILLE, 1824 (vernacular); *Jesonia* GRAY, 1840 *(nom. nud.)*; *Mytilocardia* AGASSIZ, 1847 (obj.); *Mytilicardia* TRYON, 1872 (obj.)]. Medium-sized, notably elongated, with commonly squamose ribs. Cardinal *3b* scaleniform, prolonged only backward, *AI* lacking but posterior laterals moderately distinct; lunule sunken. *Oligo.-Rec.*, cosmop.

Beguina RÖDING, 1798 [3] [**B. nephritica* (=*Chama phrenetica* BORN, 1780, =**C. semiorbiculata* LINNÉ, 1758); M] [=*Azarella* GRAY, 1854]. Broad modioliform, compressed, with fine intersecting growth lines and disparate radial riblets; beaks stretched out to cover anterior part of hinge. Posterior cardinals much elongated, laterals wanting. *Rec.*, Afr.-Asia-Polynesia.——FIG. E48,*2*. **B. semiorbiculata* (LINNÉ), Ind.O.; *2a,b*, RV ext., int., ×0.8 *(124b)*.

Subfamily CARDITAMERINAE Chavan, new subfamily

More or less trigonal or transversely trapezoidal, with strong radial ribs. Cardinal *3a*

[1] According to International Code (Art. 69,a,iii), type species is *Cardita variegata* BRUGUIÈRE, 1792; SD FLEMING, 1818. In opinion of CHAVAN, FLEMING's designation was not explicit and therefore not to be recognized.—Ed.

present,*3b* V-shaped, laterals fairly well developed. *U.Trias.(Carn.)-Rec.*

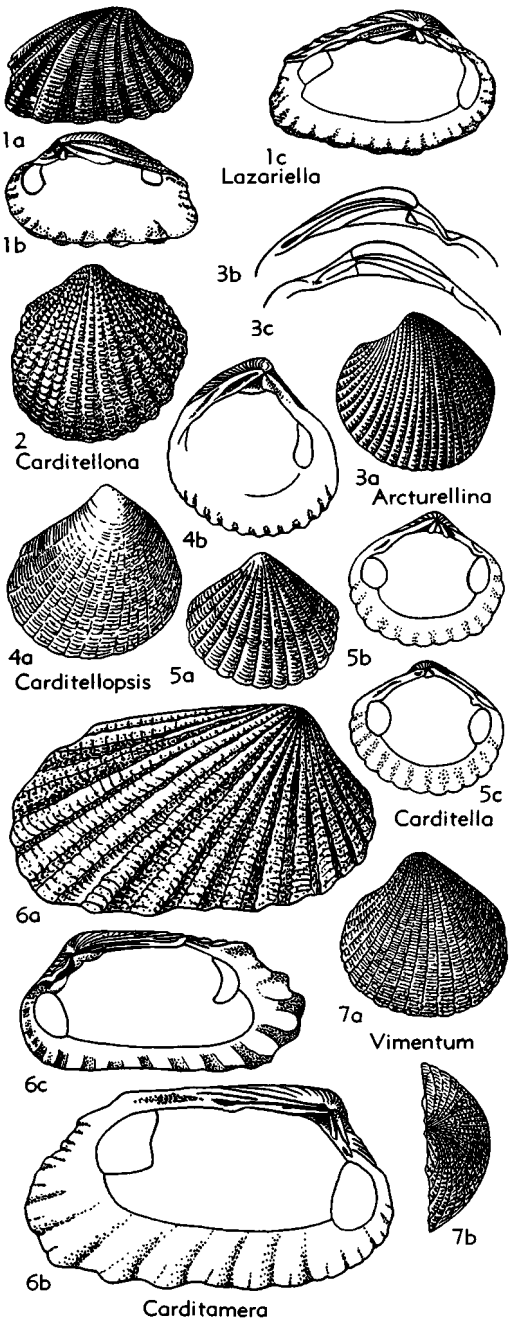


FIG. E49. Carditidae (Carditamerinae) (p. *N*549-*N*551).

Arrangement of generic taxa by CHAVAN.——1. *Carditamera.*——2. *Lazariella.*——3. *Glans.*——4. *Centrocardita.*——5. *Goossensia.*——6. *Carditella.*——7. *Carditellona.*——8. *Cyclocardia.*——9. *Scalaricardia.*——10. *Plionema.*——11. *Vimentum.*——12. *Vetericardiella.*——13. *Miodontiscus.*——14. *Tutcheria.*——15. *Choniocardia.*——16. *Carditellopsis.*——17. *Arcturellina.*——18. *Izumicardia.*——19. *Pleuromeris.*——20. *Cossmannella.*——21. *Cardiocardita.*——22. *Bathycardita.* [Insert above, 11a. *Fenestricardita;* 20a. *Cretocardia.*]

Carditamera CONRAD, 1838 [**Cypricardia arata* CONRAD, 1832; OD]. Transversely subrectangular to trapezoidal, solid, somewhat compressed, with subparallel dorsal and ventral margins; sculpture of flabellate ribs, posterior ones unequal; lunule oblique. Cardinal teeth strong, laterals (except *AIII, AIV,* and in some shells *PIV*) well defined. *U.Eoc.-Rec.,* W.Eu.-Afr.-N.Am.

C. (Carditamera) [1] [=*Lazaria* GRAY, 1854 (type, *Cardita radiata* SOWERBY, 1833; SD DALL, 1903)]. Elongate, posterior margin rounded or with slight straight truncation; ribs rugose. Hinge with faint *PIV. U.Eoc.-Rec.,* N.Am.-W.Eu.-?E. Afr.——FIG. E49,*6a,b.* **C. (C.) arata arata* (CONRAD), Mio., USA(N.Car.); *6a,b,* RV ext., LV int., ×1 (Conrad, 1839).——FIG. E49,*6c. C. (C.) arata verdevilla* GARDNER, Mio., USA(N. Car.); RV int., ×0.8 (Gardner, 1943). [=*Byssomera* OLSSON, 1961 (type, *Cardita affinis* SOWERBY, 1832; OD).]

C. (Lazariella) SACCO, 1899 [2] [**Cardita subalpina* MICHELOTTI, 1839; OD]. Shorter than *C. (Carditamera),* with concave anal truncation, more widely spaced ribs which are subquadrate and strong. Cardinals *3a* and *3b* scaleniform, laterals *AI* and *PIII* obsolete. *L.Mio.(Aquitan.)-Rec.,* SW.Eu.-W.Afr.——FIG. E49,*1. C. (L.) hippopaea* (BASTEROT), Aquitan., S.France; *1a-c,* RV ext., int., LV int., ×1 *(165).*

Arcturellina CHAVAN, 1951 [17] [*nom. subst. pro Arcturella* CHAVAN, 1941 (*non* SARS, 1897)] [**Venericardia asperula* DESHAYES, 1825; OD]. Small to medium-sized, inequilateral, trapezoidal to rounded, moderately convex; with regularly striate or squamose radial ribs; beaks small, rounded; lunule relatively convex and long, bounded forward by oblique furrow. Hinge with very thin *3a,* almost obsolete, and trigonal to subrectangular *3b* with subvertical anterior face and backward extension; *AII* linear, *PII* and *PIII* faint; shell margin deeply indented internally by ends of ribs. *Paleoc.-Rec.,* Eu.-Afr.-S.Am.-Australia.——FIG. E49,*3. *A. asperula* (DESHAYES), M.Eoc. (Lutet.), France(Paris basin); *3a,* LV ext., ×1 (Deshayes, 1837); *3b,c,* LV and RV hinges, ca. ×1.8 *(101).*

Carditella E. A. SMITH, 1881 [**C. pallida*; SD DALL, 1903]. Small, with flabellate ribs crossed

by concentric growth lines; lunule elongate; ligament small, external, adjacent to restricted resilium just behind beak and slightly narrowing tops of *3b* and *4b*. Each valve with 2 unequal cardinals and 2 remote, well-defined laterals. *Plio.-Rec.*, S. Am. - Australia - E. Asia (Japan - Formosa)-S. Atl. (Tristan da Cunha).

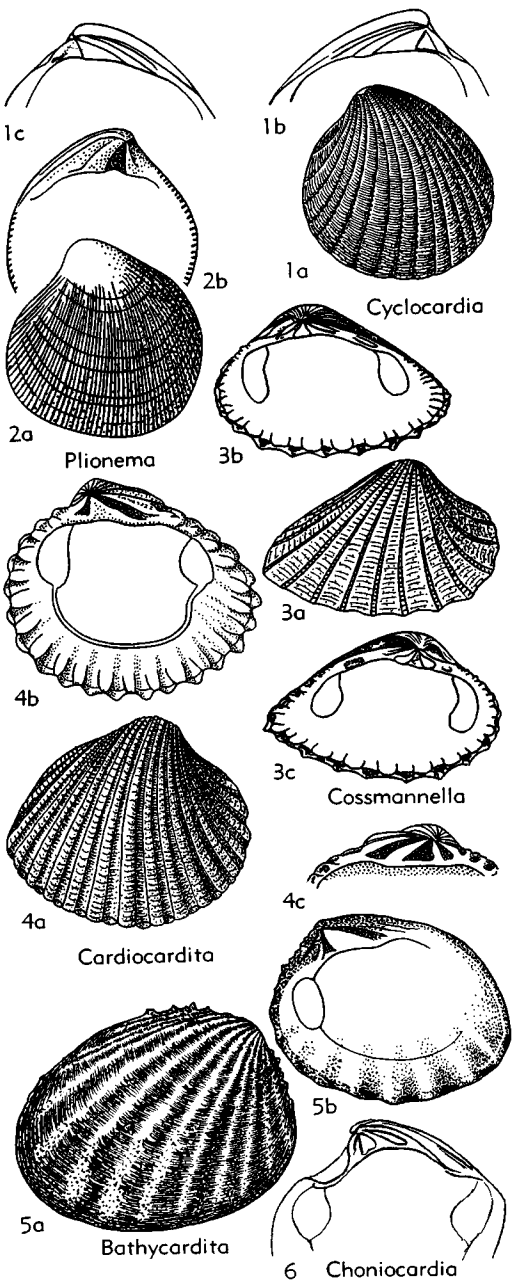


FIG. E50. Carditidae (Carditamerinae) (p. *N550-N551*).

C. (Carditella) [6]. Slightly inequilateral, mostly trigonal, with broad, close-spaced ribs. Cardinal *3a* fused to lunular margin. *Rec.*, S.Am.-Japan. ——FIG. E49,*5*. **C. (C.) pallida*, S.Am. (Port Rosario); *5a-c*, LV ext., int., RV int., ca. ×4 (Smith, 1881).

C. (Carditellona) IREDALE, 1936 [7] [**C. angasi* E. A. SMITH, 1885; OD]. Very inequilateral, obliquely rounded, with well-spaced squamose ribs. Hinge with *3a* more distinct and *AI* shorter than in *C. (Carditella)*. *Plio.-Rec.*, Australia-W. Pac.O.——FIG. E49,*2*. **C. (C.) angasi* SMITH, Australia (Port Jackson); RV ext., much enl. *(852)*.

Cardiocardita ANTON, 1839 [**Chama ajar* ADANSON, 1757 (invalid, pre-Linnaean) (=*Cardita ajar* BRUGUIÈRE, 1792); SD HERRMANNSEN, 1846]. Inequilateral, subtrapezoidal, rounded in front, obliquely truncate at rear; with strong nodular or echinate ribs; beaks low. Hinge with trihedral cardinals, *3a* very small, *3b* straight, sharp-sided, at mid-hinge; anterior laterals minute, almost obsolete. *M.Eoc.-Rec.*, SW.Eu.-Afr.-Pac.O.-Australasia.

C. (Cardiocardita) [21] [=*Cardiocardites* DE BLAINVILLE, 1825 (vernacular); *Agaria* GRAY, 1840 (obj.); *Azaria* TRYON, 1872 (*nom. null.*); *Divergidens* EAMES, 1957 (type, *Cardita triparticostata* NEWTON, 1922; OD)]. Anteriorly angular, ribs commonly well spaced and sharply defined; lunule slightly depressed. *M.Eoc.-Rec.*, SW. Eu.-Afr.-Pac.O.-N.Z.——FIG. E50,*4*. **C. (C.) ajar* (BRUGUIÈRE), Rec., W.Afr.(Senegal); *4a,b*, RV ext., int., ×1 *(7)*.

C. (Bathycardita) IREDALE, 1925 [22] [**Cardita raouli* ANGAS, 1872; OD]. More rounded than *C. (Cardiocardita)* and with less sharply delimited, spinose ribs; lunule deep. *Rec.*, Australia. ——FIG. E50,*5*. **C. (B.) raouli* (ANGAS), Tasmania; *5a,b*, RV ext., int., ×1 *(431)*.

Choniocardia COSSMANN, 1904 [**Venericardia (C.) oppenheimi*; OD]. Relatively small, depressed, with reticulate or striate ribs; lunule broad, well defined, flat and somewhat depressed. Hinge with nearly symmetrical LV cardinals, *3b* straight trigonal, *3a* oblique; anterior and posterior laterals present. *L.Eoc.-Rec.*, Eu.-Australia-E.Asia(Japan).

C. (Choniocardia) [15]. Rounded trigonal to subtrapezoidal, truncate posteriorly; with finely reticulate ribs; lunule oblique, sunken. *L.Eoc.-U.Eoc.*, W.Eu.——FIG. E50,*6*. **C. (C.) oppenheimi* (COSSMANN), M.Eoc.(Lutet.), W.France; RV int., ×3 (Chavan, n).

C. (Carditellopsis) IREDALE, 1936 [16] [**Carditella elegantula* TATE & MAY, 1901; OD]. Rounded trigonal, solid, slightly inequilateral, tending

to be slightly oblong with front side produced and no definite anterior lamellae; with broad, flattened ribs crossed by concentric striae; lunule not depressed. *M.Eoc.-Rec.,* W.Eu.-W.Pac.O.-Australia.——Fig. E49,*4*. **C. (C.) elegantula* (Tate & May), Rec., Australia; *4a,b,* RV ext., LV int., much enl. (Tate & May, 1901).

Cossmannella Mayer-Eymar, 1896 [20] [*"*Cardita (C.) aegyptiaca* Fraas" of Mayer-Eymar, 1896 (=*Cardium aegyptiacum* Mayer, 1896, *non* Fraas, 1867; =*Cardita fajumensis* Oppenheim, 1903); OD] [=*Amekiglans* Eames, 1957 (type, *Cardita costaenodulosis* Newton, 1922; OD)]. Transversely trigonal, subrounded in front, acuminate in rear; with flat ribs separated by narrow interspaces. Hinge with *3b* nearly isosceles triangular, *2* and *4b* subsymmetrical, anterior RV laterals obsolete. *AII* and remote posterior lamellae well marked. *Paleoc.-L.Mio.,* Afr.-Asia(India).——Fig. E50,*3*. *C. costaenodulosis* Newton, M.Eoc., W.Afr. (Nigeria); *3a-c,* RV ext., int., LV int., ×2 *(99)*.

Cretocardia Conrad, 1877 (20a) [**Cardita jaquinoti* Stoliczka, 1871 (=*?Cardium jaquinoti* d'Orbigny, 1847) (=*Cardita orbicularis* Forbes, 1846, *non* Sowerby, 1825); OD]. Subquadrangular, inflated, very inequilateral, with tripartite somewhat tubercular ribs separated by deep trough. Diverging thick *3a* and *3b, 2* small, tubercular and median, *4b* very long, rather thin, curved; minute tuberculiform laterals. *U.Cret.,* India.

Cyclocardia Conrad, 1867 [**Cardita borealis* Conrad, 1831; SD Stoliczka, 1871]. Subtrigonal or short trapezoidal to cordiform, thickened or somewhat compressed, ventral margin well rounded; regular radial ribs may be closely spaced, crossed by numerous equidistant growth lines; beaks very small, tending to be erect. Hinge with very faint *AII* and *PIII,* other laterals virtually obsolete; cardinals strong, *3b* straight in front, *2* straight, equilateral. *U.Cret.(Cenoman.)-Rec.,* cosmop.

C. (Cyclocardia) [8] [=*Arcturus* Humphrey in Gray, 1839 (*non* Berthold in Latreille, 1827; *nec* Curtis, 1830) (obj.); *Bendeglans* Eames, 1957 (type, *Cardita costaeirregularis* Newton, 1922; OD)]. Juvenile-stage ribs narrow, rounded, equally perlate, later becoming flattened and broadened, crossed by close-spaced growth lines; lunule large, smooth, slightly convex. *M.Eoc.-Rec.,* cosmop.——Fig. E50,*1a*. **C. (C.) borealis* (Conrad), Rec., USA(Mass.); LV ext., ×0.8 (Gould, 1841).——Fig. E50,*1b,c*. *C. (C.) granulata* (Say), Mio., USA(Md.); *1b,c,* LV and RV hinges, enl. *(101)*. [=*Strophocardia* Olsson, 1961 (type, *Venericardia megastropha* Gray, 1825; OD).]

C. (Plionema) Conrad, 1872 [10] [**Astarte guerangeri* d'Orbigny, 1843; M]. Small, fine radial ribs very numerous; lacking distinct lunule. Hinge with *2* and *4b* almost equally strong and oblique, *2b* short; laterals wanting. *U.Cret.(Cenoman.),* Eu.——Fig. E50,*2*. **C. (P.) guerangeri* (d'Orbigny), W.France; *2a,b,* LV ext., int., enl. *(695)*.

C. (Scalaricardita) Sacco, 1899 [9] [**Miodon (S.) scalaris* (=*Venericardia scalaris* J. de C. Sowerby, 1825); OD]. Ribs everywhere closely spaced, in young stage flat and regularly incised by furrows which may be slightly oblique; lunule elongate, flat, ill-defined. Hinge with remote, faint anterior laterals and longer, linear posterior laterals; *3b* trigonal-rectangular, *2* vertical, *4b* oblique. *Oligo.-Neog.,* Eu.(Aus.).

C. (Vimentum) Iredale, 1925 [11] [**Cardita dilecta* E. A. Smith, 1885; OD]. Transversely ovate, numerous rounded regular ribs crossed by very close-spaced concentric riblets; lunule cordiform, relatively elongate. Cardinal *3b* conical. *Plio.-Rec.,* Eu. (W. France) - Australia.——Fig. E49,*7*. **C. (V.) dilecta* (Smith), Rec., Australia (Bass Str.); *7a,b,* LV lat., dorsal, enl. *(852)*.

Fenestricardita Casey, 1961 [11a] [**Venus ?fenestrata* Forbes, 1845; OD]. Transversely trapezoidal, posteriorly elongated. Regularly reticulated by narrow concentric and squamose radial ribs. Hinge with marginal *3a,* high trigonal *3b,* oblique *5b,* narrow subvertical *2* and strong sharp, oblique *4b;* marginal *AII,* long well-marked *PIII;* depressed ligament. *L.Cret.-M.Cret.,* W.Eu.

Glans Megerle, 1811 [**Chama trapezia* Linné, 1767; SD Herrmannsen, 1846]. Quadrangular trapeziform, convex, inequilateral, with nodulose or squamose ribs; lunule with convex margin. Hinge as in *Carditamera* but *AIII* and *PII* faint and *PIII* less developed. Shell with well-marked medioposterior dorsal angulation. *Paleoc.-Rec.,* Eu.-Asia-N.Afr.-E.Afr.-Australia-C.Am.

G. (Glans) [3]. Truncate posteriorly, with nodulose or granular rounded ribs, posterior ones unequal in some species. Lateral teeth well developed. *Paleoc.-Rec.,* Eu.-Asia-N.Afr.-E.Afr.-C.Am.——Fig. E51,*5*. **G. (G.) trapezia* (Linné), Rec., Medit.; *5a-c,* RV ext., RV and LV hinges, ×3 *(89a, 101)*.

G. (Centrocardita) Sacco, 1899 [4] [**G.? aculeata* (=**Chama aculeata* Poli, 1795); OD]. Posterior margin rounded, with equal squamose or echinate ribs. Hinge with almost obsolete small laterals. *U.Eoc.-Rec.,* Eu.-E.Afr.-Australia.——Fig. E51,*1*. *G. (C.) aequicostata* (Cossmann), U.Eoc., France (Paris basin); *1a,b,* RV ext., int., ×1 *(160)*.

Goossensia Cossmann, 1885 [5] [**G. plicatuloides* (=*Cardita irregularis* Deshayes, 1860); M]. Relatively small, subtrapeziform, sinuate, very inequilateral, with concentric growth lines intersecting radial ribs which commonly are squamose; lunule depressed. Cardinals and laterals present, *3b* trigonal; shell margin internally irregularly denticulate. *Paleoc.-Eoc.,* W.Eu.——Fig. E51,*7*. **G. irregularis* (Deshayes), M.Eoc.(Lutet.), France

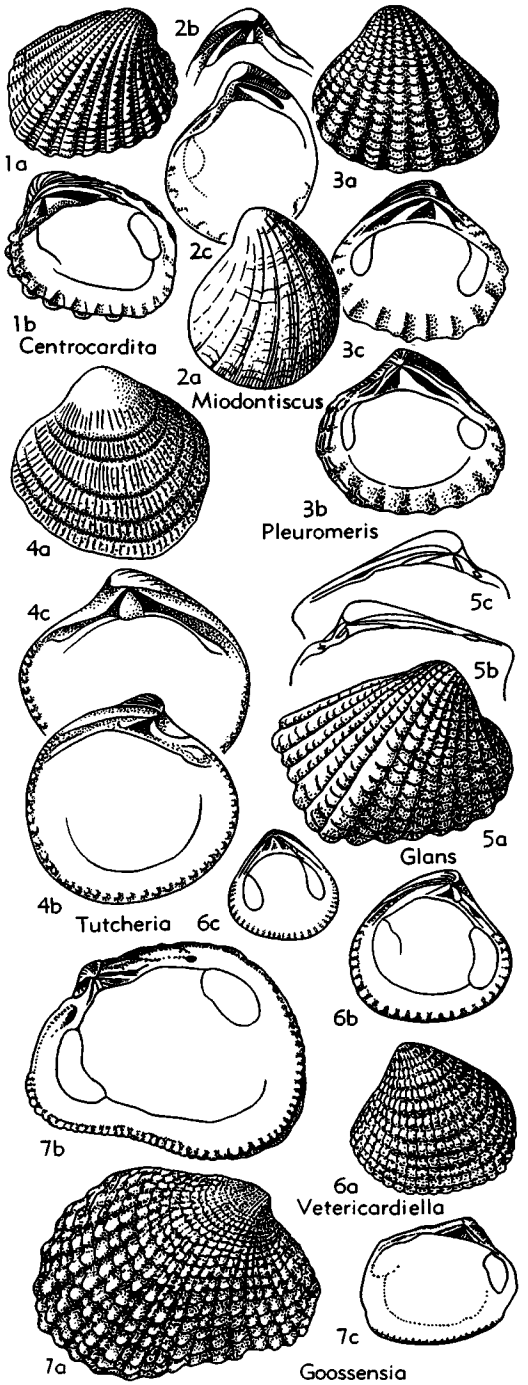


FIG. E51. Carditidae (Carditamerinae) (p. *N551-N553*).

(Paris basin); *7a,b,* RV ext., int., ×3 *(259)*; *7c,* LV int., ×2.5 *(160)*.

I...icardia ICHIKAWA in ICHIKAWA & MAEDA, 1963, p. 119 [18] [**I. parva* ICHIKAWA & MAEDA, 1963; OD]. Moderately small, roundly subquadrate, with prominent prosogyrous beaks; surface with strong, regular, approximate radial ribs. Ventral hinge margin straight, hinge with short, trigonal *3b,* lamellar *3a* and *5b, AII* horizontal, long and straight, reaching lower anterior angle of trigonal *2b, AI* horizontal, then ascending obliquely beneath lunular margin, *4b* present; posterior laterals tuberculiform. *U.Cret.(U.Senon.),* Japan.——FIG. E52,*1*. **I. parva* ICHIKAWA & MAEDA, Campan.; *1a,b,* LV int., RV int., ×1.5 *(426)*.

Miodontiscus DALL, 1903 [13] [*nom. subst. pro Miodon* CARPENTER, 1863 (*non* DUMÉRIL, 1859; *nec* SANDBERGER, 1870)] [**Miodon prolongatus* CARPENTER, 1863; OD]. Small, obliquely oblong, with strongly prosogyrate beaks and long, ill-defined lunule; sculpture of broad radial ribs crossed by concentric furrows. Cardinals oblique, scalariform, *2* short and subparallel to *4b,* which is much elongated, like *3b*; anterior laterals obsolete, posteriors very faint. *Plio.-Rec.,* W.N.Am.-Japan.——FIG. E51,*2*. **M. prolongatus* (CARPENTER), Rec., USA(Calif.); *2a-c,* LV ext., int., RV hinge, ×4 (Keen, 1939).

Pleuromeris CONRAD, 1867 [19] [**P. decemcostata* (=**Venericardia tridentata* SAY, 1826, *decemcostata* CONRAD, 1867; *non Cardita tridentata* REEVE, 1843); OD] [=*?Cycloglans* GORODISKI & FRENEIX, 1959 (1960) (type, *Glans (C.) schencki* FRENEIX *ex* GORODISKI & FRENEIX, MS; OD)]. Rounded trigonal, small, solid, relatively inflated, with erect beaks; radial ribs granular to squamose, large, tending to square transverse profile; lunule elongate, depressed or slightly convex. Hinge with long, partly undetached *3a,* trigonal *3b,* and short, stout *2* and *4b*; anterior laterals narrow but well defined *AIV* lacking, *PII, PIII, PIV* present. *?Eoc., Mio.-Rec.,* N.Am.-Australia-?C.Afr.——FIG. E51,*3*. **P. tridentata decemcostata* CONRAD, Mio., USA (N.Car.); *3a-c,* LV ext., RV int., LV int., ×2.2 (Gardner, 1943).

Tutcheria Cox, 1946 [14] [**Cardium submulticostatum* D'ORBIGNY, 1850 (*pro C. multicostatum* PHILLIPS, 1829, *non* BROCCHI, 1814; OD]. Quadrate to rounded, small, with large, depressed lunule and false escutcheon. Hinge strong, with trigonal, short, entire *3b, 2,* and *4b*; strong tuberculose laterals. *U.Trias.(Carn.)-L.Jur.(Aalen.),* Eu.-S.Am.-N.Z.——FIG. E51,*4*. *T. cingulata* (GOLDFUSS), L. Jur.(Lias.), Eng.; *4a-c,* LV ext., LV int., RV int., ×8 *(187)*.

Vetericardiella CHAVAN, **new genus,** herein [12] [*nom. subst. pro Vetericardia* AUCTT. (*non* CONRAD, 1872)] [**Astarte crenalirata* CONRAD, 1860; OD]. Trigonal, slightly inequilateral, with radial ribs

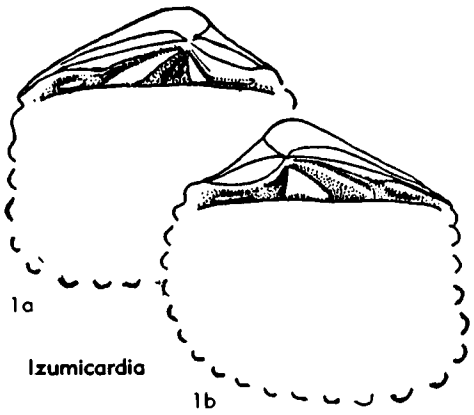


FIG. E52. Carditidae (Carditamerinae) (p. *N552*).

regularly cut off by strong, deeply separated concentric furrows; lunule large, impressed. Elongate laterals on each side of hinge, *3b* short, isosceles triangular, *2* and *4b* equally oblique. *U.Cret. (Senon.)*, N.Am.——FIG. E51,*6a,b*. **V. crenalirata* (CONRAD), USA(Tenn.); *6a,b*, LV ext., int., ×4 *(951)*.——FIG. E51,*6c*. *V. webervillensis* (STEPHENSON), USA(Tex.); RV int., ×3 *(889)*.

[*Vetericardia* is a generic name invalidly proposed by CONRAD (1872, p. 52) as replacement of *Vetocardia* CONRAD, 1868 (Feb., 1869, p. 246), which is an objective junior synonym of *Pseudocardia* CONRAD, 1866 (p. 103) because published as a substitute name for the latter. A type species of *Pseudocardia* was not designated by CONRAD and STOLICZKA's (1871, p. 283) somewhat casual mention of *Venericardia dupiniana* (=*Cardita dupiniana* D'ORBIGNY, 1843) as a form that "can fairly be taken" as the type of *Vetocardia* (and hence of *Pseudocardia*) fails to qualify with provisions of the Code (1961, art. 67,c) as an explicit subsequent designation of a type species. A valid fixation of the type species of *Pseudocardia* was first made by CHAVAN (1952, p. 117) in naming "*C. Smidti* HORN." (presumed to be an erroneous citation of *Cardium schmidti* HÖRNES), eligible as one of the species originally assigned to the genus by CONRAD. STEPHENSON (1941, p. 175) invalidly designated *Astarte crenalirata* CONRAD (1860) as type species of *Vetericardia* CONRAD. A new name consequently is required for the genus based on *A. crenalirata*; *Vetericardiella* is chosen.]

Subfamily MIODOMERIDINAE Chavan, new subfamily

Small, oblong, astartiform shells with immature ligament inframarginal. Large hinge plate with oblique *3b* and lacking *3a*. *Paleoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Miodomeris*.——2. *Chavanella*.——3. *Pteromeris*.——4. *Coripia*.

Miodomeris CHAVAN, 1936 [**Eomiodon (M.) cossmanni* CHAVAN, 1936; SD CHAVAN, 1938]. Compressed, with close-spaced concentric ribs and radial threads developed mainly at both ends; lunule with convex margin. Hinge with cardinals and laterals. *Paleoc.-U.Eoc.*, Eu.(France-Belg.).

M. (Miodomeris) [1]. Moderately thickened, oblique, with radial lines distinct; ligament marginal. Laterals relatively faint, posterior ones not very remote. *M.Eoc.-U.Eoc.*, Eu.(France).——FIG. E53,*1*. **M. (M.) cossmanni* (CHAVAN), Lutet., W.France; *1a*, LV ext., ×10 *(96)*; *1b,c*, RV and LV hinges, enl. *(96)*.

M. (Chavanella) JAWORSKI, 1938 [2] [*pro Eomiodon* CHAVAN, 1936 (*non* Cox, 1935)] [**Miodon semen* COSSMANN, 1908; OD]. Thickened, only slightly oblique, radial ribs faint; ligament inframarginal. Hinge with subsymmetrical *2* and *4b*, laterals well marked, posterior ones remote. *Paleoc.-U.Eoc.*, Eu.(Belg.-France).——FIG. E53, *3*. **M. (C.) semen* (COSSMANN), Paleoc.(Mont.), Belg.; *3a,b*, LV and RV hinges, enl. *(97)*.

Pteromeris CONRAD, 1862 [**Cardita perplana* CONRAD, 1841 (=*Astarte radians* CONRAD, 1845); OD] [*non Pteromeris* CONRAD, 1865]. Somewhat compressed, oblong, obliquely rounded; with concentric and radial ribbing; lunule ill-defined. Hinge with obsolete posterior laterals. *L.Mio.(Aquitan.)-Rec.*, W.Eu.-N.Am.-N.Z.

P. (Pteromeris) [3]. Radial ribs predominating over concentric ones laterally and around beaks; ligament marginal. *L.Mio.(Aquitan.)-Rec.*, W.Eu.-

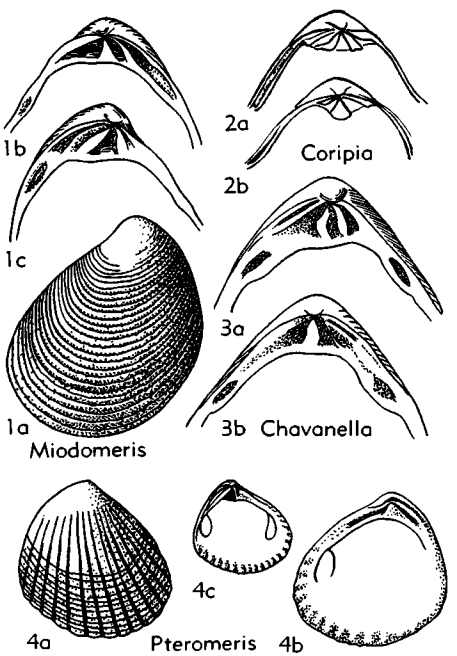


FIG. E53. Carditidae (Miodomeridinae) (p. *N553*-*N554*).

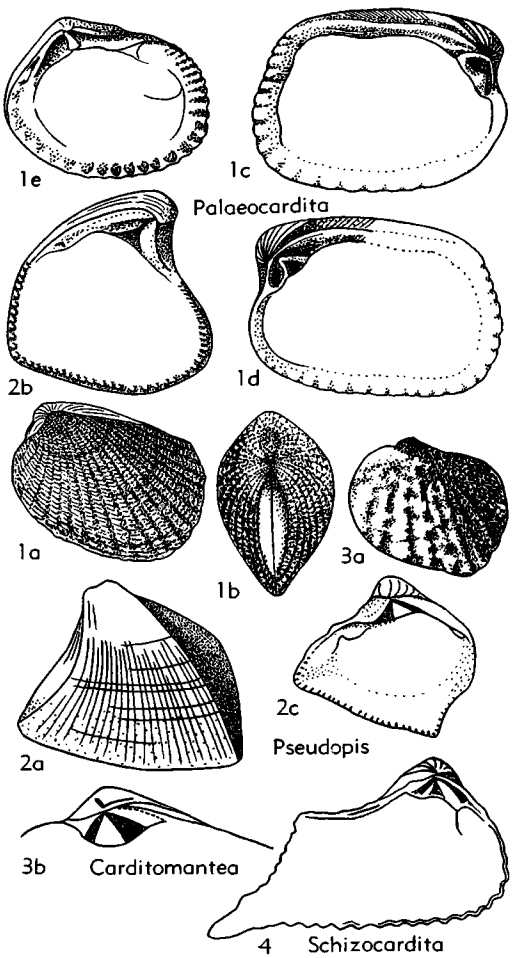


FIG. E54. Carditidae (Palaeocarditinae) (p. *N*554).

N.Am.-N.Z.——FIG. E53,*4*. *P. (P.) perplana abbreviata* (CONRAD), Mio., USA(N.Car.); *4a,b,* RV ext., int., ×3.8; *4c,* LV int., ×4 (Gardner, 1943).

P. (Coripia) DE GREGORIO, 1885 [4] [**Cardita (C.) corbis* (=*Cardita corbis* PHILIPPI, 1836, =*C. minuta* SCACCHI, 1836); M]. Sculpture uniformly reticulate; ligament partly internal. *Mio. (Helvet.)-Rec.,* W.Eu.——FIG. E53,*2*. **P. (C.) corbis* (PHILIPPI), Rec., Medit.; *2a,b,* LV and RV hinges, enl. (Chavan, n).

Subfamily PALAEOCARDITINAE Chavan new subfamily

Posteriorly enlarged to trigoniform, beaks orthogyrous or opisthogyrous, tending to be recurved. Hinge with high, pointed *3b*. *L. Dev.(Downton.)-L.Jur.*

Arrangement of generic taxa by CHAVAN.——1. *Palaeocardita.*——2. *Carditomantea.*——3. *Schizocardita.*——4. *Pseudopis.*

Palaeocardita CONRAD, 1867 [1] [**Cardita austriaca* (=**Cardium austriacum* HAUER, 1853); OD]. Inequilateral, enlarged posteriorly, with granulose or tripartite ribs; beaks almost orthogyrous. Hinge with well-developed cardinals and distant LV posterior lateral. *Trias.,* N.Z.-Eu.——FIG. E54,*1a-d*. *P. crenata* (MÜNSTER), M.Trias.(Ladin.), Aus.(Tyrol); *1a,b,* LV and dorsal views of both valves, ×1 (Münster, 1841); *1c,d,* LV int., RV int., enl. (Laube, 1865).——FIG. E54,*1e*. **P. austriaca* (HAUER), U.Trias.(Rhaet.), Aus.(Tyrol); RV int., ×1 (Stoppani, 1860-65).

Carditomantea QUENSTEDT, 1929 [2] [**C. spinata*; OD]. Trapezoidal, inequilateral, enlarged and rounded posteriorly, with mediposterior angulation; ribs spinose. Hinge with stout trigonal *3b* and well-marked *2* and *4b*; hinge plate enlarged downward. *L.Dev.(Downton.),* Arctic O.(Spitz.).——FIG. E54,*3*. **C. spinata*; *3a,* LV ext., ×1; *3b,* RV hinge, ×4 (Quenstedt, 1929).

Pseudopis Cox, 1946 [4] [**P. astonensis*; OD]. Relatively small, subquadrate, posterior margin vertically truncate, exterior sharply bicarinate, covered by fine radial threads, growth stages defined; beaks strongly prosogyrous; lunule small, deep; escutcheon lacking. Each valve with single anterior lateral, in LV prolonged by *2*, cardinal *4b* oblique, *3b* short; *PI* weak, *PII* present. *L.Jur. (Lias.),* Eu.(Eng.-France).——FIG. E54,*2*. *P. deslongchampsi* (TATE), M.Lias., Eng.; *2a-c,* LV ext., int., RV int., enl. *(187)*.

Schizocardita KÖRNER, 1937 [3] [**S. cristata*; OD]. Trigoniform, rounded in front, acuminate and biangulated posteriorly; beaks angular, prominent, slightly opisthogyrous. LV with 2 subequal diverging cardinals and single long, remote posterior lateral; RV with small anterior cardinal oblique, and trigonal, high, bifid median one, with base acuminate onward; long, curved, marginal lateral. *Trias.,* S.Am.(Peru).——FIG. E54,*4*. **S. cristata*; LV int., ×2 *(482)*.

Subfamily VENERICARDIINAE Chavan, new subfamily

Outline subtrapezoidal to rounded trigonal, beaks strongly prosogyrous, with penetrating lunule. Hinge with laminar *3a,* other cardinals curved, laterals approximate, almost obsolete. *?U.Cret.(Senon.), Paleoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Venericardia.*——2. *Venericor.*——3. *Leuroactis.*

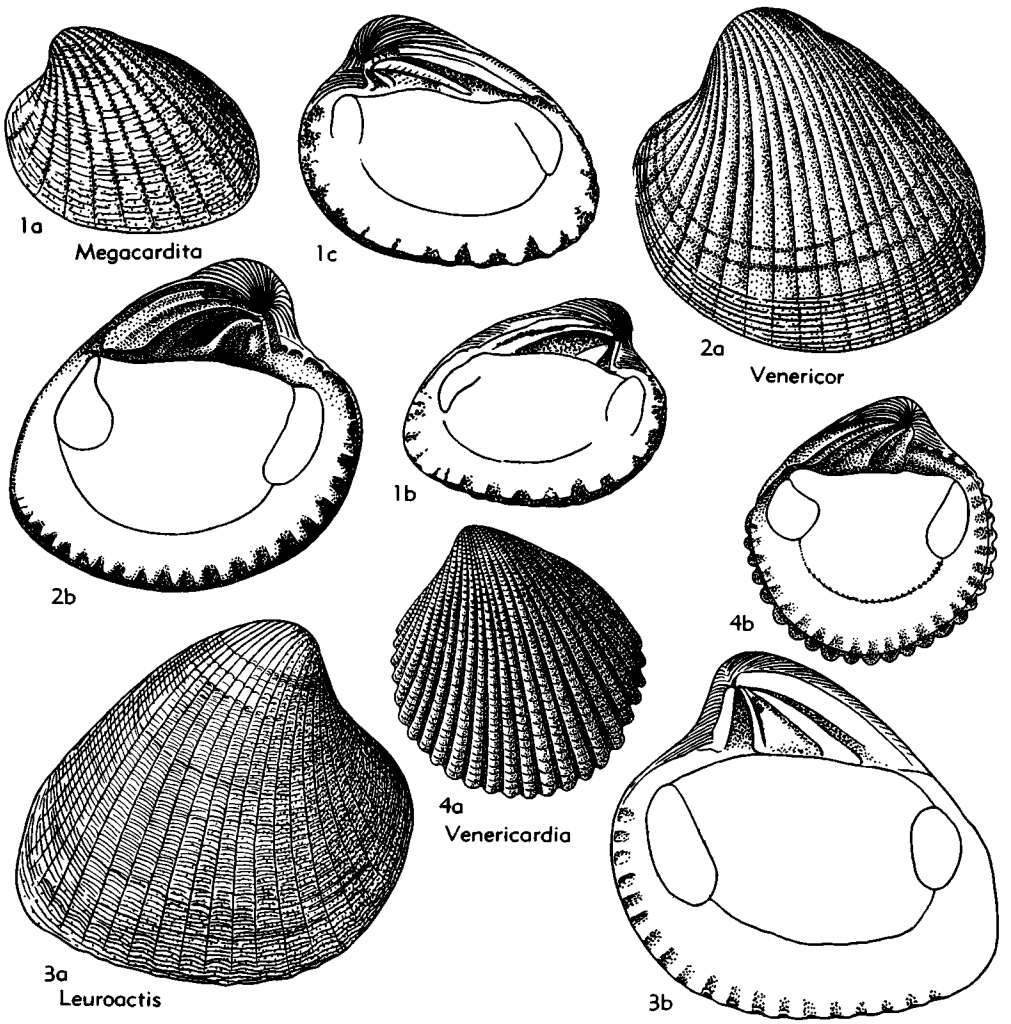


FIG. E55. Carditidae (Venericardiinae) (p. *N555-N556*).

——4. *Pacificor.*——5. *Megacardita.*——6. *Trapezicardita.*

Venericardia LAMARCK, 1801 [**V. imbricata* (=*Venus imbricata* GMELIN, 1791); SD SCHMIDT, 1818]. Rounded trigonal, inequilateral, thick-shelled, with numerous radial ribs evenly elevated at young stage but becoming flattened and enlarged in adults. Hinge with compressed *3a* and *3b* higher than long. *?U.Cret.(Senon.), Paleoc.-Eoc.,* Eu.-Afr.-N.Am.

V. (Venericardia) [1]. Subquadrangular, truncated almost vertically; ribs at juvenile stage rounded, in adults squarish and squamose; lunule very small. Cardinals narrow, high, with *2* and *4b* subparallel, elongate, *All* indistinct. *?U.Cret. (Senon.), Paleoc.-Eoc.,* Eu.-Afr.-N.Am.-N.Z.——FIG. E55,*4*. **V. (V.) imbricata* (GMELIN); M.Eoc. (Lutet.), France(Paris basin); *4a,b,* LV ext., int., ×0.8 (Deshayes, 1837).

V. (Leuroactis) STEWART, 1930 [3] [**Venericardia pilsbryi*; OD]. Obliquely subtrigonal; immature ribs trifid, later becoming rounded and vanishing rapidly, replaced by numerous growth lines; beaks erect; lunule subvertical. Hinge with high, sharp cardinals, anterior lateral wanting. *L.Eoc.,* N.Am.——FIG. E55,*3*. **V. (L.) pilsbryi,* USA(Ala.); *3a,b,* RV ext., int., ×0.5 *(892)*.

V. (Pacificor) VERASTEGUI, 1953 [4] [**V. (P.) mulleri*; OD]. Subtrigonal to rounded; immature ribs trifid, later becoming simple and rounded,

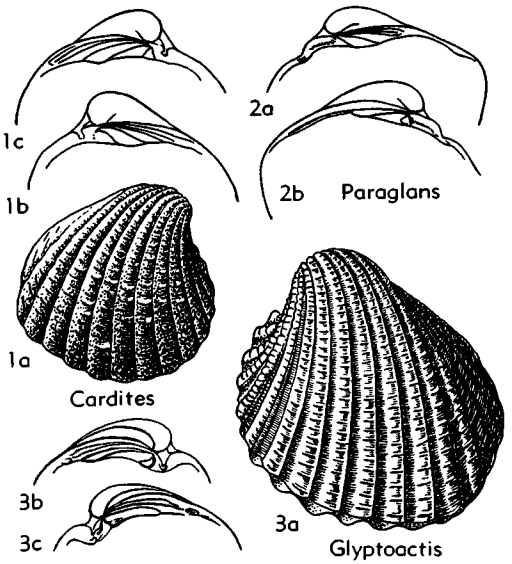


FIG. E56. Carditidae (Glyptoactininae) (p. *N556-N557*).

nodulose to irregularly striated. *Paleoc.-Eoc.*, N. Am.-?Eu.

V. (Venericor) STEWART, 1930 [2] [**Venericardia planicosta* LAMARCK, 1799 (1806); OD]. Obliquely subtrigonal; immature ribs angular and spaced evenly, in adults flat and low, approximate, and finally vanishing; lunule depressed. Cardinals stout, *2* subtrigonal, *4b* curved and thinner, *3b* oblique; *AII* tuberculiform, quite distinct, *PII* superficial. *Paleoc.-Eoc.*, Eu.-N.Am. ——FIG. E55,*2*. **V. (V.) planicosta* LAMARCK, M.Eoc.(Lutet.), France(Paris basin); *2a,b*, LV ext., int., ×0.5 (Deshayes, 1837).

Megacardita SACCO, 1899 [5] [**Venericardia jouanneti* BASTEROT, 1825; OD]. Transversely elliptical, very inequilateral, with rounded ribs becoming approximated in adult stage; beaks rounded, prominent. Hinge with weak *3a*, very oblique *3b* larger than high, *2* and *4b* present; *AII* weak, other laterals obsolete. *?Eoc., Oligo.-Rec.*, Eu.-Afr.-Australia-N.Z.——FIG. E55,*1*. **M. jouanneti* (BASTEROT), Mio.(Helvet.), S.France; *1a-c*, LV ext., int., RV int., ×0.5 *(165)*.

Trapezicardita CASEY, 1961 (6) [**Cypricardia squamosa* KEEPING, 1883; OD]. Quadrate, gibbous, very inequilateral, with obtuse medioposterior angulation; sculpture of squamous distant concentric laminae and radiating striae; prominent incurved anterior beaks; deeply impressed cordiform lunule. Hinge with 2 obtuse LV cardinals and 1 in RV; no developed laterals. Inner margin crenate. *L.Cret.*, W.Eu.

Subfamily CARDITESINAE[1] Chavan, new subfamily

Short trapezoidal to rounded, tumid, with strong, more or less scaly ribs separated by V-shaped furrows; lunule enveloping, very convex, with *3a* and *3b* arched. *L.Cret.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Glyptoactis*.——2. *Claibornicardia*.——3. *Baluchicardia*.——4. *Ludbrookia*.——5. *Xenocardita*.——6. *Paraglans*.——7. *Cardites*.

Cardites LINK, 1807 [*non* LAMARCK, 1801 (spelling error)] [7] [**Chama antiquata* LINNÉ, 1758; M] [=*Cardita* MEGERLE, 1811 (*non* BRUGUIÈRE, 1792); *Actinobolus* MÖRCH, 1853 (*non* WESTWOOD, 1842) (obj.)]. Trapezoidal to rounded, with broad, striate or squamose ribs and short anal truncature; beaks tumid; lunule very convex, depressed, cordiform. Hinge with very faint *3a*, other cardinals well marked; *AII* small, *PII* minute. *L. Eoc.-Rec.*, Eu.-Asia-Australia-Pac. O. —— FIG. E56,*1*. **C. antiquatus* (LINNÉ), Rec., Medit.; *1a*, RV ext., ×1; *1b,c*, RV and LV hinges, ×1.5 *(89a, 101)*.

Glyptoactis STEWART, 1930 [**Venericardia hadra*

[1] For avoidance of homonymy with Carditinae, based on *Cardita*, the spelling Carditesinae is introduced, approval being sought from ICZN as directed by the zoological Code (Art. 55a).

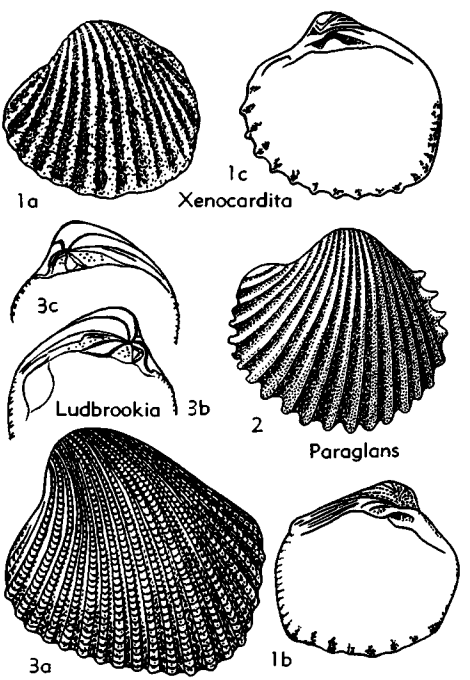


FIG. E57. Carditidae (Glyptoactininae) (p. *N557*).

DALL, 1903; OD]. Short trapezoidal, with high nodulose or echinate ribs; small, irregularly convex lunule extending under and slightly behind beaks. Hinge with very low *2*, thin, long *4b*, rather indistinct *3a*, and strong, oblique *3b*; *AII* minute tuberculiform, close to *2*, *PII* faint. *U.Cret. (Senon.)-Mio.*, N.Am.-Eu.-Afr.

G. (Glyptoactis) [1]. Short, very convex, with prominent beaks, nodulose ribs, and marked posterior depression. Cardinal *2* very low. *Oligo.-Mio.*, N.Am.——FIG. E56,*3*. **G. (G.) hadra* (DALL), Mio., USA(Fla.); *3a*, LV ext., ×1; *3b,c*, LV and RV hinges, ×1 (*229*, Chavan, n).

G. (Baluchicardia) CHAVAN, herein (*ex* RUTSCH, 1944) [3] [**Cardita beaumonti* D'ARCHIAC & HAIME, 1854; OD]. Very short in front, elongate behind, with broadly tripartite ribs, median part nodulose. *U.Cret.(Senon.)-Paleoc.*, Afr.-N. Am.

G. (Claibornicardia) STENZEL & KRAUSE, 1957 [2] [**Venericardia alticosta* CONRAD, 1833; OD]. More developed on both sides and with lower beaks than *G. (Glyptoactis)*; ribs tripartite, posteriorly echinate; lunule less depressed and *2* more developed. *Eoc.*, N.Am.-Eu.

Ludbrookia CHAVAN, 1951 [4] [**Venericardia dupiniana* (=**Cardita dupiniana* D'ORBIGNY, 1843); OD] [=*Pseudocardia* STOLICZKA, 1871 (*non* CONRAD, 1866)] [See note under *Vetericardiella*]. Short trapezoidal, with fine echinate ribs, posterior depression, and straight anal truncature; large sinuous lunule enveloping *2*. Cardinals strong, *2* and *3b* trigonal, *4* oblique, prominent; *PII* broad, relatively weak, other laterals obscure. Projecting RV posterior margin. *L.Cret. (Alb.-Cenoman.)*, Eu. (France)-N.Am.——FIG. E57,*3*. **L. dupiniana* (D'ORBIGNY), Alb.-Cenoman.; *3a*, LV ext., ×1 *(695)*; *3b,c*, LV and RV hinges, ×1.5 (Chavan, n).

Paraglans CHAVAN, 1941 [6] [**Cardium calcitrapoides* LAMARCK, 1806; OD]. Subtrapezoidal to subquadrate, small, with broad posterior truncature; ribs rounded or partly spinose, simple; long convex lunule with broadened inner anterior margin. Hinge with oblique *3b*, very thin *5b*, short, rounded trigonal *2*, and long, oblique *4b*; laterals marked but weak, *AIII* nearly obsolete. *Paleoc.-Oligo.*, W.Eu.——FIG. E56,*2*; E57,*2*. **P. calcitrapoides* (LAMARCK), M.Eoc.(Lutet.), France (Paris basin); E56,*2a,b*, RV and LV hinges, enl.; E57,*2*, RV ext., ×2 (Deshayes, 1837).

Xenocardita VOKES, 1946 [5] [**X. lacunaris* (=*Cardita lacunar* HAMLIN, 1884); OD]. Subtrapezoidal, with broad anal truncature; ribs spinose, posterior ones lamellose; lunule small, with sinuous anterior margin. Hinge with long, subhorizontal *3a*, low, trigonal *3b*, oblique *5b*, curved oblique *4b* above small trigonal *2*; anterior ridge in both valves independent of cardinals but bearing obsolete laterals, LV with 2 posterior ones remote, RV with elevated margin. *L.Cret.(Apt.)*, Lebanon.——FIG. E57,*1*. **X. lacunar* (HAMLIN); *1a-c*, LV ext., int., RV int., ×3 *(945)*.

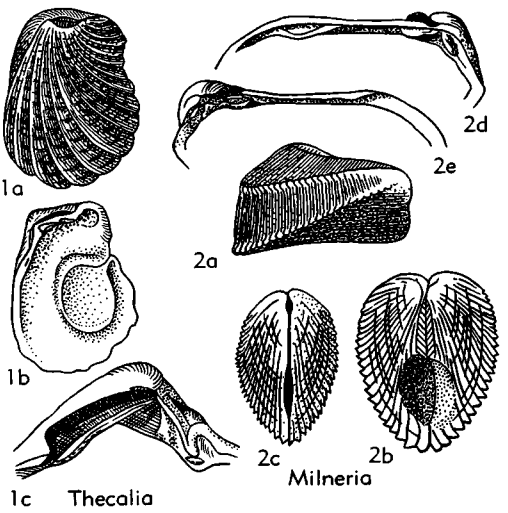


FIG. E58. Carditidae (Thecaliinae) (p. *N557-N558*).

Subfamily THECALIINAE Dall, 1903

Transversely trapezoidal, ventral margin invaginated by incubatory chamber in female. *Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Thecalia.*——2. *Milneria.*

Thecalia ADAMS & ADAMS, 1858 [1] [**Cardita concamerata* BRUGUIÈRE, 1792 (=*C. concamerata* CHEMNITZ, 1784, not binominal); M]. Trapeziform, with rounded nodulose ribs, posterior ones flabelliform; incubatory chamber internal, ovate. Each valve with 2 cardinals, including long trigonal, sinuate *3b*, and faint but distinct anterior laterals, posterior laterals obsolete. *Rec.*, S.Afr.-Austria.——FIG. E58,*1*. **T. concamerata* (BRUGUIÈRE), S.Afr.; *1a,b*, RV ext., LV int., ×1.5; *1c*, LV hinge, enl. *(85)*.

Milneria DALL, 1881 [2] [*pro Ceropsis* DALL, 1871 (*non* SOLIER, 1839)] [**Ceropsis minima* DALL, 1871; OD]. Narrowly trapeziform, very inequilateral, with 2 median posterior angulations, finely echinate ribs, concentric lines; beaks orthogyrous. Hinge with *3b* isosceles triangular, *2* and *4b* subsymmetrical, *3a* and *5b* obsolete; posterior laterals remote, anterior ones lacking. Incubatory chamber external. *Rec.*, W.N.Am.(Calif.).——FIG. E58,*2*. **M. minima* (DALL); *2a*, RV ext., ×4; *2b,c*, both valves, ventral, dorsal, enl. *(305)*; *2d,e*, hinges, enl. *(305)*.

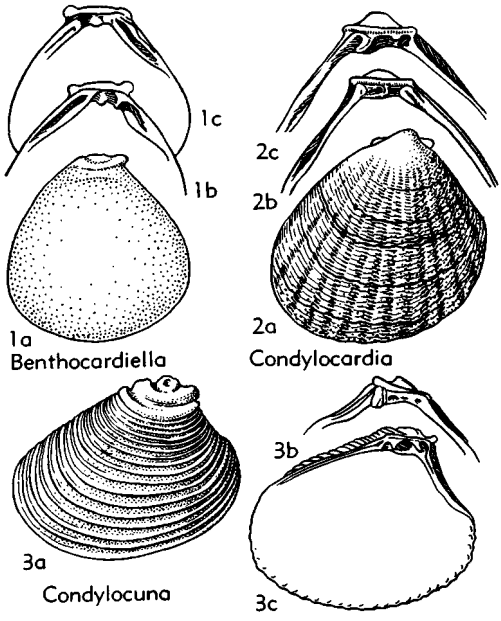


FIG. E59. Condylocardiidae (Condylocardiinae) (p. *N*558-*N*559).

Subfamily UNCERTAIN

Pseudocardia CONRAD, 1866 [**Cardium schmidti* HÖRNES, 1861; SD CHAVAN, 1952] [=*Vetocardia* CONRAD, 1868 (1869) *(nom. van.)* (obj.); *Vetericardia* CONRAD, 1872 *(nom. van.)* (obj.)] [see note under *Vetericardiella*]. *Genus dubium. Mio.,* Eu.

Family CONDYLOCARDIIDAE F. Bernard, 1897

Minute, trigonal, trapeziform or ovate, commonly higher than long; radial ribs more or less marked but may be hidden by concentric sculpture. Spondyliform hinge margin, internal ligament resilial edge partly obliterating cardinal *4b,* behind which posterior tooth *(5b-6b)* is fused to long posterior laterals. *Eoc.-Rec.*

Subfamily CONDYLOCARDIINAE F. Bernard, 1897

[*nom. transl.* CHAVAN, herein (*ex* Condylocardiidae F. BERNARD, 1897)]

Hinge margin more or less spondyliform, resilium wholly internal, both laterals long and hooked. Prodissoconch saucer-shaped. *Eoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Condylocardia.*——2. *Benthocardiella.*——3. *Condylocuna.*——4. *Radiocondyla.*——5. *Glibertia.*——6. *Micromeris.*——7. *Mesocuna.*——8. *Erycinella.*——9. *Carditopsis.*——10. *Cunanax.*——11. *Particondyla.* [Insert above, 6a. *Americuna.*]

Condylocardia F. BERNARD, 1896 [1] [**C. sanctipauli* MUNIER-CHALMAS in BERNARD, 1896 (=*C. pauliana* BERNARD, 1897); SD COSSMANN, 1902] [=*Hippella* MÖRCH, 1861 (type, *H. hippopus*; M) *(nom. oblit.,* ICZN pend.)]. Somewhat obliquely trigonal; radial ribs rounded, low, flabellate, crossed by concentric striae. Hinges with 3 cardinals in RV, 2 in LV: *AIII-3a, 3b, 5b, AII, 2a, 4b, 6b, PII, AI* much elongated. *M.Eoc.-Rec.,* S.Pac.-C.Am.-St.Atl.-Eu.——FIG. E59,*2*. **C. sanctipauli* MUNIER-CHALMAS, Rec., St.Paul Is.; *2a-c,* LV ext., LV and RV hinges, much enl. *(41)*.

Americuna KLAPPENBACH, 1962 (6a) [**A. besnardi;* OD]. Obliquely inequilateral, pyriform, with smooth well-marked prodissoconch. Dense concentric ribbing. RV (described as LV) with single cuneiform median tooth and 2 long laterals, separated from margin by narrow furrow; LV (described as RV) with 2 cardinals, 2 prominent, *4b* thinner and 2 marginal laterals. Ligament in broad socket. Margin denticulate. *Rec.,* Brazil.

Benthocardiella POWELL, 1930 [2] [**B. pusilla*; OD]. Rounded trigonal, smooth to concentricallv ribbed, large prodissoconch. Hinge plate thick, 3 RV cardinals, 2 in LV; hooked anterior and posterior duplicate laterals; resilium spoon-shaped. *?M.Eoc., Plio.-Rec.,* Australasia-?Eu.(France). ——FIG. E59,*1*. **B. pusilla,* N.Z.; *1a-c,* LV ext., LV int., RV int., much enl. (Powell, 1930).

Carditopsis E. A. SMITH, 1881 [9] [**Cardita flabellum* REEVE, 1843; OD]. Transversely trigonal, subequilateral, anteriorly only slightly produced, flabellate, granulose radial ribs well marked; beaks rounded. Hinge plate relatively narrow, with small teeth, *2, 3b,* rounded median resilium, *5b, 6b* (or *PI, PII*) behind socket nearly symmetrical with anterior cardinals; laterals very elongate, *AI* strongest. *Rec.,* S.Am.(Chile).——FIG. E60,*1*. **C.*

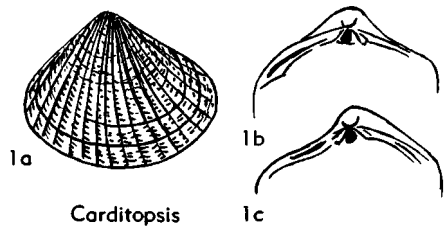


FIG. E60. Condylocardiidae (Condylocardiinae) (p. *N*558-*N*559).

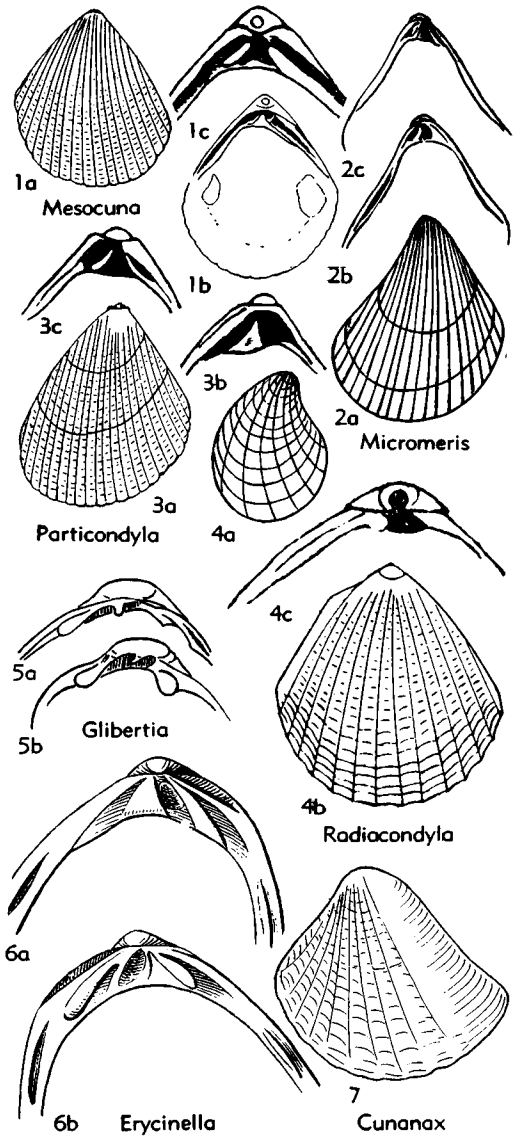


FIG. E61. Condylocardiidae (Condylocardiinae) (p. *N559-N560*).

flabellum (REEVE), Valparaiso; *1a-c,* RV ext., LV and RV hinges, ×4 (Chavan, n).

Condylocuna IREDALE, 1930 [3] [**Condylocardia projecta* HEDLEY, 1902; OD]. Transversely trigonal, very inequilateral, anteriorly elongated; sculpture of concentric waves. Cardinals *3a* weak, *3b* strong, *5b* V-shaped, *2* oblique, *4b* V-shaped, *6b* stout; well-marked RV anterior and LV posterior duplicate laterals; resilium well impressed. *Mio.-Rec.,* Australia-N.Z.——FIG. E59,*3*. **C. projecta* (HEDLEY), Rec., Australia; *3a-c,* LV ext., int., RV int., enl. *(397)*.

Cunanax IREDALE, 1936 [10] [**Cuna pisum* HEDLEY, 1908; OD]. Comparatively large, thick, prosogyrous, strongly inequilateral, outline trigonal; approximated broad, low radial ribs transversely striated. LV teeth diverging subequally, also RV *3a* and *PI* (or *5b*), *3b* bifurcate; anterior lateral remote. Lunule and escutcheon distinct; prodissoconch indistinct. *Plio.-Rec.,* Australasia.——FIG. E61,*7*. **C. pisum* (HEDLEY), Rec., Australia; LV ext., much enl. (Hedley, 1908).

Erycinella CONRAD, 1845 [8] [**E. ovalis*; M] [=*Triodonta* VON KOENEN, 1893 (*non* BORY, 1827; *nec* MULSANT, 1842; *nec* AGASSIZ, 1846; *nec* WILLESMERE, 1885) (type, *T. clara;* SD GLIBERT, 1945)]. Ovate, somewhat enlarged anteromedially; radial ribs low, tending to become obsolete; both marginal ligament and rounded trigonal resilium. Hinge with oblique, elongate *2,* scalariform stout *3b* and *4b* fused to edge of resilium socket, with elongate *PI* and *PII* just behind it, *AII, PIII* remote. *Oligo.-Rec.,* N.Am.-Eu.-S.Afr.——FIG. E61, *6*. **E. ovalis,* Mio., USA(Va.); *6a,b,* RV and LV hinges, enl. (Gardner, 1943).

Glibertia VAN DEN MEULEN, 1951 [5] [**G. prosperi*; OD]. Very small, tumid, ovate, elongated

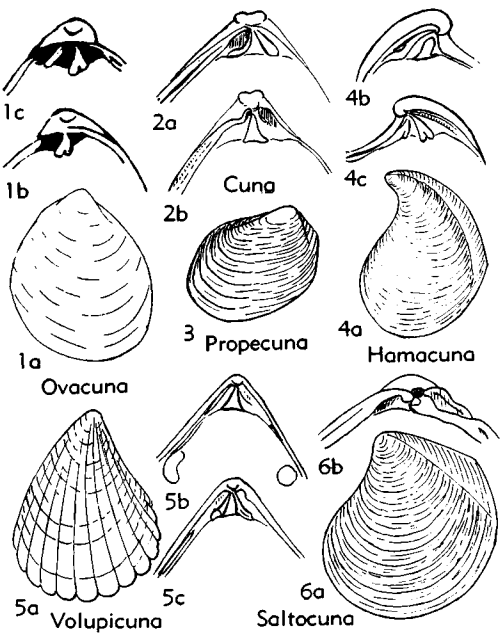


FIG. E62. Condylocardiidae (Cuninae) (p *N560-N561*).

anteriorly; concentric sculpture almost obsolete; flat prodissoconch. Hinge consisting of several projecting callosities, long *AIII-3a,* stout short *3b,* rounded *2, 5b* behind broad resilium, *6b, PIII, PI* in successive crests. *Plio.,* Neth.——FIG. E61,*5*. **G. prosperi*; *5a,b,* RV and LV hinges, much enl. (Chavan, n).

Micromeris CONRAD, 1866 [**M. minutissima* (=*Astarte minutissima* LEA, 1833); OD] [=*Pteromeris* CONRAD, 1865 (*non* CONRAD, 1862) (obj.)]. Oblong, with pointed beaks and cordate broad lunule; sculpture vertical rather than truly radial; resilium somewhat restricted. Relatively narrow cardinals and very long laterals. *Eoc.-Rec.,* N.Am.-Australia.

M. (Micromeris) [6]. Trigonal, inequilateral, elongated anteromedially; with vertical ribs and concentric striae. Hinge with obliquely trigonal *2* and *3b,* very thin *3a, 4b, 5b*; shell margin strongly crenulate internally. *Eoc.,* N.Am.; *Rec.,* Australia. ——FIG. E61,*2*. **M. (M.) minutissima* (LEA), M.Eoc., USA(Ala.); *2a,* LV ext.; *2b,c,* RV and LV hinges; much enl. (Chavan, n).

M. (Mesocuna) LASERON, 1953 [7] [**M. saza*; OD]. Ovately trigonal, subequilateral; with rugose axial ribs and concentric lines. Hinge with massive cardinals and long, strong laterals; shell margin denticulate internally. *Rec.,* Australia.—— FIG. E61,*1*. **M. (M.) saza; 1a,* RV ext.; *1b,c,* RV int., LV hinge; much enl. *(531)*.

Particondyla LASERON, 1953 [11] [**P. cuneata*; OD]. Obliquely trigonal, oblong; sculpture of radial ribs; prodissoconch saucer-shaped. Deep hinge plate with 1 cardinal on RV, 2 on LV, laterals not prominent. *Rec.,* Australia.——FIG. E61, *3*. **P. cuneata; 3a,* LV ext.; *3b,c,* RV and LV hinges; much enl. *(531)*.

Radiocondyla IREDALE, 1936 [4] [**R. arizela* (=*Condylocardia porrecta* HEDLEY & MAY, 1908) (*non* HEDLEY, 1906); OD]. Ovately oblong, relatively narrow; with broad radial ribs intersected by distant concentric furrows; prodissoconch small. Hinge with tuberculiform approximated short teeth of spondyloid appearance. *Mio.-Rec.,* Australia.——FIG. E61,*4a*. **R. arizela,* Rec.; RV ext., enl. (Chavan, n).——FIG. E61,*4b,c*. *R. jacksonensis* LASERON, Rec.; *4b,c,* LV ext., hinge, much enl. *(531)*.

Subfamily CUNINAE Chavan, new subfamily

Hinge margin more or less rounded; prodissoconch also rounded, commonly ill-defined; resilium inframarginal; laterals incomplete. *M.Eoc.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Cuna.*——2. *Saltocuna.*——3. *Ovacuna.*——4. *Propecuna.*——5. *Volupicuna.*——6. *Hamacuna.* [Insert above, 4a. *Goniocuna.*]

Cuna HEDLEY, 1902 [1] [**C. concentrica;* OD]. Narrowly trigonal, commonly obliquely angular; with concentric sculpture overlapping radial ribs which strongly crenulate internal margin. Hinge with median *3b* subtrihedral, posteriorly acuminate at base; *2* and *4b* nearly symmetrical but *4b* posteriorly restricted by resilium which does not reach inferior margin of plate; *AI, PII* thin, long, other laterals fused to margin; pallial line impressed. *M.Eoc.-Rec.,* N.Am.-Australasia.——FIG. E62,*2*. **C. concentrica,* Rec., Australia; *2a,b,* LV and RV hinges, much enl. (Chavan, n).

Goniocuna KLAPPENBACH, 1962 (4a) [**Cuna dalli* VANATTA, 1903; OD]. Subtriangular, inequilateral, very small, with concentric ribbing; hinge strong and broad, with low, long anterior and trigonal median cardinal in each valve, ligament in pit; bordered by posterior cardinal and by short rather faint posterior lateral. Adductor scars rather large; inner margin apparently smooth. *Rec.,* USA(Miss.-Fla.).

Hamacuna COTTON, 1931 [6] [**Cuna hamata* HEDLEY & MAY, 1908; OD]. Very oblique, anteromedially much elongated, with concave front margin and curved prosogyrous beaks, compressed, thick-shelled; surface with concentric sculpture and radial lines toward ventral margin; faint lunule and escutcheon. Hinge with curved bilobate *3b,* arched *2* and *4b* converging upward under beak, long curved *AIII-3a,* relieving remote *AI*; resilium narrow, elongate, and long nymph present. *?Pleist., Rec.,* Australasia.——FIG. E62,*4*. **H. hamata* (HEDLEY & MAY), Australia; *4a-c,* LV ext., int., RV int., much enl. (Chavan, n).

Saltocuna IREDALE, 1936 [**Cuna particula* HEDLEY, 1902; OD]. Broadly rounded obliquely, truncate posteriorly; sculpture coarse concentric; prodissoconch relatively large. Narrow hinge with short posterior laterals and relatively low cardinals. *Plio.-Rec.,* Australasia.

S. (Saltocuna) [2]. Very inequilateral, prodissoconch distinct. Hinge with strong *3b,* broader than high, and well-developed laterals. *Plio.-Rec.,* Australasia.——FIG. E62,*6*. **S. (S.) particula* (HEDLEY), Rec., Australia; *6a,b,* LV ext., RV hinge, much enl. (Chavan, n).

S. (Ovacuna) LASERON, 1953 [3] [**Kellia atkinsoni* TENISON-WOODS, 1876; OD]. Less inequilateral than *S. (Saltocuna),* concentric sculpture faint, prodissoconch not prominent. Hinge with distinctly bifurcate *3b* and weak laterals; pallial line impressed. *Rec.,* Australia.——FIG. E62,*1*. *S. (O.) solida* (COTTON); *1a-c,* RV ext., RV and LV hinges, much enl. *(531)*.

S. (Propecuna) COTTON, 1931 [4] [**Cardita obliquissima* TATE, 1887; OD]. Very inequilateral, oblique grooves cutting across growth lines, also with radial posterior grooves and dorsoventral angulation. *Rec.,* Australia.——FIG. E62,*3*. **S.*

(P.) obliquissima (TATE); LV ext., much enl. (Chavan, n).

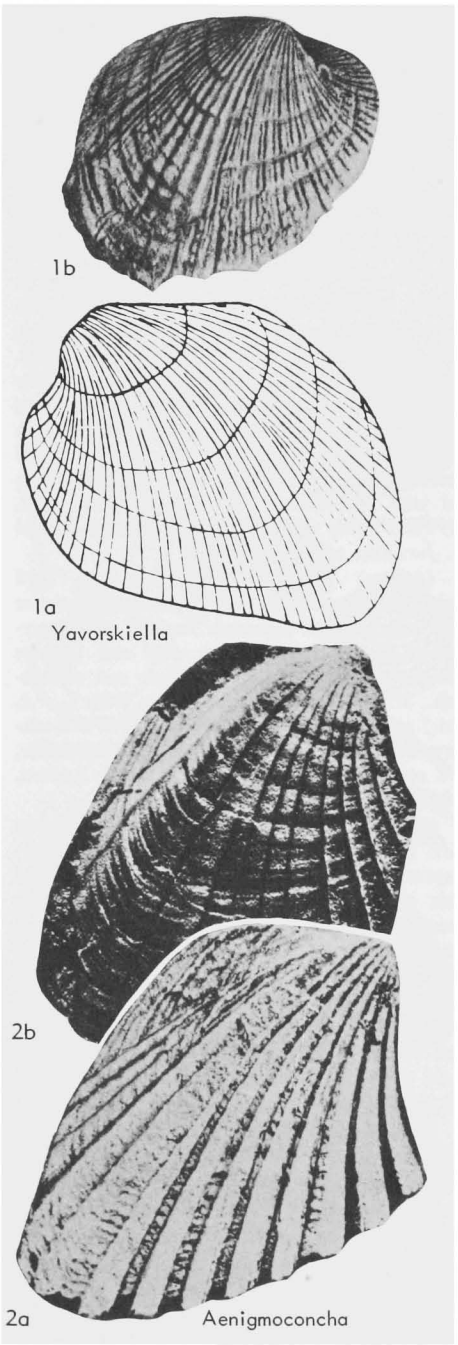


FIG. E63. Family Uncertain (p. *N*561).

Volupicuna IREDALE, 1936 [5] [**Carditella delta* TATE & MAY, 1900; OD]. Highly triangular, slightly inequilateral, rather deep, with strong, well-spaced, pectinate radial ribs. Hinge with bifurcate cardinals *3b, 2, 4b* (subsymmetrical), elongate, thin *3a-AIII* and remote *AI*; pallial line obsolete; resilium quite inframarginal, slightly depressed. *Mio.-Rec.,* Australasia.——FIG. E62,*5*. **V. delta* (TATE & MAY), Rec., Australia; *5a-c,* LV ext., LV and RV hinges, much enl. (Chavan, n).

Family UNCERTAIN

?Aenigmoconcha BENEDICTOVA, 1950 [**A. obliqua*; OD]. Shell subrhomboidal, of considerable size, umbones anteriorly directed, situated at varying distance from end. Hinge margin straight, or only slightly curved. Valves equally but not strongly inflated by diagonal elevation running from umbo to posteroventral angle; clearly delimited from steep posterior slope; valve surface almost flat near upper posterior angle, simulating obtuse auricle. Anterior slope of oblique elevation merging gradually with rest of valve; surface sculptured by narrow, rather closely set radial costae, strongest anteriorly, becoming weaker over diagonal ridge, tending to disappear on upper posterior field; costae of internal mold thin, linear, widely separated toward margins, strongest anteriorly and absent from posterior region; diagonal ridge bearing single narrow rib, simple or bifurcating downward. Flat surfaces of wide costal interspaces in mold marked by conspicuous concrescent lines. Internal characters unknown. [Nonmarine.] *L. Perm.,* USSR(W.Sib.).——FIG. E63,*2*. **A. obliqua; 2a,b,* RV ext. molds, ×1 (Ragozin, 1955). [WEIR]

?Blairella MILLER & GURLEY, 1893 [**B. sedaliensis*; OD]. At present unrecognizable. *L.Carb.,* USA (Mo.). [NEWELL]

?Yavorskiella KHALFIN, 1950 [**Yavorskia skoki* FEDOTOV, 1938; OD]. Shell short, subrhomboidal, subelliptical or quadrilateral, narrowing toward lower posterior angle. Umbones submedian to anterior, broadly based, swollen, directed more or less anteriorly. Valves moderately convex, ill-defined diagonal elevation running from umbones to posterior extremity; shell sculpture of numerous strong radial costae, varying in number and width, widest interspaces occurring on oblique elevation; costae thinner and more closely spaced in front, rather indefinite on posterodorsal surface. Radial costation intersected by well-spaced growth folds. Internal characters unknown. [Nonmarine.] *L. Perm.,* USSR(W.Sib.).——FIG. E63,*1a*. **Y. skoki* (FEDOTOV); LV ext., ×2 (Ragozin, 1955).——FIG. E63,*1b*. *Y. analoga* (BENEDICTOVA), RV mold, ×2 (Ragozin, 1955). [WEIR]

Superfamily CRASSATELLACEA Férussac, 1822

[*nom. transl.* NEWELL, 1965 (*ex* Crassatellidae FÉRUSSAC, 1822)]

[Materials for this superfamily prepared by ANDRÉ CHAVAN except as stated otherwise]

Animal with fully open mantle, or communication between branchial and pedal openings; unequal branchiae; papillate mantle edge. Shell trigonal, trapezoidal, or rounded, with concentric external sculpture, costate to striate, vanishing in some, except in Cardiniidae with internal layer of straight or arcuate radial riblets, which may be reflected as crenulations of inner shell margin. Lunule and escutcheon generally distinct; beaks prosogyrate and pointed. Hinge lucinoid, with *3b* median and *5b* commonly present on right valve, thus more or less cyrenoid in appearance. Lateral teeth laminar in many forms; no *PI* developed except in Cardiniidae and Myophoricardiidae. Ligament external or internal. Integripalliate or with very faint sinuosity. Pedal scars well marked *(110, 111)*. [Marine.] *Ord.-Rec.*

The alphabetically arranged generic descriptions in each family-group division of the Crassatellacea are accompanied by numbers inclosed by square brackets. Such numbers indicate position in the sequence of generic taxa given with the respective families or subfamilies for the purpose of recording CHAVAN's arrangement, designed to reflect "natural relationships" of these taxa as inferred by him.

Family ASTARTIDAE d'Orbigny, 1844

[=Crassinidae GRAY, 1840]

Trigonal rounded to subquadrangular in outline. Concentrically ribbed to smooth, always ribbed around beaks. Successive internal layers of radial riblets periodically set up, under concentric outer layer. Ligament external or inframarginal, with nymph and without defined internal resilial pit. *?M. Ord., Dev.-Rec.*

Subfamily ASTARTINAE d'Orbigny, 1844

[*nom. transl.* CHAVAN, herein (*ex* Astartidae D'ORBIGNY, 1844)]

Shell trigonal or transversely trapezoidal, with more or less curved beaks; hinge without distinct *AIV*, other laterals (when present) in prolongation of cardinals. *?M.Ord., Dev.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Astarte.*——2. *Leckhamptonia.*——3. *Isocrassina.*——4. *Grotriania.*——5. *Ashtarotha.*——6. *Bythiamena.*——7. *Digitariopsis.*——8. *Tridonta.*——9. *Nicania.*——10. *Rictocyma.*——11. *Nicaniella.*——12. *Trautscholdia.*——13. *Astartella.*——14. *Eodon.*——15. *Kaibabella.*——16. *Eoastarte.*——17. *Astartopis.*——18. *Astartopsis.*——19. *Matheria.*——20. *Praeconia.*——21. *Megapraeconia.*——22. *Yabea.*——23. *Neocrassina.*——24. *Coelastarte.*——25. *Prorokia.*——26. *Parisiella.*——27. *Sita.*—28. *Goodallia.*——29. *Ancliffia.*——30. *Gonilia.*——31. *Digitaria.* [Insert above, 1a. *Carinastarte;* 10a. *Filatovaella;* 16a. *Astartellopsis;* 25a. *Seendia;* 30a. *Ensio.*]

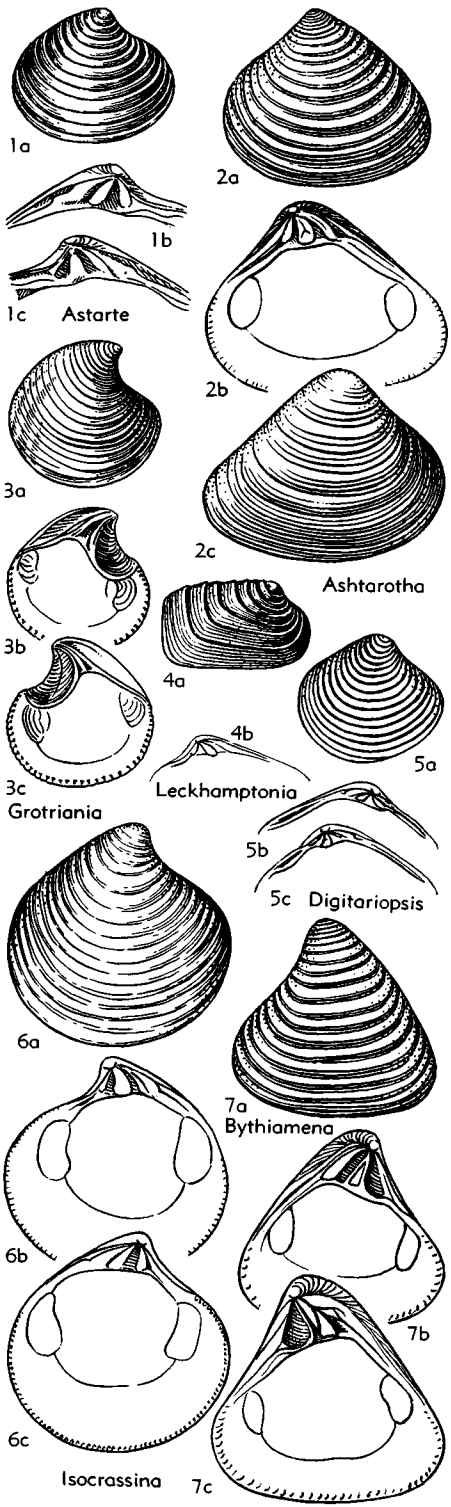
Astarte J. SOWERBY, 1816 [**Venus scotica* MATON & RACKETT, 1807 (=**Pectunculus sulcatus* DA COSTA, 1778, var. *scotica* MATON & RACKETT, 1807); OD]. Trigono-elliptical to subtrapezoidal, with regularly spaced concentric ribs or undulations, at least around prominent, but small, beaks. Inner margin denticulated or not. Hinge with well-developed cardinals, except for *3a*, faint, and *6b*, lacking; and with well-marked *AI*. Other laminae *(AII, PII, PIII)* partly obsolete. Narrow nymph behind *5b*. *Jur.-Rec.*, cosmop.

A. (Astarte) [1] [=*Crassina* LAMARCK, 1818 (obj.)]. Subquadrangular, inequilateral, posterior side enlarged and truncated; rounded strong persistent ribs. Remote lateral teeth and laminar oblique cardinals. Impressed lunule and escutcheon. *M. Jur.-Rec.*, cosmop.——FIG. E64, *1. *A. (A.) sulcata* (DA COSTA), *scotica* (MATON & RACKETT, Rec., Scot.; *1a*, RV ext., ×1.2 *(511); 1b,c*, LV and RV hinges, ca. ×2.5 (Maton & Rackett, 1807).

A. (Ashtarotha) DALL, 1903 [5] [**A. undulata* SAY, 1824; OD]. Ovatotrigonal, flattened, thick; depressed around the pointed beaks; posterior side commonly cuneiform. Sculpture of strong concentric waved ribs, in many forms vanishing on disc. Large, depressed, well-defined lunule and flat escutcheon. Teeth strong; elongated marginal laterals. *Neog.*, N.Am.-W.Eu.——FIG. E64,*2a.* **A. (A.) undulata* SAY, Mio., USA(Va.); LV ext. ×1.2 (Gardner, 1943).——FIG. E64,*2b,c. A. (A.) undulata vaginulata* DALL, Mio. USA(Va.); *2b,c*, RV int., ext., ×1.2 (Gardner, 1943).

A. (Bythiamena) GARDNER, 1926 [6] [**A. (B.) isosceles*; OD]. Narrowly trigonal, high. Thick equidistant concentric ribs. Much excavated, but restricted lunule, obliterating *3a*; other cardinals strong; posterior laterals long. *Mio.*, USA(Fla.).——FIG. E64,7. **A. (B.) isosceles*; *7a-c*, LV ext., int., RV int., ×3.6 (Gardner, 1926).

A. (Carinastarte) HINSCH, 1952 [1a] [**A. reimersi* SEMPER in RAVN, 1907; OD]. Like *A. (Astarte)* in outline, but with irregular ribbing and a



medioposterior angulation. Less remote, straighter and stouter posterior laterals, more vertical *4b*. *Oligo.-Plio.*, Eu.

A. (Digitariopsis) CHAVAN, 1952 [7] [**A. grateloupi* DESHAYES, 1843; OD]. Trapezoidal, rounded, rather small, with irregular concentric fine ribs, commonly medially flattened and laterally oblique. Lunule and escutcheon narrow, long, defined only by their smooth surface. Hinge with well-marked long laterals, 2 very oblique forward. *Neog.*, W.Eu.-Japan.——FIG. E64,*5*. **A. (D.) grateloupi* DESHAYES, L.Mio.(Burdigal.), France; *5a*, RV ext., ×2.8; *5b,c*, LV and RV hinges, ×3.6 (Chavan, n).

A. (Grotriania) SPEYER, 1860 [4] [**Grotriania semicostata;* M]. Like *Isocrassina*, but with faint, medioposterior radial lines, more curved beaks, very large, excavated, concave lunule and flattened escutcheon. Hinge with *3a* fused to margin; other cardinals very narrow; long obsolete laterals. *Oligo.*, Eu.(Ger.).——FIG. E64,*3*. **A. (G.) semicostata* (SPEYER); *3a-c*, RV ext., LV int., RV int., ×2.4 (Speyer, 1860).

A. (Isocrassina) CHAVAN, 1950 [3] [**A. castanea* SAY, 1830 (=**Venus castanea* SAY, 1822; OD]. Subtrigonal-rounded, almost equilateral, thick; strong close-set umbonal ribs passing to low, rounded, spaced concentric undulations. Large shallow lunule. Hinge thick, with high cardinals and short laterals. *U.Eoc.-Rec.*, N.Am.-W.Eu. ——FIG. E64,*6*. **A. (I.) castanea* (SAY), Rec., USA(N.J.); *6a-c*, RV ext., int., LV int., ×1.2 (Say, 1830). [=*Laevastarte* HINSCH, 1952 (type, *Tellina fusca* POLI, 1791; OD).]

A. (Leckhamptonia) COX & ARKELL, 1948 [2] [**Hiatella interlineata* LYCETT, 1850; OD]. Transversely trapezoidal, very inequilateral, rather small. Narrow sharp spaced ridges. Shallow lunule and escutcheon. Hinge with obscure laterals; *4b*, small. *Jur.*, W.Eu.——FIG. E64,*4*. **A. (L.) interlineata* (LYCETT), M.Jur.(Bathon.), Eng.; *4a,b*, RV ext., hinge, ×2.7 *(645*; Chavan, n).

Astartella HALL, 1858 [13] [**A. vera* HALL, 1858; SD MILLER, 1889]. Transversely rhomboidal to ovate, thick, rather small; laterally truncated. Surface with concentric furrows and distant lamellae. Cordiform impressed lunule. Valves margin crenulate. RV hinge with narrow, trigonal *3b*, oblique *5b*, and marginal laterals; LV hinge with 2 partly fused as hook with raised *(AII)* lunular margin, *4b*, strong, broad and oblique, and *PII* elongate. Scars small. *U.Carb.(Penn.)-Perm.*, Eu.-N.Am.-?Australia.——FIG. E65,*2a,b*. **A. vera*, Penn., USA; *2a,b*, RV ext., both valves dorsal, ×1 (Hall, 1858).——FIG. E65,*2c,d*. *A. concentrica* (CONRAD), Penn., USA(Mo.); *2c,d*, LV and RV hinges, ×1.3 (Girty, 1927). [*See* also Fig. E75,*2*.]

FIG. E64. Astartidae (Astartinae) (p. *N562-N563*).

Astartellopsis BEURLEN, 1954 (16a) [**A. prosoclina* (=*Astarte* cf. *triasina* "ROEMER" in COWPER REED, 1929); OD]. Trigonal, with high, acutely pointed, prominent prosogyrous beaks, anterior side depressed, angular where it joins broadly convex ventral margin, posterior margin convex; long lunule. No dorsal carina, but broadly spaced, rather strong concentric waves. Hinge with curved

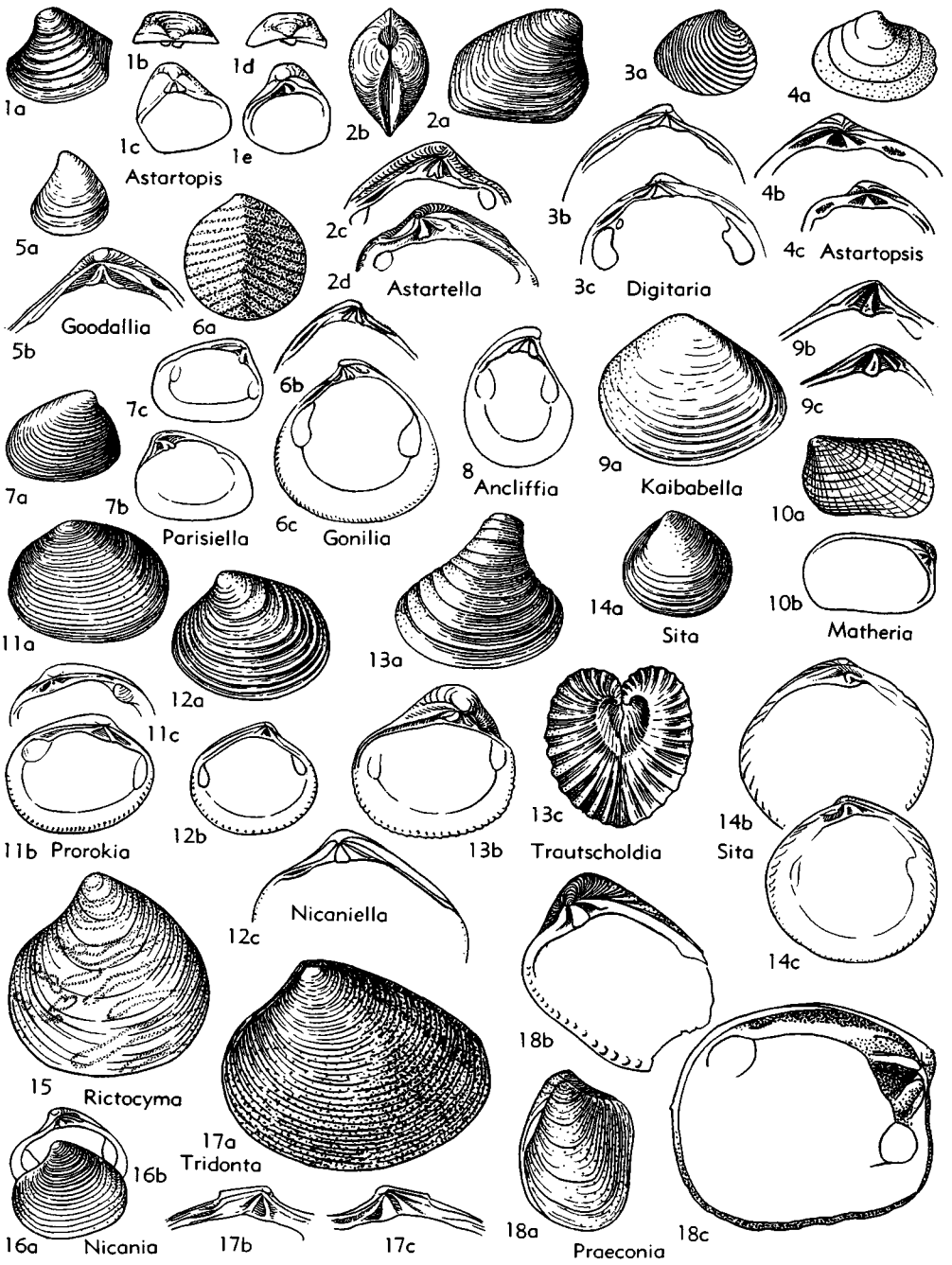


FIG. E65. Astartidae (Astartinae) (p. *N563*, *N565-N568*).

RV cardinals, *3a* marginal, prolonged into straight anterior lateral fused to margin; *2* trihedric, strong, *4b* long and curved, short nymph. *Permotrias.*, Brazil-Ger.-Japan.

Astartopis VON WÖHRMANN, 1889 [17] [**Myophoria richthofeni* STUR, 1868; M]. Small, irregularly subquadrate, deep, with distant concentric ribs and strong posterior fold. Prominent beaks. Lunule and escutcheon broad and flat. Well-marked cardinals, obscure laterals. [Considered by Cox as junior subjective synonym of *Myophoriopis* VON WÖHRMANN (see Myophoriopidae in this superfamily).] *U.Trias.*, Eu.(Aus.).——FIG. E65,*1*. **A. richthofeni* (STUR), Aus.; *1a*, LV ext., ×4; *1b,c*, LV int., hinge, ×2; *1d,e*, RV hinge, int., ×2 *(1001)*.

Astartopsis DE LORIOL, 1891 [18] [**A. elongata*; SD CHAVAN, 1952]. Rounded, convex, thin; with concentric growths. Hinge with remote well-marked anterior laterals and widely divergent cardinals. Ovate superficial scars. Margin finely denticulated. *Jur.(L.Lusitan.)*, Eu.(Switz.).——FIG. E65,*4*. **A. elongata; 4a*, LV ext., ×0.7; *4b,c*, LV and RV hinges, ×1 *(550)*.

Digitaria S. WOOD, 1853 [31] [**Astarte digitaria* WOOD, 1853 (=*Digitaria vulgaris* WOOD, 1853) (=**Tellina digitaria* LINNÉ, 1758; T); SD LAMY, 1920] [=*Woodia* DESHAYES, 1860 (obj.); *Parvati* SEMPER, 1862 (invalid name)]. Ovate, inequilateral, rather small; more or less excentric sculpture. No lunule or escutcheon. Rounded beaks. Two strongly divergent cardinals on each valve and flexuous thin, elongate laterals. *Oligo.-Rec.*, W. Eu.-S. Afr.——FIG. E65,*3*. **D. digitaria* (LINNÉ), Rec., Port.; *3a*, RV ext., ×2.5; *3b,c*, LV and RV hinges, ×5 (Chavan, n).

Eoastarte CIRIACKS, 1963 [16] [**E. subcircularis*; OD]. Shell ovate or subcircular, inequilateral, prosocline; beaks prominent, anteriorly placed, prosogyre; shell surface smooth, dentition: *3b, 5b/2, 4b* without laterals; *3b* and *4b* heavy, subtrigonal, steeply inclined to hinge; without laterals; *2* short, slender, and *5b* elongate, slender, both inclined and nearly parallel to adjacent shell margins; ligament opisthodetic; ligament nymphs and grooves short and shallow; adductor scars deep, subovate, dorsally extended, located high under hinge; anterior adductor pit bounded above by strong buttress which is fused to cardinal plate; pallial line simple. *L.Perm.*, USA(Wyo.).——FIG. E66,*1*. **E. subcircularis*, Grandeur Member, Park City F.; *1a,b*, RV ext., LV int., ×4 *(132)*. [NEWELL]

Eodon HALL in MILLER, 1877 [14] [*pro Microdon* CONRAD, 1842, *non* AGASSIZ, 1833] [**Microdon bellastriatus* CONRAD, 1842; M] [=*Microdonella* OEHLERT, 1881 (obj.)]. Trapezoidal, flattened, inequilateral, with medioposterior angulation and marginal sinuosity; concentrically striated. Hinge less developed than on *Astartella*, with *AII-2, 4b*, and *PII* in LV. *Dev.-Carb.*, USA-W.Eu.——FIG. E66A,*1a*. **E. bellastriatus* (CONRAD), M.Dev., USA; LV ext., ×1 *(146)*.——FIG. E66A,*1b*. *E. tremulus* (DE RYCKHOLT), Carb., Belg.; LV int., ×2

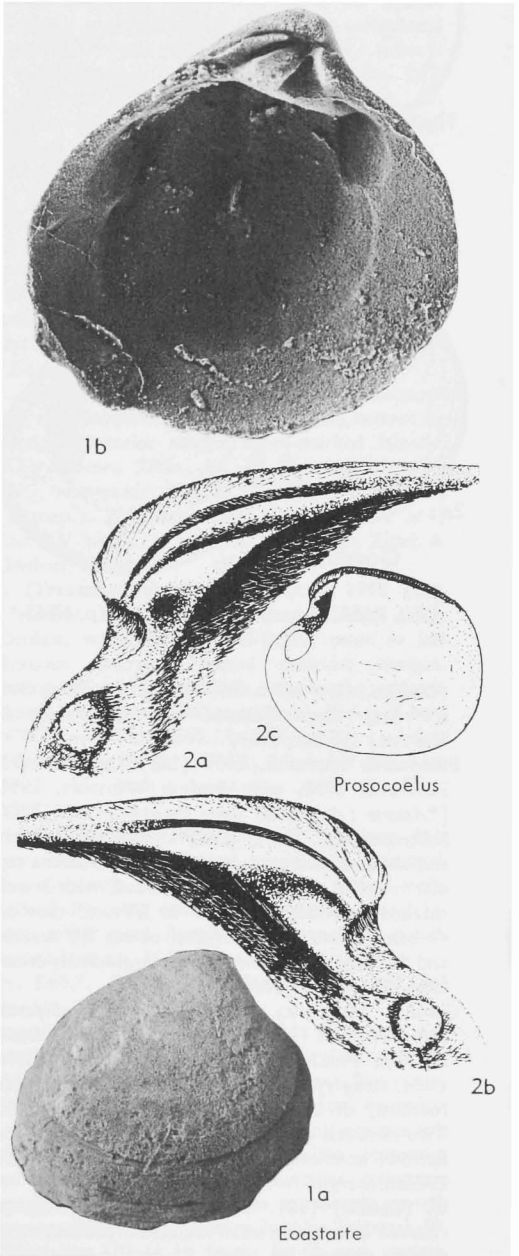


FIG. E66. Astartidae (Astartinae) *(1)*, (Opinae) *(2)* (p. *N565*, *N572*).

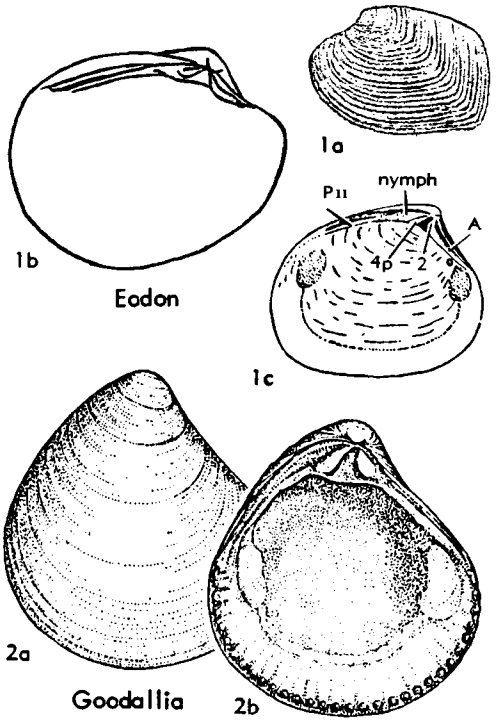


FIG. E66A. Astartidae (Astartinae) (p. *N565-N566*).

(Chavan, n).——FIG. E66A,*2*. *E.* sp., Dev., Ger.; LV int., diagr. [classed as *Cypricardella* by HAFFER] (Haffer, 1959).

Filatovaella MERKLIN, 1959 (10a) [*pro Astartella* FILATOVA, 1958, *non* HALL & WHITNEY, 1958] [**Astarte (Astartella) ioani* FILATOVA, 1958; OD]. Subtrapezoidal, short, thick, slightly inequilateral and angular backward; sculpture of numerous regular rounded ribs. Hinge plate broad, with 3 well-marked cardinals in RV, 2 in LV and thin *6b; 4b* being subvertical; marginal obtuse RV anterior and LV posterior lateral; inner margin finely crenulated. *Rec.*, Kamchatka.

Gonilia STOLICZKA, 1871 [**Lucina? bipartita* PHILIPPI, 1836 (*non* DEFRANCE, 1823) (=**Astarte bipartita* PHILIPPI, 1844, *non* SOWERBY, 1829); (=*A. calliglypta* DALL, 1903); OD]. Rather small, rounded; divaricate sculpture. Ill-defined lunule. Two cardinals on each valve; lateral teeth long and narrow, anteriorly in RV but posteriorly in LV. Crenate margin. *Jur.-Rec.*, Medit.

G. (Gonilia) [30]. Suborbicular, with rather incurved low beaks; small lunule, no posterior area. Long narrow *PII*. Rec., Medit.——FIG. E65,*6*. *G. calliglypta* (DALL), Sicily; *6a*, LV ext., ×5; *6b,c*, LV hinge, RV int., ×8 (Chavan, n; Philippi, 1847).

G. (Ensio) Cox, 1962 [30a] [**Ptychomya agassizi* LYCETT, 1850; OD]. With a trigonal tendency, erected beaks; narrow, obtusely bordered lunule and escutcheon; *4b* somewhat grooved. *Jur.*, Eng.-Afr.(Borneo).

Goodallia TURTON, 1822 [**Mactra triangularis* MONTAGU, 1803; SD HERMANNSEN, 1847]. More or less trigonal, high, small. Anterior right lateral extending upward to beak, *3b, 5b; 2* and *4b, PII*. Broad scars. Margin crenate or not. *M.Jur. (Bathon.)-Rec.*, Eu.-Atl.

G. (Goodallia) [28] [=*Mactrina* BROWN, 1827 (obj.); *Mactroidea* BROWN, 1827]. Trigonal, smooth; almost orthogyrous; *3b* strongly bifid; *AII* indistinct, *PII* elongated. Margin crenate in adult stages. *Mio.(Burdigal.)-Rec.*, W.Eu.——FIG. E65,*5*; E66A,*3*. **G. (G.) triangularis* (MONTAGU); Rec., Atl., E65,*5a*, LV ext., ×6; E65,*5b*, RV hinge, enl. *(511*; Turton, 1822); Rec., Eng.(Sussex), E66A,*3a,b*, RV ext., LV int., ×22 *(905a)*.

G. (Ancliffia) Cox & ARKELL, 1948 [29] [**Astarte pumila* J. DE C. SOWERBY, 1824; OD]. Subtrigonal-rounded, with prominent curved beaks; finely striated. Cordiform shallow lunule and posterior area. Trigonal cardinals, obscure *AII*, short *PII*. Broad scars. Margin usually crenulate. *M.Jur.*, Eu.——FIG. E65,*8*. **G. (A.) pumila* (J. DE C. SOWERBY), Bathon., Eng.; LV int., ×4 (Chavan, n).

Kaibabella H. CHRONIC, 1952 [15] [**K. curvilineata*; OD]. Ovatotrigonal, compressed, with rounded concentric ribs. Lunule and escutcheon poorly defined. Anterior cardinals in prolongation of obsolete laterals: *3a, 4b*, strong; *5b, 6b* present. No posterior laminae. Inner margin apparently smooth. *Perm.*, USA(Ariz.).——FIG. E65, *9*. **K. curvilineata*; *9a*, LV ext., ×2; *9b,c*, LV and RV hinges, ×2 *(128)*.

?Matheria BILLINGS, 1858 [19] [**M. tener*; SD MILLER, 1889]. Subrectangular, very inequilateral; numerous concentric ribs and several growth-furrows; prosogyrous rounded beaks; concave lunule. Hinge with 2 LV and 1 RV distinct cardinals; short right lunular margin. [May belong in Cyrtodontidae; see Cyrtodontacea.] *M.Ord.*, N.Am. (Can.).——FIG. E65,*10*. **M. tenera*; *10a,b*, LV ext., int., ×1 *(618)*.

Megapraeconia CHAVAN, 1952 [21] [**Hippopodium bajocense* THÉVENIN, 1909 (*ex* D'ORBIGNY, 1850); OD]. Trapezoidal to ovate, large, very inequilateral and thick, posteriorly attenuated. Concentric irregular ribbing. Cordiform deep lunule under the curved beaks. Strong anterior scar. Much extended hinge plate with 2 high, massive, cardinals on each valve and obsolete short posterior laterals. Smooth margin. *Jur.(Bajoc.-Lusitan.), ?L.Cret. (Neocom.)*, W.Eu.——FIG. E67,*2*. **M. bajocensis* (THÉVENIN), Bajoc., W.France; *2a,b*, RV int., LV int., ×0.5 (Thévenin, 1909).

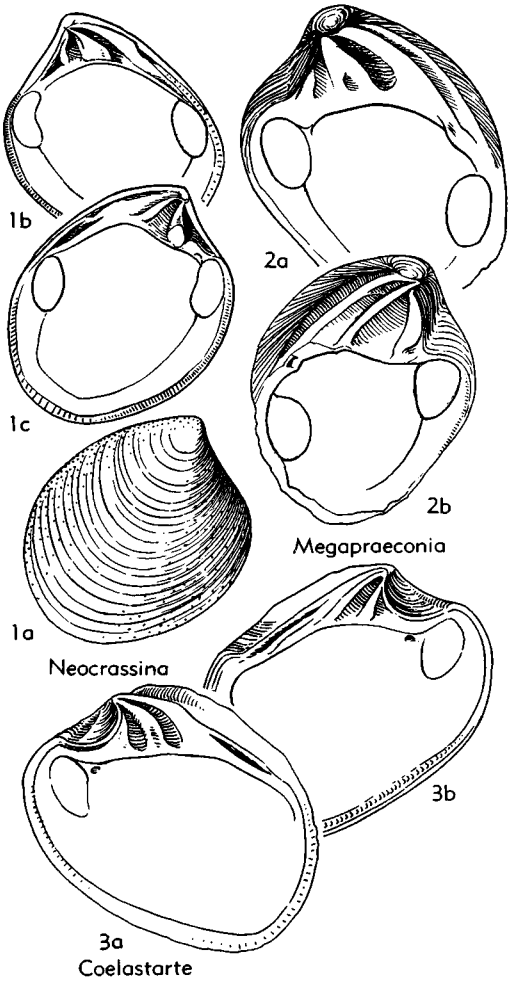


FIG. E67. Astartidae (Astartinae) (p. *N565-N567*).

Neocrassina FISCHER, 1886 [1887] [*nom. subst. pro Crassinella* BAYLE, 1878 (*non* GUPPY, 1874)] [**Astarte obliqua* DESHAYES, 1830 (=*Cypricardia obliqua* LAMARCK, 1819); SD DALL, 1903] [=*Puschia* ROUILLIER & VOSSYNSKI, 1847 (subj.) (type, *Astarte planata* SOWERBY, 1816; M]; *Oreada* ROUILLIER & VOSSYNSKI, 1847 *(nom. nud.)*; *Pruvostiella* AGRAWAL, 1955 (subj.) (type, *Astarte (P.) freneixae*)]. Ovate or trapezoidal, inequilateral, rather thick; concentric ribs commonly vanishing on adults. Two trigonal cardinals and strong posterior lateral on each valve. Broad flattened nymph; no *5b*. Margin denticulated or not. *L.Jur.(U.Lias.)-U.Cret.(Turon.)*, Eu.-Madag.-S.Afr.

N. (Neocrassina) [23]. Slightly depressed lunule; external escutcheon; *PII* considerably behind nymph. *L.Jur.(U.Lias.)-L.Cret.*, Eu.-Madag.——FIG. E67,*1*. **N. (N.) obliqua* (LAMARCK), Bajoc., W.France; *1a-c*, RV ext., int., LV int., ×0.5 (Bayle, 1879).

N. (Coelastarte) BÖHM, 1893 [24] [**Astarte excavata* SOWERBY, 1819; OD]. Excavated lunule; obliquely penetrating, flat escutcheon; compressed cardinals; *PII* just behind nymph. *L.Jur.(Aalen.)-U.Cret.(Turon.)*, Eu.-Madag.-S.Afr.——FIG. E67, *3*. **N. (C.) excavata* (SOWERBY), Bajoc., W. France; *3a,b*, RV int., LV int., ×0.6 (Böhm, 1893).

Nicaniella CHAVAN, 1945 [**Astarte communis* ZITTEL & GOUBERT, 1861; OD]. Trigonal or trapezoidal, small. Concentric ribs regular anteriorly and medially, faint or irregular posteriorly and ventrally. Inner margin usually crenate. Broad well-defined lunule and escutcheon. Hinge with small and strong cardinals, no *3a;* laminar laterals; short narrow nymph. *M.Jur.-Paleoc., ?Plio.*, N.Eu.-W.Eu.-Japan.

N. (Nicaniella) [11]. Trigonal to subquadrangular, with moderately prominent beaks; convex or straight posterior margin. Well-marked laterals. *U.Jur.-Paleoc., ?Plio.*, Eu.——FIG. E65,*12*. **N. (N.) communis* (ZITTEL & GOUBERT), U.Jur. (Sequan.), W.France; *12a,b*, LV ext., int., ×4; *12c*, RV hinge, ×5.1 (Chavan, 1945; Zittel & Goubert, 1861).

N. (Trautscholdia) Cox & ARKELL, 1948 [12] [**Astarte cordata* TRAUTSCHOLD, 1861; OD]. Cordate, wtih high inflated beaks; more or less flexuous anterior, concave posterior margin. Strong *AI*; narrow cardinals. Impressed cordiform lunule and lanceolated escutcheon. *M.Jur.-U.Jur.*, NW.Eu.——FIG. E65,*13*. **N. (T.) cordata* (TRAUTSCHOLD), Jur., USSR; *13a,b*, LV ext., int., ×0.7; *13c*, both valves, ant., ×0.7 (Rouillier, 1847).

Parisiella COSSMANN, 1887 [26] [**P. ambigua*; M]. Very oblique, inequilateral, small and flattened. Fine concentric ribbing. Each valve with 2 well-marked divergent cardinals, *3b* lobate; lateral remote, rather faint. Posterior scar somewhat raised. Smooth margin. *M.Eoc.(Lutet.)*, Eu.(France).——FIG. E65,*7*. **P. ambigua*, Paris basin; *7a-c*, RV ext., int., LV int., ×10 *(160)*.

Praeconia STOLICZKA, 1871 [20] [**Astarte terminalis* ROEMER, 1842 (=*A. terminalis* DESHAYES, 1839-42, =*Hippopodium gibbosum* THÉVENIN, 1909) (*ex* D'ORBIGNY, 1850); OD] [=*Theveninia* ROMAN, 1921 (obj.)]. Subtrapezoidal, compressed, thick, very inequilateral, with median depression and posterior enlargement. Numerous concentric rounded ribs and more or less equidistant growth furrows. Small deep concave lunule. Trigonal *3b*, with faint *AIII-3a* in front; *2, 4b* and remote, elongated *PII*. Margin irregularly crenate. *Jur.(L. Lias.-Lusitan.)*, Eu.(France)-Japan.——FIG. E65, *18a,b*. **P. terminalis* (DESHAYES), M.Jur.(Bajoc.),

W.France; *18a,* RV view, ext., ×0.7; *18b,* RV int., ×1 (*257*; Thévenin, 1909).——Fig. E65, *18c. P. sarthacensis* Cossmann, M.Jur.(Bathon.), W.France; LV int., ×1 (Cossmann, 1914).

Prorokia Böhm, 1893 [25] [**Cardita ovalis* Quenstedt, 1852; OD] [=*Pachytypus* Munier-Chalmas (*ex* Fischer, MS), 1887 (type, *Cardita problematica* Buvignier, 1852; OD)]. Subelliptical, thick, rather small, concentrically ribbed. No lunule or escutcheon. Widely divergent cardinals. *3b* largely trigonal, *3a, 2* and *4b* long and thin; remote posterior laterals, no anterior ones. Raised posterior scar. Crenate margin. *M.Jur.(Bathon.)-U.Jur.(Kimmeridg.),* Eu.——Fig. E65,*11. P. problematica* (Buvignier), U.Jur.(Raurac.), E. France; *11a-c,* LV ext., int., RV int., ×2 (Buvignier, 1852).

?**Seendia** Casey, 1961 (25a) [**Crassatella saxoneti* Pictet & Roux, 1847; OD]. Transversely inequilateral, subrectangular, thick, compressed. Narrow well-defined lunule. Concentric ridges and faint radial lines; margin crenate. Narrow hinge, with 2 cardinals in each valve, *3b* much larger; ligament said to be sunken; posterior adductor surelevated. [Possibly belongs to Eryphylinae.] *L.Cret.,* W.Eu.

Sita Semper, 1862 [27] [**Woodia crenulata* Deshayes, 1860; SD Chavan, herein] [=*Crenimargo* Cossmann, 1902 (obj.)]. Ovate, smooth, rather small. Each valve with 2 cardinals, LV anterior and RV posterior ones strongly lobate; no laterals. Ovately elongated scars. Margin obliquely crenulate. *Eoc.,* W.Eu.——Fig. E65,*14. *S. crenulata* (Deshayes), M.Eoc.(Lutet.), France(Paris basin); *14a,* LV ext., ×4; *14b,c,* U.Eoc.(Barton.), Belg., LV int., RV int., enl. (Glibert, 1936).

[Although originally indicated to be Sanskrit name, *Sita* is here accepted as a properly latinized designation with priority over *Crenimargo,* which was based on misinterpretation of the same species.]

Tridonta Schumacher, 1817 [**T. borealis* (=**Venus borealis* Chemnitz, 1784, invalid nonbinom. ICZN); M] [=*Triodonta* Agassiz, 1846 *(nom. null.)*]. Transversely quadrangular to rounded; closely spaced concentric ribs at least in early growth stages; inner margin usually smooth. Hinge lacking *AIV* and *PI*; strong short *AI* and *PII*. Broad nymph behind small *6b*. [Localized in cold and temperate waters.] *L.Cret.-Rec.,* Arctic-N.N.Am.-Japan-Eu.

T. (Tridonta) [8]. Medium-sized, transversely inequilateral; concentric ribs more or less vanishing on the disc. Flattened long lunule. *L.Cret. (Neocom.)-Rec.,* Atl.——Fig. E65,*17. *T. (T.) borealis,* Rec., North Sea; *17a,* LV ext., ×1; *17b,c,* LV and RV hinges, ×0.5 (*511*; Sowerby, 1854).

T. (Nicania) Leach, 1819 [9] [**N. banksii* (=*Venus montagui* Dillwyn, 1817 *var. banksii*); SD Gray, 1847]. Smaller, less inequilateral, with persistent concentric rounded ribs. Very long more depressed lunule, obliterating *3a;* large, somewhat bifid *3b*; posterior cardinals laminar; *AI* strong and *PII* remote, springing from under hinge plate. *Pleist.-Rec.,* circumpolar-N.Eu.-N.N.Am.-Japan.——Fig. E65,*16. *T. (N.) montagui* (Dillwyn), Rec., USA(Mass.); *16a,b,* LV ext., RV int., ×1 (Gould, 1841).

T. (Rictocyma) Dall, 1872 [10] [**R. mirabilis*; M] [=*Rhectocyma* von Martens, 1873, emend.]. With concentric striae and larger ribs, becoming broadly irregular, oblique, and interrupted on disc. *Plio.-Rec.,* Arctic.——Fig. E65,*15. *T. (R.) mirabilis* (Dall), Rec., Unga Is.; LV ext., ×3 (Dall, 1872).

Yabea Hayami, 1965 [22] [**Astarte shinanoensis* Yabe & Nagao in Yabe, Nagao, & Shimizu, 1926; OD]. Very inequilateral, strongly convex, trapezoidal, with prominent prosogyrous beaks; deeply depressed lunule; margin crenulated; *3a* short, curved, *3b, 5b* narrow, not clearly separated from the nymph; *2, 4b*; well developed both anterior and long posterior laterals. *L.Cret.,* Japan.

Subfamily ERIPHYLINAE Chavan, 1952

Shell lenticular or crassatelliform, commonly with pointed beaks. Hinge with *AIV* reaching almost to beak, its socket forming narrow groove in front of *3a*; other laterals (when present) also elongate and laminar. *Dev.-Eoc.*

Arrangement of generic taxa by Chavan.——1. *Eriphyla.*——2. *Dozyia.*——3. *Herzogina.*——4. *Amphiaraus.*——5. *Bruniastarte.*——6. *Eriphylopsis.*——7. *Disparilia.*——8. *Crassatellopsis.*——9. *Astartemya.*——10. *Freiastarte.*——11. *Crassatellina.*——12. *Cardiniopsis.*——13. *Lirodiscus.*——14. *Crustuloides.*

Eriphyla Gabb, 1867 [**E. umbonata* Gabb, 1864; OD]. Almost equilateral, rounded; smooth or finely lamellar. Obliquely depressed lunule; narrow escutcheon. Hinge with 2 cardinals on each valve, *4b* not reaching inferior margin of plate but posteriorly fused to nymphal thickening; *AIII, AIV, PII, PIII* present. Shallow pallial inflexion. Margin smooth or crenulate. *Cret.,* W.N.Am.-W.Eu.-Japan. [=*Mikayoella* Hayami, 1965 (type, *Astarte mikayoensis* Nagao in Yabe, 1927; OD).]

E. (Eriphyla) [1]. Thickened, high; *3a* fused to *AIII, 3b* not very oblique, *4b* reduced to its upper part; posterior laterals not far behind cardinals. *Cret.,* W.N.Am.-W.Eu.——Fig. E68,*1. E. (E.) lapidis* (Packard), U.Cret., USA(Calif.); *1a,b,* LV and RV hinges, ×0.75 *(748)*.

E. (Dozyia) Bosquet in Dewalque, 1868 [2] [**D. lenticularis* (=**Lucina lenticularis* Goldfuss, 1840); M]. Broader and thinner than *E. (Eriphyla)*; *3a* separated from *AIII, 3b* very oblique, *4b* widened posteriorly; posterior laterals

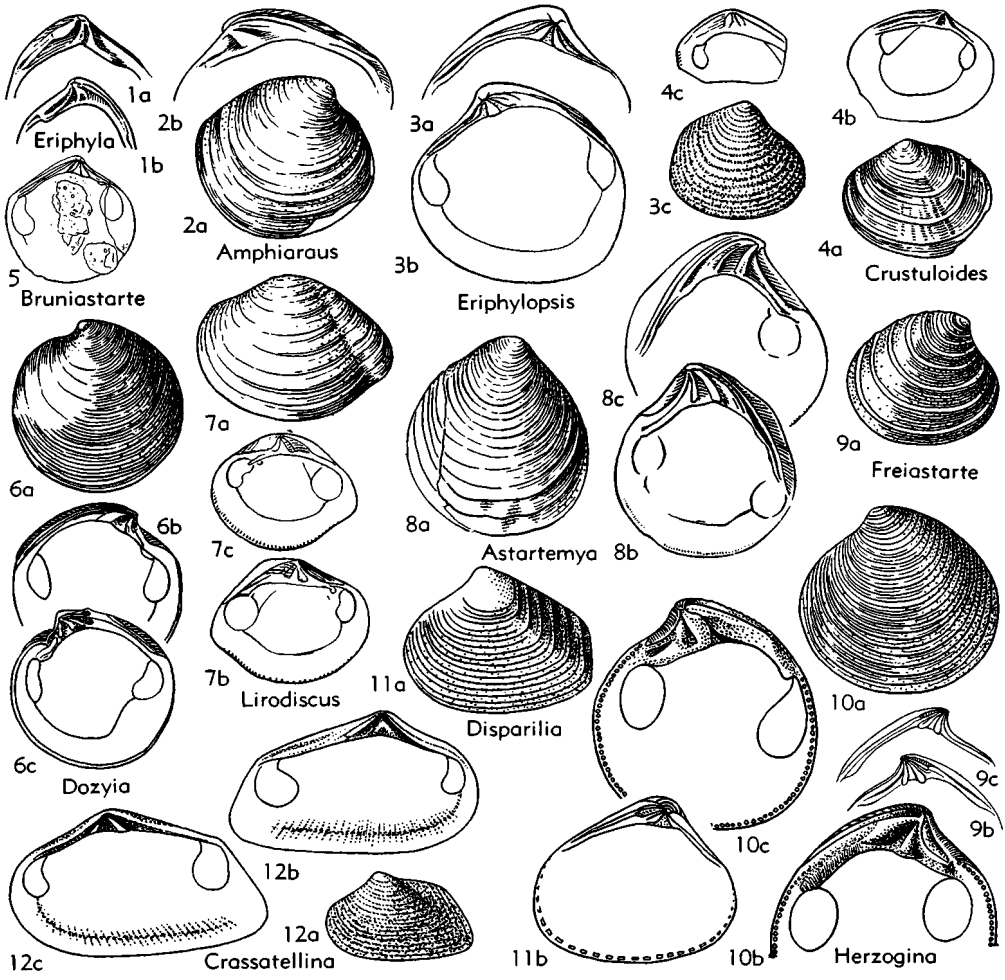


FIG. E68. Astartidae (Eriphylinae) (p. *N*568-*N*571).

remote. *U.Cret.(Senon.)*, W.N.Am.-W.Eu.——FIG. E68,*6*. **E. (D.) lenticularis* (GOLDFUSS), Campan., Neth.; *6a-c*, LV ext., int., RV int., ×0.7 *(415)*.

Amphiaraus VOKES, 1946 [**A. seleniscus*; OD]. Flattened and rounded, inequilateral, smooth. Almost flat lunule and sharply limited escutcheon. Hinge with *AIII-3a* under *AIV*; *3b* trigonal, *5b*, and broad nymphal plate; remote posterior laterals. *M. Jur.(Bajoc.)-L. Cret.(Apt.)*, M. East(Lebanon)-W.Eu.

[Supposition by Cox that *Amphiaraus* is a junior synonym of *Eomiodon* Cox, 1935, classed in the family Eomiodontidae of the Glossacea, is firmly rejected by CHAVAN, who points out that the shell of *Amphiaraus* is lenticular, contrasting strongly with the peculiar trigonal-transverse outline of the angular shell of *Eomiodon*, with lamellose ornament. Further, *Eomiodon* has long sinuate lateral teeth, no *AIV* groove above *3a*, and bears *PI*, a tooth which is lacking in *Amphiaraus* and basically in other astartids.—Ed.] [CHAVAN states (11 January, 1967): "*Amphiaraus* has been treated by several authors as a small neomiodontid (arcticacean), but its small, remote *fAIV* above a stout, noncorbiculoid *AIII*, as well as its *PIII*, instead of *PI*, astartoid cardinals, and lenticular form, are characteristic of the Eriphylinae."]

A. (Amphiaraus) [4]. Transversely ovate. Broad *AIII-3a*; *3b* very oblique; strong right posterior ridge or lateral. *L.Cret.(Apt.)*, Lebanon.——FIG. E68,*2*. **A. (A.) seleniscus* VOKES; *2a,b*, RV ext., hinge, ×0.75, ×1 *(945)*.

A. (Bruniastarte) CHAVAN, 1952 [5] [**Astarte thoas* THÉVENIN, 1909; OD]. Subquadrangular. *AIV* straight and raised; *AIII-3a* thinner; *3b* not very oblique, *PIII* faint. *M.Jur.(Bajoc.)*, Eu.(W. France).——FIG. E68,*5*. **A. (B.) thoas* (THÉVENIN); LV int., ×1 *(110, 111)*.

Astartemya STEPHENSON, 1941 [**A. fentressensis*; OD]. Subtrigonal to ovate, flattened; prominent

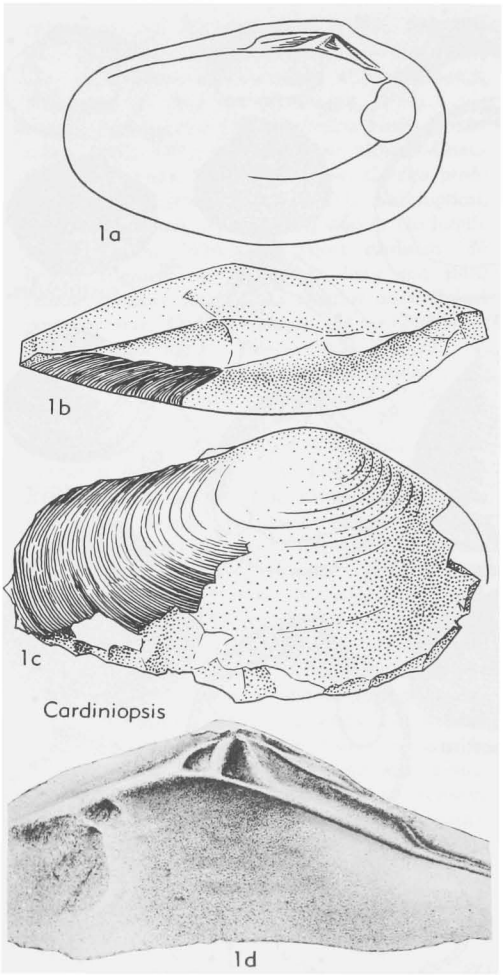


FIG. E69. Astartidae (Eriphylinae) (p. *N570*).

curved beaks. Concentric waves or ribs and fine growth lines. Depressed lunule, flat escutcheon. Hinge with long laterals prolonged upward, commonly to beaks; 2 oblique cardinals on each valve, *5b* obsolete. Flat nymphal plate in front of narrow crest and furrow. Slight pallial impression. *U.Cret., ?Paleoc.,* cosmop.

A. (Astartemya) [9]. Higher than long, subovate; shallow undulations; grooved cardinals; laterals bounded by flangelike plate, anterior ones reaching beaks. Broad nymph. Fine marginal crenulations. *U.Cret.(Senon.),* cosmop.——FIG. E68,*8*. **A. (A.) fentressensis* STEPHENSON, USA(Tex.); *8a-c,* RV ext., int., LV int., ×0.7 *(889)*.

A. (Freiastarte) CHAVAN, 1952 [10] [*nom. subst. pro Freia* BÖHM, 1884 (*non* CLAPARÉDE & LACHMANN, 1858)] [**Astarte coelata* MÜLLER, 1847 (=**Astarte similis* MÜNSTER in GOLDFUSS, 1837 [1840]); OD]. Small, subtrigonal; concentric distant ribs. Anterior laterals not completely reaching beaks, posterior ones thickened behind, *5b* conspicuous. Ligamentary plate on a superficial reed-shaped area. Margin strongly crenate, sometimes smooth. *Cret.,* and possibly *Paleoc.,* W.Eu.-S.Afr.-India. —— FIG. E68,*9*. **A. (F.) similis* (MÜNSTER in GOLDFUSS), Campan., Neth.; *9a-c,* RV ext., RV and LV hinges, ×0.7 *(110, 111, 415)*.

Cardiniopsis STANTON, 1895 [12] [**C. unioides*; OD]. Largely transverse, anteriorly rounded and posteriorly narrowed. Hinge with one prominent median RV cardinal; *3a, 5b,* faint, and 2 subsymmetric LV teeth. Broad long nymph, no laterals except for weak *AIV* in front of 2. Well-impressed pedal scars. *L.Cret.,* USA(Calif.).——FIG. E69,*1*. **C. unioides; 1a,* LV int., ×0.3; *1b,* both valves, dorsal, ×0.3; *1c,* RV ext., ×0.3; *1d,* RV hinge, ×0.5 *(877)*.

Crassatellina MEEK, 1871 [11] [**C. oblonga*; OD]. Transversely subtrapezoidal, rather small. Well-marked anterior lateral prolonged up to beak, in front of cardinals; *2* and *3b* bifid. Elongated nymph. No posterior laterals. *U.Cret.,* USA(N. Dak.-Kans.).——FIG. E68,*12*. **C. oblonga,* USA (Kan.); *12a,* LV ext., ×1; *12b,c,* LV int., RV int., ×2 (Meek & Hayden, 1856).

Crassatellopsis BEUSHAUSEN, 1895 [8] [**C. hauchecornei*; M]. Sublenticular, almost smooth. Pointed beaks. Hinge with stout trigonal anterior LV cardinal and obliquely directed RV one; posterior left and anterior right, both thinner. Very narrow, almost linear resilium apparently present. Anterior scar somewhat elliptical. *Dev.,* Eu.(Ger.).——FIG. E70,*1*. **C. hauchecornei,* Rheinland; *1a-c,* LV int., RV int., LV int., ×1 *(47)*.

Disparilia CHAVAN, 1953 [7] [**Astarte disparilis* D'ORBIGNY, 1843; OD]. Trigonal-transverse, posteriorly narrowed; concentric somewhat lamellar ribs. Hinge with almost obsolete laterals, narrow *3a* and *5b, 2,* stout *3b* and *4b*. External ligament sunken into recess of escutcheon, simulating resilial socket. Crenate margin. *Cret.,* W.Eu.-N.Afr.-Lebanon.——FIG. E68,*11*. **D. disparilis* (D'ORBIGNY), L.Cret.(Neocom.), E.France; *11a,b,* LV ext., int., ×1.5 *(115, 695)*.

Eriphylopsis MEEK, 1876 [6] [**Eriphyla gregaria* MEEK & HAYDEN, 1856; OD]. Subtrapezoidal to rounded, rather small; concentrically undulate, lunule relatively broad. Hinge with elongate laterals, RV anterior and LV posterior ones duplicate, and anterior cardinals more or less in prolongation of their laterals; stout posterior cardinals. *U.Cret.,* W.Eu.-S.Eu.-W.N.Am.——FIG. E68,*3*. **E. gregaria* (MEEK & HAYDEN), USA(Mont.); *3a,b,* LV hinge, RV hinge, ×2 (Chavan, n); *3c,* RV ext., ×1.5 (Meek & Hayden, 1856).

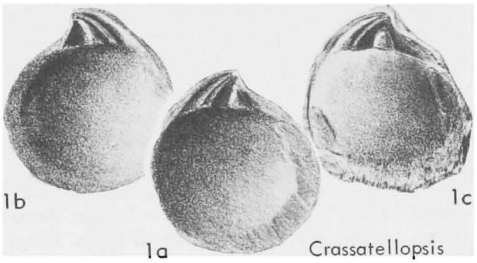


FIG. E70. Astartidae (Eriphylinae) (p. *N570*).

Herzogina CHAVAN, 1952 [3] [**Astarte herzogi* KRAUSS, 1850 (=**Cytherea herzogii* HAUSSMANN, 1837); OD]. Rounded, moderately convex, with strong concentric ribs. Depressed lunule. Hinge with marginal *AIV, AIII* almost perpendicular to *3a, 3b* curved onwards on its lower part; a broad depression for *4b* and the nymph; remote posterior laterals. Crenate margin. *L.Cret.(Neocom.),* S.Afr.——FIG. E68,*10*. **H. herzogii* (HAUSSMANN); *10a-c,* LV ext., int., RV int., ×0.7 (Krauss, 1850).

Lirodiscus CONRAD, 1869 [**Astarte tellinoides* CONRAD, 1833; SD DALL, 1903]. More or less transversely rounded and compressed. Concentrically sculptured. Flattened beaks and escutcheon. Two cardinals on each valve; anterior laterals obliquely directed; posterior ones prolonged under ligamentar extension. Well-impressed scars. Margin commonly denticulate. *Eoc.,* USA.

L. (Lirodiscus) [13]. Thickened, with strong concentric ribs and growth striae; with posterior fold. Broad lunule and escutcheon. Flat nymph with undulating growth striae, extending up from posterior margin to and above *3b* and *4b*. Anterior left laterals bifurcate under lunule. *Eoc.,* USA.——FIG. E68,*7*. **L. (L.) tellinoides* (CONRAD), M.Eoc., Ala.; *7a-c,* LV ext., int., RV int., ×1 (Harris, 1919).

L. (Crustuloides) G. D. HARRIS, 1919 [14] [**Crassatellites (Scambula) psychopterus* DALL, 1903; M]. Thin, much compressed; irregularly striated, undulating peripherally; lunule and escutcheon linear. Hinge plate enlarged in front, with one straight anterior lateral; posterior ones somewhat broadened. *L.Eoc.,* USA(Miss.).——FIG. E68,*4*. **L. (C.) psychopterus* (DALL); *4a-c,* LV ext., int., RV int., ×1 (Harris, 1919).

Subfamily OPINAE Chavan, 1952

[*nom. correct.* herein (*pro* Opisinae CHAVAN, 1952)]

Very high beaks; anterior laterals obsolete; high, trigonal cardinals. Oblong or transverse carinated shell, with a defined posterior area *(50). Dev.-U.Cret.*

Arrangement of generic taxa by CHAVAN.——1. *Opis.*——2. *Trigonopis.*——3. *Pachyopis.*——4. *Coelopis.*——5. *Cryptocoelopis.*——6. *Prosocoelus.*——7. *Tripleura.*——8. *Prosocoelogeton.*——9. *Heteropis.*——10. *Trigonastarte.*——11. *Seebachia.*——12. *Opisoma.*

Opis DEFRANCE, 1825 (1824, *nom. nud.*) [**Trigonia cardissoides* LAMARCK, 1819; M]. Obliquely oblong, with prominent beaks. Ventral margin curved in front of medioposterior undulation; posterior margin then truncated. Concentric ribbing. More or less shallow lunule. Large hinge, without laterals; one strong RV trigonal and 2 LV cardinals, commonly with their lateral faces striated; *4b* stronger than *2*. Ligament narrow. Margin more or less crenate. *L.Jur.(Lias.)-U.Cret.,* Eu.-Madag.-N.Am.-Japan.

O. (Opis) [1]. Subtrigonal, rounded in front and ventrally, inflated, obliquely elongated. Erect beaks. Lunule large, somewhat depressed. Ribs closely spaced. Hinge with *3b* triangular and high. *L.Jur.(Lias.)-U.Cret.,* Eu.-N.Am.-Madag.——FIG. E71,*2*. **O. (O.) cardissoides* (LAMARCK), U.Cret.(Cenoman.), Belg.; *2a,b,* RV ext., ant.; *2c,d,* LV hinge view, ant.; *2e,* LV int. mold, ×1 (*50*; d'Archiac, 1847).

O. (Pachyopis) BIGOT, 1895 [3] [**O. ponderosa* DESLONGCHAMPS, 1883; OD]. Much inflated, thick; ventrally (instead of posteroventrally) elongated. Ribs crossed by median and postmedian angulation. Beaks rounded and conspicuously prosogyrous. Very shallow lunule. Rudimentary anterior LV cardinal. Margin crenate. *Jur. (Bajoc.-Lusitan.),* W.Eu.——FIG. E72,*3*. **O. (P.) ponderosa* DESLONGCHAMPS, Bajoc., W. France; *3a,b,* RV ext., int., ×0.7 *(50)*.

O. (Trigonopis) FISCHER (*ex* MUNIER-CHALMAS, MS), 1887 [2] [**Opis similis* D'ORBIGNY, 1844 (=*Cardita similis* SOWERBY, 1819); M]. Subtrapezoidal, angular in front; inflated, but slightly curved forward; narrow regularly spaced ribs; strong medioposterior angulation. Rounded beaks. Shallow lunule; *3b* largely and more or less obtusely triangular. *L.Jur.-L.Cret.,* W.Eu.——FIG. E71,*3*. *O. (T.) praesimilis* COSSMANN, M.Jur. (Bajoc.), France; *3a-c,* RV ext., int., LV int., ×3 *(161)*.

Coelopis FISCHER (*ex* MUNIER-CHALMAS, MS), 1887 [*"*Opis lunulata* MILLER" (*errore pro *Cardita lunulata* J. SOWERBY, 1819); M]. Subquadrangular to subtrapezoidal, with almost enrolled prosogyrous beaks and large depressed well-defined lunule. Concentric ribbing; anteromedian and medioposterior carinas. Relatively restricted hinge with one strong RV and 2 LV narrow cardinals, without lateral striations; 2 very rudimentary. Denticulated margin. *M.Trias.-L.Cret.,* Eu.

C. (Coelopis) [4]. Without chamber individualized in front of teeth. *M.Trias.-L.Cret.,* Eu.——FIG. E71,*1a*. **C. (C.) lunulata* (SOWERBY), M.Jur.

(Bathon.), France; RV ext., ×3 (Cossmann, 1918).——Fig. E71,*1b-d. C. (C.) affinis* Laube, M.Trias.(Ladin.), Aus.(Tyrol); *1b,c,* LV ant., hinge; *1d,* RV hinge; all ×3 *(58).*

C. (Cryptocoelopis) Bittner, 1895 [5] [**Opis locularis* Bittner, 1895 (=*?O. affinis* Laube, 1865, "female form"); SD Chavan, herein].

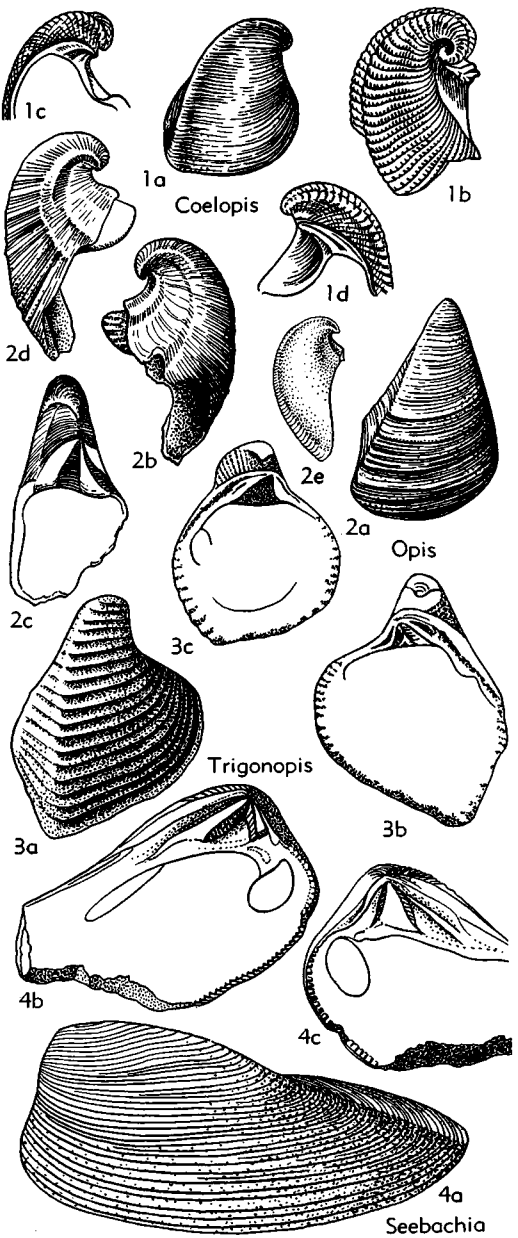


Fig. E71. Astartidae (Opinae) (p. *N*571-*N*573).

With a wide chamber individualized between the lunular margin and the anterior margin of the hinge plate, thus duplicated. *M.Trias. (Ladin.),* Eu.(Aus.).——Fig. E72,*2. *C. (C.) loculoris* (Bittner), Tyrol; LV hinge, ×3 *(58).*

Heteropis Böhm, 1893 [9] [**Opis carinata* Quenstedt, 1858; OD]. Higher than long, inequilateral, with medioposterior angulation; finely ribbed. Large flattened or shallow lunule. Prosogyrous oblique prominent, but small beaks. Hinge with anterior laterals partly developed and fused to anterior cardinals, *3b* narrow; posterior ones rudimentary. Smooth inner margin. *Jur.(Bathon.-Lusitan.),* Eu.——Fig. E72,*1a,b. *H. carinata* (Quenstedt), Lusitan., Ger.; *1a,b,* LV ext., int., ×2 (Buvignier, 1852).——Fig. E72,*1c. H. raulinea* (Buvignier), U.Jur.(U.Oxford.), E.France; RV int., ×1 (Böhm, 1893).

Opisoma Stoliczka, 1871 [12] [**Opis paradoxa* Buvignier, 1852 (=**Cardium paradoxum* Buvignier, 1843); OD]. Trigonal, extremely oblong, with an anteromedian strong carina. Opisthogyrous erect beaks. Concentric striation. Three RV and 2 LV much elongated narrow cardinals; *6b* fused to narrow nymph. Anterior scar on a long platform. *Jur.(Infralias-Raurac.),* Eu.(France).——Fig. E72,*4. *O. paradoxum* (Buvignier), U.Jur. (Lusitan.), E.France; *4a-c,* LV ext., int., RV int., ×0.7 (Buvignier, 1852).

Prosocoelus Keferstein, 1857, p. 155 [**Venus prisca* Roemer, 1843; SD Haffer, 1959]. Medium-sized, ovate, gibbous, umbones high, prosogyrous, more or less anterior; lunule very deep, just below beaks; without lateral teeth; RV with strong cardinal tooth received between 2 teeth of LV, anterior of which is ill-defined conical and posterior rather thin; with several diagonal folds and furrows on mid-posterior area or lacking ornament. *Dev.,* Eu.-Spitz.

P. (Prosocoelus) [6]. Short subquadrate, nearly smooth. *L.Dev.,* Ger.——Fig. E66,*2. *P. (P.) priscus* (Roemer); *2a,b,* RV and LV hinges, ×1; *2c,* RV int., ×0.3 (Haffer, 1959).

P. (Tripleura) Sandberger, 1889 [7] [**T. pesanseris* (=**Grammysia pesanseris* Zeil & Wirtgen, 1851); OD]. Posteriorly elongate, with several radial folds. *L.Dev.,* Ger.

P. (Prosocoelogeton) Quenstedt, 1926 [8] [**P. (P.) lenticularis;* OD]. With distinct *3a* along lunular margin, *4b* shorter and stouter than *3a. U.Dev.,* Spitz.

Seebachia Holub & Neumayr, 1881 [11] [**Astarte bronni* Krauss, 1850; OD]. Transversely trigonal, large and very inequilateral; anterior end rounded, posterior much elongated with dorsal angulation. Concentric ribbing. Lunule and escutcheon developed. Cardinals unequal, striated on their lateral faces, *3b* strongest; anterior laterals small, posterior ones absent. Scars impressed, posterior one

on platform. Margin crenate. *L.Cret.(Neocom.)*, S.Afr.-India.——Fig. E71,*4*. **S. bronni* (Krauss), S.Afr.; *4a-c*, LV ext., int., RV int., ×0.5 (Krauss, 1850).

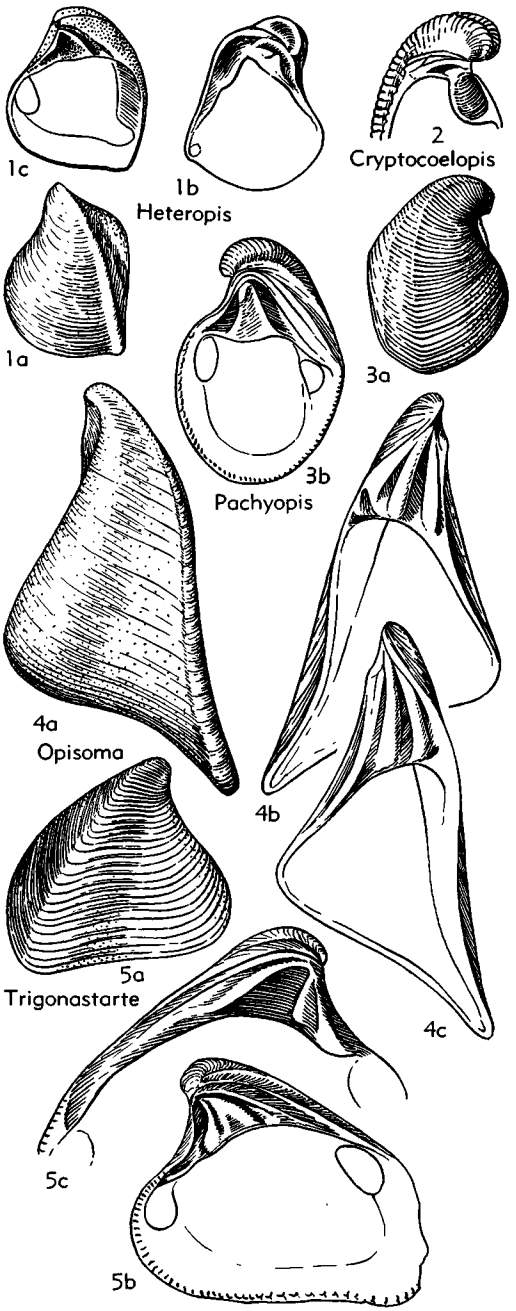


Fig. E72. Astartidae (Opinae) (p. *N571-N573*).

Trigonastarte Bigot, 1895 [10] [**Astarte trigonalis* J. de C. Sowerby, 1824; OD] [=*Opisastarte* Frech & Meyer, 1922 (type, *Astarte trigonalis* Sowerby, 1824; SD Chavan, herein)]. Transversely and inequilaterally trigonal, shortened forward. Prosogyrous beaks; somewhat depressed lunule. Concentric ribbing with medioposterior angulation. One strong RV trigonal and 2 LV cardinals, striated on their lateral faces; poorly marked anterior right and posterior left laterals. Crenulated margin. *M.Jur.*, W.Eu.-Indon.——Fig. E72,*5*. **T. trigonalis* (Sowerby), Bajoc., W.France; *5a-c*, RV ext., int., LV int., ×0.7 *(50, 870)*.

Family CRASSATELLIDAE Férussac, 1822

[=Crassatellitidae Dall, 1895]

Subquadrangular to trigonal in outline, rounded in front, more or less truncated posteriorly. Concentrically ribbed to smooth. Internal layer of radial riblets straight and continuous (so far as observable). Ligament internal, in pit, which commonly obliterates upper part of tooth *4b*; narrowly marginal nymphal ridge behind pit. *Dev.-Rec.*

Subfamily CRASSATELLINAE Férussac, 1822

[*nom. transl.* Chavan, 1952 (*ex* Crassatellidae Férussac, 1822)]

Prosogyrous or orthogyrous beaks; anterior laterals not passing up in front of anterior cardinals. Cardinals divergent. Resilium well developed. *Dev.-Rec.*

Arrangement of generic taxa by Chavan.——1. *Crassatella*.——2. *Pachythaerus*.——3. *Landinia*.——4. *Indocrassatella*.——5. *Salaputium*.——6. *Oriocrassatella*.——7. *Cypricardella*.——8. *Uddenia*.——9. *Crassatina*.——10. *Chattonia*.——11. *Talabrica*.——12. *Eucrassatella*.——13. *Hybolophus*.——14. *Spissatella*.——15. *Bathytormus*.——16. *Anthonya*.

Crassatella Lamarck, 1799 [**Mactra cygnaea* Lamarck, 1799 (*non* Chemnitz, 1782) (=*C. gibba* Lamarck, 1801 =*Venus ponderosa* Gmelin, 1791); SD Schmidt, 1818] [=?*Crassatellites* Krueger, 1823 (type, *C. sinuatus* (*non Crassatella sinuata* Lamarck, 1818); M) *(nom. dub.)*; *Roissya* "Lesson" Schaufuss, 1869]. Subtrapezoidal, thick; prosogyrous beaks. Concentric ribbing and posterior angulation. Lunule and escutcheon deeply sunken. Resilial pit large, but not reaching lower margin of plate. Scars broad, anterior one reniform, posterior one ovate and truncate. Valve margins finely crenulate. *M.Cret.(Turon.)-Mio.*, Eu.-N.Am.

C. (Crassatella) [1]. High, irregular, with more or less vanishing ribs. Short anterior laterals. Post-

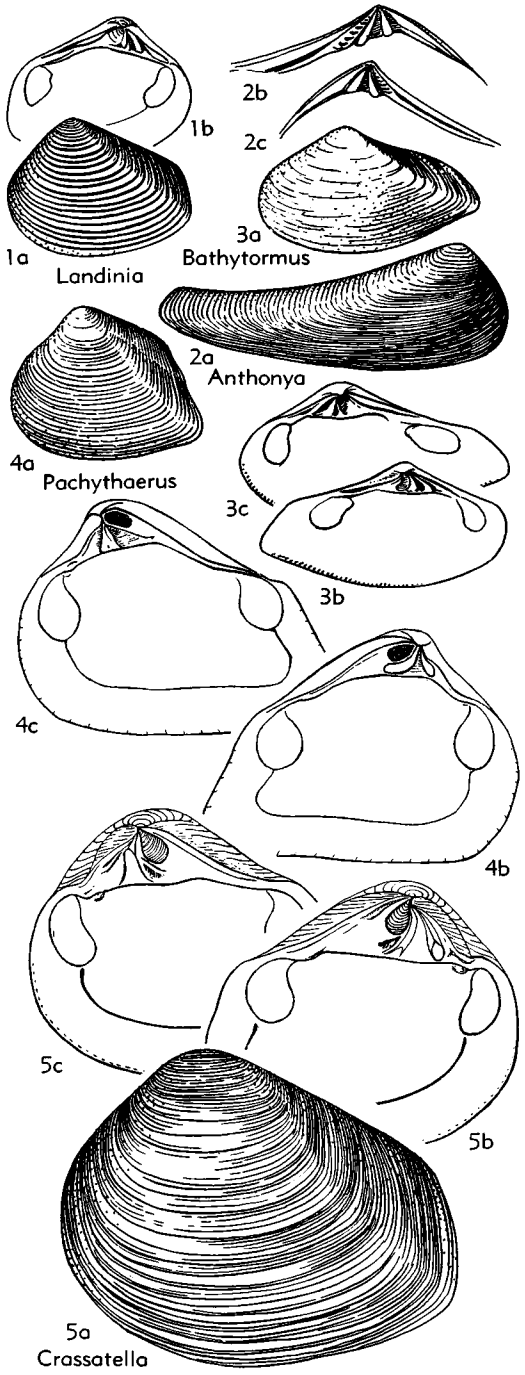


FIG. E73. Crassatellidae (Crassatellinae) (p. *N573-N574*).

resilial ridge prolonged by posterior laterals. *U. Cret.(Turon.)-Mio.(Helvet.)*, Eu.-N.Am.——FIG. E73,*5*. *C. (C.) ponderosa* (GMELIN), M.Eoc., France(Paris basin); *5a-c*, LV ext., int., RV int., ×0.5 (Chavan, n; Deshayes, 1837).

C. (Landinia) CHAVAN, 1952 [3] [**C. landinensis* NYST, 1843; OD]. Transversely elongate, obliquely truncate posteriorly; compressed. Rounded ribs. Anterior teeth long, *2* slightly oblique forward. Strong postresilial ridge, prolonged by remote posterior laterals. *U.Cret.(Senon.)-U.Eoc.*, Eu.-N. Am.-?Palestine.——FIG. E73,*1*. **C. (L.) landinensis* NYST, L.Eoc., France(Paris basin); *1a,b*, LV ext., int., ×0.7 (Deshayes, 1837).

C. (Pachythaerus) CONRAD, 1869 [2] [**C. vindinnensis* D'ORBIGNY, 1843; OD]. With prominent dorsal slope and well-marked posterior angulation. Ribs commonly lamellar. *3b* trigonal, pointed; *4b* curved, continuing far below pit. Postresilial ridge almost fused with margin of escutcheon above laterals. *M.Cret.-M.Eoc.*, Eu.-N.Am.-Japan.——FIG. E73,*4*. **C. (P.) vindinnensis* D'ORBIGNY, L.Turon., W.France; *4a*, LV ext., ×0.75; *4b,c*, LV int., RV int., ×1.4 *(695;* Chavan, n).

Anthonya GABB, 1864 [16] [**A. cultriformis*; M]. Narrowly and transversely inequilateral, flattened; anteriorly rounded, posteriorly much elongated and tapering. Suborthogyrous beaks. Oblique and narrow lunule, flattened escutcheon. Broad obsolete upper anterior lateral, 2 well-developed cardinals, largely oblique resilium and long posterior lateral. *Cret., ?Eoc.*, N.Am.-W.Eu.-Afr.-Asia-Australia-Japan.——FIG. E73,*2*. **A. cultriformis*, U.Cret., USA(Calif.); *2a-c*, RV ext., hinge, LV hinge, ×1 *(333)*.

Bathytormus STEWART, 1930 [15] [**Crassatella protexta* CONRAD, 1832; OD] [=*Crenocrassatella* HABE, 1951 (type, *Crassatella foveolata* SOWERBY, 1870; OD) (subj.)]. Transversely subtrigonal, anterior side rounded, posterior attenuated, in many shells ventrally narrowed. Very small, feebly prosogyrous beaks. Anterior RV lateral laminar, cardinals oblique, very large pit pushing them forward and extending downward to margin of plate and with thin ridge behind it; remote strong laminar laterals. Large scars. Valve margins usually crenulate. *U.Cret.-Rec.*, W.Eu.-N.Am.-NE.Mex.-Asia(India-Japan)-Ghana.——FIG. E73,*3*. **B. protextus* (CONRAD), M.Eoc., USA(Ala.); *3a-c*, LV ext., int., RV int., ×0.7 (Harris, 1919).

Crassatina KOBELT, 1881 [**Crassatella triquetra* "SOWERBY" REEVE (1842) 1843; OD] [=*Crassatina* WEINKAUFF, 1881 *(nom. nud.)*]. Subtrigonal to subquadrate, rather small; prosogyrous beaks. Concentric ribs divided or vanishing backward. Narrow lunule and escutcheon. Anterior RV cardinal more or less prolonging laterals; posterior narrow cardinals and elongate laterals. Trigonal resilium. *Paleoc.-Rec.*, Eu.-Asia(Japan)-Afr.

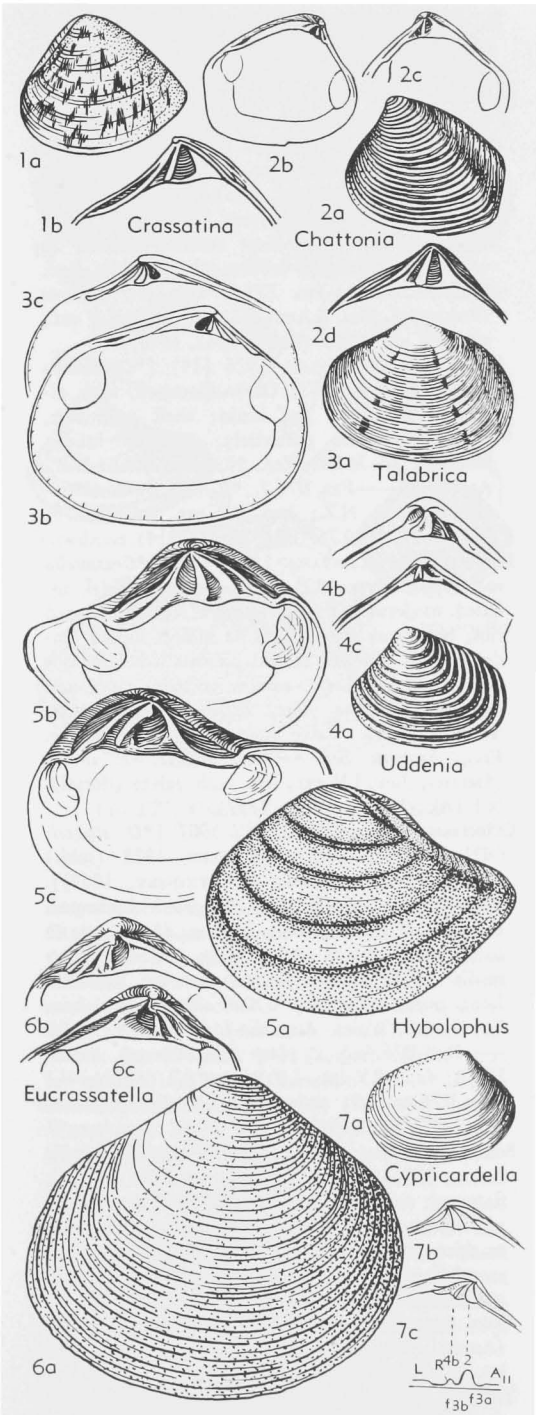


FIG. E74. Crassatellidae (Crassatellinae) (p. *N574-N577*).

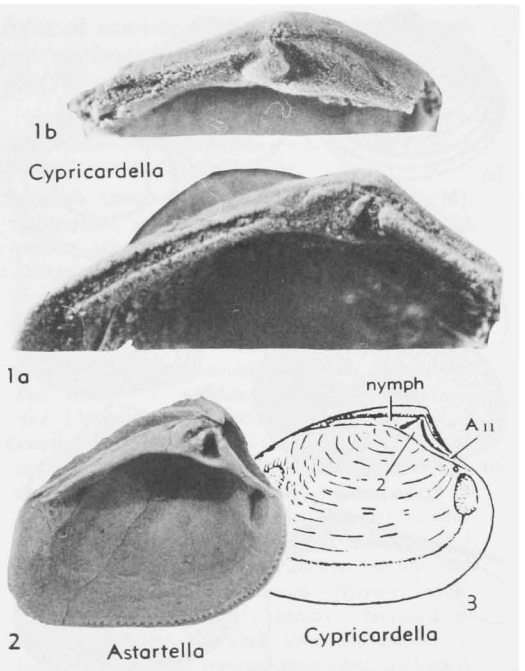


FIG. E75. Crassatellidae (Crassatellinae) (p. *N575-N576*).

C. (Crassatina) [9]. Valve margins crenulate; shell rather thick. Anterior RV cardinal in prolongation of lateral; *3b* slightly curved forward; well-marked ligamentary ridge in prolongation of laterals. *U.Eoc.-Rec.,* Eu.-Afr.-Asia.——FIG. E74,*1a.* **C. (C.) triquetra* (REEVE), Rec., W.Afr.; RV ext., ×1 (Reeve, 1843).——FIG. E74,*1b. C. (C.)* sp. cf. *C. bronni* (WOOD), U.Eoc., Eng.; RV hinge, ×0.7 *(100).*

C. (Chattonia) MARWICK, 1928 [10] [**C. animula;* OD]. Valve margins smooth. Anterior RV cardinal more distinct than lateral; *3b* curved forward; ligamentary ridge and posterior laterals separated. *Paleoc.-Rec.,* W.Eu.-Australia-N.Z.——FIG. E74,*2a-c.* **C. (C.) animula* MARWICK, Oligo., N.Z.; *2a-c,* LV ext., int., RV int., ×4 *(593).*——FIG. E74,*2d. C. (C.) bartonensis* (WOOD), U.Eoc. (Barton.), Eng.; RV hinge, enl. *(100).*

Cypricardella HALL, 1858 [7] [**C. subelliptica*; SD MILLER, 1889]. Subtrapezoidal, flattened, rather small, with somewhat lamellar concentric ribs. Hinge plate narrow; laterals present, long and straight; anterior RV and posterior LV cardinals thin; *3b* stout, virguliform, *2* more or less fused to termination of *AII.* Resilium in front of flat nymph. Elliptical small scars. *Dev.-Carb.,* W. Eu.-N.Am.-India.——FIG. E75,*1.* **C. subelliptica,* Miss., Iowa; *1a,b,* topotypes, LV, RV hinges, ×20, ×12 (Newell, n).——FIG. E75,*3. C.* sp., L.Dev.,

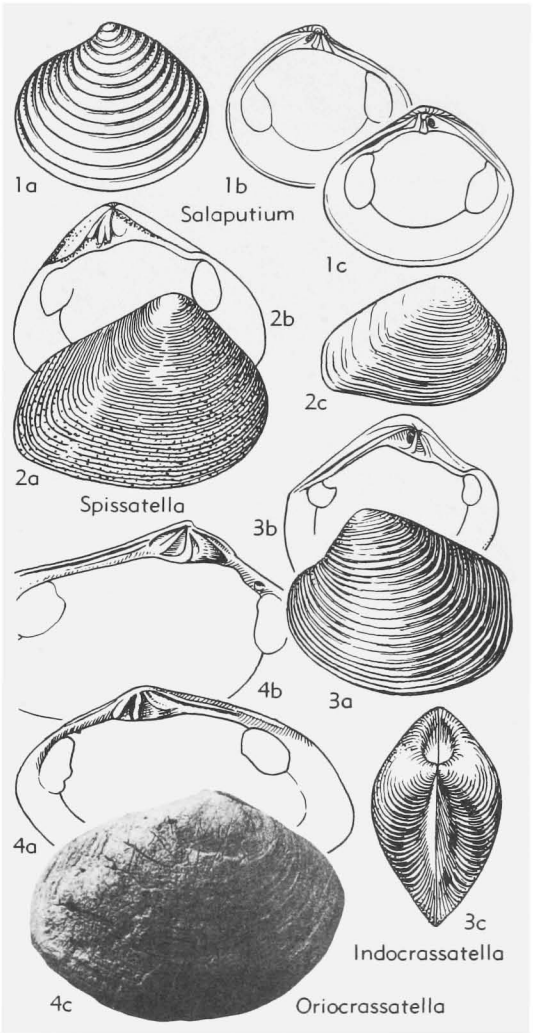


FIG. E76. Crassatellidae (Crassatellinae) (p. *N*576).

Ger.; LV int., diagr. (Haffer, 1959).——FIG. E75, *2. Astartella vera* HALL, U.Penn., Tex.; LV int., ×2 [for comparison with *Cypricardella*] (Newell, n).——FIG. E74,*7. C. baudeti* CHAVAN, Carb., Belg.; *7a,* RV ext., ×1.3 (Hall, 1858); *7b,c,* RV and LV hinges, ×1.3 *(109)*.

Eucrassatella IREDALE, 1924 [**Crassatella kingicola* LAMARCK, 1805; OD]. Transversely subtrigonal and inequilateral, large, thickened; with rounded ventral margin. Concentric ribs vanishing ventrally, stronger and closer toward more or less orthogyrous beaks. Cardinals strong, posterior ones straight in front of large pit which extends downward to lower margin of plate; laterals large. Inner margin smooth. *Paleoc.-Rec.,* Antarctic-N.Z.-W.Eu.-Australia-N.Am.-S.Am.

E. (Eucrassatella) [12]. Rounded, with almost prosogyrous beaks; posterior side truncate. Anterior laterals elongated, cardinals oblique. *Paleoc.,* W.Eu.; *Oligo.-Rec.,* N.Z.-Australia.——FIG. E74, *6. *E. (E.) kingicola* (LAMARCK), Australia; *6a-c,* RV ext., RV and LV hinges, ×0.7 *(509)*.

E. (Hybolophus) STEWART, 1930 [13] [**Crassatella gibbosa* SOWERBY, 1832; OD]. Flattened, with somewhat opisthogyrous beaks; shell tapering backward. Very short anterior laterals; *3a* well separated from lunular margin. *Mio.-Rec.,* N.Am.-S.Am.——FIG. E74,*5. *E. (H.) gibbosa* (SOWERBY), Rec., S.Am.(W.Coast); *5a-c,* LV ext., int., RV int., ×0.7 (Reeve, 1841, 1843).

E. (Spissatella) FINLAY, 1926 [14] [**Crassatella trailli* HUTTON, 1873; OD]. Flattened, with almost orthogyrous flat beaks; shell acuminate, scarcely truncate posteriorly. Narrow lunule. Marginal *3a. M.Eoc.-Rec.,* N.Am.-Australia-N.Z.-Antarctica.——FIG. E76,*2. *E. (S.) trailli* (HUTTON), L.Mio., N.Z.; *2a,b,* RV ext., int., ×0.75; *2c,* RV ext., ×0.75 (*303*; Suter, 1914).

Indocrassatella CHAVAN, 1952 [4] [**Crassatella indica* E. SMITH, 1895; OD]. Subtrapezoidal, inflated, moderately thin. Concentric regular rounded ribs; no dorsal angulations. *3a* almost hidden under lunular margin; resilial pit small, behind upper part of *4b*. Long, narrow posterior ridge and LV lateral lamina. Very small, rounded, partly truncated scars. Valve margins finely crenulate. *Rec.,* Arabian Sea.——FIG. E76,*3. *I. indica* (SMITH); *3a-c,* LV ext., int., both valves (dorsal), ×1 (Alcock & Anderson, 1897).

Oriocrassatella ETHERIDGE, JR., 1907 [**O. stokesi*; OD] [=*Procrassatella* YAKOVLEV, 1928 (subj.) (type, *Schizodus planus* GOLOVKINSKY, 1869)]. Transversely inequilateral, elongated backward. Hinge with *2* strong bifid, *3a* long, *3b* narrow, *4b* curved in front of rather large pit, with postresilial ridge isolating upper part of ligament. Long posterior laterals. *U.Carb.-Perm.,* Aus.-Asia-Eu.-New S. Wales - Australia-Indon.-USSR-Greenl.——FIG. E76,*4a,b. P. plana* (GOLOVINSKI), Perm., USSR; *4a,b,* RV int., LV int., ×0.7 *(1010)*.——FIG. E76,*4c. *O. stokesi,* W.Australia; RV ext., ×0.7 (Dickins, 1956).

Salaputium IREDALE, 1924 [5] [**Crassatella fulvida* ANGAS, 1871; OD]. Subtrigonal, ventrally rounded, flattened; rather small. Concentric ribbing. Resilial pit adjacent to apophysis of posterior cardinal, not reaching lower margin of plate. Laterals very long, especially anterior ones. Anterior scar large, subreniform. Valve margins finely crenulate. *Neog.-Rec.,* Australia-Indon.——FIG. E76,*1. *S. fulvidum* (ANGAS), Rec., Australia; *1a-c,* LV ext., int., RV int., ×2 (Angas, 1863; Chavan, n).

Talabrica IREDALE, 1924 [11] [**Crassatella aurora* ADAMS & ANGAS, 1863; OD]. Transversely subelliptical, compressed, with small orthogyrous beaks. Concentric ribs not divided backward but

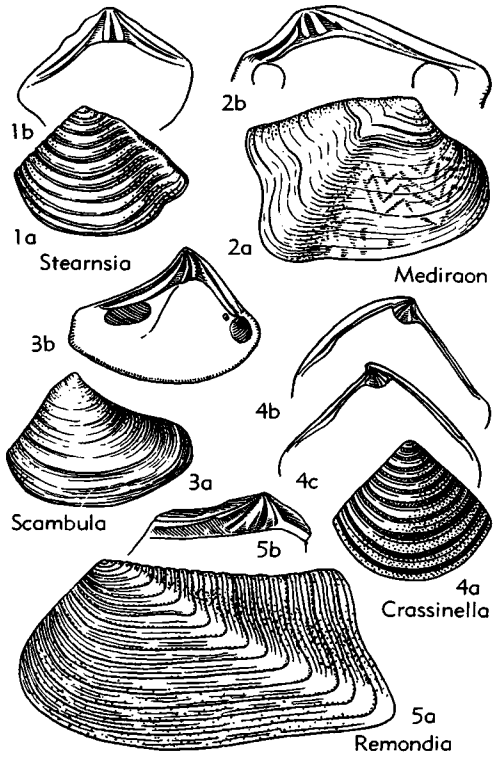


FIG. E77. Crassatellidae (Scambulinae) (p. *N577-N578*).

irregular ventrally. Escutcheon narrow, ill-defined. Cardinals oblique, *4b* not narrowed by pit; anterior laterals elongate, clearly distinguishable from cardinals, posterior laterals remote. Margin feebly crenulate. *U.Plio.-Rec.*, N.Z.-Australia.——FIG. E74,*3*. **T. aurora* (ADAMS & ANGAS), Rec., Tasmania; *3a*, LV ext., ×1 (Angas, 1863); *3b,c*, LV int., RV int., ×1.5 (Chavan, n).

Uddenia STEPHENSON, 1941 [8] [**Gouldia conradi* WHITFIELD, 1885; OD]. Subquadrate to subtrigonal, small; anteriorly rounded, posteriorly attenuated and truncated. Concentric, spaced, narrow and irregular ribs. Orthogyrous beaks. Marginal narrow anterior, large and grooved posterior cardinals; long and remote posterior laterals. Small scars. Valve margins grooved and smooth. *U.Cret.*, N.Am.——FIG. E74,*4*. **U. conradi* (WHITFIELD), Emscher., USA(N.Car.); *4a*, LV ext., ×2.5; *4b,c*, LV and RV hinges, ×8, ×5 *(887)*.

Subfamily SCAMBULINAE Chavan, 1952

Strongly opisthogyrous, or orthogyrous beaks; anterior laterals reaching beaks in front of anterior cardinals. Subparallel, narrow cardinals; reduced resilium in narrow pit *(109)*. *L.Cret.-Rec.*

Arrangement of generic taxa by CHAVAN.——1. *Scambula*.——2. *Remondia*.——3. *Mediraon*.——4. *Stearnsia*.——5. *Crassinella*.

Scambula CONRAD, 1869 [1] [**S. perplana*; M]. Subtrigonal, inequilateral, much compressed, with convex ventral and concave posterior margins. Pointed beaks. Cardinals approximate and striated; short resilium and ligamentary support above and behind top of LV posterior cardinal; broad and very long laterals on both valves. Small anterior scar. Valve margins crenulate. *U.Cret.*, N.Am.—— FIG. E77,*3*. **S. perplana*, Senon., USA(Tenn.); *3a,b*, LV ext., int., ×2 *(951)*.

Crassinella GUPPY, 1874 [5] [**Crassatella martinicensis* D'ORBIGNY in SAGRA, 1853; M] [=*Pseuderiphyla* FISCHER, 1887 (obj.); *Gouldia* AUCTT. (*non* C. B. ADAMS, 1847)]. Trigonal-rounded, short, compressed, small; anterior side rounded, posterior somewhat longer, angular at its end. Concentric lamellar undulations. Narrow lunule; posterior margin strongly concave, bounded by broad escutcheon. Cardinals long and slender, in front of deep, large resilium protruding backward; very long anterior RV and posterior LV laterals. Smooth inner margin. *M.Eoc.-Rec.*, Am.-W.Indies. ——FIG. E77,*4a*. **C. martinicensis* (D'ORBIGNY), Rec., Cuba; RV ext., ×10 (d'Orbigny in Sagra, 1853).——FIG. E77,*4b,c*. *C. branneri* (ARNOLD), Pleist., USA(Calif.); *4b,c*, RV and LV hinges, enl. *(100)*.

Remondia GABB, 1869 [**R. furcata*; M]. Transversely subtrapezoidal, anteriorly rounded, posteriorly elongated, with sinuous truncation. Concentric external undulations and medioposterior angle. Cardinals and laterals curved. Posterior part of *4b* on minor elevation. Inner shell margin crenulate. *L.Cret.*, W.Eu.-N.Am.

R. (Remondia) [2]. Much elongated posteriorly. Teeth arcuate; with nymphal ridge and another one in front of it, which divides resilium. Lunule and escutcheon excavated. *L.Cret.*, W.Eu.-N.Am. ——FIG. E77,*5*. **R. (R.) furcata* GABB, L.Cret., Mexico; *5a,b*, LV ext., hinge, ×0.75, ×0.7 *(333, 877)*.

R. (Mediraon) VOKES, 1946 [3] [**M. divaricatum*; OD]. Shorter backward, much flattened. Resilium not divided, barely separated from nymphal ridge. *L.Cret.*, W.Eu.-Lebanon-N.Am. ——FIG. E77,*2*. **R. (M.) divaricata* (VOKES), Apt., Lebanon; *2a,b*, RV ext., hinge, ×1.5 *(945)*.

Stearnsia WHITE, 1887 [4] [**S. robbinsi*; OD]. Subtrigonal, compressed, almost equilateral; laterally angulated; ventrally rounded, posteroventrally narrowed. Concentric undulations on disc, with sharp posterior carina. Long narrow lunule and

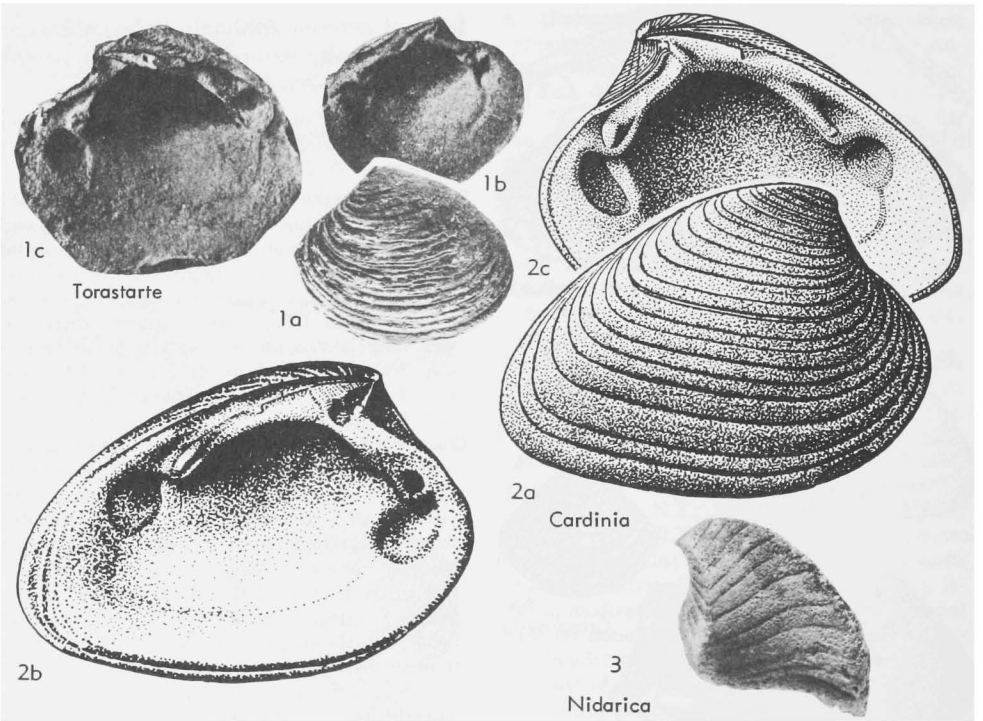


FIG. E78. Cardiniidae (p. *N*578-*N*580).

longer escutcheon. Beaks angular, appressed, almost orthogyrous. Approximate strong cardinals and long laterals; resilium narrowly separated from ligament by septum. Valve margins smooth. *L.Cret.*, W.Eu.-N.Am.——FIG. E77,*1*. **S. robbinsi*, USA(Tex.); *1a,b*, LV ext., int., ×0.7 (White, 1887).

Family CARDINIIDAE Zittel, 1881

[*emend.* COX, 1961] [=Cypricardiniidae ULRICH, 1897] [Materials for this family prepared by L. R. Cox and ANDRÉ CHAVAN except as recorded otherwise]

Ovate or subtrigonal, more or less inequilateral, thick-shelled, equivalve, convexity weak to moderate. Lunule and escutcheon well defined in more typical genera. Ligament opisthodetic, external although deeply sunk in some forms owing to steep slope of escutcheon. Cardinal teeth low, not more than two in each valve, *3b* oblique, *2* more or less fused to margin, more or less obsolete in many forms. Laterals strong, obliquely increasing in prominence, posterior ones of RV never duplicated on LV (no *PIV*) and entirely posterior to ligamental nymphs. Anterior laterals present or absent. Adductor scars deep, subequal; accessory scars rarely present. Pallial line simple. Ornament coarsely concentric or lacking. [Marine.] *Ord.-Rec.*

Besides *Cardinia,* a heterodont genus, ZITTEL originally included in the Cardiniidae several nonheterodont genera which now are referred to the Anthracosiidae and Pachycardiidae *(201)*.

Cardinia AGASSIZ, 1841 [**Unio listeri* J. SOWERBY, 1817; SD ICZN, Op. 292] [=*Thalassides* BERGER, 1833 (suppressed by ICZN); *Ginorga* GRAY, 1840 *(nom. nud.); Sinemuria* DE CHRISTOL, 1841 (suppressed by ICZN); *Cardinea* STUTCHBURY, 1842 *(nom. null.)*; *Pachyodon* STUTCHBURY, 1842 (*non* VON MEYER, 1838); *Dihora* "Gray" Anon., 1842 (obj.); *Thalassites* QUENSTEDT, 1843 *(nom. van.)* (*non* SWAINSON, 1837); *Storthodon* "Brown" ZITTEL, 1881 (*non* GIEBEL, 1856) (obj.)]. Medium-sized to large, ovate to cuneiform. Lunule and escutcheon bordered by more or less distinct ridges, steeply inclined, in some forms lying almost in plane of commissure of valves, ligamental nymph thus deeply sunk, although not internal; lunule commonly extending to posterior side of beak. Single weak, radially elongated cardinal

tooth *(3b)* present in RV in some species (but indistinguishable in others), and received in shallow recess in LV. Lateral teeth heavy, LV posterior and RV anterior ones each with tubercle-like termination received in recess between corresponding tooth and dorsal margin of opposite valve. Ornament of concentric ribs or imbrications, or lacking. *U. Trias. (Carn.) - U. Lias. (Toarc.),* cosmop. [Records from Bajocian based on poor material and doubtfully acceptable.].——Fig. E78,*2. C. hybrida* (Sowerby), L.Lias., Eng.; *2a-c,* RV ext., LV int., RV int., ×1 (Cox, n).

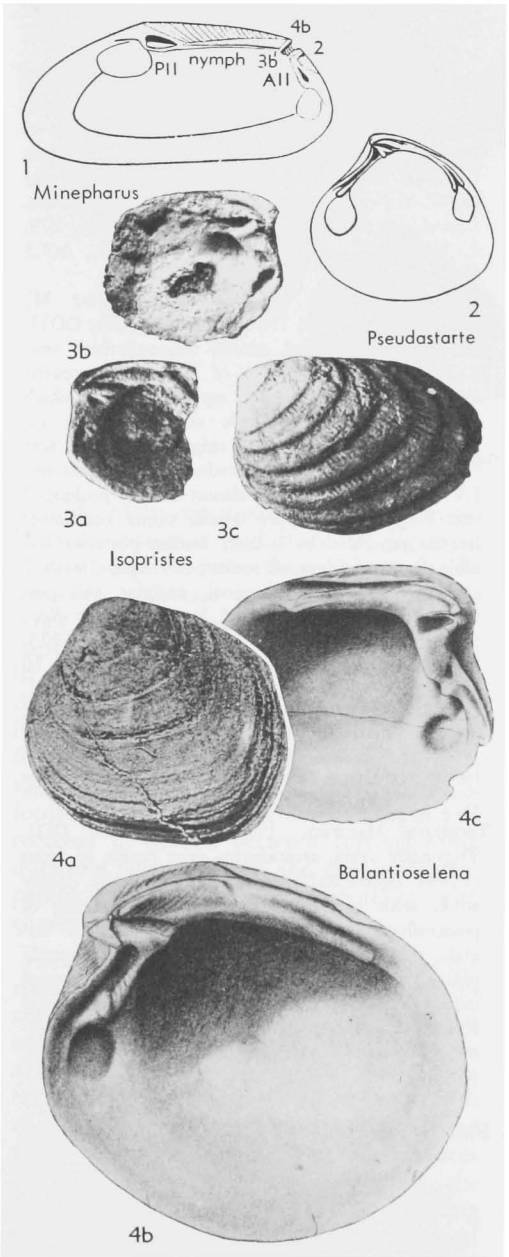


Fig. E79. Cardiniidae (p. *N*579-*N*580).

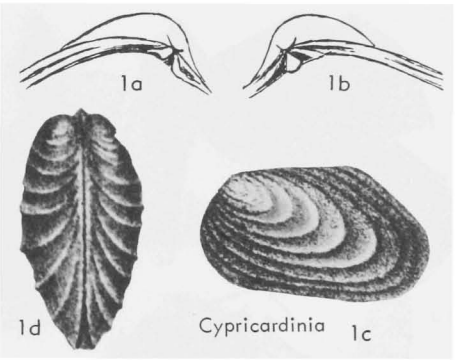


Fig. E80. Cardiniidae (p. *N*579).

Balantioselena Speden, 1962, p. 96 [**B. gairi*; OD]. Small, subrectangular, ovate or subtrigonal; umbo placed well forward, prosogyrous; lunule deep, no distinct escutcheon; nymph prominent; cardinal teeth well developed, *3b* in RV received between *2* and *4b* in LV; one anterior lateral in each valve, that of RV tuberculiform; 2 slightly oblique posterior laterals in RV, 1 in LV. *M.Trias.(Ladin.),* N.Z.——Fig. E79,*4. *B. gairi*; *4a-c,* LV ext. (holotype), RV int., LV int., all ×5.5 (Speden, 1962).

Cypricardinia Hall, 1859 [*pro C. lamellosa* Hall, 1859; *non C. lamellosa (Sanguinolaria lamellosa)* Goldfuss, 1840] [**C. halli* Beushausen, 1897; OD] [=*?Synopleura* Meek, 1871 (type, *Cypricardinia? carbonaria* Meek, 1871, *L. Carb.*)]. RV more convex than LV, very inequilateral; modioliform in shape, beaks anterior; outline variable, wider posteriorly; umbonal slope prominent, often obtusely angular; surface with strong imbricating concentric equidistant lamellose undulations and commonly with radiating costellae; valves crossed obliquely by shallow byssal sulcus; dentition *(AIII-3a), 3b, 5b, PI, PIII / (AIV), AII-2, 4b, PII. Ord.(Llandeilo),* Eu.; *Sil.(Medinan)-L. Perm.,* cosmop.——Fig. E80,*1a,b. C. lamellosa* (Goldfuss), M.Dev., Ger.; *1a,b,* LV and RV hinges, enl. (Chavan, n, from Beushausen).——Fig. E80,*1c,d. *C. halli* Beushausen, L.Dev.(L. Helderberg.), USA(N.Y.); *1c,d,* LV ext., both valves dorsal, ×3 *(373).*

Isopristes Nicol & Allen, 1953 [**I. crassus;* OD]. Thick, subquadrate, beaks prosogyrate, located nearly at anterior end of dorsal border; no lunule. Sculpture of strong equidistant spaced concentric

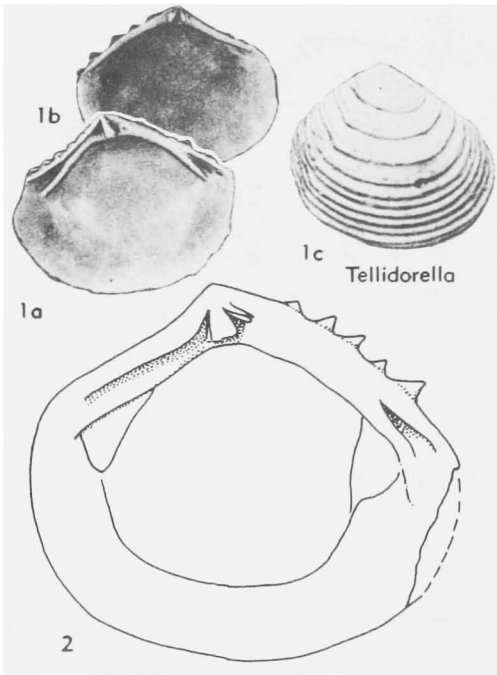


FIG. E80A. Cardiniidae (p. N580).

folds and small, closely spaced radial riblets. Anterior scar rather small and deep; posterior larger. LV with 2 oblique teeth, RV with 1 small round anterior lateral; posterior hinge not preserved; apparently a nymph. Inner margin crenate. *U.Trias. (Nor.),* S.Am.(Peru).——FIG. E79,*3. *I. crassus; 3a-c,* RV and LV int., LV ext., ×0.7 (Nicol & Allen, 1953).

?Minepharus TOKUYAMA, 1958 [**Palaeopharus (Minepharus) triadicus;* OD]. Shell elliptical, tapering slightly anteriorly; umbo prosogyre; ligament area wide, transversely striate; lunule small but distinct; anterior adductor scar strong; posterior scar larger and less distinct; dentition consists of 1 RV and 2 LV cardinals and anterior and posterior lateral; *2b* not clearly separated from margin of lunule; *4b* elongated, slender and welded to depressed triangular nymph; socket *3b* deep, fairly short; socket *PI* profound; *PIII* less distinct than *PI*; narrow furrow divides anterior lateral *AIII*; ornament consisting of radial costae and lines of growth. *U.Trias.,* Japan.——FIG. E79,*1. *M. triadicus*(TOKUYAMA); Yamaguchi Prefecture; LV int., ×1 (A. Tokuyama, 1958). [NEWELL].

Nidarica COX, 1961 [**Cardinia slatteri* WILSON & CRICK, 1889]. Small-medium in size, *Opis*-like, with strongly prosogyrous, terminal umbones from which prominent, angular carinae pass to extremities of concave ventral margin. Lunule deep, with angular posterior end; nymphs not quite so deeply sunk as in *Cardinia.* No distinct cardinal teeth, but lunular marginal region of LV projects and is much thickened, this projection being received in corresponding recess in RV. Lateral teeth as in *Cardinia.* Ornament of wide-spaced growth imbrications. *L.Jur.(M.Lias.,Domer.-U.Lias., basal Toarc.),* Eng.——FIG. E78,*3. N. slatteri* (WILSON & CRICK), basal Toarc.; LV ext., ×1 (Cox, n).

Pseudastarte COSSMANN, 1921, p. 17 [**Astarte (Pseudastarte) emarginata;* M]. Very small, trigonally ovate, beaks at anterior quarter of length; convexity feeble; lunule shallower than in *Cardinia,* escutcheon narrow; cardinal tooth *(3b)* of RV well developed, bifid; laterals as in *Cardinia. L.Jur.(Lias.,Hettang.),* Eu.(France).——FIG. E79, *2. *P. emarginata* (COSSMANN); RV int., ×5.3 (Chavan, n).

Tellidorella BERRY, 1963 [**T. cristulata;* M] [=*Lirotarte* OLSSON, 1964 (type, *L. paphia;* OD)]. Small, solid, flattened, acutely subequilateral, ventrally rounded. Sculpture of laminate concentric ridges, each one cristate on carinations which bound long narrow lunule and ecutcheon; intervals radially striate or ridged. Anterior scar reniform, posterior one rounded. Median massive LV cardinal, anterior one almost directly prolonged into long anterior upper lateral; upper and lower laterals separated by socket; distant posterior laterals forming edges of socket; LV hinge with 2 cardinals and long, marginal, anterior and posterior lateral; short external ligament. *Mio.-Rec.,* S. Am.(Ecuador)-N. Am.(Mexico).——FIG. E80A, *2. *T. cristulata,* Rec., Mexico; RV int., ×10 (Keen, n).——FIG. E80A,*1. T. paphia* (OLSSON), Mio., Ecuador; *1a-c,* RV int., LV int., RV ext., ×6 (Olsson, 1964).

[This small shell is a "living fossil," having all morphological characters of the Cardiniidae, among which are the *right* duplicate, V-shaped posterior laterals, lack of distinct *5b,* a long *AI,* no marginal *AIV* and *PIV.*]

Torastarte MARWICK, 1953 [**T. bensoni;* OD]. Trigonally ovate, astartiform; deep lunule in front of beak, ligamental nymphs relatively heavy, deeply sunk, with corresponding downward arching of posterodorsal margin. Strong RV tubercular laterals, those of LV marginal, *2, 3b, 4b* narrowly oblique and partly covered. Ornament of unequal closely spaced concentric ribs. *U.Trias.(Otapir.= Rhaet.)-L.Jur.(Lias.),*N.Z.——FIG. E78,*1. *T. bensoni,* Rhaet.; *1a-c,* LV ext., LV int., RV int., ×1 *(593).*

Family MYOPHORICARDIIDAE Chavan in Vokes, 1967

[Materials for this family prepared by L. R. Cox and ANDRÉ CHAVAN]

Small to small-medium, equivalve, subtrigonal to trapezoidal, subequilateral to strongly inequilateral with umbones anterior

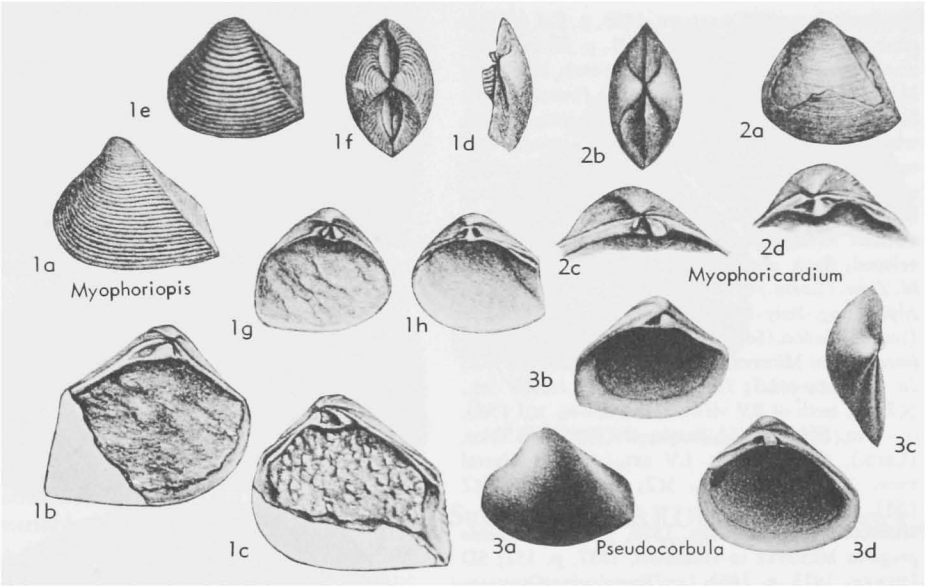


FIG. E81. Myophoricardiidae (p. *N*581-*N*582).

to mid-length; commonly carinate posteriorly, with posterior end truncate; ligament external, opisthodetic, short; hinge fundamentally with one anterior and one posterior lateral in each valve, and two (perhaps three) cardinals in LV, two cardinals in RV, anterior one small, some cardinals commonly suppressed, so that only one may be present in single valve (either LV or RV) and two in other, or only one in each valve; lateral teeth lamelliform, those of LV formed by projections of dorsal margin and received in sockets between corresponding duplicate laterals of RV and dorsal margin; pallial line entire; surface smooth or with concentric riblets. *Trias.*

Much disagreement has existed as to the systematic position of genera placed in this new family, and consequently, in notations applicable to their cardinal teeth. Provisional association of the family with the Crassatellacea implies that the two cardinal teeth of the LV are interpreted as *2* and *4b* and those of the RV as *3a* and *3b*. ODHNER *(683,* p. 582), however, considered the hinge to be of "cyrenoid" type, interpreting the teeth of the LV as *2a* and *2b,* those of the RV as *1* and *3b;* he cited a statement by FRECH that a third (very weak) cardinal *(4b)* can be detected in some specimens of the LV of *Myophoriopis.* ODHNER therefore considered that the genus should be regarded as an early member of the Corbiculacea. The fact that some specimens of *Myophoriopis* have only one cardinal in the LV, received between two in the RV (Fig. E81,*1b,c*), with this arrangement reversed in other specimens (Fig. E81,*1g,h*), is not attributable to hinge inversion (since arrangement of the lateral teeth remains the same) but to great variability in the development of individual teeth and to incomplete preservation. It is owing to this variability that the interpretation of the elements of the hinge presents difficulty.

Myophoricardium VON WÖHRMANN, 1889, p. 226 [**M. lineatum*; M] [=*Myophorocardium* NEUMAYR, 1891 *(nom. null.)*]. Trapeziform to subtrigonal, slightly inequilateral, length only slightly exceeding height; posterior ridge obtuse, no lunule or escutcheon; LV with strong anterior and weak posterior tooth, almost equally divergent and bordering recess for single strong tooth of RV; anterior laterals weak; surface almost smooth. *U. Trias. (Carn.),* Eu.(N. Alps-S. Alps-Sicily-Hung.)-SW.Asia(Jordan)-China(Yunnan).——FIG. E81,*2.* **M. lineatum;* Carinthia *(2a,b),* N.Alps *(2c,d);* *2a,* LV ext., *2b,* dorsal view, both ×1.3; *2c,d,* LV and RV hinges, both ×3 *(58).*

Myophoriopis VON WÖHRMANN, 1889, p. 221 [**Myophoria lineata* VON MÜNSTER, 1841, p. 88 (=*Lyrodon lineatus* VON MÜNSTER in GOLDFUSS, 1837-40); M] [=*Myophoriopsis* NEAVE, 1940 *(nom. null.)*]. Subtrigonal, moderately to strongly inequilateral, with prominent posterior carina; lunule and escutcheon well developed; either valve with single strong cardinal tooth in median position, received between 2 divergent cardinals in other valve; cardinal teeth transversely ridged; laterals well developed; flank ornamented with concentric riblets. *M. Trias. (Ladin.)-U. Trias. (Nor.)*, Eu.(N. Alps-S. Alps-Hung.-Italy-Balkans)-Afr. (Libya)-SW. Asia (Jordan)-Indon.(Sumatra).——FIG. E81,*1a-d*. **M. lineata* (VON MÜNSTER), M.Trias.(Ladin.), S.Tyrol; *1a*, LV ext., ×1.3; *1b*, LV int., ×2; *1c*, RV int., ×2; *1d*, teeth of RV viewed from above, ×2 *(58)*. ——FIG. E81,*1e-h*. *M. rosthorni* (BOUÉ), U.Trias. (Carn.), Carinthia; *1e*, LV ext., ×2; *1f*, dorsal view, ×2; *1g*, LV int., ×2; *1h*, RV int., ×2 *(58)*.

Pseudocorbula E. PHILIPPI, 1898, p. 168 [**Nucula gregaria* MÜNSTER in GOLDFUSS, 1837, p. 152; SD DIENER, 1923, p. 186] [=*?Raetolucina* OSSWALD, 1930 (type, *Corbula alpina* WINKLER, 1859; OD); *Myophoriaemorphis* MAZAROVICH, 1939 (no diagnosis) (type, *Cucullaea nuculiformis* ZENKER)]. Transversely subtrigonal, slightly to strongly inequilateral; with or without weak posterior carina; lunule and escutcheon present; LV with strong anterior cardinal and in some specimens weak posterior cardinal; RV with single strong posteriorly directed cardinal received in recess between LV cardinals, accompanied by well-developed long laterals duplicated in RV, teeth without transverse ridges; surface smooth. *L.Trias.-U.Trias.*, Eu.(Ger.-Spain-S. Alps-Sardinia)-S. Am. (Brazil-Uruguay). ——FIG. E81,*3*. **P. gregaria* (VON MÜNSTER), M. Trias., M.Muschelkalk, W.Ger.; *3a-c*, LV ext., int. and dorsal view; *3d*, RV int., all ×3 (Hohenstein, 1913).

Family HIPPOPODIIDAE Cox, new family

[Materials for this family prepared by L. R. Cox with addition by AURÈLE LAROCQUE]

Medium-sized to large, thick-shelled, irregularly reniform or pyriform, gibbose, with anteriorly placed, terminal or subterminal, prosogyrous beaks, well separated in full-grown specimens; valve margins closed; anisomyarian, posterior adductor scar moderately large, anterior scar smaller, deep, situated in anteroventral lobe; pallial line virtually entire; internal marginal region much broadened anteroventrally by growth laminae, edges of which form rugose

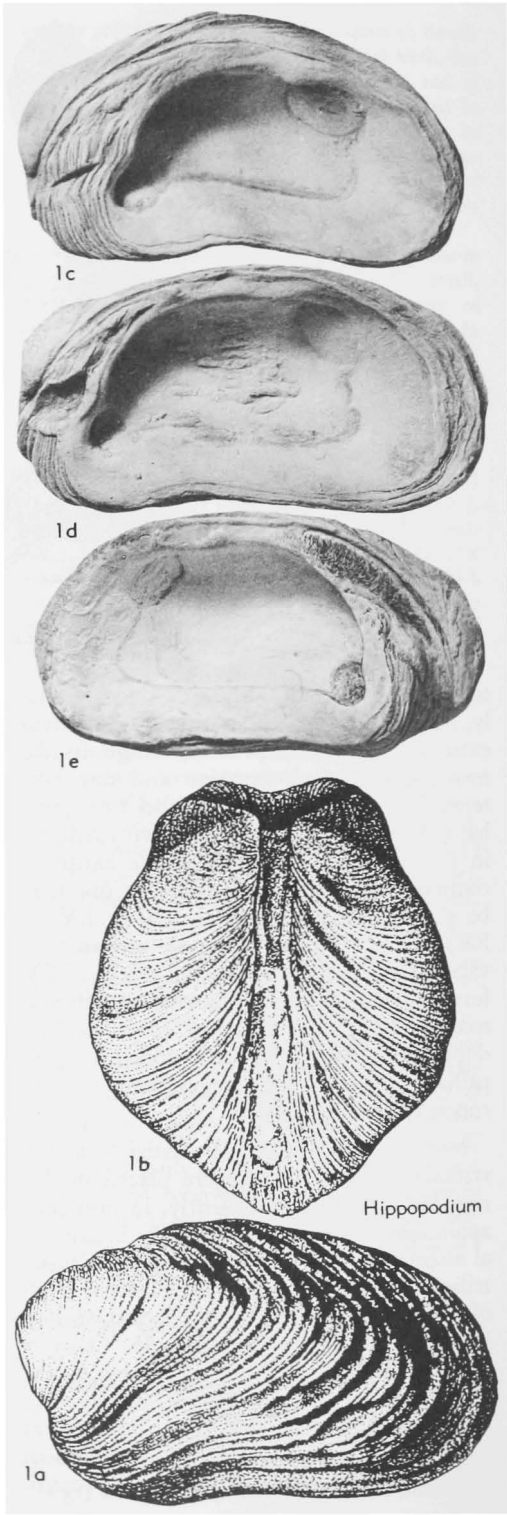


FIG. E82. Hippopodiidae (p. *N*583).

area continued by broad hinge plate bearing cardinal teeth and recesses as follows: adjacent to nymph in RV, broad tooth which is triangular and ridgelike in some specimens but rectangular and flat-topped in others, and anterior to which is broad, shallow recess for similar tooth of LV; RV with weak posterior lateral tooth, LV with or without posterior lateral; ligament external, opisthodetic; nymph strong, arched; exterior of shell with very irregular and pronounced growth rugae. *?Dev., L.Jur.-U.Jur.*

The single cardinal tooth of the RV is presumably to be interpreted as *3b* and the main cardinal of the LV as *2*. An angular edge projecting from the face of the nymph in some LV's is possibly to be regarded as a second cardinal *(4b)*, but the dentition is very variable and the interpretation of minor ridges doubtful.

This family is known only by its type genus,[1] which is remarkable for its discontinuous distribution. Abundant in northwestern Europe (particularly in England) from the Hettangian to the Pliensbachian stages of the Lower Jurassic, it has otherwise been met with only in the uppermost Jurassic of one area in East Africa. Although the East African species was originally made the type of a genus named *Epihippopodium*, differences between it and Lower Jurassic specimens are of no more than specific importance.

Hippopodium J. Sowerby, 1819, p. 91 [**H. ponderosum*; M] [=*Epihippopodium* Dietrich, 1933, p. 71 (type, *E. quenstedti*)]. Characters of family. *L.Jur.(Hettang.-Pliensbach.)*, Eu.; *U.Jur.(Tithon.)*, E.Afr.——Fig. E82,*1*. **H. ponderosum*, L.Jur. (Pliensbach.), SW.Eng.; *1a,b*, LV ext. and dorsal view, ×0.8 *(202)*; *1c-e*, int. of 2 RV's showing variation in cardinal dentition and 1 LV, all ×0.82 (Cox, n).

?Tusayana Stoyanow, 1948 [**T. cibola*; OD]. Nearly circular, beaks almost in middle of hinge line; surface smooth, umbones moderate, beaks prosogyre, lunule small; ligament external; hinge plate thick; LV with 2 cardinal teeth, one of which is bifid, other long and simple, lying behind anterior adductor muscle; RV with 1 amorphous cardinal tooth; 1 posterolamellar tooth in each valve. *Dev.(Island Mesa beds, Jerome F.)*, USA (Ariz.).——Fig. E83,*1*. **T. cibola*; *1a,b*, LV int., RV int., ×1 (Stoyanow, 1948). [LaRocque]

[1] Inclusion of the Paleozoic *Tusayana* in this family is very dubious.—Ed.

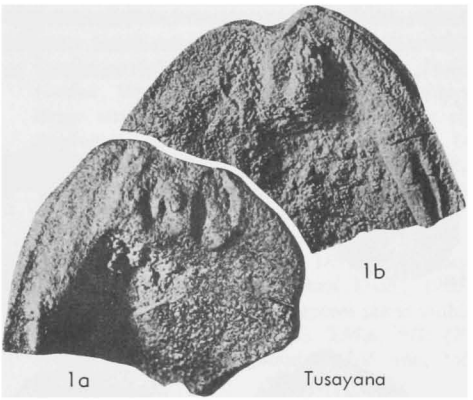


Fig. E83. Hippopodiidae (p. N583).

Superfamily CARDIACEA Lamarck, 1809

[*nom. transl.* Gill, 1871 (*ex* family Cardiacea Goldfuss, 1820) (=cardiacées Lamarck, 1809)] [Materials for this superfamily prepared by Myra Keen]

Sculpture normally radial, with change of ribbing pattern in most forms on posterior slope; hinge with two conical cardinal teeth, those in LV of unequal size, anterior larger, in RV fused to some extent; lateral teeth distant from cardinals, anterior laterals wanting in some groups. Pallial line entire in marine forms; some brackish-water forms with pallial sinus and long siphons. *U.Trias.-Rec.*

Family CARDIIDAE Lamarck, 1809

[*nom. correct.*, Broderip, 1839 (*ex* Cardiacea Goldfuss, 1820) (=cardiacées Lamarck, 1809)]

Ligament parivincular, external, typically short. Adductor scars subequal. Hinge with two nonbifid cardinal teeth in either valve, cruciform in arrangement; lateral teeth present, one anterior, one posterior in LV, two anterior, one posterior in RV. *U.Trias.-Rec.*

Subfamily CARDIINAE Lamarck, 1809

[*nom. transl.* Stoliczka, 1870 (*ex* family Cardiacea Goldfuss, 1820) (=cardiacées Lamarck, 1809)]

Semicircular to quadrangular or, rarely, elliptical; rib ornamentation along rib crests, as beading or furrowing, or in intercostal spaces, never arising from sides of ribs; posterior margin digitate or crenulate;

hinge, with few exceptions, nearly straight (deviating less than 25 degrees from straight line), relatively long, posterior cardinal in LV elevated. *U.Trias.-Rec.*

Cardium LINNÉ, 1758 [**C. costatum*; SD CHILDREN, 1823] [=*Bucardites* VON SCHLOTHEIM, 1820 *(nom. van.); Cordium* GISTL, 1848 *(nom. null.); Tropidocardium* RÖMER, 1865 (obj.)]. Ribs either

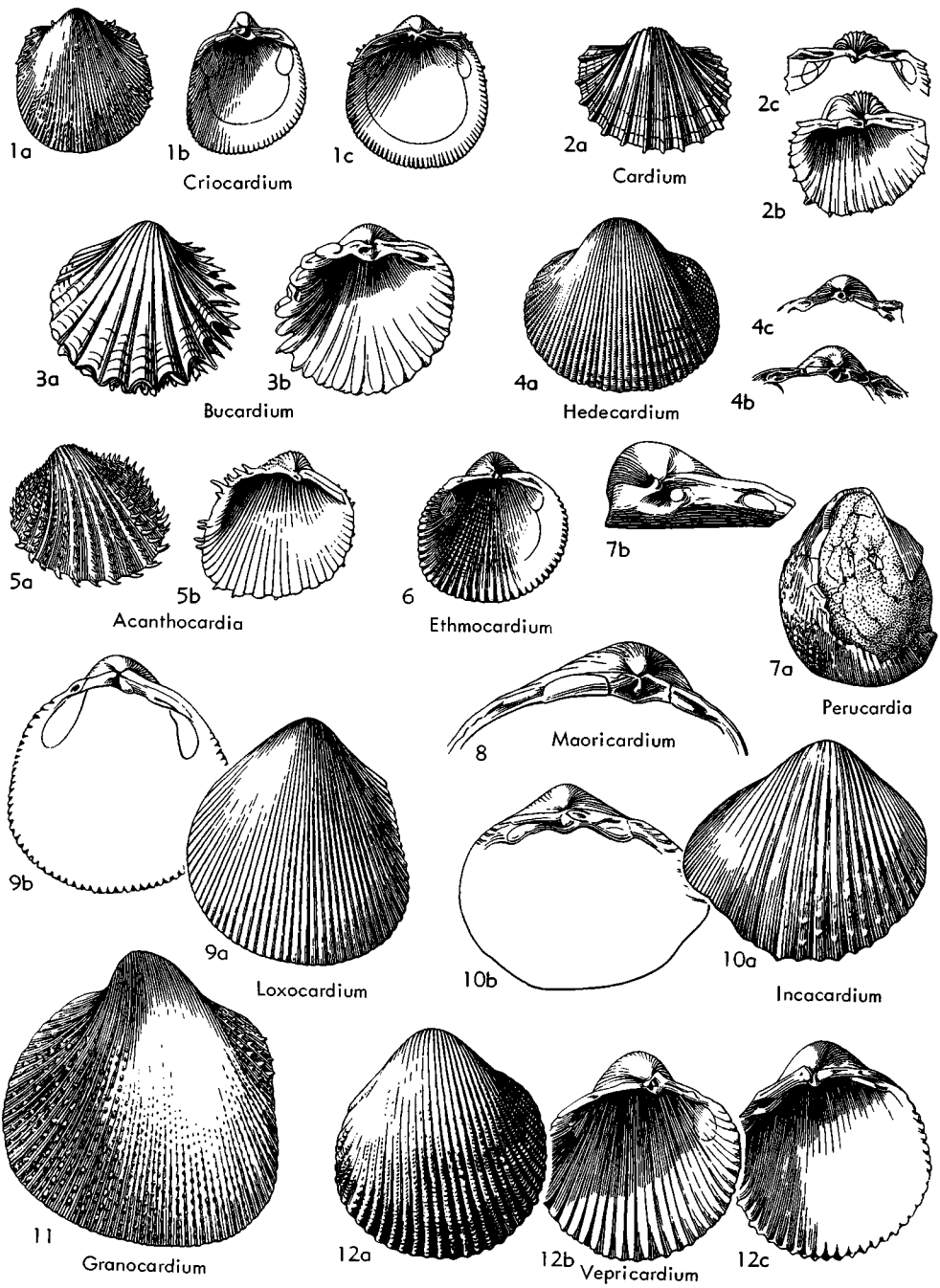


FIG. E84. Cardiidae (Cardiinae) (p. *N585-N586*).

keeled or spinose; cardinal *4b* elevated *(458). Mio.-Rec.,* S.Eu.-W.Afr.

C. (Cardium). Shell gaping at posterior margin; cardinal *4b* vertically above *2* or nearly so. *Mio.-Rec.,* France-W.Afr.——Fig. E84,*2*. **C. (C.) costatum* Linné, Rec., W.Afr.; *2a-c,* LV ext., int., RV int., ×0.25 (Tryon).

C. (Bucardium) Gray, 1853 [**Cardium ringens* Bruguière, 1789; SD von Vest, 1875] [=*Ringicardium* Fischer, 1887 (obj.)]. Posterior ribs strongly digitate; no posterior gape. *L.Mio.-Rec.,* S.France-W.Afr.——Fig. E84,*3*. **C. (B.) ringens* Bruguière, Rec., W.Afr.; *3a,b,* LV ext., int., ×1 (Tryon).

Acanthocardia Gray, 1851 [**Cardium aculeatum* Linné, 1758; SD Stoliczka, 1870] [=*Orbis* de Blainville, 1825 (*non* Müller, 1767, obj.; M); *Archicardium* Sandberger, 1863 (obj.); *Eucardium* Fischer, 1887 (obj.); *Sphaerocardium* Coen, 1933 (type, *Cardium paucicostatum* Sowerby, 1841, *non* Deshayes, 1838; SD Keen, 1937); *Sphoerocardium* Coen, 1933 *(nom. null.)*]. Oblique-quadrate; cardinal teeth in LV partially fused at base; ribs nodose to spinose. *U.Cret.-Rec.,* Eu.-Asia-N.Am.-S.Am.

A. (Acanthocardia). Ribs spinose *(458). U.Oligo.-Rec.,* S.Eu.-Medit.——Fig. E84,*5*. **A. (A.) aculeata* (Linné), Rec., Medit.; *5a,b,* LV ext., int., ×0.5 (Tryon).

A. (Agnocardia) Stewart, 1930 [**Cardium claibornense* Aldrich, 1911; OD]. Ribs numerous, flat-topped, with hollow, A-shaped spines *(892). Eoc.-Mio.,* N.Am-S.Am.

A. (Incacardium) Olsson, 1944 [**Cardium mellisum*; OD]. Posterior area set off by sinuation; ribs with A-shaped spines on central and anterior slopes; hinge relatively short. *U.Cret.,* Peru.——Fig. 84,*10*. **A. (I.) mellisa* (Olsson); *10a,b,* RV ext., int., ×1 (Olsson).

A. (Rudicardium) Coen, 1915 [**Cardium tuberculatum* Linné, 1758; SD Keen, 1937]. Ribs noded. *Mio.-Rec.,* Medit.

A. (Schedocardia) Stewart, 1930 [**Cardium hatchetigbeense* Aldrich, 1886; OD] [=*Africofragum* Eames, 1957 (type, *Fragum (A.) newtoni;* OD)]. Less oblique than *A. (Acanthocardia);* spines on ribs weak to obsolete, especially anteriorly *(892). Paleoc.-Eoc.,* SE.Asia-Afr.-Eu.-N.Am.-S.Am.

Granocardium Gabb, 1869 [**Cardium carolinum* d'Orbigny, 1844; SD Stewart, 1930]. Smooth-ribbed to spinose, with 1 to 3 intercalary ribs between primaries or with internal pits in intercostal spaces *(892). L.Cret.-U.Cret.,* N.Am.-S.Am.-Afr.-Eu.-Asia-N.Z.

G. (Granocardium). Elliptical, hinge nearly straight, wide; intercalary ribs 2 to 3. *L.Cret.-U.Cret.,* cosmop.——Fig. E84,*11*. **G. (G.) carolinum* (d'Orbigny), U.Cret., France; LV ext., ×1 (Orbigny).

G. (Criocardium) Conrad, 1870 [**Cardium dumosum* Conrad, 1870; SD Stoliczka, 1871] [=*Criocarpium* Böhm, 1884 *(nom. null.); Cardea* Whitfield, 1885 (obj.)]. Quadrate, hinge straight, relatively long; intercalary ribs tending to be single rows of small spines between ribs. *U.Cret.,* N.Am.-Eu.——Fig. E84,*1*. **G. (C.) dumosum* (Conrad), USA(N.J.); *1a-c,* RV ext., LV int., RV int., ×1 (Wade).

G. (Ethmocardium) White, 1880 [**Cardium speciosum* Meek & Hayden, 1857 (*non* Adams & Reeve, 1850) (=**C. whitei* Dall, 1900); OD]. Small, thin, intercostal spaces pitted within. *U.Cret.,* N.Am.-S.Pac.——Fig. E84,*6*. **G. (E.) whitei* (Dall), USA(Mont.); LV int., ×2 (Keen).

Loxocardium Cossmann, 1886 [**Cardium formosum* Deshayes, 1858; SD Crosse, 1886]. Nearly equilateral, posterior margin slightly truncate; posterior ribs notched; rib sculpture of fine looped cross-threads or A-shaped nodes; hinge relatively short *(458). Eoc.-Mio.,* Eu.——Fig. E84,*9*. **L. formosum* (Deshayes), Eoc., France; *9a,b,* LV ext., int., ×2 (Deshayes).

Parvicardium Monterosato, 1884 [**Cardium parvum* Philippi, 1844 (*non* da Costa, 1778) (=**C. exiguum commutatum* Bucquoy, Dautzenberg & Dollfus, 1892); SD Crosse, 1885]. Small, hinge weak, cardinal teeth minute, fused at base in LV; ribs sculptured with heavy cross-threads or spines; resembling *Plagiocardium (Papillicardium)* but with weaker hinge and sharper sculpture *(458). Eoc.-Rec.,* Eu.-N.Am.

Plagiocardium Cossmann, 1886 [**Cardium granulosum* Lamarck, 1805; SD Crosse, 1887]. Elliptical-oblique, hinge arched; rib sculpture of bead-like nodes. *Paleoc.-Rec.,* Eu.-Afr.-E.Indies-N.Z.

P. (Plagiocardium). Shell medium in size; cardinal teeth nearly equidistant between lateral teeth *(458). Paleoc.-Mio.,* Eu.-E.Indies.

P. (Maoricardium) Marwick, 1944 [**Cardium spatiosum* Hutton, 1873; OD]. Shell large, heavy; anterior section of hinge shorter than posterior *(598). Oligo.-Rec.,* Afr.-E.Indies-N.Z.——Fig. E84,*8*. **P. (M.) spatiosum* (Hutton), Plio., N.Z.; LV hinge, ×0.5 *(598)*.

P. (Papillicardium) Sacco, 1899 [**Cardium papillosum* Poli, 1795; OD]. Small, resembling *Parvicardium* but with heavier hinge and with beaded rather than spinose sculpture on ribs *(458). Eoc.-Rec.,* Eu.-W.Asia.

Septocardia Hall & Whitfield, 1877 [**S. typica*; OD] [=*Pascoella* Cox, 1949 (type, *P. peruviana*; OD)]. Thick-shelled, ribs beaded, incremental lines conspicuous in interspaces as cross-striae; ligament inserted in broad and slightly oblique furrow bordered by nymph with pointed summit; hinge plate wide, anteriorly forming deep cavity for reception of anterior adductor muscle; anterior lateral teeth small, placed at junction of muscle-

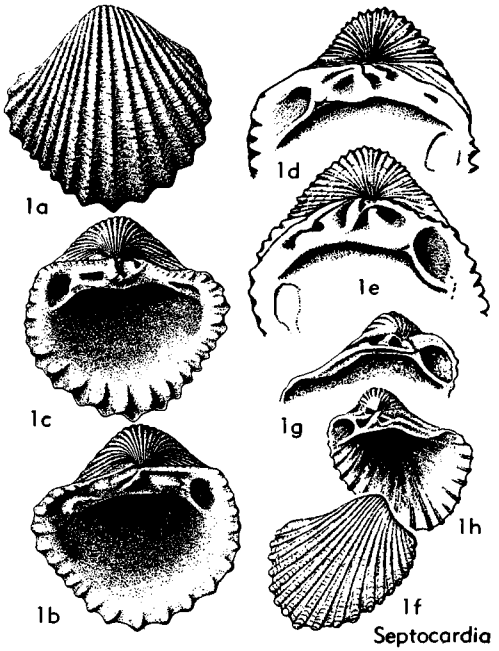


FIG. E85. Cardiidae (Cardiinae) (p. *N585-N586*).

cavity flange and hinge plate proper, cardinal teeth with 2 salient, *4b* lamellar, sloping obliquely backward from beak, *3a-3b* joined above; posterior lateral teeth well developed; pallial line entire, posterior muscle scar ovate, not impinging on hinge plate; inner margins strongly crenulate. [Hitherto allocated to Carditidae, this group seems rather to be the ancestral stock in Cardiacea, but with close affinities to *Palaeocardita,* which is contemporaneous at some localities in N.Am.] *U. Trias.(Nor.),* N.Am.-S.Am.——FIG. E85,*1. *S. typica; 1a-c,* RV ext., LV int., RV int., ×1 (Cox); *1d,e* (Alaska), RV and LV hinges, ×1.3 (Keen, n), from USGS specimens); *1f-h* (USA, Nev.), RV ext., LV and RV hinges, all enl. (Hall & Whitfield).

Vepricardium IREDALE, 1929 [**V. pulchricostatum;* OD]. Like *Bucardium* in outline but larger, posterior ribs not digitate; dorsal margins with smooth areas *(458). U.Cret.-Rec.,* Australia-Afr.-Eu.-S.Am.

V. (Vepricardium). Rib sculpture of close-set spines. *Paleoc.-Rec.,* Eu.-Afr.-E.Indies-Australia. ——FIG. E84,*12. *V. (V.) pulchricostatum* IREDALE, Rec., Australia; *12a-c,* RV ext., LV int., RV int., ×0.6 *(433).*

V. (Hedecardium) MARWICK, 1944 [**Cardium waitakiense* SUTER, 1907; OD]. Ribs smooth, finer on posterior area, interspaces linear *(598). Eoc.-L.Mio.,* N.Z.-Australia-Burma.——FIG. E84, *4. *V. (H.) waitakiense* (SUTER), Oligo., N.Z.; *4a-c,* LV ext., LV and RV hinges, ×0.5 *(598).*

V. (Orthocardium) TREMLETT, 1950 [**Cardium porulosum* SOLANDER, 1766; OD]. Rib-sculpture tending to form vertical frill at rib crest; outline more quadrate than in *V. (Vepricardium),* hinge line narrower and straighter. *M.Eoc.-U.Eoc.,* Eu.

V. (Perucardia) OLSSON, 1944 [**Cardium brueggeni*; OD]. Ribs with granular nodes. *U.Cret.,* Peru.——FIG. E84,*7. *V. (P.) brueggeni* (OLSSON); *7a,b,* LV ext., hinge, ×0.5 (Olsson).

Subfamily TRACHYCARDIINAE Stewart, 1930

Ovate but not oblique; rib ornamentation normally of spines or imbricating scales along posterior sides of ribs; hinge relatively short, either nearly straight or sharply bent; cardinal teeth unequal in size, *All* with socket above; posterior margin notched to digitate. *?Eoc., Oligo.-Rec.*

Trachycardium MÖRCH, 1853 [**Cardium isocardia* LINNÉ, 1758; SD VON MARTENS, 1870] [=*Kathocardia* TUCKER & WILSON, 1932 (type, *Cardium (K.) aclinense*; OD)]. Outline nearly equilateral, height greater than length; hinge heavy, short, nearly straight. *?Eoc., Oligo.-Rec.,* tropic Am.

T. (Trachycardium). Sculpture of imbricating scales over entire shell, reduced to beads anteriorly *(458). Oligo.-Rec.,* W.Indies-E.C.Am.-W. C.Am.-S.Am.——FIG. E86,*5. *T. (T.) isocardia* (LINNÉ), Rec., W.Indies; *5a-c,* LV ext., int., RV int., ×0.5 (*5a,c,* Perry; *5b,* Keen).

T. (Dallocardia) STEWART, 1930 [**Cardium quadragenarium* CONRAD, 1837; OD]. Large shells with ornamentation of nonimbricating spines along posterior sides of ribs *(892). U.Oligo.-Rec.,* N.Am.-S.Am.

T. (Mexicardia) STEWART, 1930 [**Cardium procerum* SOWERBY, 1833; OD]. Ribs scaly in young, nearly smooth in adults; hinge heavy, short; posterior margin somewhat digitate *(892). ?Eoc., Mio.-Rec.,* N.Am.-S.Am.

T. (Phlogocardia) STEWART, 1930 [**Cardium belcheri* BRODERIP & SOWERBY, 1829; OD]. Central ribs with frills along posterior sides, anterior ribs with knobby spines *(892). Mio.-Rec.,* W.C. Am.

Acrosterigma DALL, 1900 [**Cardium dalli* HEILPRIN, 1887; OD]. Elliptical, hinge strongly bent; cardinal teeth unequal in size *(458). U.Oligo.-Rec.,* N.Am.-S.Am.-Eu.-E.Indies-S.Pac.

A. (Acrosterigma). Hinge bent to angle of 60 degrees or more; ribs smooth except for slight pitting along edges of incised intercostal spaces. *Mio.-Plio.,* USA(Fla.)-W.Indies.——FIG. E86,*6. *A. (A.) dalli* (HEILPRIN), Plio., USA(Fla.); *6a,b,* LV ext., int., ×0.25 (Cooke).

A. (Ovicardium) MARWICK, 1944 [**Trachy-*

cardium (O.) rossi; OD]. Ovate, intercostal spaces cross-striate, with vertical sides; hinge with oblique groove behind *4b (598). Plio.,* N.Z.-Australia.

A. (Regozara) IREDALE, 1936 [**R. olivifer;* OD]. Hinge less angulate than in *A. (Acrosterigma);* sculpture of small scales or cross-threads on posterior sides of ribs. *Neog.-Rec.,* E.Indies-Australia.

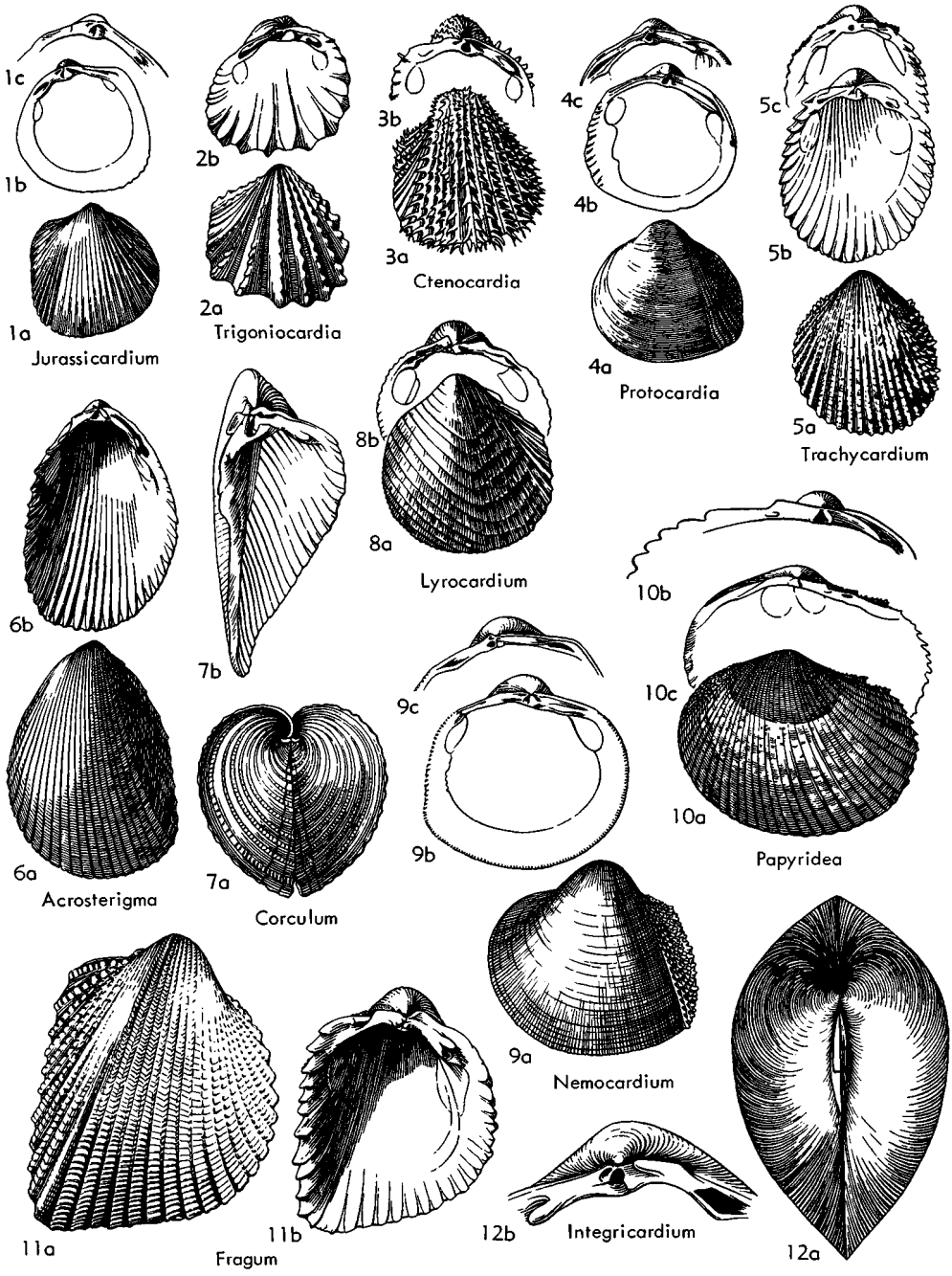


FIG. E86. Cardiidae (Trachycardiinae) *(5-6, 10);* (Fraginae) *(2-3,7,11),* (Protocardiinae) *(1,4,8-9,12)* (p. *N*586, *N*588-*N*589).

A. (Vasticardium) IREDALE, 1927 [**V. nebulosum* (*ex* MARTYN, *nonbinom.*); OD]. Resembling *A. (Acrosterigma)* but eaves of ribs more strongly sculptured; posterior margin notched *(458)*. *U. Oligo.-Rec.*, IndoPac.-N.Am.-C.Am.-Eu.

Papyridea SWAINSON, 1840 [**Cardium soleniforme* BRUGUIÈRE, 1789; SD GRAY, 1847]. Shell longer than high, gaping at both ends, ribs spinose; hinge short; posterior margin notched *(458)*. *Mio.-Rec.*, tropic Am.——FIG. E86,*10*. **P. soleniformis* (BRUGUIÈRE), Rec., W.Indies; *10a-c*, LV ext., hinge, RV int., ×1 (*10a,c*, Perry; *10b*, Keen).

Subfamily FRAGINAE Stewart, 1930

Posterior slope set off by low ridge to sharp keel, postero-ventral margin angulate; rib ornamentation of threads or imbricating spines, intercostal spaces narrow, cross-striate; hinge short, bent more than 25 degrees from horizontal; cardinal teeth mostly unequal in size. *Oligo.-Rec.*

Fragum RÖDING, 1798 [**Cardium fragum* LINNÉ, 1758; T] [=*Hemicardia* SPENGLER, 1799, AUCTT. (invalidly proposed)]. Triangular; hinge with cardinals subequal, peg-shaped; rib ornamentation threadlike *(458)*. *Mio.-Rec.*, E.Indies.

F. (Fragum). Lunular area not depressed. *Mio.-Rec.*, E.Indies.——FIG. E86,*11*. **F. (F.) fragum* (LINNÉ), Rec., E.Indies; *11a,b*, RV ext., LV int., ×1 (Keen).

F. (Lunulicardia) GRAY, 1853 [**Cardium retusum* LINNÉ, 1758; M] [=*Opisocardium* BAYLE, 1879 (obj.)]. Lunule very deeply impressed. *Pleist.-Rec.*, Japan-IndoPac.

Corculum RÖDING, 1798 [**Cardium cardissa* LINNÉ, 1758; SD VON MARTENS, 1870] [=*Cardissa* MEGERLE VON MÜHLFELD, 1811 (obj.); *Hemicardia* FLEMING, 1818 (obj.); *Hemicardium* SCHWEIGGER, 1820 (obj.)]. Foreshortened, posterior slope nearly plane, bounded by carina, of glassy texture; sculpture on ribs faint *(458)*. *Rec.*, E.Indies.——FIG. E86,*7*. **C. cardissa* (LINNÉ); *7a,b*, both valves ant., LV int., ×0.5 (*7a*, Tryon, *7b*, Keen).

Ctenocardia H. ADAMS & A. ADAMS, 1857 [**Cardium hystrix* REEVE, 1844 (*non* LIGHTFOOT, 1786) (=*Fragum symbolicum* IREDALE, 1929); SD DALL, 1900]. With imbricating or tubular spines on ribs; hinge with cardinals subequal, midway between laterals *(458)*. *Mio.-Rec.*, E.Indies-S.Afr.

C. (Ctenocardia). Outline quadrate, not oblique. *Mio.-Rec.*, E.Afr.-E.Indies.——FIG. E86,*3*. *C. (C.) symbolica* (IREDALE), Rec., E.Indies; *3a,b*, RV ext., LV int., ×1 (*3a*, Tryon; *3b*, Keen).

C. (Afrocardium) TOMLIN, 1931 [**Fragum (A.) shepstonense*; OD]. Oblique, umbonal ridge indistinct *(458)*. *Pleist.-Rec.*, S.Afr.-E.Indies.

C. (Microfragum) HABE, 1951 [**Cardium festivum* DESHAYES, 1854; OD]. Quadrate, with little or no sculpture on ribs. *Rec.*, E.Indies-Japan.

Trigoniocardia DALL, 1900 [**Cardium graniferum* BRODERIP & SOWERBY, 1829; OD]. Ovate to quadrate; hinge asymmetric, anterior section shorter than posterior. *Oligo.-Rec.*, tropic Am.

T. (Trigoniocardia). Ovate, mostly small, sculpture beaded, with intercostal striations. *Oligo.-Rec.*, C. Am.——FIG. E86,*2*. **T. (T.) granifera* (BRODERIP & SOWERBY), Rec., W.Mex.; *2a,b*, RV ext., LV int., ×2 (Keen & Frizzell).

T. (Americardia) STEWART, 1930 [**Cardium medium* LINNÉ, 1758; OD]. Quadrate, medium in size, ribs and intercostal spaces smooth *(892)*. *L. Mio.-Rec.*, C.Am.

T. (Apiocardia) OLSSON, 1961 [**Cardium obovale* SOWERBY, 1833; OD]. Rounded-ovate, ribs nearly smooth. *Plio.-Rec.*, W.C.Am.-S.Am.

Subfamily PROTOCARDIINAE Keen, 1951

Rounded quadrate, beaks nearly central; posterior slope well defined by umbonal ridge, its radial ribs tending to be spinose; hinge long, slightly arched, cardinals *2* and *3b* larger, peglike, curved upward, sinuating lower border of hinge plate; pallial line mostly entire, some with small sinus near posterior adductor scar. *U.Trias.(Rhaet.)-Rec.*

Protocardia VON BEYRICH, 1845 [**Cardium hillanum* SOWERBY, 1813; SD HERRMANNSEN, 1847] [=*Hassbergia* KRUMBECK, 1939 (invalidly proposed, without type designation)]. Posterior slope with radial ribs in most, remainder of shell with more or less well developed concentric ribs *(893, 1006)*. *U.Trias.-U.Cret.*, Eu.-N.Am.-S.Am.-Afr.

P. (Protocardia). Anterior concentric and posterior radial ribs well developed. *U.Trias.-U.Cret.*, Eu.-Asia-Afr.-N.Am.-S.Am.——FIG. 86,*4*. **P. (P.) hillana* (SOWERBY), L.Cret., Eng.; *4a-c*, LV ext., int., RV hinge, ×0.5 *(1006)*.

P. (Brevicardium) STEPHENSON, 1941 [**B. fragile*; OD]. With faint radial ribs crossing concentric sculpture of central and anterior slopes *(889)*. *U.Cret.*, N.Am.-Eu.-Asia.

P. (Globocardium) HAYAMI, 1965 [**Cardium sphaeroideum* FORBES, 1845; OD]. Globose, with weak radial ribs. *L.Cret.*, Eu.-Japan.

P. (Leptocardia) MEEK, 1876 [**Cardium subquadratum* EVANS & SHUMARD, 1857; SD DALL, 1901]. Small, polished, posterior radial ribs faint; marginal crenulations strong near junction of posterior and central slopes *(458)*. *L.Cret.-U.Cret.*, N.Am.

P. (Pachycardium) CONRAD, 1869 [**Cardium spillmani* CONRAD, 1858; SD DALL, 1900]. Relatively short, with high narrow beaks; concentric sculpture fine, radial sculpture covering up to half central slope; hinge thickened *(458)*. *L.Cret.-U.Cret.*, Afr.-Eu.-Asia-N.Am.-S.Am.

P. (Tendagurium) DIETRICH, 1933 [**Cardium (T.) propebanneianum*; SD KEEN, 1937]. Radial sculpture wanting on posterior slope *(458). Jur.-Cret.*, Afr.-Eu.-E.Asia.

Integricardium ROLLIER, 1912 [**Cardium dupinianum* D'ORBIGNY, 1844; OD]. Elliptical to elongate-quadrate; sculpture obsolete; hinge as in *Protocardia (795). M.Jur.-U.Cret.*, Eu.-N.Afr.-W.Asia-N.Am.

I. (Integricardium). Elliptical, without umbonal ridge. *M.Jur.-U.Cret.*, Eu.-N.Afr.-W.Asia.——FIG. 86,*12*. **I. (I.) dupiniana* (D'ORBIGNY), U.Cret., France; *12a,b*, both valves dorsal, RV hinge, ×0.6 (d'Orbigny).

I. (Onestia) MCLEARN, 1933 [**Laevicardium onestae* MCLEARN, 1931; OD]. Elongate-quadrate; lateral teeth small; external ligament in deep groove *(458). L.Cret.*, Can.

Jurassicardium COSSMANN, 1906 [**Cardium (J.) axonense*; SD KEEN, 1937]. Posterior-dorsal margin rectangular; posterior ribs not spinose, other radial riblets indistinct *(458). Jur.*, Eu.(France).——FIG. 86,*1*. **J. axonense* (COSSMANN); *1a-c*, RV ext., int., LV hinge, ×2 *(458)*.

Nemocardium MEEK, 1876 [**Cardium semiasperum* DESHAYES, 1858; SD SACCO, 1899] [=*Awadia* ABBASS, 1962 (type, *N. (A.) magharense*; OD)]. Sculpture radial throughout, strong on posterior slope *(459). L.Cret.-Rec.*, Eu.-Asia-S.Pac.-N.Am.-S.Am.

N. (Nemocardium). Central and anterior slopes nearly smooth, marginal crenulations changing abruptly in size at posterior-ventral junction. *L. Cret.-Rec.*, cosmop.——FIG. 86,*9*. **N. (N.) semiasperum* (DESHAYES), Eoc., France; *9a-c*, LV ext., int., RV hinge, ×1 (Deshayes).

N. (Arctopratulum) KEEN, 1954 [**N. (A.) griphus*; OD]. Ovate-trigonal, hinge short. *Oligo.-Mio.*, Japan-W.N.Am.

N. (Discors) DESHAYES, 1858 [**Cardium discors* LAMARCK, 1805 (*non* MONTAGU, 1803) (=**C. parisiense* D'ORBIGNY, 1850); T] [=*Hemidiscors* ROVERETO, 1898 (type, *Cardium (H.) rugiferum*; OD)]. Ovate, smaller than *N. (Nemocardium)*; oblique secondary striae crossing ribs of central and anterior slopes, posterior ribs faint. *Eoc.-Mio.*, Eu.-Asia.

N. (Divaricardium) DOLLFUS & DAUTZENBERG, 1886 [**Cardium discrepans* BASTEROT, 1825; SD COSSMANN, 1886]. More quadrate than *N. (Discors)*, oblique secondary sculpture on posterior slope; central slope nearly smooth. *Oligo.-Plio.*, Eu.-Asia.

N. (Frigidocardium) HABE, 1951, p. 147 [**Cardium eos* KURODA, 1929; OD] [=*Erigidocardium* HABE, 1951, p. 152 *(nom.null.)*]. Radial sculpture beaded throughout, alternate ribs higher. *Rec.*, Japan-IndoPac.

N. (Keenaea) HABE, 1951 [**N. samarangae* MAKIYAMA, 1934; OD]. Resembling *N. (Pratulum)* but with secondary concentric sculpture on posterior slope. *Oligo.-Rec.*, Japan-W.N.Am.

N. (Lophocardium) FISCHER, 1887 [**Cardium cumingii* BRODERIP, 1833; OD]. Fragile, sculpture of faint sinuous radial and concentric threads; periostracum forming laminar keel at junction of posterior and central slopes; cardinal teeth well developed, lateral teeth obsolescent *(226). ?Eoc., Mio.-Rec.*, C.Am.-S.Am.

N. (Lyrocardium) MEEK, 1876 [**Cardium lyratum* SOWERBY, 1841; SD DALL, 1900] [=*Amphicardium* VON MARTENS, 1880 (obj.)]. Like *N. (Discors)* but more quadrate, oblique secondary sculpture more widely and evenly spaced *(458). Pleist.-Rec.*, E.Indies.——FIG. 86,*8*. **N. (L.) lyratum* (SOWERBY), Rec., E.Indies; *8a,b*, LV ext., RV int., ×0.5 (Tryon).

N. (Microcardium) THIELE, 1934 [**Cardium peramabile* DALL, 1881; SD KEEN, 1937]. Small, with secondary concentric sculpture on central and anterior slopes both in intercostal spaces and as beads along ribs. *Mio.-Rec.*, C.Am.

N. (Pratulum) IREDALE, 1924 [**Cardium thetidis* HEDLEY, 1902; OD]. More equilateral than *N. (Nemocardium)*; radial ribs evident throughout but coarser on posterior slope *(459). L.Cret.-Rec.*, Eu.-N.Z.-Australia.

N. (Trifaricardium) HABE, 1951 [**Cardium nomurai* KURODA & HABE, 1951; OD]. Near *N. (Microcardium)* but secondary concentric sculpture on anterior slope only. *Rec.*, Japan.

N. (Varicardium) MARWICK, 1944 [**Cardium patulum* HUTTON, 1873; OD]. Heavy, with strong but irregular secondary concentric ridges anteriorly and ventrally overriding radial ribs; ribs of posterior slope without tubercles or spines *(598). Mio.*, N.Z.

Subfamily LAEVICARDIINAE Keen, 1936

Elliptic-oblique; rib ornamentation of looped threads or small nodes, not spines; ribs of posterior slope weaker than those of central and anterior slopes or obsolescent; posterior margin wavy rather than notched; hinge long and arched (line joining laterals and cardinals bends more than 25 degrees); cardinal teeth somewhat unequal in size, anterior left lateral bladelike. *Eoc.-Rec.*

Laevicardium SWAINSON, 1840 [**Cardium oblongum* GMELIN, 1791; SD STOLICZKA, 1871] [=*Liocardium* AGASSIZ, 1846 *(nom.van.)*; *Exocardium* OLSSON, 1964 (type, *Cardium ecuadoriale* OLSSON, 1932; OD)]. Ribs faintly to moderately developed, weaker on posterior slope; smooth to threaded or noded. *Eoc.-Rec.*, Eu.-Atl.-Pac.

L. (Laevicardium). Smooth, nongaping; cardinals unequal. *Eoc.-Rec.*, Eu.-W.Atl.-E.Pac.-W.Pac.——FIG. E87,*2*. **L. (L.) oblongum* (GMELIN), Rec.,

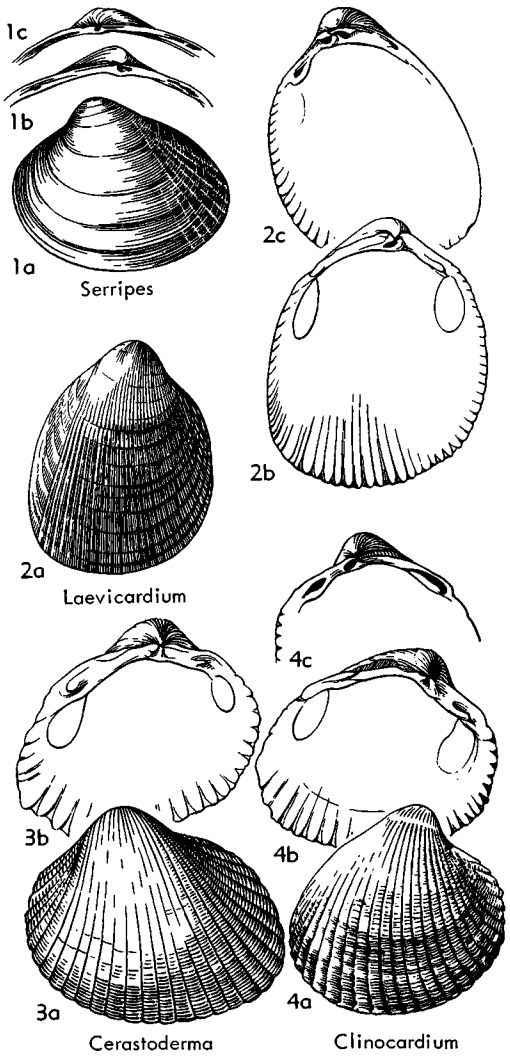


FIG. E87. Cardiidae (Laevicardiinae) (p. N589-N590).

Eu.; *2a-c*, RV ext., LV int., RV int., ×0.5 *(2a-c, 89a; 2b*, Keen).

L. (Dinocardium) DALL, 1900 [**Cardium robustum* LIGHTFOOT, 1786; OD]. Ribbing on anterior slope and beaks stronger than in *L. (Laevicardium)*; ornamentation of threadlike nodes crossing ribs *(892)*. *Eoc.-Rec.*, N.Am.-S.Am.

L. (Fulvia) GRAY, 1853 [**Cardium apertum* BRUGUIÈRE, 1789; M]. Thin-shelled, ventricose, slightly gaping posteriorly; cardinal teeth subequal. *Mio.-Rec.*, Japan-E.Indies-Alaska.

Cerastoderma POLI, 1795 [**Cardium edule* LINNÉ, 1758; SD VON MARTENS, 1870] [=*Cerastes* POLI, 1795 (*non* LAURENTI, 1768); *Edulicardium* MONTEROSATO, 1923 (obj.)]. Oblique-quadrangular, hinge only moderately arched; beaks orthogyrate; ribs moderately strong on posterior slope, sculptured with cross-threads *(242)*. *U.Oligo.-Rec.*, Eu. ——FIG. E87,*3*. **C. edule* (LINNÉ), Rec., Eu.; *3a,b*, LV ext., int., ×1 (*3a*, Tryon; *3b*, Keen).

Clinocardium KEEN, 1936 [**Cardium nuttallii* CONRAD, 1837; OD]. Oblique-elliptical, hinge well arched; beaks prosogyrate, ribs weak on posterior slope, ornamented with cross-threads; cardinal *4b* weak, left posterior lateral double *(458)*. *U.Mio.-Rec.*, N.Pac.-NW.Atl.——FIG. E87,*4*. **C. nuttallii* (CONRAD), Rec., USA(Calif.); *4a-c*, RV ext., LV int., RV hinge, ×0.5 (Keen).

Serripes GOULD, 1841 (*ex* BECK, MS) [**Cardium groenlandicum* BRUGUIÈRE, 1789; M] [=*Aphrodite* LEA, 1834 (*non* HÜBNER, 1816)]. Sculpture almost obsolete; shell medium-sized to large, inequilateral; cardinal teeth weak in adults or absent, laterals also evanescent *(458)*. *Mio.-Rec.*, N.Atl.-N.Pac.-Japan.——FIG. E87,*1*. **S. groenlandicus* (BRUGUIÈRE), Rec., Arctic O.; *1a-c*, LV ext., LV and RV hinges, ×0.5 (Tryon).

Family LAHILLIIDAE Finlay & Marwick, 1937

Orbicular to oblong in outline; surface smooth, without radial sculpture; internal margins smooth, not crenulate; ligament external, on large nymph. Cardinal teeth two in each valve, arranged as in Cardiidae; anterior lateral teeth absent, posterior laterals one in each valve. *U.Cret.-Mio.*

Lahillia COSSMANN, July, 1899 [*pro Iheringia* COSSMANN, April 1899, *nom. correct. pro Theringia* COSSMANN, Jan. 1899 (*non* KEYSERLING, 1891) *et pro Amathusia* PHILIPPI, 1887 (*non* FABRICIUS, 1807)] [**Amathusia angulata* PHILIPPI, 1887; SD FINLAY & MARWICK, 1937]. Medium-sized to large, ovate, thin; hinge plate broad, thick. *U.Cret.-Mio.*, S.Am.-N.Z.-Australia-Antarctic.

L. (Lahillia). Pallial line entire *(598)*. *U.Cret.-Mio.*, S.Am.-N.Z.-Australia-Antarctic.——FIG. E88,*5*. **L. (L.) angulata* (PHILIPPI), Oligo.,?Mio., Chile; *5a,b*, RV ext., int., ×0.5 (*5a*, Philippi; *5b*, Wilckens).

L. (Lahilleona) FINLAY & MARWICK, 1937 [**L. neozelanica* MARSHALL & MURDOCH, 1923; OD]. With well-defined rounded pallial sinus *(598)*. *U.Cret.*, N.Z.——FIG. E88,*6*. **L. (L.) neozelanica* MARSHALL & MURDOCH; *6a-c*, LV ext., int., RV hinge, ×0.5 *(304)*.

Family LYMNOCARDIIDAE Stoliczka, 1870

[*nom. transl.* (as Adacnidae), VON VEST, 1875 (*ex* Lymnocardiinae STOLICZKA, 1870)]

Shells ribbed to smooth, small to medium-sized, many with alations on dorsal margin, some with shell gaping. Normal hinge with two cardinals in either valve, obsolescent in some; lateral teeth distant, varying from large to obsolete; pallial line entire or sinuate to a varying extent. [Brackish-water forms, perhaps of polyphyletic origin, characterized by great variability.] *Mio.-Rec.*

The classification here is adapted from an outline by EBERSIN (1965), the most complete modern summary of named taxa; however, differential diagnoses of many nominal taxa are yet unavailable.

Subfamily LYMNOCARDIINAE Stoliczka, 1870

Shells oblique, umbones in front of midline; hinge with well-developed anterior lateral teeth. Pallial line normally entire, valves mostly not gaping. *Mio.-M.Plio.*

Lymnocardium STOLICZKA, 1870 [**Cardium haueri* HÖRNES, 1861; OD] [=*Limnocardium (nom. null.)*]. Long-quadrate; ribs few, smooth or with spines; cardinals 2 and *3b* present. *M.Mio.-M.Plio.*, Eu.

L. (Lymnocardium). Hinge teeth and sculpture well developed. *M.Mio.(Sarmat.)-L.Plio.(Ruman.)*, E.Eu.——FIG. E88,*4*. **L. (L.) haueri* (HÖRNES), L.Plio., Aus.; *4a-c*, LV ext., LV hinge, RV int., ×0.5 (Andrussov, 1903).

L. (Arpadicardium) EBERSIN, 1947 [**L. (A.) peregrinum*; OD]. Hinge nearly edentulous; pallial line slightly sinuate. *L.Plio.(Pont.)*, S.USSR.

L. (Bosphoricardium) EBERSIN, 1947 [**Cardium emarginatum* DESHAYES, 1838 (*non* DESHAYES, 1820) (=*C. aperturatum* DESHAYES, 1857); OD]. Ovate, ribs numerous, low; cardinal teeth weak. *L.Plio.(Pont.)*, S.USSR.

L. (Ecericardium) EBERSIN, 1947 [**L. (E.) ecericum;* OD]. Nearly smooth, ribs low; lateral teeth somewhat reduced. *M.Plio.(Kimmer.-Kuialnik.)*, S.USSR.

L. (Euxinicardium) EBERSIN, 1947 [**L. subsyrmiense* ANDRUSSOV, 1903; OD]. Ovate, ribs triangular in section, cardinals weak. *L.Plio.(Pont.)*, S.USSR.

L. (Moquicardium) EBERSIN, 1947 [**L. moquicum* SENINSKY, 1905; OD]. Subrounded to ovate-triangular; ribbed within; pallial line raised anteriorly. *M.Plio.(Kimmer.)*, S.USSR.

L. (Nargicardium) EBERSIN, 1947 [**L. (N.) nargiavagicum;* OD]. Ribs widely spaced, triangular in section; hinge with weak cardinals, strong anterior laterals, obsolete posterior laterals. *L.Plio. (Pont.)*, S.USSR.

L. (Pannonicardium) STEVANOVIĆ, 1951 [**L. dumićići* GORIANOVIC-KRAMBERGER, 1899 (*fide* EBERSIN, 1965)]. *L.Plio.(Pont.)*, S.Eu.

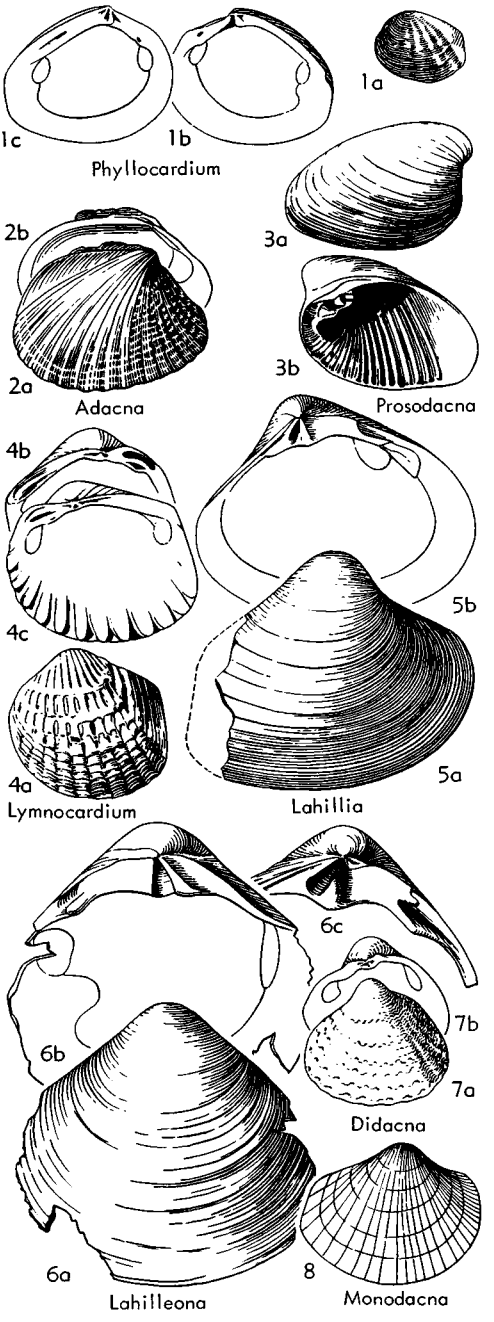


FIG. E88. Lahillidae *(5-6)*; Lymnocardiidae (Lymnocardiinae) *(3-4)*, (Didacninae) *(1,7)*, (Adacninae) *(2,8)* (p. *N*590-*N*593).

L. (Tauricardium) EBERSIN, 1947 [**L. subsquamulosum* ANDRUSSOV, 1903; OD]. Ribs few, well developed anteriorly. *Plio.(Pont.-Kimmer,)*, S. USSR.

Budmania BRUSINA, 1897 [**Adacna meisi* BRUSINA, 1884; SD EBERSIN, 1965]. Ribs few, narrow, crested; hinge weak. *L.Plio.(Pont.)*, S.Eu.

Eoprosodacna DAVIDASCHVILI, 1934 [**Cardium (E.) kartlicum*; M] [=*Limnopappia* SCHLICKUM, 1962 (type, *L. schuetti;* OD)]. *L.Mio.-M.Mio.*, USSR (S.Caucasus).

E. (Eoprosodacna). *L.Mio.-M.Mio.*, USSR(S.Caucasus).

E. (Succuridacna) KOROBKOV, 1954 [**Cardium goriense* DAVIDASCHVILI, 1934; OD] [=*Limnopagetia* SCHLICKUM, 1963 (type, *Cardium friabile* KRAUSS, 1852; OD)]. Ribs widely spaced. *L.Mio.-M.Mio.*, USSR(S.Caucasus).

Horiodacna SABBA STEFANESCU, 1896 [**H. rumana;* M]. Smooth, beaks prosogyrate; shell ribbed internally; hinge with rudimentary cardinal in 1 valve, fossette in other. *L.Plio.(Pont.)*, Eu.(Rumania).

Limnodacna EBERSIN, 1936 [**L. cristulata*; OD]. Posterior slope set off by several carinate ribs; hinge of LV reduced to 1 weak cardinal. *M. Plio.(Kimmer.)*, S.USSR.

Pachydacna EBERSIN, 1955 [*pro Natella* EBERSIN, 1949 (*non* WATSON, 1934)] [**Natella natella* EBERSIN, 1949; M]. Ribs few, hinge heavy. *M. Plio.(Kimmer.-Kuialnik.)*, Euxine Basin, S.USSR.

Prionopleura EBERSIN, 1949 [**Prosodacna prionopleura* WASSOIEVICH & EBERSIN, 1931 (*ex* ANDRUSSOV MS); T]. Ribs keeled, crossed by raised regular growth lamellae. *M.Plio.(Kimmer.)*, S.USSR.

Prosodacna TOURNOUËR, 1882 [**Cardium macrodon* DESHAYES, 1838; OD] [=*Psilodon* COBALESCU, 1883 (*non* PERTY, 1830); *Pseudoprosodacna* GILLET, 1943 (*fide* EBERSIN, 1959)]. Ovate, oblique, beaks prosogyrate; exterior ribbing weak, interior ribs strong; hinge with cardinals wanting, laterals *AI, AII* thick, *AIII* thin; pallial line entire. *L.Plio.-M.Plio.*, S.USSR.

P. (Prosodacna). *L.Plio.-M.Plio.(Pont.-Kuialnik.)*, S.USSR.——FIG. E88,*3*. **P. (P.) macrodon* (DESHAYES), Plio., Euxine Basin, S.Eu.-S.USSR, *3a,b*, RV ext., int., ×0.4 (Davidaschvili).

P. (Metadacna) [**P. metoica* DAVIDASCHVILI, 1930; OD]. *M.Plio.*, Azov area, S.USSR.

P. (Prosochiasta) EBERSIN, 1959 [**P. prosochiasta* ANDRUSSOV, 1917; OD]. *L.Plio.(Pont.)*, S.USSR.

P. (Prosodacnomya) EBERSIN, 1959 [**Cardium rostratum* SINZOV, 1900 (*non* DE KONINCK, 1841) (=*Prosodacna sinzovi* ANDRUSSOV, 1917); OD]. *L.Plio.(Pont.)*, S.USSR.

Stylodacna SABBA STEFANESCU, 1896 [**Psilodon heberti* COBALESCU, 1883; OD] [=*Styladacna* DOLLFUS, 1905 *(nom. null.)*]. Internal ribs heavy, lamellar; hinge without cardinals, laterals small, lamellar. *M.Plio.*, Eu.(Rumania).

Subfamily DIDACNINAE Ebersin, 1962

Umbones subcentral; lateral teeth wanting. *L.Plio.(Pont.)-Rec.*

Didacna EICHWALD, 1838 [**Cardium trigonioides* PALLAS, 1771; SD STOLICZKA, 1870]. Rounded-trigonal, slightly truncate; pallial line entire. *L. Plio.(Pont.)-Rec.*, S.USSR.

D. (Didacna). *Rec.*, Caspian Sea.——FIG. E88,*7*. **D. (D.) trigonioides* (PALLAS); *7a,b*, LV ext., RV int., ×0.5 (Reeve, 1843).

D. (Crassadacna) EBERSIN, 1962 [**Cardium crassatellatum* DESHAYES, 1838; OD]. *Plio.(Pont.-Kimmer.)*, S.USSR.

D. (Pontalmyra) SABBA STEFANESCU, 1896 [**P. placida;* SD SACCO, 1899] [=*Tschaudia* DAVIDASCHVILI, 1956 (type, *Didacna tschaudae* ANDRUSSOV, 1910; OD)]. *Plio.(Pont.-Kuialnik.)*, S. USSR-S.Eu.

Brachiodacna EBERSIN, 1964 [**Cardium negativum* ANDRUSSOV, 1909; OD]. *L.Plio.(Pont.)*, S.USSR (*fide* EBERSIN, 1965).

Caladacna ANDRUSSOV, 1917 [**Cardium steindachneri* BRUSINA, 1884; M] [=*Kaladacna* ANDRUSSOV, 1923 (type, *Cardium fittoni* D'ORBIGNY, 1845; OD)]. Ribs triangular in section, conspicuous, irregular. *Plio.(Pont.-Kimmer.)*, S.USSR.

Didacnomya ANDRUSSOV, 1923 [**Cardium vulgaris* SINZOV, 1876 (*non* DA COSTA, 1778) (?=*Monodacna vulgaris planior* KRESTOVNIKOV, 1928); OD]. *Plio.(Pont.-Kuialnik.)*, S.USSR.

Oraphocardium EBERSIN, 1949 [**Phyllocardium oraphense* DAVIDASCHVILI, 1930; OD]. Like *Phyllocardium* but posterior margin rectangular instead of oblique. *Plio.(Pont.-Kimmer.)*, S.USSR.

Oxydacna DAVIDASCHVILI, 1930 [**O. tenericardo, ex* ANDRUSSOV MS; M]. Ribs narrow at crests. *M.Plio.(Kimmer.)*, S.USSR.

Phyllocardium FISCHER, 1887 [**Cardium planum* DESHAYES, 1838; M] [=*Phyllicardium* AUCTT. *(nom. null.)*]. Ovate, tending toward alation of dorsal margin. *Plio.(Pont.-Kimmer.)*, S.USSR.——FIG. E88,*1*. **P. planum* (DESHAYES), L.Plio., S. USSR; *1a-c*, LV ext., RV int., LV int., ×1 (Andrussov).

Plagiodacna ANDRUSSOV, 1903 [**Cardium carinatum* DESHAYES, 1838 (*non* BRONN, 1831) (=*C. angulosum* DESHAYES, 1857); SD CROSSE, 1905]. Rhomboidal, with umbonal ridge. *Plio.(Pont.-Kuialnik.)*, S.USSR.

Pseudocatillus ANDRUSSOV, 1903 [**Cardium pseudocatillus* BARBOT-DE-MARNY, 1869; T]. Shell somewhat compressed, ribs weak. *Plio.(Pont.-Kuialnik.)*, S.USSR.

Pteradacna ANDRUSSOV, 1907 [**Cardium edentulum* DESHAYES, 1838 (*non* MONTAGU, 1808) (=*C. subedentulum* D'ORBIGNY, 1852; M]. Ribs numerous, with threadlike nodes; dorsal margin alate; hinge edentulous. *M.Plio.(Kimmer.)*, S.USSR.

Stenodacna ANDRUSSOV, 1923 [**Cardium angusti-*

costatum ROUSSEAU, 1842; M]. *M.Plio.(Kimmer.)*, S.USSR.

Subfamily PARADACNINAE Ebersin, 1964

Shells very thin and fragile, mostly edentulous; pallial line entire or nearly so. *Plio. (Pont.-Kimmer.)*.

Paradacna ANDRUSSOV, 1909 [*pro Abichia* ANDRUSSOV, 1907 (*non* GEMMELLARO, 1888)] [**Cardium abichi* HÖRNES, 1874; M]. Elongate, trapezoidal, posterior slope smooth, posterior ribs carinate, wide-spaced. *Plio.(Pont.-Kimmer.)*, S.USSR.

Arcicardium FISCHER, 1887 [**Cardium acardo* DESHAYES, 1838; M]. Shell flattened, trigonal, very inequilateral, edentulous. *L.Plio.*, USSR (Crimea).

Chartoconcha ANDRUSSOV, 1907 [**Cardium bayerni* HÖRNES, 1874; M]. Smooth, hinge edentulous. *Plio.(Pont.-Kuialnik.)*, S.USSR.

Panticapaea ANDRUSSOV, 1923 [**Cardium duboisi* MAYER, 1856; M]. *U.Plio.(Kimmer.)*, S.USSR.

Papyrocardium GABUNIA, 1953 [**P. fragilicostatum* (*fide* EBERSIN, 1965)]. *U.Plio.(Kimmer.)*, S.USSR.

Parvidacna STEVANOVIĆ, 1951 [**P. planicostata* (*fide* EBERSIN, 1965)]. *L.Plio.(Pont.)*, S.USSR.

Subfamily ADACNINAE von Vest, 1875

[*nom. transl.* EBERSIN, 1965 (*ex* Adacnidae VON VEST, 1875)]

Hinge weak to edentulous; pallial sinus present in most; some forms gaping at one or both ends. *U. Plio. (Aktschagyl.-Apscheron.)-Rec.*

Adacna EICHWALD, 1838 [**Glycimeris laeviuscula* EICHWALD, 1829 (?=*A. laeviuscula* EICHWALD, 1838); SD VON VEST, 1875]. Edentulous; valves thin, gaping at both ends; pallial sinus large. *U. Plio.(Apscheron.)-Rec.*, Caspian Sea-S.USSR.——FIG. E88,*2*. **A. laeviuscula* (EICHWALD), Rec., Caspian Sea; *2a,b*, RV ext., LV int., ×1 (Chenu, 1857).

Apscheronia ANDRUSSOV, 1903 [**Cardium propinquum* EICHWALD, 1841 (*non* MÜNSTER, 1837) (=*C. proximum* DESHAYES, 1857); M]. Shell surface smooth, without ribs. *U.Plio.(Apscheron.)*, S.USSR.

Avicardium KOLESNIKOV, 1950 [**Cardium nikitini* ANDRUSSOV, 1902; OD]. *U.Plio.*, Caspian Basin.

Caspicardium ASTAFIEVA, 1955 [**Cardium trapezinum* ANDRUSSOV, 1923 (*fide* EBERSIN, 1965)]. *U.Plio.(Apscheron.)*, S.USSR.

Catilloides ANDRUSSOV, 1923 [**Monodacna catilloides;* OD]. *U.Plio.(Apscheron.)*, S.USSR.

Hypanis EICHWALD, 1838 (*ex* PANDER MS) [**Cardium plicatum*; M]. Resembling *Adacna* but with wide-spaced sharp ribs. *U.Plio.(Apscheron.)*, S. USSR.

Hyrcania KOLESNIKOV, 1950 [**Didacna hyrcana*

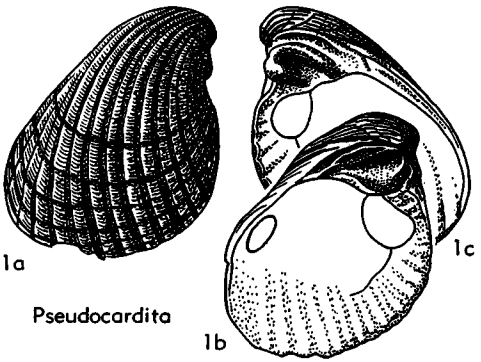


FIG. E89. Lahillidae (Pseudocarditinae) (p. *N*593).

ANDRUSSOV, 1923; OD] [=*Turkmena* POPOV, 1956 (type, *Didacna turkmena* ANDRUSSOV, 1923; OD); *Irinia* POPOV, 1956 (type, *Didacna turkmena major* ANDRUSSOV, 1923; OD)]. *U.Plio. (Apscheron.)*, S.USSR.

H. (Hyrcania). *U.Plio.(Apscheron.)*, S.USSR.

H. (Didacnoides) ASTAFIEVA, 1955 [**Monodacna didacnoides* ANDRUSSOV, 1923; T (*fide* EBERSIN, 1965)]. *U.Plio.(Apscheron.)*, S.USSR.

H. (Hyrcanomya) ASTAFIEVA, 1955 [**Monodacna bakuana* ANDRUSSOV, 1923 (*fide* EBERSIN, 1965)]. *U.Plio.(Apscheron.)*, S.USSR.

Monodacna EICHWALD, 1938 [**Corbula caspia* EICHWALD, 1829; SD VON VEST, 1875]. Rounded-quadrate, ribs broad; hinge with cardinals *2* and *3b*, no laterals; pallial sinus small. *U.Plio. (Apscheron.)-Rec.*, Caspian-S.USSR.——FIG. E88, *8*. **M. caspia* (EICHWALD), Rec., Caspian Sea; RV ext., ×1 *(124b)*.

Parapscheronia EBERSIN, 1955 [**Apscheronia volarovici* ANDRUSSOV, 1923; M]. *U.Plio.(Apscheron.)*, S.USSR.

Plagiodacnopsis ANDRUSSOV, 1923 [**Monodacna (P.) isseli;* OD]. *U.Plio.(Apscheron.)*, S.USSR.

Subfamily PSEUDOCARDITINAE Ebersin, 1964

Outline oblique; hinge lacking laterals and right anterior cardinal; pallial line entire. *Plio.*

Pseudocardita OPPENHEIM, 1918 [**Cardium (P.) bukowskii;* SD KEEN, 1937]. Oblique, inequilateral, ribs broad, rounded; hinge plate wide, teeth stout, nymphs elongate. *Neog.(?Pont.)*, Asia Minor. ——FIG. E89,*1*. **P. bukowskii* (OPPENHEIM), Plio., S.Turkey; *1a-c*, RV ext., LV int., RV int., ×1 (Oppenheim, 1918).

Subfamily UNCERTAIN

Diversicostata EBERSIN & WASSOIEVIĆ, 1930 [**Monodacna maxima, ex* ANDRUSSOV MS; SD SALISBURY,

1932 (proposed as an undefined "section" and later rejected as invalid by EBERSIN)].

Myocardia VON VEST, 1861 [**M. truncata*; SD VON VEST, 1875]. Hinge resembling that of *Cardium* but shells with the pallial sinus of *Adacna*. *Mio.*, Eu.(Hung.).

Prophyllicardium JEKELIUS, 1944 [**P. soceni* (*fide* Zool. Record, 1946)]. *Mio.*, Eu.(Rumania).

Replidacna JEKELIUS, 1944 [**R. carasi* (*fide* Zool. Record, 1946)]. *Mio.*, Eu.(Rumania).

Uniocardium CAPELLINI, 1880 [**U. meneghini*; M]. *Plio.*, Eu.(Italy).

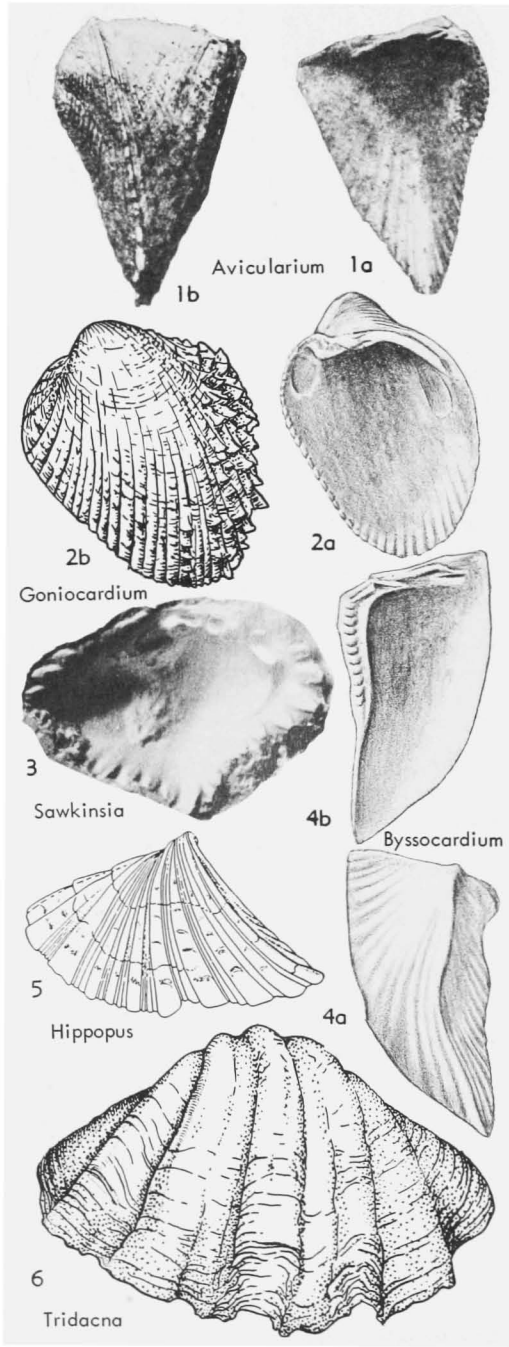


FIG. E90. Tridacnidae (p. *N*594-*N*595).

Superfamily TRIDACNACEA Lamarck, 1819

[*nom. transl.* DALL, 1895 (*ex* Tridacnidae GOLDFUSS, 1820) (=tridacnées LAMARCK, 1819)] [Materials for this superfamily prepared by MYRA KEEN]

Medium-sized to very large shells, with radial ribbing; byssal gape in most; hinge with two oblique lamellar cardinal teeth and one or more lateral teeth; soft parts "rotated" within shell as special adaptation to mode of life among corals; posterior adductor and large posterior pedal retractor muscle scar centrally located, anterior adductor scar wanting; pallial line entire. *?U. Cret., Tert.-Rec.*

Family TRIDACNIDAE Lamarck, 1819

[*nom. correct.* MENKE, 1830 (*pro* Tridacnadae *nom. transl. et correct.* FLEMING, 1828, *ex* ?tribe Tridacnae GOLDFUSS, 1820) (=tridacnées LAMARCK, 1819)]

Radial ribs smooth or with spinose ornamentation. *?U.Cret., Tert.-Rec.*

Tridacna BRUGUIÈRE, 1797 [**Chama gigas* LINNÉ, 1758; SM LAMARCK, 1799] [=*Tridachnes* RÖDING, 1798 (obj.); *Tridacnodites* KRÜGER, 1823 (obj.); *Dinodacna* IREDALE, 1937 (obj.)]. Large to massive, ribs few, strong; anterior lateral teeth wanting. *?U.Cret., Tert.-Rec.*, Eu.-E.Indies-Afr.-S.Pac.

T. (Tridacna). Ribs deeply folded; umbones subcentral. Shells unattached but among reef corals. *L.Mio.-Rec.*, Eu.-E.Indies.——FIG. E90,6. **T. (T.) gigas* (LINNÉ), Rec., E.Indies; LV ext., ×0.05 *(562; 797)*.

T. (Chametrachea) MÖRCH, 1853 [**Tridacna crocea* LAMARCK, 1819; SD IREDALE, 1937] [=*Flodacna* IREDALE, 1937 (type, *T. squamosa* LAMARCK, 1819; OD); *Sepidacna* IREDALE, 1937 (type, *T. troughtoni* =*Tridachnes maxima* RÖDING, 1798; OD); *Vulgodacna* IREDALE, 1937 (type, *T. maxima* var. *fossor* HEDLEY, 1921 =*Tridachnes maxima* RÖDING, 1798; OD)]. Valves equilateral to strongly inequilateral, umbones anterior to mid-line; sculpture tending to be scaly. Boring into coral. *?U.Cret., Tert.-Rec.*, Afr.-Eu.-E.Indies.

T. (Persikima) IREDALE, 1937 [**P. whitleyi* (=*Tridachnes derasa* RÖDING, 1798); OD]. Um-

bones posterior to mid-line, shell strongly inequilateral. *Rec.*, S.Pac.

Avicularium GRAY, 1853 [*"*Cardium aviculare* LAM." (=*Cardita avicularia* LAMARCK, 1805); SD DALL, 1900] [=*Lithocardium* WOODWARD, 1854 (obj.)]. Triangular, higher than long, ribs evident but nearly smooth. *M.Eoc.-L.Oligo.*, Eu.-W.Indies.——FIG. E90,*1*. **A. avicularium* (LAMARCK), Eoc., France; *1a,b*, LV int., ext., ×0.5 (Cossmann & Pissarro, 1904).

Byssocardium MUNIER-CHALMAS, 1882 [**Cardium emarginatum* DESHAYES, 1829; OD]. With an anterior gape bordered by plaits, as in *Tridacna*, but shell more triangular. *M.Eoc.-L.Mio.*, Eu.——FIG. E90,*4*. **B. emarginatum* (DESHAYES), Eoc., France; *4a,b*, RV ext., int., ×0.7 (Deshayes).

Goniocardium VASSEUR, 1880 [**Cardium rachitis* DESHAYES, 1829; SD KEEN, 1937]. Oblique-ovate, spinose, anterior lateral teeth wanting. *M.Eoc.-U.Eoc.*, Eu.——FIG. E90,*2*. **G. rachitis* (DESHAYES), Eoc., France; *2a*, RV int., ×0.7; *2b*, LV ext., ×1 (Cossmann & Pissarro, 1904).

Hippopus LAMARCK, 1799 [**Chama hippopus* LINNÉ, 1758; M] [=*Pelvis* MEGERLE, 1811 (obj.); *Cerceis* GISTL, 1848 (obj.) *(nom. van.)*]. Like *Tridacna* in general form but byssal gape closed in adult. *Mio.-Rec.*, E.Indies-W.Indies.——FIG. E90,*5*. **H. hippopus* (LINNÉ), Rec., E.Indies; RV ext., ×0.3 (Stasek, 1962).

Sawkinsia Cox, 1941 [**S. matleyi*; OD]. Resembling *Tridacna* but not gaping; anterior lateral teeth present. *U.Eoc.-U.Oligo.*, Carib.——FIG. E90,*3*. **S. matleyi*, Eoc., Jamaica; RV int., ×1 (Cox, 1941).

Superfamily MACTRACEA Lamarck, 1809

[*nom. transl.* DALL, 1895 (*ex* family Mactracea GRAY, 1823) (=mactracées LAMARCK, 1809)] [Materials for this superfamily prepared by MYRA KEEN]

Thin-shelled, porcelaneous; hinge with inverted V-shaped cardinal tooth in LV, two cardinals in RV; lateral teeth and accessory cardinal laminae present in most groups; external ligament small or wanting, internal ligament or resilium seated in socket-like resilifer; pallial sinus normally well developed *(507, 510)*. *U.Cret.-Rec.*

Family MACTRIDAE Lamarck, 1809

[*nom. correct.* SWAINSON, 1835 (*pro* family Mactracea GRAY, 1823) (=mactracées LAMARCK, 1809)]

Periostracum present, glossy; shell smooth or concentrically sculptured; valves slightly gaping; pallial line with sinus; siphons of animal united to their tips *(510)*. *U.Cret.-Rec.*

Subfamily MACTRINAE Lamarck, 1809

[*nom. transl.* ADAMS & ADAMS, 1856 (*ex* family Mactracea GRAY, 1823) (=mactracées LAMARCK, 1809)]

Subequilateral, nearly closed; hinge well developed, two cardinals of RV somewhat joined; siphons wholly retractile within shell. *U.Cret.-Rec.*

Mactra LINNÉ, 1767 [**Cardium stultorum* LINNÉ, 1758; SD FLEMING, 1818 (+ICZN, Dir. 72, as of GRAY, 1847)] [=*Trigonella* DA COSTA, 1778 (obj.; SD WINCKWORTH, 1926); *Deikea* MAYER, 1872 (type, *M. gallensis* MAYER, 1867; SD KEEN, herein); *Colorimactra* IREDALE, 1929 (type, *M. queenslandica* E. A. SMITH, 1914; OD); *Telemactra* IREDALE, 1929 (type, *M. obesa* REEVE, 1854, *ex* DESHAYES MS; OD)]. Trigonal to oval, somewhat inflated, subequilateral; lunule and escutcheon delimited; ligament separated from resilium by shelly lamina; lateral teeth smooth; pallial sinus oval. *Eoc.-Rec.*, cosmop.

M. (Mactra). Lunule and escutcheon not set off by groove; hinge of LV with *AII* and *4b;* RV with *3a-3b* not fused above, laterals doubled; pallial sinus rounded, not deep. *Rec.*, circumtrop.——FIG. E91,*2*. **M. (M.) stultorum* (LINNÉ), Medit.; *2a*, LV ext., ×0.5 (Reeve, 1854); *2b,c*, LV and RV hinges, ×1 *(510)*.

M. (Allomactra) TOMLIN, 1931 [*pro Heteromactra* COSSMANN & PEYROT, 1909 (*non* LAMY, 1906)] [**M. (H.) grateloupi* COSSMANN & PEYROT, 1909, *ex* DESHAYES MS; OD]. Trigonal, flattened, smooth, resembling *M. (Eomactra)* but with wider cardinal plate, resilifer pyriform, *4b* wanting, also nymph; pallial sinus long and broad. *Mio. (Burdigal.)*, Eu.——FIG. E91,*3*. **M. (A.) grateloupi* COSSMANN & PEYROT, France; *3a,b*, RV ext., int., ×1; *3c*, LV hinge, ×2 *(164)*.

M. (Andrussella) KOROBKOV, 1954 [**M. acutecarinata* ANDRUSSOV, 1902; OD]. Posterior slope meeting central slope in sharp keel that may be prolonged into spout. *Plio.*, E.Eu.——FIG. E91,*1*. **M. (A.) acutecarinata* ANDRUSSOV, S.Caucasus; *1a,b*, RV, LV ext., ×1.5; *1c*, RV hinge, ×5 (Andrussov, 1902).

M. (Austromactra) IREDALE, 1930 [**A. caloundra;* OD]. Trigonal, equivalve, sculpture of laminar concentric ridges wavy at ends; hinge broad; pallial sinus small, rounded. *Rec.*, S.Pac.——FIG. E91,*6*. **M. (A.) caloundra* (IREDALE), Australia; *6a,b*, LV ext., int., ×1 (Iredale, 1930).

M. (Avimactra) ANDRUSSOV, 1905 [**M. (A.) aviculoides*; M]. Trigonal, dorsal margin long and straight, ventral attenuated by radial fold; hinge with large resilifer. *Plio.*, E.Eu.——FIG. E91,*5*. **M. (A.) aviculoides*, S.Caucasus; *5a*, RV ext., ×1; *5b*, RV hinge, ×2 (Andrussov, 1905).

M. (Barymactra) COSSMANN & PEYROT, 1909 [**Mactra burdigalensis* MAYER, 1864; OD]. Large, thick, short, hinge teeth close-set; pallial sinus

short, slightly descending, line doubled, bordered above by row of punctate scars. *Eoc.-Mio.*, Eu.-SW.Afr.——Fig. E91,*4*. **M. (B.) burdigalensis* Mayer, Mio., France; *4a,b*, RV int., LV int., ×0.5 *(164)*.

M. (Coelomactra) Dall, 1895 [**M. violacea* Gmelin, 1791; OD]. Valves thin, inflated, dorsal areas grooved, resilifer not roofed at apex; hinge plate oblique, teeth not concentrated, laterals long, thin, cardinals buttressed; pallial sinus short, high. *Rec.*, Pac.——Fig. E92,*6*. **M. (C.) violacea* Gmelin, E.Indies; *6a*, LV ext., ×0.5 (Reeve, 1854), *6b,c*, LV and RV hinges, ×2 *(510)*.

M. (Cryptomactra) Andrussov, 1902 [**Lucina*

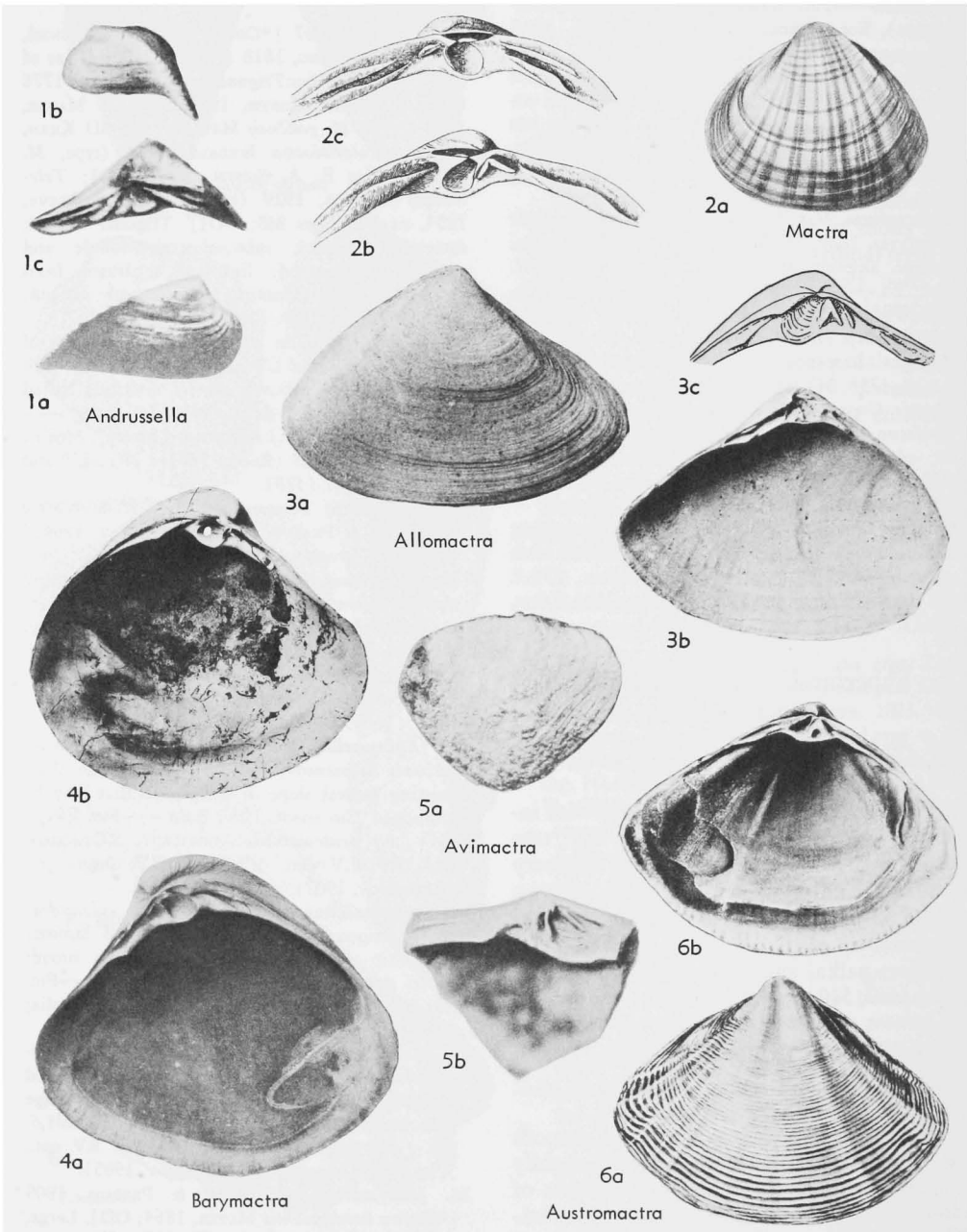


Fig. E91. Mactridae (Mactrinae) (p. *N595-N596*).

pesanseris MAYER-EYMAR, 1857; M]. Small, trapezoidal, with 1 or 2 strong radial folds, making ventral margin sinuous. *Mio.(Sarmat.)*, E.Eu.—— FIG. E92,*1*. **M. (C.) pesanseris* (MAYER-EYMAR), U.Mio., S.Caucasus; *1a,b*, LV ext., RV ext., ×1; *1c,d*, RV and LV hinges, ×1.5 (Andrussov, 1902).

M. (Cyclomactra) DALL, 1895 [**M. tristis* "GRAY" *(err. pro *M. tristis* REEVE, 1854)*; OD]. Like *M. (Mactroderma)* but subcircular, compressed, liga-

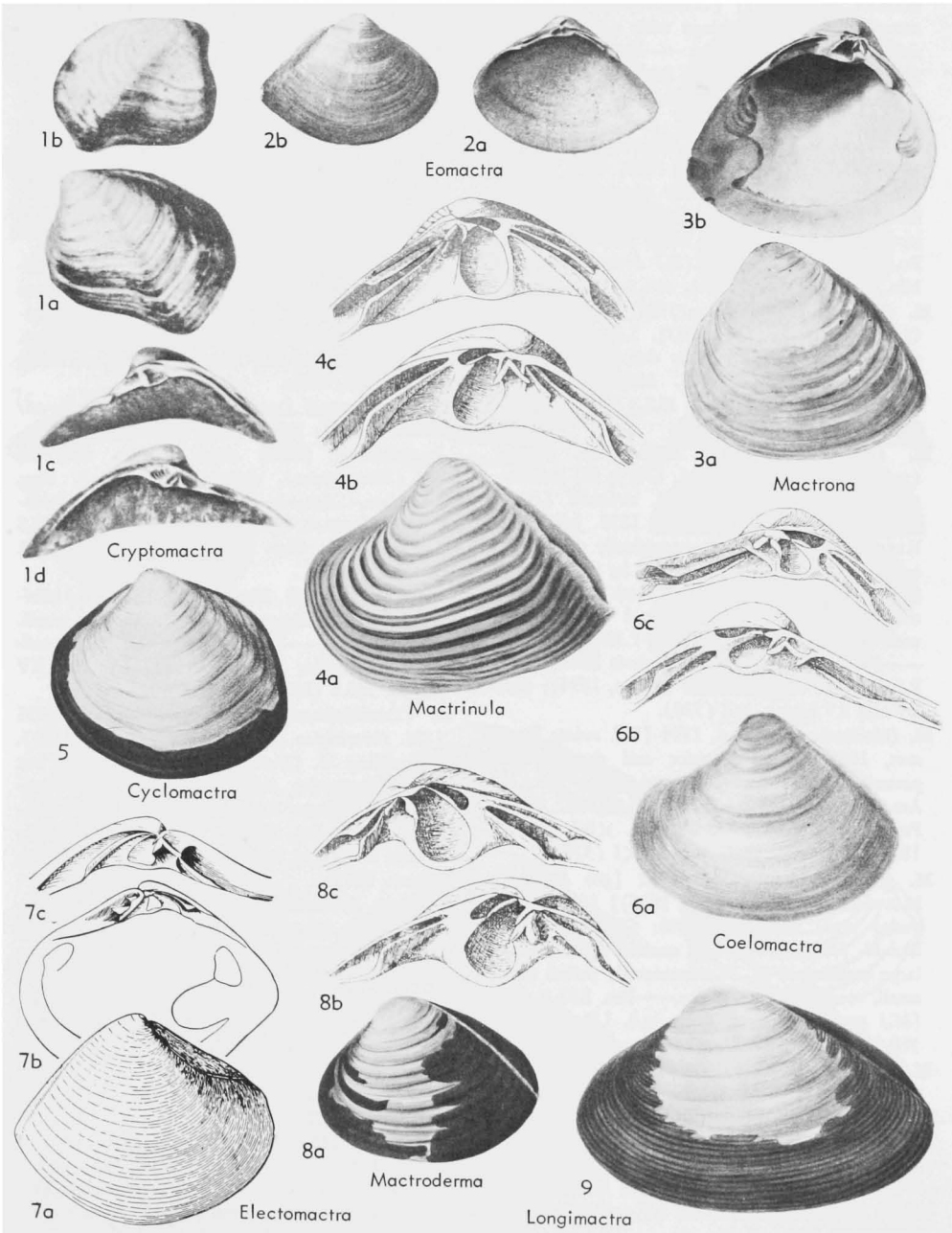


FIG. E92. Mactridae (Mactrinae) (p. *N*596-*N*598).

ment almost submerged though separate from resilium. *Plio.-Rec.*, S.Pac.——Fig. E92,*5*. **M. (C.) tristis* Reeve, Rec., N.Z.; LV ext., ×0.7 (Reeve, 1854).

M. (Electomactra) Iredale, 1930 [**M. parkesiana* Hedley, 1902; OD] [=*Electromactra*, spelling error]. Small, short, hinge wide and heavy for size of shell. *Rec.*, S.Pac.——Fig. E92,*7*. **M. (E.) parkesiana* Hedley, Australia; *7a,b*, RV ext., int., ×1.5; *7c*, LV hinge, ×5 (Hedley, 1902).

M. (Eomactra) Cossmann in Cossmann & Peyrot, 1909 [**M. basteroti* Mayer, 1853; OD]. Small, triangular, smooth except for concentric ribs on lunule and escutcheon; resilifer small, not projecting beyond margin of hinge plate. *Eoc.-Plio.*, Eu.——Fig. E92,*2*. **M. (E.) basteroti* Mayer, Mio., France; *2a,b*, RV int., ext., ×1 *(164)*.

M. (Longimactra) Finlay, 1928 [**M. elongata* Quoy & Gaimard, 1835; OD]. Long, concentric ribs stronger at ends; sinus deep, muscle scars large. *Rec.*, S.Pac.——Fig. E92,*9*. **M. (L.) elongata* Quoy & Gaimard, N.Z.; LV ext., ×0.5 (Reeve, 1854).

M. (Mactrinula) Gray, 1853 [**M. plicaria* (=**Mactra plicataria* Linné, 1767); M] [=*Mactrella* Gray, 1853 (type, *M. striatula* Linné, 1767; M); *Papyrina* Mörch, 1853 (obj.; SD Keen, herein)]. Valves concentrically plicate, inequilateral, posterior slope set off by ridge; resilifer large and narrow, hinge teeth not concentrated, cardinal in LV reinforced by apophysis, with accessory lamella in front. *L.Mio.-Rec.*, Pac. ——Fig. E92,*4*. **M. (M.) plicataria* Linné, Rec., E.Indies; *4a*, LV ext., ×0.5 (Reeve, 1854); *4b,c*, LV and RV hinges, ×2 *(510)*.

M. (Mactroderma) Dall, 1894 [**M. velata* Philippi, 1848; OD]. Anterior end shorter than posterior; pallial sinus large and round. *Rec.*, N. Am.-S.Am.——Fig. E92,*8*. **M. (M.) velata* Philippi, W.C.Am.; *8a*, LV ext., ×0.3 (Reeve, 1854); *8b,c*, LV and RV hinges, ×1 *(510)*.

M. (Mactrona) Marwick, 1952 [*pro Mactrula* Marwick, 1948 (*non* Risso, 1826)] [**M. (Mactrula) mula* Marwick, 1948; OD]. Exteriorly like *M. (Mactra)* but with sunken ligament and large cardinal of *M. (Cyclomactra)*; pallial sinus small, rounded. *Plio.*, S.Pac.——Fig. E92,*3*. **M. (M.) mula* Marwick, N.Z.; *3a,b*, LV ext., int., ×0.4 (Marwick, 1948).

M. (Mactrotoma) Dall, 1894 [**M. fragilis* Gmelin, 1791; OD]. With thin, silky periostracum, posterior area set off by angular ridge over which periostracum is wrinkled; ligament long, resilifer large, shallow. *Rec.*, circumtrop.——Fig. E93,*11*. **M. (M.) fragilis* Gmelin, Carib.; *11a*, LV ext., ×0.5 (Reeve, 1854); *11b,c*, LV and RV hinges, ×2 *(510)*.

M. (Maorimactra) Finlay, 1928 [**M. ordinaria* E. A. Smith, 1898; OD]. Small, outline *Corbula*-like, posterior end longer. *Rec.*, S.Pac.——Fig. E93,*4*. **M. (M.) ordinaria* Smith, N.Z.; LV ext., ×2 (Smith, 1898).

M. (Micromactra) Dall, 1894 [**M. californica* Conrad, 1837; M]. Shell small, solid, beaks and umbones with undulating concentric ribs; hinge as in *M. (Mactrotoma)*. *Rec.*, W.N.Am.-C.Am. ——Fig. E93,*3*. **M. (M.) californica* Conrad, Panama; LV ext., ×1 (Reeve, 1854).

M. (Nannomactra) Iredale, 1930 [**M. jacksonensis* E. A. Smith, 1885; OD]. Thin, glassy, concentrically striate, trigonal; hinge narrow, delicate; pallial sinus shallow. *Rec.*, S.Pac.——Fig. E93,*6*. **M. (N.) jacksonensis* Smith, Australia, *6a,b*, RV int., dorsal, ×1.5 *(852)*.

M. (Sarmatimactra) Korobkov, 1954 [**M. vitaliana* d'Orbigny, 1845; OD]. Subtrigonal, umbones wide; hinge fairly massive; lamina between ligament and resilifer toothlike; pallial sinus short, rounded, pallial line deeply incised, vertically striate. *Mio.*, E.Eu.

M. (Simomactra) Dall, 1894 [**M. dolabriformis* Conrad, 1837; M]. Outline flattened cuneiform, inequilateral; pallial sinus smaller than in *M. (Mactrotoma)*, siphonal gape small. *Rec.*, W.N.Am.-C.Am.——Fig. E93,*7*. **M. (S.) dolabriformis* Conrad, USA(Calif.); *7a*, LV ext., ×0.3 (Dall, 1894); *7b,c*, RV and LV hinges, ×1 *(510)*.

M. (Stiphromactra) Böhm, 1929 [**M. (S.) welwitschi*; OD]. Hinge wide but teeth very small. *Eoc.*, W.Afr.——Fig. E93,*10*. **M. (S.) welwitschi*, Angola; *10a-c*, RV ext., LV and RV hinges, ×0.5 (Böhm, 1929).

M. (Tumbeziconcha) Pilsbry & Olsson, 1935 [**M. thracioides* Adams & Reeve, 1848; OD]. Resembling *M. (Mactrinula)* as to sculpture but lacking posterior ridge; concentric ribs intersected by oblique striae on posterior slope. *Rec.*, W.C.Am.——Fig. E93,*2*. **M. (T.) thracioides* Adams & Reeve, Peru; LV ext., ×1 (Pilsbry & Olsson, 1935).

Aliomactra Stephenson, 1952 [1953] [**A. compressa*; OD]. More compressed than *Mactra*; ligament short, external, with internal part on surface sloping down and forward from nymph; pallial sinus rounded, moderate, not confluent. *U.Cret.*, N.Am.——Fig. E93,*9*. **A. compressa*, USA(Tex.); *9a*, RV ext., ×1; *9b,c*, RV and LV hinges, ×1.5 (Stephenson, 1953).

Cymbophora Gabb, 1869 [**Mactra ashburnerii* Gabb, 1864; OD] [=*Veleda* Conrad, 1870 (*non* Blackwall, 1859) (type, *V. lintea*=*Cardium lintea* Conrad, 1860, *non* Conrad, 1855=*Cymbophora intoxicata* Hanna, 1924)]. Trigonal, resilifer narrow and shallow, bordered by accessory lamella; lateral teeth strong, close to beaks. *U.Cret.*, E.N.Am.-W.N.Am.-Eu.——Fig. E93,*8*. **C. ash-*

burnerii (GABB), USA(Calif.); LV hinge, ×1 *(748)*.

Diaphoromactra IREDALE, 1930 [**Hemimactra versicolor* TATE, 1887; OD]. Small, solid, oblique, anterior end short, posterior with umbonal ridge; lateral teeth partially or entirely wanting in LV; pallial sinus broad and shallow. *Rec.*, S.Pac.—— FIG. E93,*1*. **D. versicolor* (TATE), Rec., Australia;

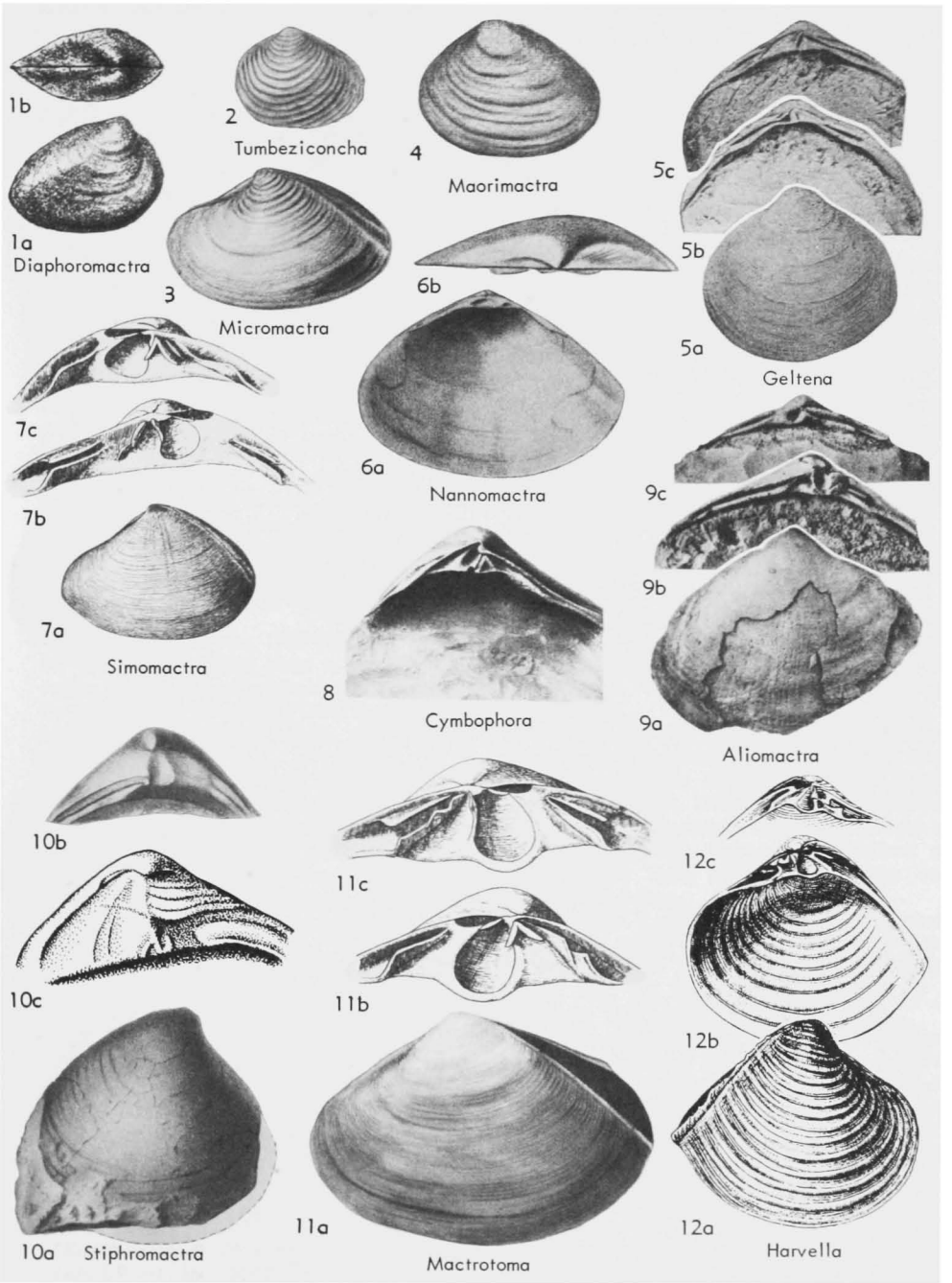


FIG. E93. Mactridae (Mactrinae) (p. *N598-N601*).

1a,b, RV ext., both valves dorsal, ×1.5 (Tate, 1887).

Geltena STEPHENSON in VOKES, 1946 [**G. subequilatera*; OD]. Subcircular to broadly subovate; resilifer very small; nymph plate heavy; hinge plate with deep groves above laterals. *U.Cret.*, Eu.-N.Am.-W.Asia.——FIG. E93,*5*. **G. subequilatera*, USA(Tex.); *5a,* LV ext., ×1; *5b,c,* ×1, LV and RV hinges, ×1.3 (Stephenson in Vokes, 1946).

Harvella GRAY, 1853 [**Mactra elegans* SOWERBY,

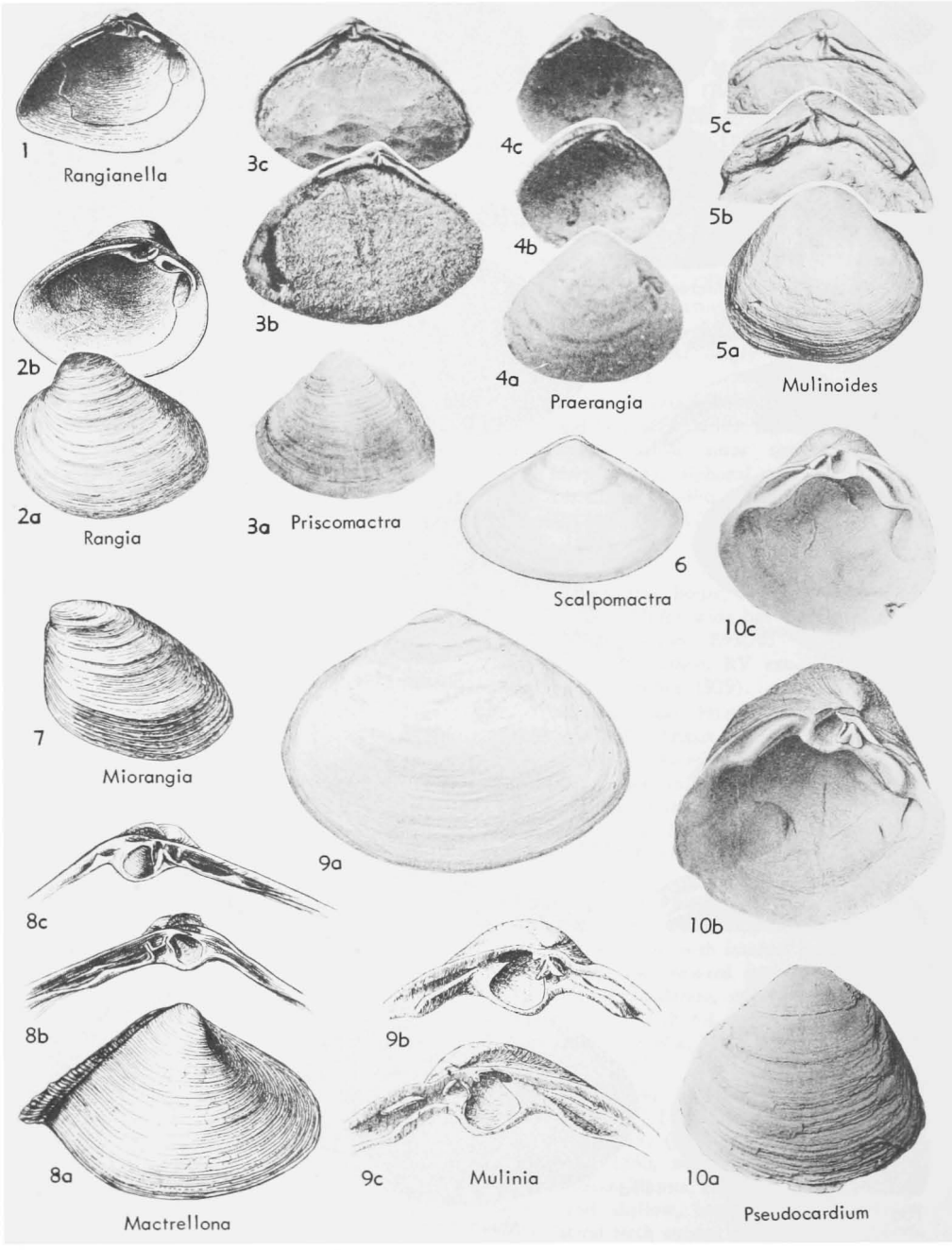


FIG. E94. Mactridae (Mactrinae) (p. *N601*).

1825; M]. Resembling *Mactrellona* but with spaced concentric undulations in front of keel; anterior lateral teeth short. *Rec.*, W.C.Am.——Fig. E93,*12*. **H. elegans* (Sowerby); *12a-c*, RV ext., int., LV hinge, ×1 (H. Adams & A. Adams, 1856).

Mactrellona Marks, 1951 [**Mactra alata* Spengler, 1802; OD] [=*Mactrella* auctt. (*non* Gray, 1853)]. Trigonal, inequilateral, thin, inflated, posterior slope set off by keel, umbones prominent; hinge concentrated, anterior laterals short. *Mio.-Rec.*, E.C.Am.-W.C.Am.——Fig. E94,*8*. **M. alata* (Spengler), Rec., Carib.; *8a*, RV ext., ×0.5; *8b,c*, RV and LV hinges, ×1 (H. Adams & A. Adams, 1856).

Mulinia Gray, 1837 [**M. typica* (=*Mactra edulis* King & Broderip, 1832); T]. Outline as in *Mactra* but ligament entirely internal, not separated from resilium by shelly ridge; shell not gaping; pallial sinus short, small. Estuarine. *Rec.*, W.C.Am.-E.C.Am.-S.Am.-E.Afr.——Fig. E94,*9*. **M. edulis* (King & Broderip), S.Am.; *9a*, LV ext., ×1 (Carcelles, 1950); *9b,c*, RV and LV hinges, ×2 *(510)*.

Mulinoides Olsson, 1944 [**M. chilca*; OD]. Resembling *Cymbophora* but shell more solid, rounded, lateral teeth stronger, less lamellar, resilifer more mactroid in form; posterior dorsal area well marked, set off by ridge; lunule present. *U.Cret.*, W.S.Am.——Fig. E94,*5*. **M. chilca; 5a*, RV ext., Peru; ×0.5; *5b,c*, LV and RV hinges, ×1 (Olsson, 1944).

Priscomactra Stephenson, 1952 [1953] [**P. cymba*; OD]. Ligament and hinge as in *Geltena* but outline subtrigonal and mactroid. *U. Cret.*, N.Am.——Fig. E94,*3*. **P. cymba*, USA(Tex.); *3a*, LV ext., ×1; *3b,c*, LV and RV hinges, ×1.3 (Stephenson, 1953).

Pseudocardium Gabb, 1866 [**Cardium gabbii* Rémond, 1863 (=*Mulinia densata* Conrad, 1857); M]. Shell solid, rounded-trigonal; hinge with long substriate or pitted laterals; pallial sinus short, rounded. *Oligo.-Rec.*, W.N.Am.-E.Asia.——Fig. E94,*10*. **P. densatum* (Conrad), Plio., USA (Calif.); *10a-c*, LV ext., int., RV int., ×0.5 (Packard, 1916).

Rangia Des Moulins, 1832 [**R. cyrenoides* (=*Gnathodon cuneatus* Sowerby, 1831); M] [=*Gnathodon* Sowerby, 1831 (*non* Goldfuss, 1820); *Colombia* Rang, 1834 *(nom.nud.)*; *Perissodon* Conrad, 1863 (type, *Mactra clathrodonta* Conrad, 1833; SD Dall, 1894)]. Shell somewhat resembling *Mulinia* but with lateral teeth elongate, curved, cross-striate, posterior pair longer; pallial sinus small. [Estuarine.] *?Paleoc.,-Mio.-Rec.*, N.-Am.-S.Am.-Eu.

R. (Rangia). Anterior lateral teeth hooked. *Mio.-Rec.*, E.N.Am.-W.N.Am.-S.Am.——Fig. E94,*2*. **R. (R.) cuneata* (Sowerby), Rec., USA(La.); *2a,b*, LV ext., int., ×0.5 (Dall, 1894).

R. (Miorangia) Dall, 1894 [**Gnathodon johnsoni* Dall, 1892; OD]. Small, extremely inequilateral, with cardinals reversed, superior pair in LV; pallial sinus obsolete. *Mio.*, E.N.Am.——Fig. E94,*7*. **R. (M.) johnsoni* (Dall), USA(Miss.); LV ext., ×1.5 (Dall, 1894).

R. (Rangianella) Conrad, 1868 [**Gnathodon trigonum* Petit, 1853 (=*Mactra mendica* Gould, 1851); M]. Small, nearly equilateral, lateral teeth short, straight, subequal, faintly rugose; pallial sinus inconspicuous or obsolete. Estuarine to marine. *Rec.*, W.C.Am.-N.Am.——Fig. E94,*1*. **R. (R.) mendica* (Gould), W.C.Am.; LV int., ×1 (Dall, 1894).

R. (?Praerangia) Cossmann, 1908 [**P. minuscula*; OD]. Resembling *Rangia* in form but much smaller, with shallower sinus. *Paleoc.(Mont.)*, Eu.——Fig. E94,*4*. **R. (?P.) minuscula* (Cossmann), Belg.; *4a-c*, RV ext., LV int., RV int., ×7 (Cossmann, 1908).

Scalpomactra Finlay in Marwick, 1928 [**Mactra scalpellum* Reeve, 1854; OD]. Resembling *Spisula* but lateral teeth not striate; resilium stout, oblique, triangular below, produced above as long spike curved to front, with minute ligament attached at top and united nearly its full length. *Plio.-Rec.*, S.Pac.——Fig. E94,*6*. **S. scalpellum* (Reeve), Rec., N.Z.; LV ext., ×1 (Powell, 1957).

Scissodesma Gray, 1837 [**Mactra spengleri* Linné, 1767; SD Gray, 1847] [=*Schizodesma* Gray, 1838 *(nom.van.)*]. Ligament only partially external, in deep slit, no lamina separating it from resilium. *Rec.*, Pac.——Fig. E95,*8*. **S. spengleri* (Linné), E.Indies; *8a-c*, RV ext., int., LV hinge, ×1 (H. Adams & A. Adams, 1856); *8d-e*, LV, RV hinges *(510)*.

Spisula Gray, 1837 [*"*Mactra solida* Montagu" (=**Cardium solidum* Linné, 1758); SD Gray, 1847] [=*Spisulina* Fischer, 1887 (type, *Mactra truncata* Montagu, 1808; M)]. Trigonal to ovate, not gaping, concentrically striate; lunule and escutcheon delimited; ligament and resilium not separated by shelly lamella; pallial sinus oval. *Tert.-Rec.*, cosmop.

S. (Spisula). Lanule and escutcheon concentrically grooved; lateral teeth striate. *Rec.*, Atl.——Fig. E95,*4*. **S. (S.) solida* (Linné), Eng.; *4a-c*, RV int., ext., LV hinge, ×1 (H. Adams & A. Adams, 1856).

S. (Crassula) Marwick, 1948 [**Mactra aequilateralis* Deshayes, July 1854 (=**M. aequilatera* Reeve, May 1854); OD]. Posterior area bounded by sharp ridge, sculpture only on anterior end, not wavy. *Rec.*, S.Pac.——Fig. E95,*5*. * *S. (C.) aequilatera* (Reeve), N.Z.; LV ext., ×0.5 (Reeve, 1854).

S. (Crepispisula) Eames, 1957 [**S. (C.) amekiensis*; OD]. Near *Scissodesma* in outline but with concentric sculpture, posterior carina less marked, ligament slit smaller, lateral teeth not crenulate; lunule and escutcheon sulcate. *Eoc.*, W.Afr.——

FIG. E95,7. **S. (C.) amekiensis*, Nigeria; *7a,b*, RV int., LV int., ×2 (Eames, 1957).

S. (Hemimactra) SWAINSON, 1840 [**Mactra gigantea* LAMARCK, 1818 (=*M. solidissima* DILLWYN, 1817); M]. Large, ovate-trigonal, with dorsal areas not sulcate; anterior arm of cardinal in RV confluent with ventral lamina, cardinals markedly compressed; laterals striate. *Tert.-Rec.*, E.N.Am.-Atl.——FIG. E95,2. **S. (H.) solidissima* (DILLWYN), Rec., USA(Mass.); *2a*, LV ext.,

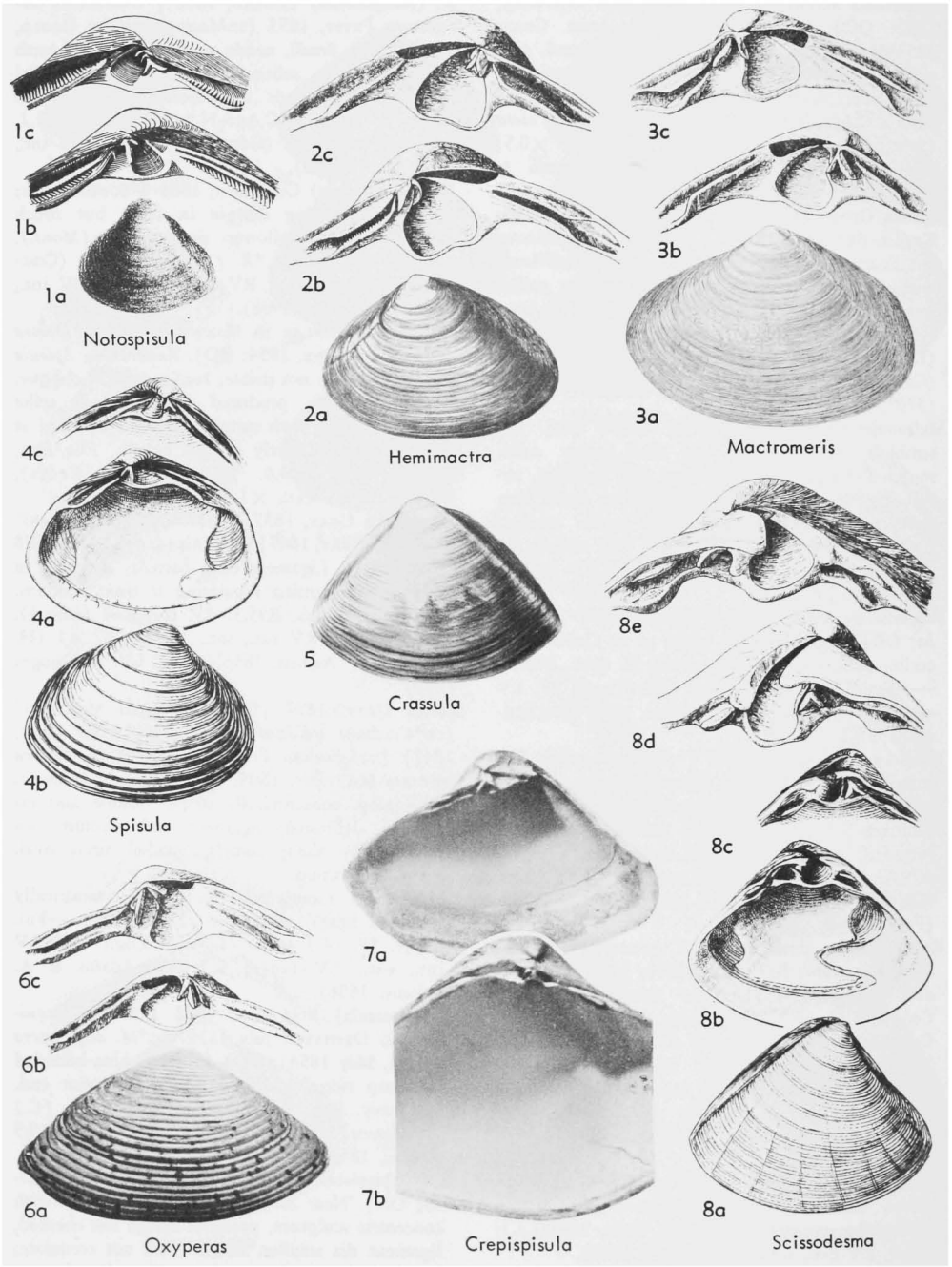


FIG. E95. Mactridae (Mactrinae) (p. *N601-N603*).

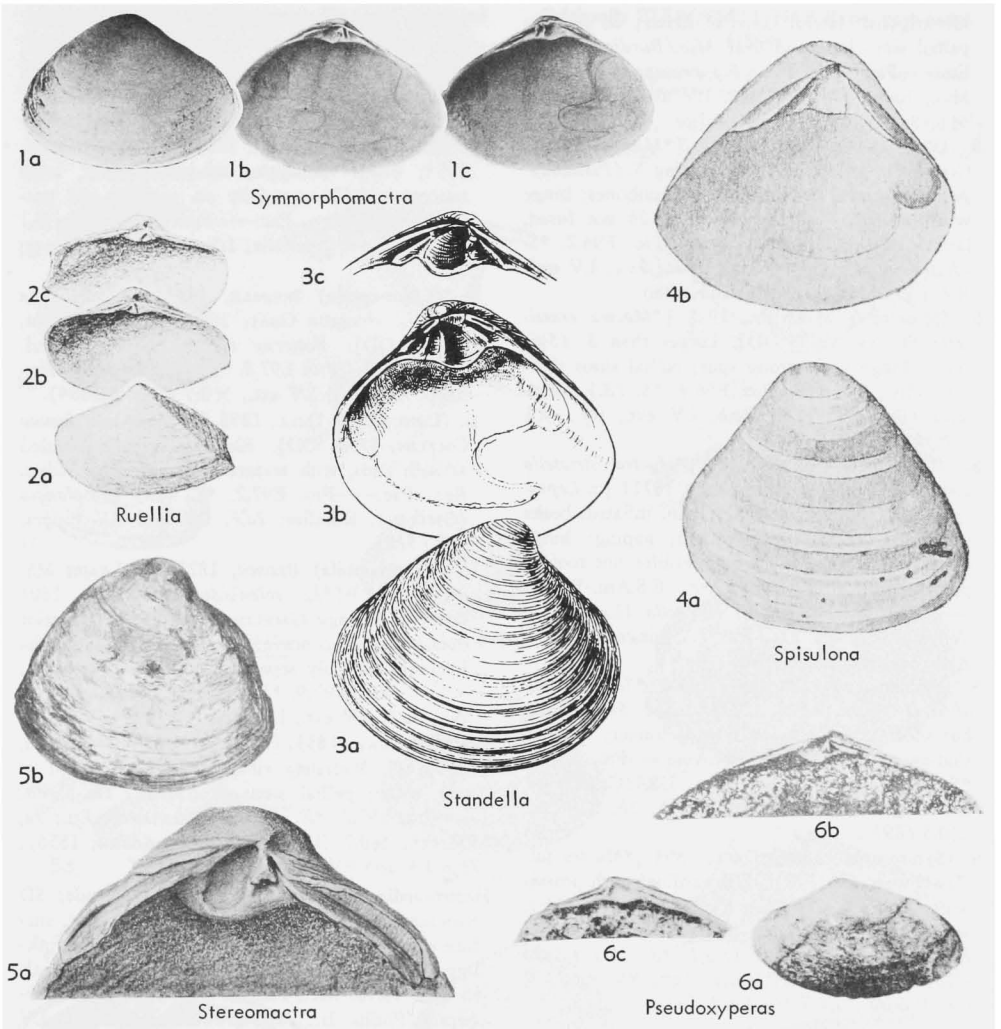


FIG. E96. Mactridae (Mactrinae) (p. *N*603-*N*604).

×0.3 (Gould-Binney, 1870); *2b,c,* RV and LV hinges *(510)*.

S. (Mactromeris) CONRAD, 1868 [**Mactra ovalis* GOULD, 1840 (*non* SOWERBY, 1817) (=**M. polynyma* STIMPSON, 1860); SD STOLICZKA, 1871] [=*Mactrodesma* CONRAD, 1869 (type, *M. ponderosa* CONRAD, 1830 [*non* EICHWALD, 1830] =*M. subponderosa* D'ORBIGNY, 1852; M)]. With fibrous periostracum; lateral teeth smooth, cardinals not compressed, anterior arm of *3a* not confluent with ventral lamina. *Mio.-Rec.,* W.N.Am.-Japan-N.Atl.——FIG. E95,*3*. **S. (M.) polynyma* (STIMPSON), Rec., N.Atl.; *3a,* LV ext., ×0.5 *(217)*; *3b,c,* LV and RV hinges, ×1 *(510)*.

S. (Notospisula) IREDALE, 1930 [**Gnathodon parvum* PETIT, 1853; OD]. Small, thick, trigonal, tumid, rounded anteriorly, pointed posteriorly; lateral teeth ridged; pallial sinus small to obsolete. *Rec.,* S.Pac.——FIG. E95,*1*. **S. (N.) parva* (PETIT), Australia; *1a,* LV ext., ×1 (Petit, 1853); *1b,c,* RV and LV hinges, ×3 *(397)*.

S. (Oxyperas) MÖRCH, 1853 [*"*Mactra triangularis* LAMARCK, 1818" (*non* MONTAGU, 1803) (=**M. lentiginosa* GOULD, 1852); M]. Triangular, with well-marked concentric folds; pallial sinus deep. *Rec.,* Pac.——FIG. E95,*6*. **S. (O.) lentiginosa* (GOULD), ?E.Indies; *6a,* RV ext., ×0.7 *(510)*; *6b,c,* LV and RV hinges, ×2 *(510)*.

S. (Pseudoxyperas) SACCO, 1901 [**P. proaspersa;* OD]. Differing from *S. (Oxyperas)* by being

less trigonal; lateral lamellae striate; *4a* present; pallial sinus long and oval. *Mio.(Burdigal.)-Rec.*, Eu.——Fig. E96,*6*. **S. (P.) proaspersa* (Sacco), Mio., Italy; *6a-c*, LV ext., LV and RV hinges, ×1 (Sacco, 1901).

S. (Ruellia) Cossmann, 1914 [**Mactra bernayi* Cossmann, 1886; OD]. Resembling *S. (Pseudoxyperas)* but with lower beaks and umbones; hinge with *4a*, as in *S. (Oxyperas)*, *2a-2b* not fused, laterals not striate. *Eoc.*, Eu.——Fig. E96,*2*. **S. (R.) bernayi* (Cossmann), France; *2a-c*, LV ext., RV, LV int., ×1.3 (Cossmann, 1886).

S. (Spisulona) Marwick, 1948 [**Mactra crassitesta* Finlay, 1927; OD]. Larger than *S. (Spisula)*; hinge with strong spur; pallial sinus shallow. *Plio.*, S.Pac.——Fig. E96,*4*. **S. (S.) crassitesta* (Finlay), N.Z.; *4a,b*, LV ext., int., ×1 (Hutton, 1893).

S. (Standella) Gray, 1853 [**Mactra striatella* Lamarck, 1818; SD Stoliczka, 1871] [=*Leptospisula* Dall, 1895 (obj.)]. Thin, inflated, beaks undulated, dorsal areas smooth; gaping; hinge concentrated, laterals smooth, resilifer not roofed; pallial sinus large, deep. *Rec.*, E.S.Am.-W.Afr.——Fig. E96,*3*. **S. (S.) striatella* (Lamarck), W.Afr.; *3a-c*, RV ext., int., LV hinge, ×1 (H. Adams & A. Adams, 1856).

S. (Stereomactra) Stewart, 1930 [**Schizodesma abscissa* Gabb, 1866; OD]. Like *Scissodesma* but shell larger, heavier, laterals longer; resilium shallow. *U.Mio.-Plio.*, W.N.Am.——Fig. E96,*5*. **S. (S.) abscissa* (Gabb), Mio., USA(Calif.); *5a*, LV hinge, ×0.5 (Packard, 1916); *5b*, RV ext., ×0.3 *(892)*.

S. (Symmorphomactra) Dall, 1894 [**Mactra falcata* Gould, 1851; M]. With cardinal teeth prominent, thin, posterior arm overhanging resilifer, accessory teeth present, hinge plate flat. *Mio.-Rec.*, W.N.Am.——Fig. E96,*1*. **S. (S.) falcata* (Gould), Rec., USA(Calif.); *1a-c*, RV ext., LV int., RV int., ×0.7 (Packard, 1916).

Subfamily LUTRARIINAE Adams & Adams, 1856

Inequilateral, shell widely gaping; hinge somewhat irregular, concentrated, laterals tending to be obsolete; resilifer broadly open. Siphons of animal not retractile within shell, covered to tips with rough epidermis. *Mio.-Rec.*

Lutraria Lamarck, 1799 [**Mya lutraria* Linné, 1758; T] [=*Cacophonia* Gistel, 1848 *(nom. van., pro Lutraria)*; *Eustylon* Gistel, 1848 *(nom. van., pro Cacophonia)*; *Lutaria* Mayer, 1875 *(nom. null.)*]. Elongate, thin, gaping at each end; ligament short; no lunule or escutcheon. *Mio.-Rec.*, cosmop.

L. (Lutraria). Outline elliptical; hinge with *2a-2b* heavy, prominent. *Mio.-Rec.*, Eu.-IndoPac.——Fig. E97,*5*. **L. (L.) lutraria* (Linné), Rec., Medit., *5a-c*, RV ext., int., LV hinge, ×1 (H. Adams & A. Adams, 1856); *5d-e*, LV and RV hinges, ×2 *(510)*.

L. (Goniomactra) Mayer, 1867 [**L. impar* Reeve, 1854; OD]. Elongate, subquadrangular, with concentric folds, especially on anterior and posterior slopes. *Rec.*, Pac.——Fig. E97,*6*. **L. (G.) impar* Reeve, Australia; LV ext., ×0.5 (Reeve, 1854).

L. (Lutromactra) Iredale, 1929 [**L. impedita* (*pro L. elongata* Gray, 1837) (*non* Münster, 1835); OD]. Posterior end somewhat pointed. *Rec.*, Pac.——Fig. E97,*8*. **L. (L.) impedita* Iredale, Australia; LV ext., ×0.5 (Reeve, 1854).

L. (Lutrophora) Dall, 1895 [**Mactra complanata* Gmelin, 1791; OD]. Elongate, evenly rounded at both ends, with texture and surface of *Raeta*. *Rec.*, Pac.——Fig. E97,*2*. **L. (L.) complanata* (Gmelin), E.Indies; *2a,b*, LV and RV hinges, ×2 *(510)*.

L. (Psammophila) Brown, 1827 (*ex* Leach MS, *in synon.*) [**L. solenoides* Lamarck, 1801 (=*Mya oblonga* Gmelin, 1791); M]. Posterior dorsal margin concave; hinge with *2a-2b* weak; ligament partially separated from resilium. *Rec.*, Atl.——Fig. E97,*9*. **L. (P.) oblonga* (Gmelin), Eu.; *9a,b*, RV ext., LV int., ×1 *(124)*.

Eastonia Gray, 1853 [**Mactra rugosa* Helbling, 1779; M]. Radiately ribbed or striate except at ends, ovate; pallial sinus deep. *Rec.*, Eu.-Medit.——Fig. E97,*7*. **E. rugosa* (Helbling), Eu.; *7a*, RV ext., ×0.7 (H. Adams & A. Adams, 1856); *7b,c*, LV and RV hinges, ×1 *(510)*.

Heterocardia Deshayes, 1855 [**H. gibbosula*; SD Stoliczka, 1871]. Short, dorsal slope arched, surface concentrically striate, with vermiculate wrinkling; ligament as in *Mactra*; posterior laterals in each valve. *Rec.*, Pac.——Fig. E97,*1*. **H. gibbosula*, Philip. Is.; *1a-c*, LV int., RV hinge, LV ext., ×1 (H. Adams & A. Adams, 1856).

Meropesta Iredale, 1929 [**M. meridiana*; OD] [=*Merope* H. & A. Adams, 1856 (*non* Newman, 1838) (type, *Mactra nicobarica* Gmelin, 1791; SD Stoliczka, 1871); *Standella* auctt. (*non* Gray, 1853)]. Resembling *Eastonia* but thinner, ovate, with radiating sculpture; hinge deep; pallial sinus broadly rounded, long, reaching mid-line of shell. *Rec.*, IndoPac.——Fig. E97,*4*. **M. nicobarica meridiana*, Australia; LV ext., ×0.5 (Allan, 1950).

Tresus Gray, 1853 (Jan.) [**Lutraria maxima* Middendorff, 1849 (*non* Jonas, 1844) (=*L. nuttalli* Conrad, 1837); M] [not preoccupied by *"Trésus"* Walckenaer, 1833, vernacular and *nom. nud.*; =*Cryptodon* Conrad, 1837 (*non* Turton, 1822; obj.); *Schizothaerus* Conrad, 1853 (Feb.; obj.; M)]. Large, ovate, ventricose, gaping posteriorly;

hinge teeth small, resilifer large; ligament separated from resilium by shelly plate. *U.Mio.-Rec.*, W.N.Am.-E.Asia.——Fig. E97,*3*. **T. nuttalli* (Conrad), Rec., USA(Calif.); *3a*, RV ext., ×0.2 (Stanford Univ. specimen); *3b,c*, LV and RV hinges, ×1 *(510)*.

Subfamily PTEROPSELLINAE Keen, new name (1894)

[*nom. subst.* Keen, herein (*pro* Pteropsinae Dall, 1894, based on junior homonym)]

Shell thin, valves subequilateral, nearly closed; hinge feeble, concentrated, laterals

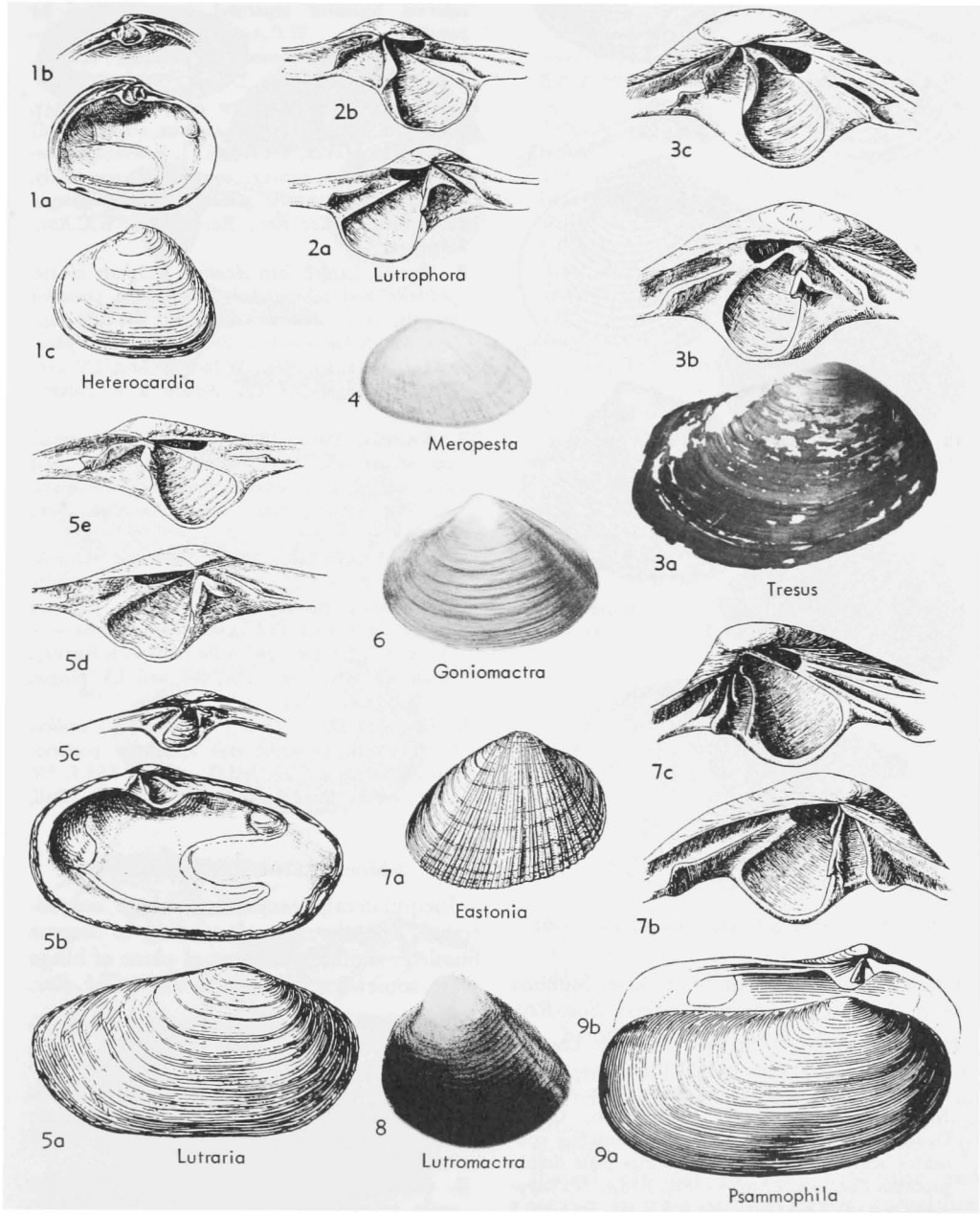


Fig. E97. Mactridae (Lutrariinae) (p. *N*604-*N*605).

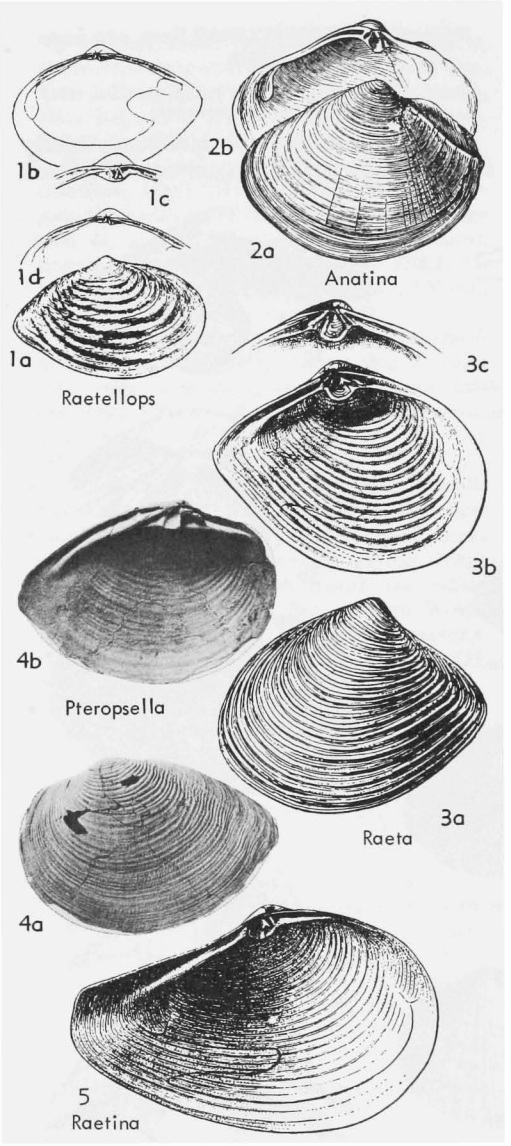


FIG. E98. Mactridae (Pteropsellinae) (p. *N606*).

much reduced or partially obsolete. Siphons of animal wholly retractile, naked. *Eoc.-Rec.*

Pteropsella VOKES, 1956 [*pro Pteropsis* CONRAD, 1860 (*non* RAFINESQUE, 1814)] [**Lutraria papyria* CONRAD, 1833; OD] [=*Kymatox* STENZEL & KRAUSE, 1957 (type, *K. praelapidosus*; OD)]. Ovate, posteriorly attenuate; with undulating concentric sculpture; resilifer ovate; hinge plate deeply grooved. *Eoc.*, SE.N.Am.——FIG. E98,*4*. **P. papyria* (CONRAD), USA(Ala.); *4a,b*, LV ext., int., ×0.5 (Stenzel & Krause, 1957).

Anatina SCHUMACHER, 1817 [**A. pellucida* (=**Mactra anatina* SPENGLER, 1802); M] [=*Labiosa* MÖLLER, 1832 (*ex* SCHMIDT MS) (*nom. van. pro Anatina*); *Cypricia* GRAY, 1847 (obj.); *Leucoparia* MAYER, 1867 (*nom. van. pro Cypricia*)]. Thin, ovate, anterior end rounded, posterior end gaping, set off by ridge; lunule and escutcheon evident; external ligament separated from resilium by lamella. *Rec.*, W.C.Am.-E.N.Am.-E.S.Am.——FIG. E98,*2*. **A. anatina* (SPENGLER), E.S.Am. (?Brazil); *2a,b*, RV ext., LV int., ×0.7 *(836)*.

Raeta GRAY, 1853 [**Mactra campechensis* GRAY, 1825 (=**L. plicatella* LAMARCK, 1818); M] [=*Lovellia* MAYER, 1867 (obj.)]. Resembling *Anatina*, but more convex, compressed posteriorly, sculpture of concentric plications; dorsal margin not reflected. *Eoc.-Rec.*, Eu.-E.N.Am.-W.C.Am.-S.Am.

R. (Raeta). Larger than *Anatina*, sculpture coarse, posterior end subrounded; hinge with posterior laterals, as in *Anatina*. *Eoc.-Rec.*, Eu.-E.N.Am.-W.C.Am.-S.Am.——FIG. E98,*3*. **R. (R.) plicatella* (LAMARCK), Rec., W.Indies; *3a-c*, LV ext., int., RV hinge, ×1 (H. Adams & A. Adams, 1856).

R. (Raetella) DALL, 1898 [**Labiosa (R.) tenuis* (*ex* ADAMS MS); OD]. Small, thin, dorsal areas well defined, shell inflated; hinge with no lateral lamellae; pallial sinus short, rounded. *Rec.*, E.Asia.

R. (Raetellops) HABE, 1952 [**Poromya pulchella* ADAMS & REEVE, 1850; OD]. Shell small, sculpture coarse; posterior end rostrate; posterior lateral teeth well developed. *Rec.*, E.Asia.——FIG. E98,*1*. **R. (R.) pulchella* (ADAMS & REEVE), Japan; *1a-d*, RV ext., int., RV and LV hinges, ×1.5 (Habe, 1952).

R. (Raetina) DALL, 1898 [**Labiosa (R.) indica*; OD]. Small, posterior end attenuate; posterior laterals wanting. *Rec.*, Ind.O.——FIG. E98,*5*. **R. (R.) indica* (DALL), India; LV int., ×1 (Dall, 1925).

Subfamily ZENATIINAE Dall, 1895

Inequilateral, compressed; hinge concentrated, irregular, laterals tending to become obsolete; resiliifer bent out of plane of hinge plate, somewhat adherent to valve. *Eoc.-Rec.*

Zenatia GRAY, 1853 [**Lutraria zelandica* GRAY, 1837 (=**L. acinaces* QUOY & GAIMARD, 1835); M] [=*Metabola* MAYER, 1867 *(nom. van., pro Zenatia)*]. Quadrate, periostracum conspicuous; ends gaping, beaks nearer anterior end; valves reinforced by radial buttress below hinge; pallial sinus very deep. *Mio.-Rec.*, S.Pac.

Z. (Zenatia). Moderately elongate, not conspicuously narrow. *Rec.*, S.Pac.——FIG. E99,*5*. **Z. (Z.) acinaces* (QUOY & GAIMARD), N.Z.; *5a*, RV

ext., ×1 *(124b); 5b,c,* LV and RV hinges, ×2 *(510).*

Z. (Zenatiopsis) TATE, 1879 [**Zenatiopsis angustata;* M]. Outline narrower than *Z. (Zenatia). Mio.-Rec.,* S.Pac.——FIG. E99,*3*. **Z. (Z.) angustata* (TATE), Mio., Australia; *3a,b,* RV ext., LV int., ×1 (Tate, 1879).

Z. (Zenatraria) BEU, 1966 [**Z. (Z.) vellai;* OD]. *Pleist.,* N.Z.

Darcinia CLARK & DURHAM, 1946 [**D. colombiana*; OD]. With posterior umbonal ridge as in *Darina*; sculpture and posterior gape as in *Eastonia*; hinge plate with deeply excavated resilifer, heavy cardinals, well-developed anterior laterals and nearly obsolete posterior laterals. *Eoc.,* W.S.Am.——FIG. E99,*2*. **D. colombiana,* Colombia; *2a,* RV ext., ×1; *2b,* RV hinge, ×1.5 (Clark & Durham, 1946).

Darina GRAY, 1853 [**Erycina solenoides* KING, 1832; M]. Elongate, thin, with periostracum; beaks back of mid-line; both ends gaping; ligament short, deep, resilifer large, resting on ray-like buttress; hinge teeth weak; pallial sinus deep. *Rec.,* W.S.Am.——FIG. E99,*1*. **D. solenoides* (KING), *1a,* LV ext., ×1 (H. Adams & A. Adams, 1856); *1b,c,* LV and RV hinges, ×2 *(510).*

Resania GRAY, 1853 (Jan.) [**R. lanceolata*; M] [=*Vanganella* GRAY, 1853 (Apr.) (type, *V. taylorii,* =*R. lanceolata*; M); *Laminaria, Myomactra* MAYER, 1867 *(nom. van. pro Vanganella, Resania)*]. Elongate, anterior end longer, smooth, gaping; ligament not set off by shelly ridge, resilifer large, oblique, resting on thickened radial rib; second rib behind anterior adductor scar; pallial sinus short, broad. *Rec.,* S. Pac.——FIG. E99,*4*. **R. lanceolata,* N.Z.; *4a,b,* RV ext., LV int., ×1 *(124b).*

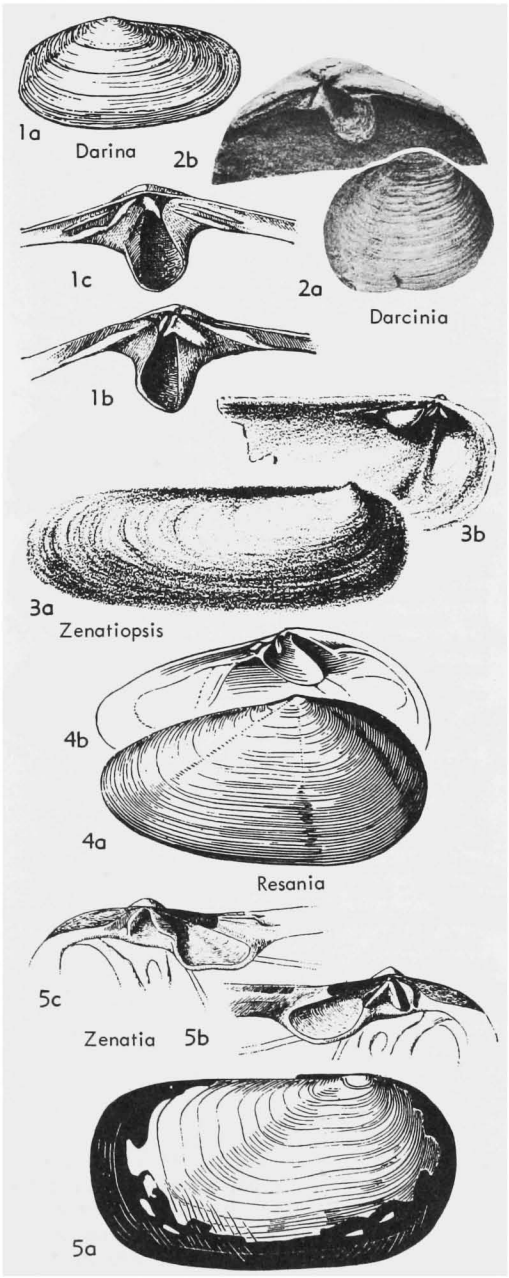


FIG. E99. Mactridae (Zenatiinae) (p. *N606-N607*).

Family ANATINELLIDAE Gray, 1853

[*nom. correct.* THIELE, 1934 (*pro* Anatinelladae GRAY, 1853)]

Shell inflated, gaping; hinge with prominent narrow resiliifer, narrow cardinal and accessory lamella in each valve; laterals wanting; pallial line without sinus *(510). Rec.*

Anatinella SOWERBY, 1833 [**A. sibbaldii* (=*Mya nicobarica* GMELIN, 1791); M]. Thin, sculpture of concentric striae and fine radial lines; ligament short, separated from resilium by shelly plate. *Rec.,* IndoPac.——FIG. E100,*2*. **A. nicobarica* (GMELIN), Japan; *2a,b,* RV ext., int., ×1 (Kuroda, 1951).

Family CARDILIIDAE Fischer, 1887

Equivalve, higher than long, beaks inturned, subspiral; external ligament on strong nymph, resilium in large, oblique resilifer; hinge with strong inverted V-shaped cardinal in LV, triangular and weaker lamellar cardinal in RV; pallial line entire *(510). ?Eoc., Oligo.-Rec.*

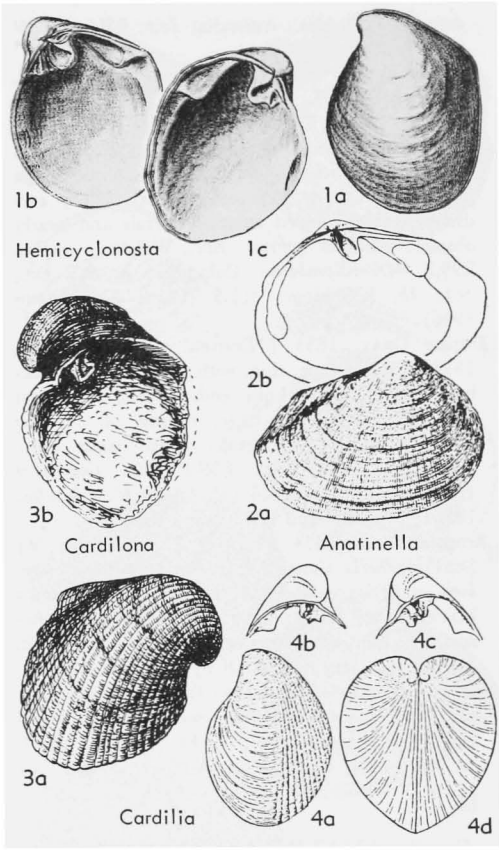


FIG. E100. Anatinellidae *(2)*; Cardiliidae *(1-,3-4)* (p. *N607-N608*).

Cardilia DESHAYES, 1835 [**Isocardia semisulcata* LAMARCK, 1819; SD HERRMANNSEN, 1846] [=*Leptina* PICTET, 1855 (*non* MEIGEN, 1830; obj.)]. Sculpture of radial ribs over at least part of shell; cardinal teeth on buttress below resilifer; one lateral present in RV; posterior muscle scar on myophore or flange projecting from dorsal margin of shell. *L.Mio.-Rec.*, IndoPac.——FIG. E100,*4*. **C. semisulcata* (LAMARCK), Rec., Japan; *4a-d*, LV ext., LV and RV hinges, both valves ant., ×1.3 (Kuroda, 1951).

Cardilona MARWICK, 1943 [**C. bensoni*; OD]. Like *Cardilia* in form and sculpture, with strong resilifer, but lacking hinge plate, cardinal teeth, and posterior myophore. *Oligo.*, S.Pac.——FIG. E100,*3*. **C. bensoni*, N.Z.; *3a,b*, RV ext., int., ×0.8 (Marwick, 1943).

?Hemicyclonosta MICHELIN, 1828 [**H. michelini* "DESHAYES" (=*Hemicyclodonta* DESHAYES, 1850, *ex* MS); M] [=*Hemicyclostera* BRONN, 1838, *Hemicycloster* PAETEL, 1875 *(nom. null.)*, spelling errors] [The evidence for valid publication by MICHELIN is inconclusive, although accepted by his contemporaries; should the work be rejected, the generic name may revert to synonymy with *Cardilia*]. Resembling *Cardilia* but without radial sculpture. *Eoc.-Plio.*, Eu.——FIG. E100,*1*. **H. michelini*, Eoc., France, *1a-c*, LV ext., RV int., LV int., ×1.3 *(259)*.

Family MESODESMATIDAE Gray, 1839

[*nom. correct.* DALL, 1895 (*pro* Mesodesmidae GRAY, 1839)] [=Paphiinae H. ADAMS & A. ADAMS, 1856)]

Shells cuneiform, more or less compressed, disproportionately heavy. Siphons retractile, naked, nearly or completely separated *(507, 510)*. *Eoc.-Rec.*

Subfamily MESODESMATINAE Gray, 1840

[*nom. transl. et correct.* DALL, 1895 (*ex* Mesodesmidae GRAY, 1840)]

Texture porcelaneous, periostracum conspicuous; ligament small or obsolete, resilium narrow, oblique; hinge in Eocene forms with cardinal lamella in RV, weak or obsolescent in Recent forms but long narrow cardinal in LV becoming stronger, crossing apex of resilifer. *Eoc.-Rec.*

Mesodesma DESHAYES, 1832 [**Mactra donacia* LAMARCK, 1818; SD ANTON, 1839] [="*Amphidesma* LAM." AUCTT. (*non* LAMARCK); *Ceronia* GRAY, 1853 (type, *Erycina denticulata* GRAY, 1825,=*Mactra deaurata* TURTON, 1822; M)]. Donaciform, posterior end short; hinge strong, ligament short, internal, resilifer with raised margins; pallial sinus well marked. *Rec.*, N.Am.-S.Am.-Pac.

M. (Mesodesma). Posterior end obliquely truncate; resilifer broad; lateral teeth striate. *Rec.*, Eu.-E.N.Am.-W.S.Am.-Pac.——FIG. E101,*13*. **M. (M.) donacium* (LAMARCK), Chile; *13a,b*, LV ext., RV int., ×1 *(124b)*.

M. (Amesodesma) IREDALE, 1930 [**A. perfuga*; OD]. Posterior end somewhat quadrate; resilifer narrow. *Rec.*, S.Pac.——FIG. E101,*2*. **M. (A.) perfuga* (IREDALE), Australia; RV int., ×1 (Iredale, 1930).

Atactodea DALL, 1895 [*pro Paphia* LAMARCK, 1799 (*non* RÖDING, 1798)] [**Mactra glabrata* GMELIN, 1791; OD]. Subtrigonal, strong, smooth or concentrically sculptured; hinge strong, ligament submarginal; resilium narrow; pallial sinus short. *Rec.*, IndoPac.——FIG. E101,*4*. **A. glabrata* (GMELIN), E.Indies; *4a-c*, RV int., LV hinge, RV ext., ×1 (H. Adams & A. Adams, 1856).

?Ceroniola WILCKENS, 1904 [**Cultellus australis* GABB, 1860; M]. Resembling *Mesodesma* in form; shell gaping at each end; ligamental pit not well developed; hinge with 2 laterals but cardinal area not clear. *U.Tert.*, S.Am.——FIG. E101,*8*. **C. australis* (GABB), Chile; *8a-c*, LV ext., int., RV int., ×1 (Wilckens, 1904).

Donacilla PHILIPPI, 1836 (*ex* LAMARCK, vernacular) [**D. lamarckii* (=*Amphidesma donacilla* LAMARCK, 1818) (=*Mactra cornea* POLI, 1795); M] [="*Donacilla* DE BLAINVILLE, 1819," AUCTT., proposed in synonymy]. Ligament marginal, obsolete; laterals not sulcate, anterior lateral long,

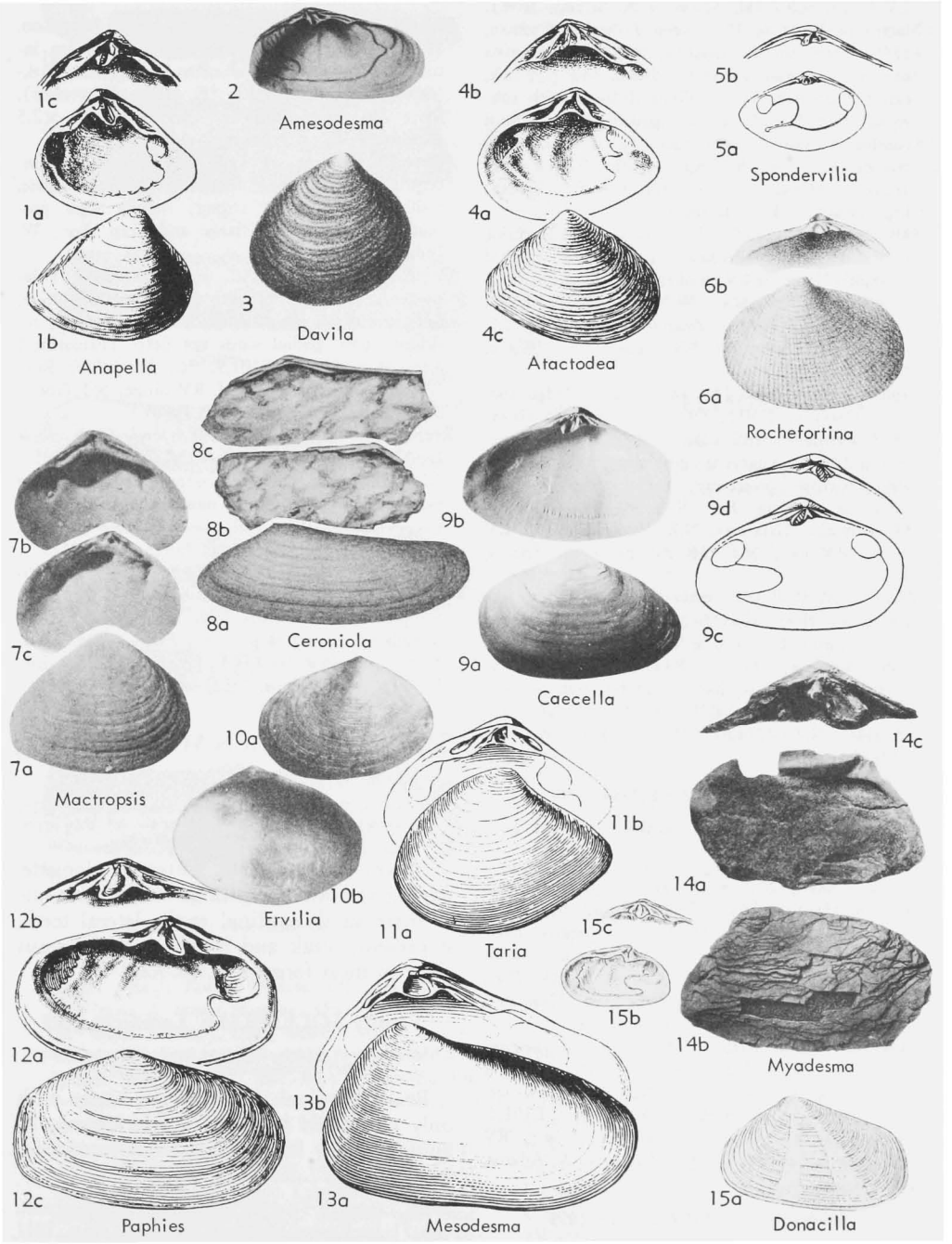


FIG. E101. Mesodesmatidae (Mesodesmatinae) *(2,4,7-8,11-14)*, (Davilinae) *(1,3)*, (Erviliinae) *(5-6,9-10)* (p. *N*608-*N*610).

posterior short; margin of resilial pit toothlike. *Rec.*, Eu.-S.Pac.——FIG. E101,*15*. **D. cornea* (POLI), Eu.; *15a*, RV ext., ×1.3; *15b,c*, RV int., LV hinge, ×0.7 (H. Adams & A. Adams, 1856).

Mactropsis CONRAD, 1854 [*pro Triquetra* CONRAD, 1846 (*non* DE BLAINVILLE, 1828)] [**Erycina aequorea* CONRAD, 1833; SD DALL, 1895]. Thick, cardinal plate heavy, cardinals distinct, with subequal arms, laterals striate; ligament and resilium combined, near dorsal border; pallial sinus small but distinct. *Eoc.*, E.N.Am.——FIG. E101,*7*. **M. aequorea* (CONRAD), USA(Ala.); *7a-c*, RV ext., int., LV int., ×1.5 (Harris, 1919).

?Myadesma CLARK, 1922 [**M. dalli;* OD]. Posterior end short, beaks opisthogyrate; resilifers directed anteriorly, large in LV, sunken in RV; pallial sinus small, broad. *Eoc.-Mio.*, W.N.Am.——FIG. E101, *14*. **M. dalli*, Oligo., Vancouver Is.; *14a,b*, LV int., ext., ×0.5; *14c*, RV hinge, ×1 (Clark, 1922).

Paphies LESSON, 1830 [**P. roissyana* (=**Mya australis* GMELIN, 1791); OD] [=*Machaena* GRAY, 1843, *ex* LEACH MS (obj.); M]. Ovate-elongate, subequilateral; ligament internal, small, resilifer long, narrow, projecting; pallial sinus angular, small, or wanting. *Rec.*, S.Pac.——FIG. E101,*12*. **P. australis* (GMELIN), N.Z.; *12a-c*, RV int., LV hinge, RV ext., ×1 (H. Adams & A. Adams, 1856).

Taria GRAY, 1853 [**T. stokesii* (=*Mesodesma lata* DESHAYES, 1843) (?=*M. quoyi* DESHAYES, 1832); M] [=*Taria* H. ADAMS & A. ADAMS, 1856, AUCTT. (obj., KOBELT, 1881)]. Resembling *M. (Mesodesma)* but more equilateral, lateral teeth smooth. *Rec.*, S.Pac.——FIG. E101,*11*. **T. quoyi* (DESHAYES), N.Z.; *11a,b*, LV ext., RV int., ×1 *(124b)*.

Subfamily DAVILINAE Dall, 1895

Outline somewhat rounded; pallial line without sinus. *Rec.*

Davila GRAY, 1853 [**D. polita* (=*Mesodesma planum* HANLEY, 1843); M]. Smooth, compressed, periostracum thin; ligament small, nearly marginal, resilium narrow, elongate; cardinal tooth large and prominent in LV, obsolete in RV. *Rec.*, IndoPac.——FIG. E101,*3*. **D. plana* (HANLEY), Philip. Is.; RV ext., ×1 (Reeve, 1854).

Anapella DALL, 1895 [**Mesodesma triquetrum* HANLEY, 1843; OD]. Resembling *Atactodea* in form; hinge with cardinal tooth bifid in RV, laterals smooth. *Rec.*, W.Pac.-S.Pac.——FIG. E101,*1*. **A. triquetra* (HANLEY), S.Australia; *1a-c*, RV int., ext., LV hinge, ×1 (H. Adams & A. Adams, 1856).

Subfamily ERVILIINAE Dall, 1895

Small, thin, equilateral; ligament marginal, subobsolete, resilium small; hinge concentrated, laterals small, one cardinal in either valve, RV larger, LV bifid; pallial sinus distinct. *Pleist.-Rec.*

Ervilia TURTON, 1822 [**Mya nitens* MONTAGU, 1806; M]. Concentrically striate, periostracum inconspicuous; ligament obsolete. *Pleist.-Rec.*, Atl.-Medit.——FIG. E101,*10*. **E. nitens* (MONTAGU), Rec., USA(Fla.); *10a,b*, RV ext., int., ×2.5 (Smith, 1937).

Argyrodonax DALL, 1911 [**A. haycocki*; M]. Concentrically sculptured; external ligament feeble, resilium narrow but strong; muscle scars pronounced; pallial sinus large and deep. *Rec.*, W. Indies.

Caecella GRAY, 1853 [**C. horsfieldii;* OD]. Relatively large, elongate, with fine concentric striae; periostracum thick, brown; ligament obsolete; resilium small; pallial sinus not deep. [Estuarine.] *Rec.*, Pac.——FIG. E101,*9*. **C. horsfieldii; 9a-c*, LV ext., int., int., ×3; *9d*, RV hinge, ×1 (specimens, British Museum, N.H.).

Rochefortina DALL, 1924 [**Rochefortia (R.) semele* (=**Ervilia sandwichensis* E. A. SMITH, 1885); OD]. Sculpture radial and concentric; with minute escutcheon; pallial sinus moderately deep. *Rec.*, Pac.——FIG. E101,*6*. **R. sandwichensis* (SMITH), Hawaiian Is.; *6a,b*, LV ext., hinge, ×8 *(852)*.

Spondervilia IREDALE, 1930 [**Ervilia australis* ANGAS, 1877 (=**E. bisculpta* GOULD, 1861); OD]. Sculpture radial at ends, with fine wavy concentric threads on central slope. *Rec.*, Pac.——FIG. E101, *5*. **S. bisculpta* (GOULD), Japan; *5a,b*, LV int., RV hinge, ×3 (Habe, 1952).

Superfamily SOLENACEA Lamarck, 1809

[*nom. transl.* TRYON, 1884 (*ex* family Solenacea GRAY, 1823) (=solenacées LAMARCK, 1809)] [Materials for this superfamily prepared by MYRA KEEN]

Valves cylindrical to flattened, elongate, gaping at both ends, hinge weak, with one to three small cardinal teeth; lateral teeth, if present, weak and laminar; pallial sinus short in most forms. *L.Cret.-Rec.*

Family SOLENIDAE Lamarck, 1809

[*nom. correct.* LEACH, 1823 (*pro* family Solenacea GRAY, 1823) (=solenacées LAMARCK, 1809)]

Beaks terminal or nearly so; hinge with only one tooth in either valve; siphons of animal fused, foot modified for rapid digging in sand. *L.Eoc.-Rec.*

Solen LINNÉ, 1758 [**S. vagina;* SD SCHUMACHER, 1817] [=*Vagina* MEGERLE VON MÜHLFELD, 1811 (obj., T); *Solenia* OKEN, 1823 *(nom. null.)*; *Listera* GRAY, 1852, *ex* LEACH MS (*non* TURTON,

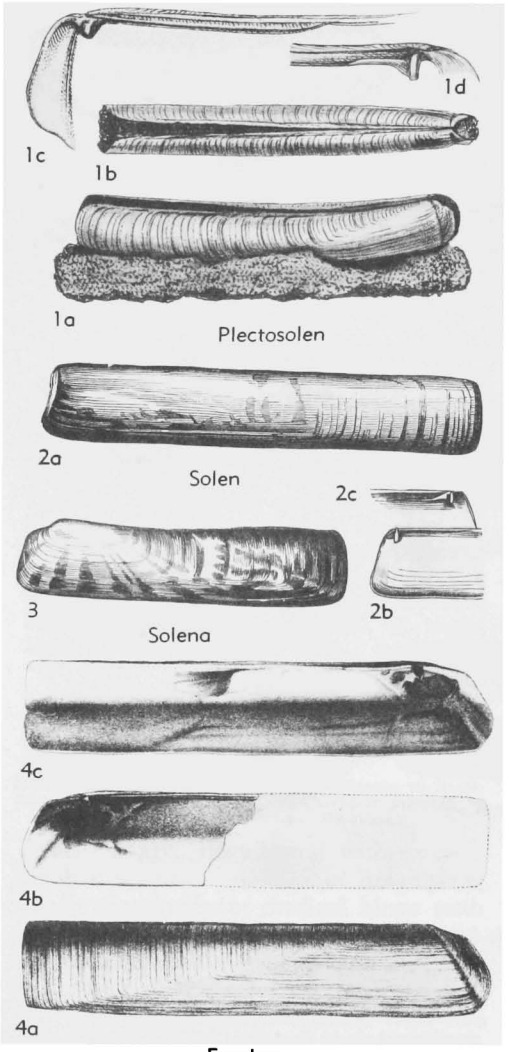


FIG. E102. Solenidae (p. *N*611).

1822) (obj.); *Fistula* MÖRCH, 1853, *ex* MARTINI MS (type, *S. brevis* HANLEY, 1842, *ex* GRAY MS; SD KEEN, herein)]. Long, nearly straight; anterior margin truncate, smooth within; anterior adductor muscle scar elongate. *Eoc.-Rec.,* N.Am.-Eu.-Pac. ——FIG. E102,*2*. **S. vagina,* Rec., Eu.; *2a-c,* LV ext., RV hinge, LV hinge, ×0.4 *(124b)*.

Solena MÖRCH, 1853 [**Solen obliquus* SPENGLER, 1794; SD STOLICZKA, 1871] [=*Hypogella* GRAY, 1854 (type, *S. ambiguus* LAMARCK, 1818, =*S. obliquus;* SD DALL, 1900)]. Anterior end somewhat produced beyond beaks, obliquely truncate; anterior adductor scar short. *Eoc.-Rec.,* Asia-Eu.-Am.

S. (Solena). Anterior margin thickened within, smooth outside. *Oligo.-Rec.,* E.Asia-Eu.-C.Am. ——FIG. 102,*3*. **S. (S.) obliquus* (SPENGLER), Rec., Carib.; LV ext., ×0.5 *(124b)*.

S. (Eosolen) STEWART, 1930 [**Solen plagiaulax* COSSMANN, 1906 (*nom. subst. pro S. obliquus* SOWERBY, 1844, *non* SPENGLER, 1794); OD]. With external oblique groove near anterior end. *Eoc.,* Eu.-N.Am.——FIG. E102,*4*. **S. (E.) plagiaulax* (COSSMANN), M.Eoc., France; *4a-c,* RV ext., RV hinge, LV hinge, ×0.5 (Deshayes, 1860).

S. (Plectosolen) CONRAD, 1866 [**Solen gracilis* SOWERBY, 1844; SD STOLICZKA, 1871]. Dorsal margin slightly curved, anterior end rounded, set off by furrow. *L.Eoc.-M.Eoc.,* Eu.-W.N.Am.—— FIG. E102,*1*. **S. (P.) gracilis* (SOWERBY), Eng.; *1a,b,* LV ext., both valves, dorsal, ×1; *1c,d,* RV, LV hinge, ×2.5 (Sowerby, 1844).

Family CULTELLIDAE Davies, 1935

Valves wider and more compressed than in Solenidae, beaks mostly not terminal; hinge with one to three cardinal teeth. *L. Cret.-Rec.*

Cultellus SCHUMACHER, 1817 [**C. magnus* (=*Solen lacteus* SPENGLER, 1794); M]. Oblong, ends rounded, gaping; hinge with 1 cardinal in RV, 2 in LV, posterior bifid; pallial sinus small. *L.Eoc.-Rec.,* Eu.-Asia-IndoPac.

C. (Cultellus). Large, with rib above rounded anterior adductor scar. *L.Eoc.-Rec.,* Eu.-C.Asia-IndoPac.——FIG. E103,*2*. **C. (C.) lacteus* (SPENGLER), Rec., E.Indies; RV int., ×0.7 (Woodward).

C. (Cultrensis) COEN, 1933 [**C. (C.) adriaticus;* M]. Small and thin, dorsal margin straight, with 2 furrows from beak to ventral margin. *Rec.,* Medit.

Ensis SCHUMACHER, 1817 [**E. magnus* (=*Solen ensis* LINNÉ, 1758); T] [=*Ensatella* SWAINSON, 1840 (obj.)]. Beaks terminal or nearly so, dorsal margin slightly curved; 2 cardinal teeth or cardinal chevrons present; anterior adductor scar elongate. *L.Eoc.-Rec.,* N.Am.-Eu.——FIG. E103,*6*. **E. ensis* (LINNÉ), Rec., Medit.; *6a,b,* LV ext., RV int., ×0.3 *(89a)*.

Leptosolen CONRAD, 1865 [**Siliquaria biplicata* CONRAD, 1858; M] [=*Solenaria* STOLICZKA, 1870 (*?non* RAFINESQUE, 1815) (type, *Leguminaria affinis* EICHWALD, 1867; M)]. Like small *Siliqua* with radial sulcus and strong internal rib; ligament long and narrow. *L.Cret.-U.Cret.,* N.Am.-E.Eu.——FIG. E103,*9*. **L. biplicata* (CONRAD), U.Cret., USA(Ala.); *9a,b,* LV ext., int., ×1 (Wade).

Neosolen GHOSH, 1920 [**N. aquae-dulcioris*; M]. Small, thin, translucent, truncate in front, pos-

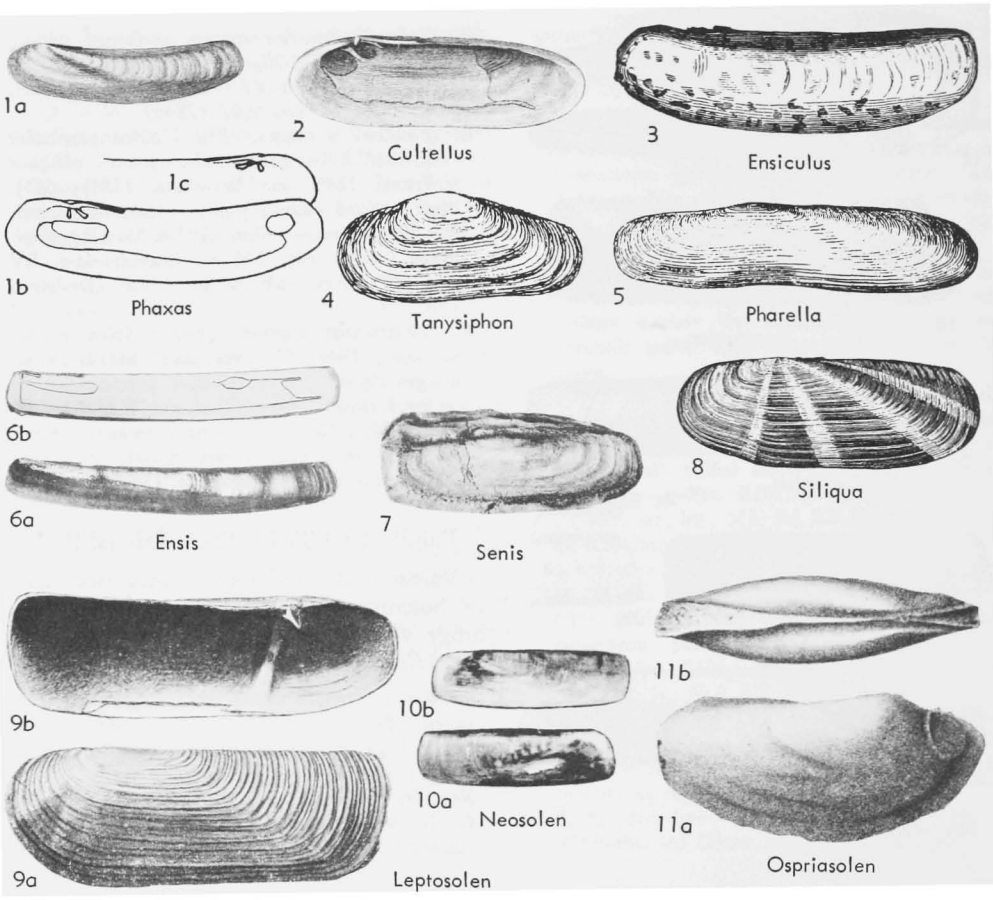


FIG. E103. Cultellidae (p. *N*611-*N*613).

teriorly rounded; RV with 1 small, long tooth; anterior adductor scar long, triangular, posterior small, rounded. *Rec.,* S.Asia. [Estuarine.]——FIG. E103,*10*. **N. aquaedulcioris,* India; *10a,b,* RV ext., int., ×1 (Ghosh).

Ospriasolen CONRAD, 1868 [**Cultellus cretaceus* GABB, 1860; M] [=*Ospirasolen,* spelling error]. Elongate, gaping, pallial line with deep sinus. *U. Cret.,* N.Am.——FIG. E103,*11*. **O. cretaceus* (GABB), USA(N.J.); *11a,b,* RV int. mold, both valves dorsal, ×1 (Weller, 1907).

Pharella GRAY, 1854 [**Solen javanicus* LAMARCK, 1818; SD KOBELT, 1881]. Subcylindrical, rounded at ends, ventral margin contracted, umbones in front of mid-line; anterior adductor scar elongate, subtrigonal; hinge with 2 cardinals in RV, 3 in LV. *Plio.-Rec.,* E.Indies.——FIG. E103,*5*. **P. javanica* (LAMARCK), Rec., Java; LV ext., ×1 (Fischer).

Phaxas GRAY, 1852 (*ex* LEACH MS) [**S. pellucidus* PENNANT, 1777; M] [=*Subcultellus* GHOSH, 1920 (obj.)]. Dorsal margin curved, ends of shell rounded; beaks near anterior end; anterior adductor scar long and triangular, posterior scar small, sinus short. *Eoc.-Rec.,* Asia-Eu.-E.Indies.

P. (Phaxas). Shell small and thin. *Eoc.-Rec.,* E. Asia-Eu.——FIG. E103,*1*. **P. (P.) pellucidus* (PENNANT), Rec., Eng.; *1a,* LV ext., ×1 (Locard); *1b,c,* RV int., LV hinge, ×1.3 (Stanford Univ. specimen).

P. (Ensiculus) H. ADAMS, 1860 [**Solen cultellus* LINNÉ, 1758; OD] [=*Cultellus* AUCTT. (*non* SCHUMACHER)]. Larger and more solid than in *P.(Phaxas). Rec.,* E.Indies.——FIG. E103,*3*. **P. (E.) cultellus* (LINNÉ); LV ext., ×0.5 *(124b)*.

?**Senis** STEPHENSON, 1952 [1953] [**S. elongatus;* OD]. Long-quadrangular, beaks slightly in front of mid-line; ligament external, long, narrow, nymph thin and prominent; hinge smooth, without teeth. *U.Cret.,* N.Am.——FIG. E103,*7*. **S. elongatus,* USA(Tex.); LV ext., ×1.5 *(890)*.

Siliqua MEGERLE VON MÜHLFELD, 1811 [**Solen radiatus* LINNÉ, 1758; M] [=*Aulus* OKEN, 1815,

AUCTT. (in work rejected by ICZN, 1956, Op. 417) (obj.; SD HERRMANNSEN, 1846); *Leguminaria* SCHUMACHER, 1817 (obj.; M); *Solecurtoides* DESMOULINS, 1832 (obj.; SD DALL, 1900); *Machaera* GOULD, 1841 (*non* CUVIER, 1832) (type, *Solen costatus* SAY, 1822; SD DALL, 1900)]. Thin-shelled, moderately large, with internal rib; pallial sinus widely rounded, fairly deep. *Eoc.-Rec.*, N. Am.-Eu.-Pac.-Asia.

S. (Siliqua). Internal rib nearly vertical, from beaks to ventral margin. *Eoc.-Rec.*, N.Am.-Eu.-E.Indies. ——FIG. E103,*8*. **S. (S.) radiata* (LINNÉ), Rec., E.Indies; LV ext., ×0.3 *(124b)*.

S. (Neosiliqua) HABE, 1965 [**Aulus winterianus* DUNKER, 1853; OD]. Internal rib narrow, running diagonally from beaks to anteroventral margin. *Rec.*, W.Pac.

?Tanysiphon BENSON, 1858 [**T. rivalis;* M]. Resembling *Glauconome* in Veneracea, small, thin, long-ovate, with greenish periostracum; beaks in front of mid-line, ligament short; hinge with 3 teeth in either valve, anterior 2 smaller, posterior tooth flattened, resembling a resilifer; pallial sinus large, rounded, extending beyond mid-line. *Rec.*, S.Asia. [Estuarine.]——FIG. E103,*4*. **T. rivalis*, India; LV ext., ×1 (Benson, 1858).

Superfamily TELLINACEA de Blainville, 1814

[*nom. transl.* DALL, 1895 (*ex* family Tellinacées DE BLAINVILLE, 1814)] [Materials for this superfamily prepared by MYRA KEEN except as otherwise indicated]

Shells mostly inequilateral with external ligament or, if sunken, in pit on hinge plate, not in chondrophore; cardinal hinge teeth two in either valve, tending to be bifid, lateral teeth well developed in most families; adductor muscle scars connected by pallial line with distinct sinus. Animal with two elongate siphons that are not fused. *U.Trias.-Rec.*

Family TELLINIDAE de Blainville, 1814

[*nom. correct.* SWAINSON, 1840 (*pro* family Tellinacées DE BLAINVILLE, 1814)]

Somewhat elongate; ligament external; valves more or less unequal, most forms with posterior flexure, especially in RV *(822)*. *L.Cret.-Rec.*

Subfamily TELLININAE de Blainville, 1814

[*nom. transl.* H. ADAMS & A. ADAMS, 1856 (*ex* family Tellinacées DE BLAINVILLE, 1814)]

Lateral teeth present in at least one valve; sculpture various. *L.Cret.-Rec.*

Tellina LINNÉ, 1758 [**T. radiata;* SD CHILDREN, 1823] [=*Musculus* MÖRCH, 1853 (*ex* MARTINI, nonbinom.) (*non* RÖDING, 1798); *Liotellina* FISCHER, 1887 (obj.); *Tellinarius, emend.*]. Characteristics of subfamily. [Most modern attempts to divide *Tellina, s.l.*, into a number of genera, each with several subgenera, abound in inconsistencies. Evolutionary history of the family in different ocean basins seems to have resulted in many parallel forms or homeomorphs, so that subdivision on one set of characters (e.g., shell outline) runs counter to that on another (e.g., hinge details or musculature). A proper review being beyond the scope of the present summary, the expedient of a conservative classification is adopted herein, treating most generic taxa as subgenera of *Tellina.*] *?Cret., Tert.-Rec.*, cosmop.

T. (Tellina). Smooth, polished, hinge with 2 cardinals and 2 laterals in either valve. *Rec.*, E.N.Am. W.Indies.——FIG. E104,*11*. **T. (T.) radiata* LINNÉ, W.Indies; *11a,b*, LV ext., RV hinge, ×0.7 (Chenu).

T. (Abranda) IREDALE, 1924 [**A. rex* (*pro T. elliptica* SOWERBY, 1868) (*non* BROCCHI, 1814); OD]. Small, compressed, elliptical; concentrically ridged behind the angle setting off posterior slope. *Rec.*, Australia.——FIG. E104,*1*. **T. (A.) rex* (IREDALE); LV ext., ×1 (Sowerby in Reeve).

T. (Acorylus) OLSSON & HARBISON, 1953 [**T. suberis* DALL, 1900; OD]. Small, solid, subovate, flexed; hinge stout, RV with 2 cardinals, 2 laterals, LV with 1 cardinal, no laterals; pallial sinus deep, widely confluent with pallial line. *Plio.*, E.N.Am.——FIG. E104,*7*. **T. (A.) suberis* DALL, USA(Fla.); *7a*, RV ext., ×3 (Olsson & Harbison); *7b*, RV int., ×4 (Dall, 1900).

T. (Angulus) MEGERLE VON MÜHLFELD, 1811 [**T. lanceolata* GMELIN, 1791; SD GRAY, 1847]. Of moderate size, elongate, posterior end pointed but not twisted; hinge with *AI* strong, near cardinals, other laterals wanting, cardinals small. *Rec.*, Pac.——FIG. E104,*8*. **T. (A.) lanceolata* GMELIN, E.Indies; *8a*, RV ext., ×1 (Chenu), *8b*, RV hinge, ×2 (Olsson & Harbison).

T. (Arcopagia) BROWN, 1827 (*ex* LEACH MS) [**T. crassa* PENNANT, 1777; SD HERRMANNSEN, 1846] [=*Cydippe* GRAY, 1852 (*ex* LEACH MS) (*non* ESCHSCHOLTZ, 1829) (obj.)]. Rounded, somewhat inflated, concentrically ridged, with 2 laterals in RV; pallial sinus deep, rounded, not confluent. [See also *T. (Sinuosipagia).*] *?Cret., Eoc.-Rec.*, Eu.-N.Afr.——FIG. E104,*6*. **T. (A.) crassa* PENNANT, Rec., Medit.; *6a,b*, LV lat., ×0.5 (Reeve); *6c*, RV int., ×0.5 (Davies).

T. (Arcopaginula) LAMY, 1918 [**T. inflata* GMELIN, 1791; M]. Medium-sized, white, smooth, posterior area set off by rib; inequivalve, LV larger; *AI* and *AII* short, *PI* long, *PII* weak; pallial sinus confluent. *Rec.*, W.Pac.——FIG.

E104,*12*. **T. (A.) inflata* GMELIN, Japan; *12a,b*, RV ext., int., ×1 (Habe).

T. (Arcopella) THIELE, 1934 [**T. balaustina* LINNÉ, 1758; M]. Near *T. (Arcopagia)* but smaller, posterior end shorter; lateral teeth weak in LV. *Rec.*, Eu.——FIG. E104,*5*. **T. (A.) balaustina* LINNÉ, France; *5a-c*, RV ext., int., LV int., ×1 *(89a)*.

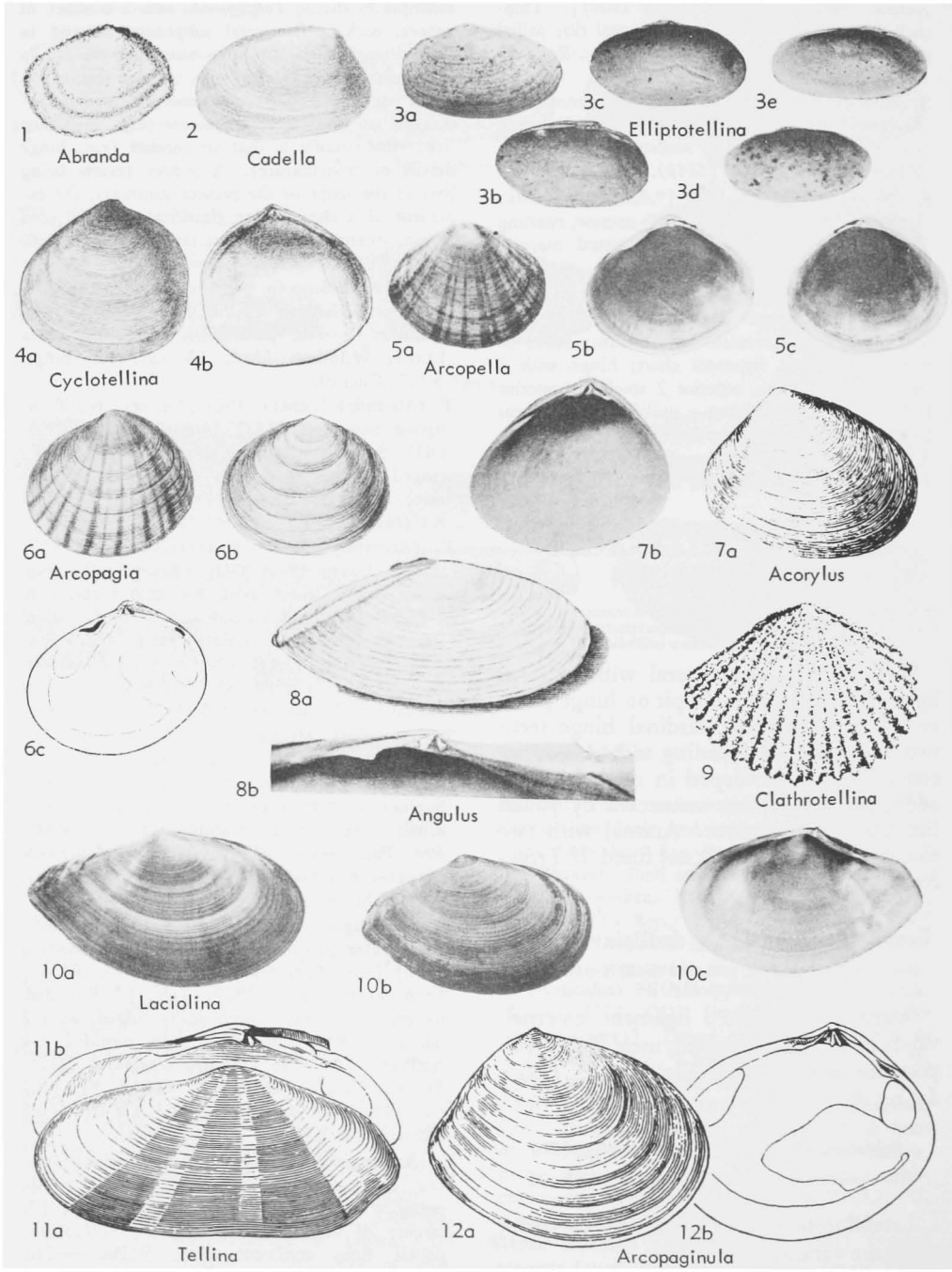


FIG. E104. Tellinidae (Tellininae) (p. *N613-N615*).

T. (Cadella) DALL, BARTSCH, & REHDER, 1939 [**T. lechriogramma* MELVILLE, 1893; OD]. Small, resembling *T. (Semelangulus)* in outline and sculpture but with normal ligament; also resembling *T. (Moerella)* but with smaller pallial sinus. *Rec.,* Indo-Pac.——FIG. E104,*2*, **T. (C.) lechriogramma* MELVILLE, India; LV ext., ×1.5 (Melville).

T. (Clathrotellina) THIELE, 1934 [**T. pretiosa* DESHAYES, 1855 (*non* EICHWALD, 1830)=*T. pretium* SALISBURY, 1934; M]. Small, with cancellate sculpture, otherwise resembling *T. (Merisca). Rec.,* IndoPac.——FIG. E104,*9*. *T. (C.) pretium* SALISBURY, E.Indies; RV ext., ×2 (Reeve).

T. (Cyclotellina) COSSMANN, 1887 [**Donax lunulata* LAMARCK, 1805; OD]. Shape as in *T. (Arcopagia)* but with posterior lateral in LV; pallial sinus smaller, partly confluent, angular, joined to adductor by linear scar. *Eoc.-Rec.,* Eu.-Carib.-IndoPac.——FIG. E104,*4*. **T. (C.) lunulata* (LAMARCK), Eoc., France; *4a,b,* RV ext., int., ×1 (Deshayes).

T. (Elliptotellina) COSSMANN, 1887 [**Donax tellinella* LAMARCK, 1805; OD]. Near *T. (Tellinella)* but smaller, with lateral teeth weak or wanting in LV. *L.Eoc.-M.Eoc.,* Eu.——FIG. E104,*3*. **T. (E.) tellinella* (LAMARCK), France; *3a-e,* RV ext., int., LV ext., int., RV int., ×2 (Cossmann).

T. (Elpidollina) OLSSON, 1961 [**T. decumbens* CARPENTER, 1865; OD]. Thin, subtrigonal, somewhat inflated, cardinal teeth small, laterals large in RV, pallial sinus large and deep. *Rec.,* W.C. Am.——FIG. E105,*11*. **T. (E.) decumbens* CARPENTER, Panama; *11a,b,* LV ext., RV int., ×0.7 (Reeve; Olsson).

T. (Eurytellina) FISCHER, 1887 [**T. punicea* BORN, 1790; M]. Medium-sized, elongate, posterior end not rostrate; sculpture concentric; hinge with *4b* small, laterals in LV not as strong as in RV, anterior laterals close to cardinals, posterior distant; pallial sinus confluent with pallial line, approaching or touching anterior adductor. *Mio.-Rec.,* E.N.Am.-W.N.Am.-S.Am.——FIG. E105,*1*. **T. (E.) punicea* BORN, Rec., W.Indies; *1a-c,* LV ext., RV and LV hinges, ×1 (Chenu).

T. (Fabulina) GRAY, 1851 [**T. fabula* GMELIN, 1791; SD WINCKWORTH, 1932] [=*Tellinula* MÖRCH, 1853 (*ex* CHEMNITZ) (obj.)]. Ovate, with oblique sculpture on RV except at ends; hinge with only 1 lateral, *AI,* near cardinals. [See also *T. (Scissula).*] *Mio.-Rec.,* Eu.——FIG. 105,*7*. **T. (F.) fabula* GMELIN, Rec., Medit.; *7a,b,* LV ext., RV ext., ×1 (Reeve).

T. (Finlayella) LAWS, 1933 [**F. sinuaris*; OD]. Small, pallial sinus asymmetrically developed, deeper in LV than in RV. *Mio.-Plio.,* S.Pac.——FIG. E105,*8*. **T. (F.) sinuaris* (LAWS), Mio., N.Z.; *8a-c,* RV ext., LV int., RV int., ×2 (Laws).

T. (Gastranopsis) COSSMANN, 1906 [**G. bureaui;* OD]. Resembling *Gastrana* but with lateral teeth in RV. *Eoc.,* Eu.——FIG. E105,*2*. **T. (G.) bureaui* (COSSMANN), France; *2a-d,* RV ext., LV int., LV ext., RV int., ×3 (Cossmann).

T. (Hemimetis) THIELE, 1934 [**T. plicata* VALENCIENNES, 1827; M]. Thin, somewhat lenticular, resembling *Apolymetis* but with lateral teeth and a lunule in RV; sculpture of concentric lamellae; ligament narrow; pallial sinus not confluent. *Rec.,* IndoPac.——FIG. E105,*5*. **T. (H.) plicata* VALENCIENNES, Japan; *5a,b,* LV ext., RV int., ×0.5 (Habe).

T. (Hertellina) OLSSON, 1961 [**T. nicoyana* HERTLEIN & STRONG, 1949; OD]. Outline as in *Sanguinolaria* but hinge and oblique sculpture as in *T. (Scissula). Rec.,* W.C.Am.——FIG. E105, *3*. **T. (H.) nicoyana* HERTLEIN & STRONG, W. Costa Rica; *3a-c,* RV ext., LV and RV hinges, ×1 (Hertlein & Strong).

T. (Homalina) STOLICZKA, 1870 [**T. triangularis* "Chemnitz" DILLWYN, 1817 (*non* GMELIN, 1791) (=*T. trilatera* GMELIN, 1791); OD]. Thin, trigonal, posterior end slightly longer; hinge weak, anterior lateral teeth short, close to cardinals, posterior laterals at end of ligament; pallial sinus deep, confluent. [See also *T. (Macomona).*] *Rec.,* E.Indies.——FIG. E105,*9*. **T. (H.) trilatera* GMELIN, E.Indies; *9a,b,* LV ext., RV ext., ×1 (Reeve, 1867).

T. (Iraqitellina) DANCE & EAMES, 1966 [**I. iraqensis;* OD]. *Rec.,* Persian Gulf.

?T. (Jactellina). [*See Exotica (Jactellina),* subfamily Macominae.]

T. (Laciolina) IREDALE, 1937 [**T. quoyi* SOWERBY in REEVE, 1868; OD] [=*Bosempra* BROWN, 1844, *ex* LEACH MS (invalidly proposed in synonymy of *Tellina depressa* GMELIN, 1791)]. Large, oblique, smooth, posterior end shorter; ligament long, somewhat sunken. *Rec.,* Pac.O.-W.Atl.-Eu.-N.Am.——FIG. E104,*10*. *T. (L.) incarnata* LINNÉ, France; *10a,b,* RV ext., ×1; *10c,* RV int., ×1 *(89a).*——FIG. E105,*4*. **T. (L.) quoyi* SOWERBY, N.Australia; RV ext., ×0.7 (Reeve, 1868).——FIG. E106,*15*. *T. (L.) ochracea* (CARPENTER), W.Mexico; *15a,* RV ext., ×0.5; *15b,* LV hinge, enl. (Hertlein & Strong, 1940-51).

?T. (Loxoglypta) DALL, BARTSCH, & REHDER, 1939 [*See Exotica (Loxoglypta),* subfamily Macominae.]

T. (Lyratellina) OLSSON, 1961 [**T. lyra* HANLEY, 1844; OD]. Elliptical, posterior end unflexed; escutcheon deep and narrow, below valve margin. *Mio.-Rec.,* NW.S.Am.-W.C.Am.——FIG. E105, *10*. **T. (L.) lyra* HANLEY, Rec., Panama; *10a,* LV ext., ×0.7; *10b,c,* LV hinge, RV hinge, ×2 (Olsson, 1961).

T. (Macaliopsis) COSSMANN, 1887 [**T. barrandei* DESHAYES, 1857; SD DALL, 1900]. Rounded-trapezoidal, posterior end truncate, sculpture of spaced concentric ridges; cardinals and laterals

strong, remote; pallial sinus narrow, only slightly confluent. *Paleoc.-Mio.*, Eu.-E.C.Am.—— Fig. E107,*6*. **T. (M.) barrandei* Deshayes, Eoc., France; *6a,b*, LV ext., RV int., ×1 (Deshayes).

T. (Macomona) Finlay, 1927 [**T. liliana* Iredale, 1915; OD]. Resembling *T. (Homalina)* but larger, compressed, posterior end twisted and somewhat pointed; RV with 2 cardinals and 2 laterals, posterior weak; pallial sinus deep, confluent, reaching to anterior muscle scar. *Tert.-*

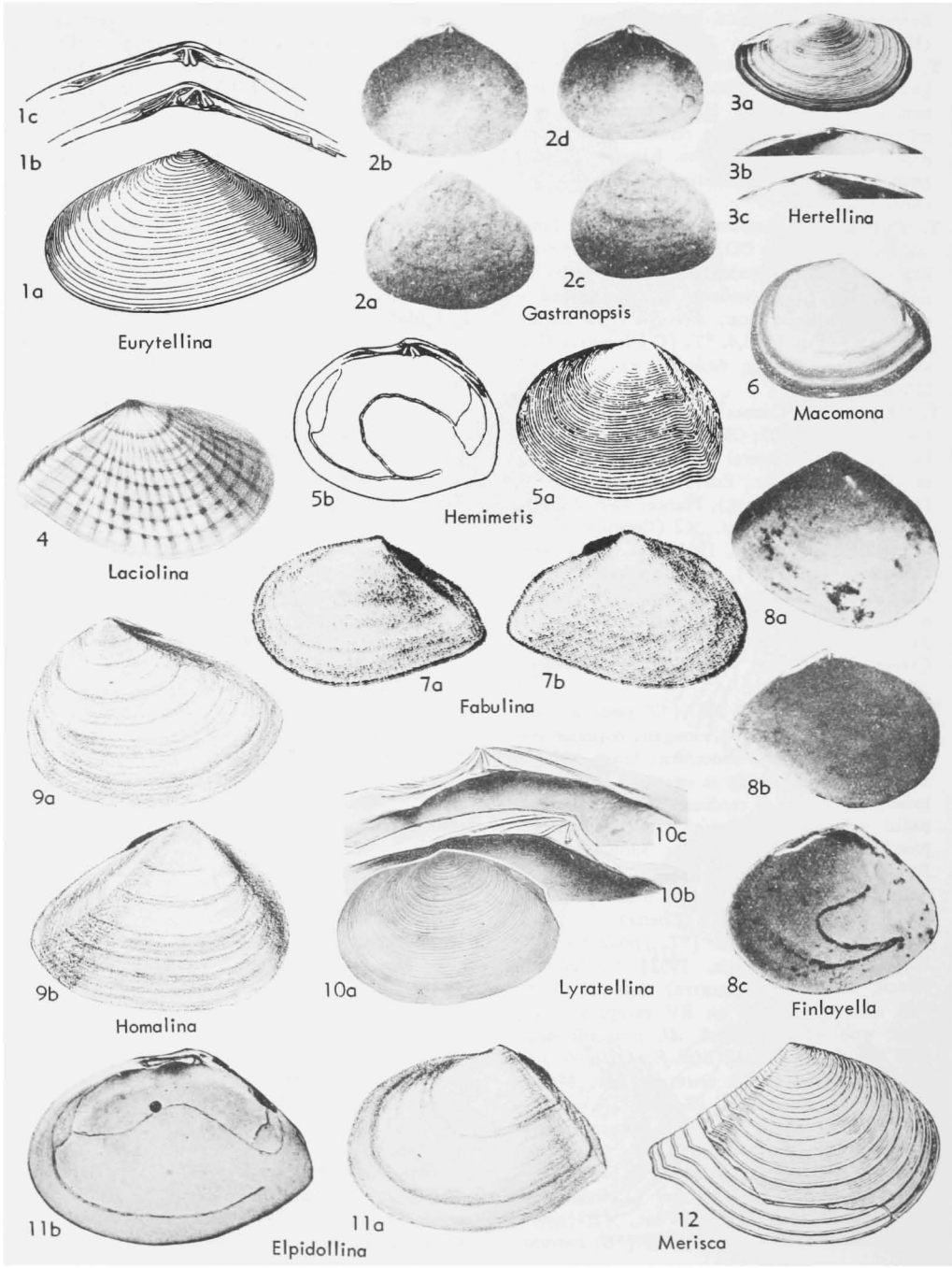


Fig. E105. Tellinidae (Tellininae) (p. *N615-N618*).

Rec., Australia.——FIG. E105,6. **T. (M.) liliana* IREDALE, Rec., N.Z.; LV ext., ×0.3 (Powell).

T. (Merisca) DALL, 1900 [**T. crystallina* WOOD, 1815=*T. cristallina* SPENGLER, 1798; OD]. Small to moderate-sized, posterior end rostrate, with basal margin emarginate in front of rostrum; sculpture of distant thin concentric lamellae; hinge without laterals in LV; pallial sinus

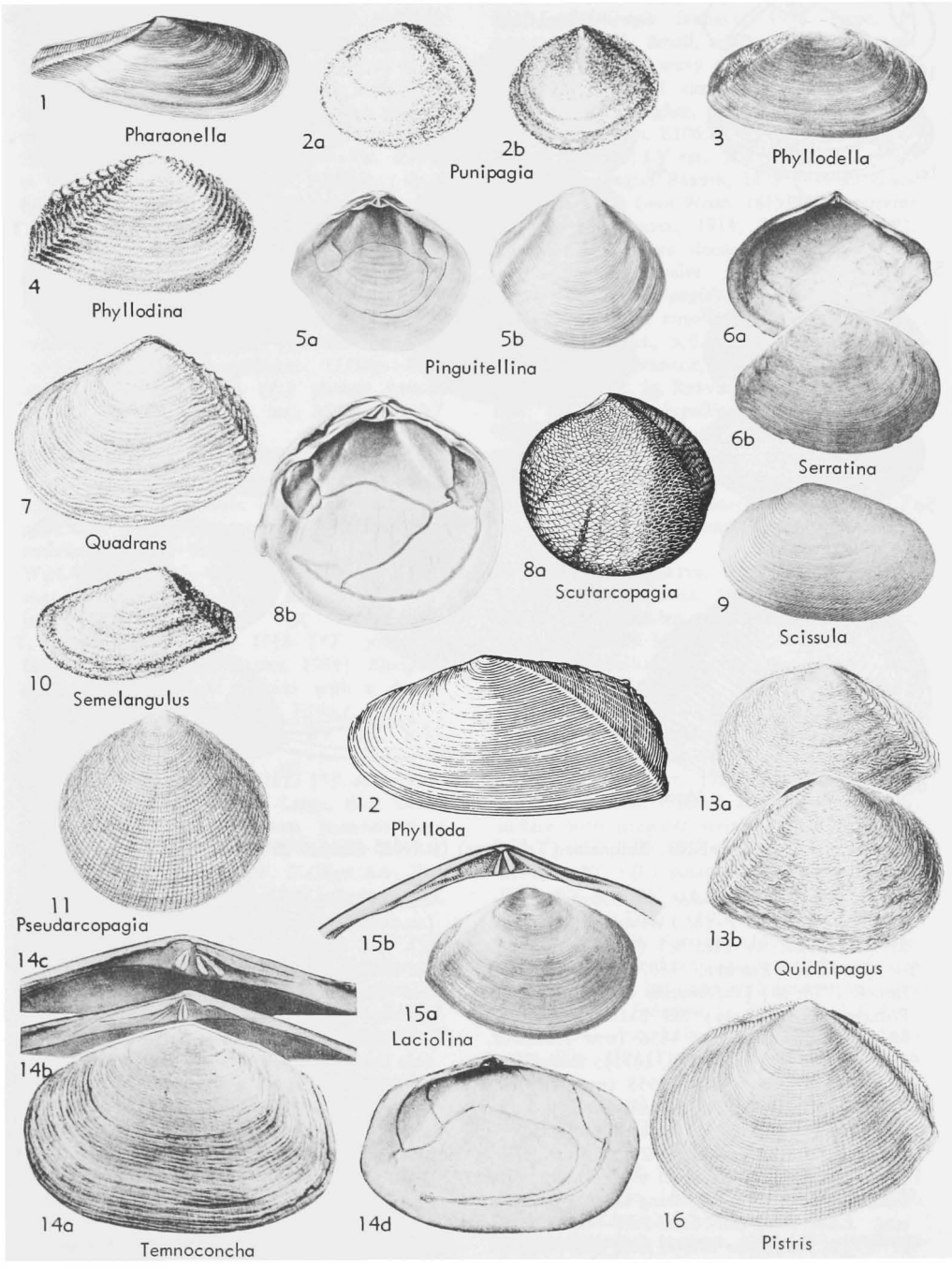


FIG. 106. Tellinidae (Tellininae) (p. *N*615-*N*620, *N*625).

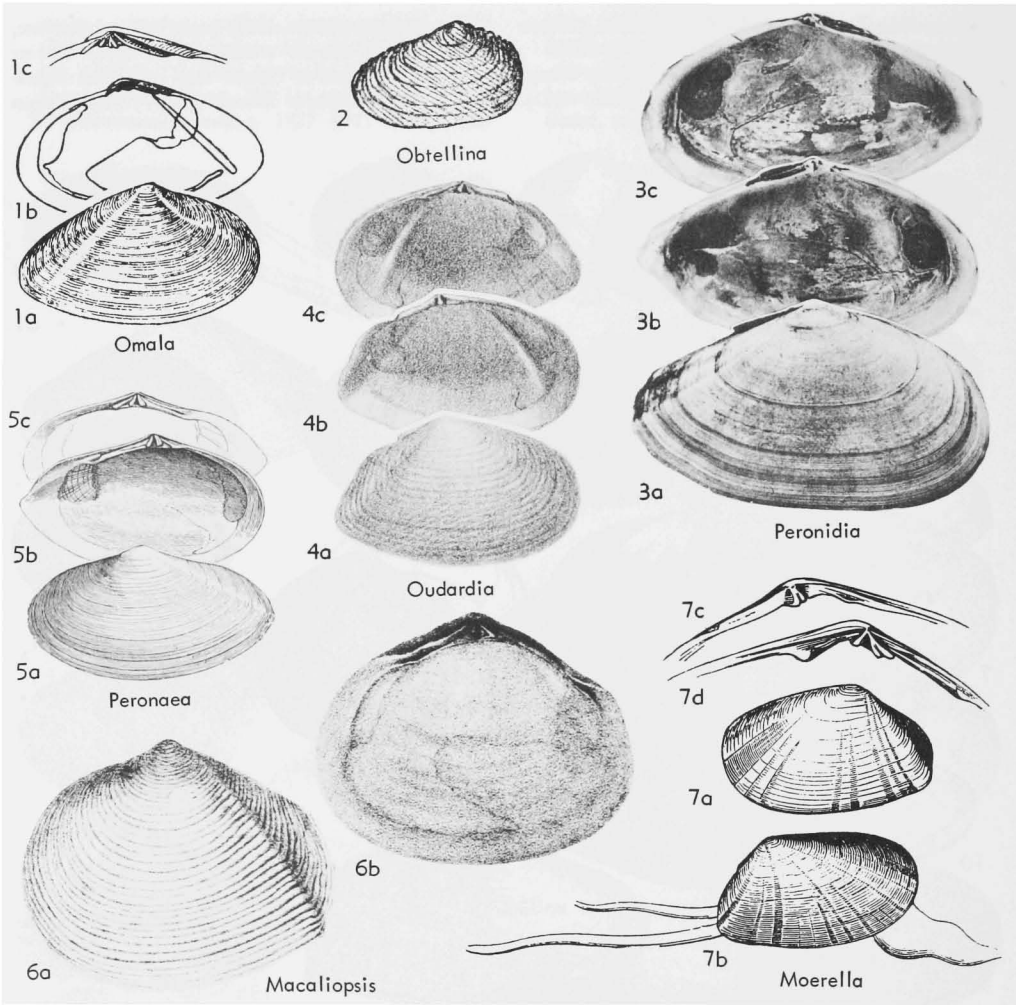


FIG. E107. Tellinidae (Tellininae) (p. *N*615-*N*616, *N*618-*N*619).

deep, confluent. *Mio.-Rec.,* E.C.Am.-W.C.Am. ——FIG. E105,*12*. **T. (M.) cristallina* SPENGLER, Rec., W.Indies; RV ext., ×1 (Dall).

T. (Moerella) FISCHER, 1887 [**T. donacina* LINNÉ, 1758; M] [=*Donacilla* GRAY, 1851 (*non* PHILIPPI, 1836) (obj.; SD SALISBURY, 1934); *Moera* H. & A. ADAMS, 1856 (*non* HUEBNER, 1819) (obj.; SD STOLICZKA, 1871); *Bathytellina* KURODA & HABE in HABE, 1958 (type, *B. citrocarnea*)]. Rather small, elongate-ovate, posterior end obscurely rostrate; sculpture of concentric threads; hinge with *3a* bifid, *2* very small, laterals strong, anterior pair closer to cardinals; pallial sinus confluent, almost touching anterior adductor scar. *L.Eoc.-Rec.,* Eu.-N.Am-Pac.——FIG. E107, *7*. **T. (M.) donacina* LINNÉ, Rec., Eu.; *7a-d,* LV ext., RV ext., LV and RV hinges, ×1 (Chenu). [=*Asbjoernsenia* FRIELE, 1886 (type, *A. striata;* M). Dr. OCKELMANN of Helsingør, Denmark, has studied the type specimens and has reported that they represent young *Tellina (Moerella) pygmaea* LOVÉN.]

T. (Nitidotellina) SCARLATO, 1965 [**Tellina nitidula* DUNKER, 1860; OD]. *Rec.,* E.Asia.

T. (Obtellina) IREDALE, 1929 [**T. bougei* SOWERBY, 1909; OD]. Beaks near posterior end; surface with fine oblique lines and irregular spines on posterior margin; pallial sinus largely confluent. *Rec.,* Pac.——FIG. E107,*2*. **T. (O.) bougei* SOWERBY, New Caledonia; LV ext., ×1.5 (Sowerby).

T. (Omala) SCHUMACHER, 1817 [**O. inaequivalvis*

=*Tellina hyalina* GMELIN, 1791; M]. Ovate, thin, pellucid, ligament long, sunken; hinge with *AI* close to cardinals. *Rec.*, Pac.——FIG. E107,*1*. **T. (O.) hyalina* GMELIN, Japan; *1a-c*, RV ext., int., hinge, ×0.5 (Habe).

T. (Oudardia) MONTEROSATO, 1884 [**T. oudardii* PAYRAUDEAU, 1826 =*T. compressa* BROCCHI, 1814; OD]. Resembling *T. (Moerella)* in form but with a thick internal rib, radiating from beak to ventral margin in front of mid-line; surface with or without fine oblique lines of sculpture. *?Eoc., Oligo.-Rec.*, Eu.-W.N.Am.——FIG. E107, *4*. **T. (O.) compressa* BROCCHI, Plio., Eu.; *4a-c*, RV ext., LV int., RV int., ×1 (Hörnes).

T. (Peronaea) POLI, 1791 [**T. planata* LINNÉ, 1758; SD STOLICZKA, 1870] [=*Peronaeoderma* POLI, 1795 (obj.; SD KEEN, herein)]. Ovate, posteriorly rounded, inequivalvae, LV flatter; sculpture of incremental lines and a few fine radials; lateral teeth weak; ligament long, depressed; pallial sinus confluent. *U.Oligo.-Rec.*, Eu.——FIG. E107,*5*. **T. (P.) planata* LINNÉ, Mio., Aus., *5a-c*, LV ext., int., RV int., ×0.7 (Zittel).

T. (Peronidia) DALL, 1900 [**T. albicans* GMELIN, 1791; OD]. Elongate, solid, compressed, subequivalve, without lunule, escutcheon long, narrow; shell with fine concentric grooves, stronger anteriorly; lateral teeth weak. *Eoc.-Rec.*, Eu.-W.N.Am.-E.Asia.——FIG. E107,*3*. **T. (P.) albicans* GMELIN, Rec., Algeria; *3a-c*, RV ext., LV int., RV int., ×0.7 *(89a)*.

T. (Pharaonella) LAMY, 1918 [**T. pharaonis* HANLEY, 1844; SD SALISBURY, 1934]. Elongate, posterior end strongly rostrate, with a double radial rib. *Rec.*, Pac.——FIG. E106,*1*. **T. (P.) pharaonis* HANLEY, Red Sea; RV ext., ×0.5 (Reeve).

T. (Phylloda) SCHUMACHER, 1817 [**P. aurea* =*T. foliacea* LINNÉ, 1758; M]. Large, thin, ovate, posterior dorsal margin serrate, posterior slope with spinose radials; with 2 laterals in RV, laterals weak or absent in LV. *U.Oligo.-Rec.*, Eu.-Pac.——FIG. E106,*12*. **T. (P.) foliacea* LINNÉ, Rec., E.Indies; LV ext., ×0.5 (Chenu).

T. (Phyllodella) HERTLEIN & STRONG, 1949 [**T. insculpta* HANLEY, 1844; OD]. Like *T. (Eurytellina)* but with the foliations of *T. (Phyllodina)* on posterior slope. *Rec.*, W.C.Am.——FIG. E106,*3*. **T. (P.) insculpta* HANLEY; RV ext., ×1 (Hertlein & Strong).

T. (Phyllodina) DALL, 1900 [**T. squamifera* DESHAYES, 1855; OD]. With concentric sculpture forming spines along posterior dorsal margin; pallial line not confluent. *Oligo.-Rec.*, E.C.Am.-W.C.Am.——FIG. E106,*4*. **T. (P.) squamifera* DESHAYES, Rec., W.Indies; RV ext., ×1 (Reeve).

T. (Pinguitellina) IREDALE, 1927 [**T. robusta* HANLEY, 1844; OD]. Small, inflated, smooth, posterior slope set off by an angle; pallial sinus long. *Rec.*, Pac.——FIG. E106,*5*. **T. (P.) robusta* HANLEY, NE.Australia; *5a,b*, LV int., RV ext., ×2 (Iredale).

T. (Pistris) THIELE, 1934 [*pro Pristis* LAMY, 1918 (*non* LINCK, 1790)] [**T. pristis* LAMARCK, 1818; M] [=*Pristipagia* IREDALE, 1936 (type, *P. gemonia*; OD)]. Small, relatively high, ligament deep; sculpture of wavy ribs and fine impressed radial lines; pallial sinus free; resembling *T. (Serratina)* but higher, with stronger sculpture. *Rec.*, Pac.——FIG. E106,*16*. **T. (P.) pristis* LAMARCK, E.Indies; LV ext., ×1 (Reeve).

T. (Pseudarcopagia) BERTIN, 1878 [**T. decussata* LAMARCK, 1818 (*non* WOOD, 1815) =*T. victoriae* GATLIFF & GABRIEL, 1914; SD DALL, 1900]. Lenticular, sculpture decussate; hinge with 2 laterals in either valve. [See also *T. (Arcopagia)*, *T. (Sinuosipagia)*.] *Rec.*, Pac.——FIG. E106,*11*. **T. (P.) victoriae* GATLIFF & GABRIEL, Australia; LV ext., ×0.5 (Reeve).

T. (Punipagia) IREDALE, 1930 [**T. subelliptica* SOWERBY, 1868, in REEVE (*non* MEEK & HAYDEN, 1857) =*T. hypelliptica* SALISBURY, 1934; OD] [=*Punigapia* THIELE, 1934, spelling error]. Small, rounded, ligament short, somewhat sunken; pallial sinus deep, triangular, about half confluent. *Rec.*, Pac.——FIG. E106,*2*. *T. (P.) hypelliptica* SALISBURY, Australia; *2a,b*, LV ext., ×1 (Reeve).

T. (Quadrans) BERTIN, 1878 [**T. gargadia* LINNÉ, 1758; SD DALL, 1900]. Shell thin, posterior slope wrinkled, the margin with spines; ligament sunken; laterals feeble, 2 in RV, wanting in LV, pallial sinus confluent below. *Rec.*, Pac.——FIG. E106,*7*. **T. (Q.) gargadia* LINNÉ, E.Indies; LV ext., ×1 (Reeve).

T. (Quidnipagus) IREDALE, 1929 [*"*Cochlea palatam* Martyn" IREDALE, 1929 (=*T. rugosa* BORN, 1778, *non* PENNANT, 1777); OD]. Somewhat attenuate posteriorly, lunule and escutcheon small; surface with irregular wrinkles and radial furrows; pallial sinus half free. *Rec.*, Pac.——FIG. E106,*13*. **T. (Q.) palatam* (IREDALE), E.Indies; *13a,b*, LV ext., RV ext., ×0.5 (Reeve).

T. (Scissula) DALL, 1900 [**T. decora* SAY, 1826 =*T. similis* SOWERBY, 1806; OD]. Ovate-quadrate, surface of both valves with fine oblique grooving not in harmony with incremental lines [see also *T. (Fabulina)*]. *Plio.-Rec.*, E.C.Am.-W.C.Am.——FIG. E106,*9*. **T. (S.) similis* SOWERBY, Plio., USA(Fla.); RV ext., ×2 (Olsson & Harbison).

T. (Scutarcopagia) PILSBRY, 1918 [**T. scobinata* LINNÉ, 1758; OD]. Lenticular, inflated, with scaly or granose sculpture. *Pleist.-Rec.*, IndoPac. ——FIG. E106, *8*. **T. (S.) scobinata* LINNÉ, Rec.; *8a*, NE.Australia, LV ext., ×0.5 (Iredale); *8b*, E.Indies, LV int., ×0.5 (Chenu).

T. (Semelangulus) IREDALE, 1924 [**T. tenuilirata* SOWERBY, 1867, in REEVE; OD]. Small, ovate,

somewhat cuneiform, anterior end longer; sculpture of concentric striae; ligament sunken, almost internal; hinge of RV with 2 laterals, wanting in LV. *Rec.,* Pac.——Fig. E106,*10*. **T. (S.) tenuilirata* Sowerby, SE.Australia; LV ext., ×1 (Reeve).

T. (Serratina) Pallary, 1922 [**T. serrata* Brocchi, 1814; OD] [=*Striotellina* Thiele, 1934 (obj.)]. Relatively high for length, ovate, sculpture concentric, radial ribs obsolete. *Mio.-Rec.,* Eu.-E.Atl.——Fig. E106,*6*. **T. (S.) serrata* Brocchi, Mio., France,; *6a,b,* RV int., ext., ×1 (Cossmann & Peyrot).

T. (Sinuosipagia) Cossmann, 1921 [**T. colpodes* Bayan, 1873; OD]. Resembling *T. (Arcopagia)* but muscle impressions more unequal and lateral teeth more sharply truncate. *Eoc.,* Eu.——Fig. E108,*6*. **T. (S.) colpodes* Bayan, France; *6a,b,* RV ext., int., ×0.8 (Cossmann).

T. (Tellinangulus) Thiele, 1934 [**T. aethiopica* Thiele & Jaeckel, 1931; M]. Small, asymmetrically rounded, somewhat rostrate; sculpture

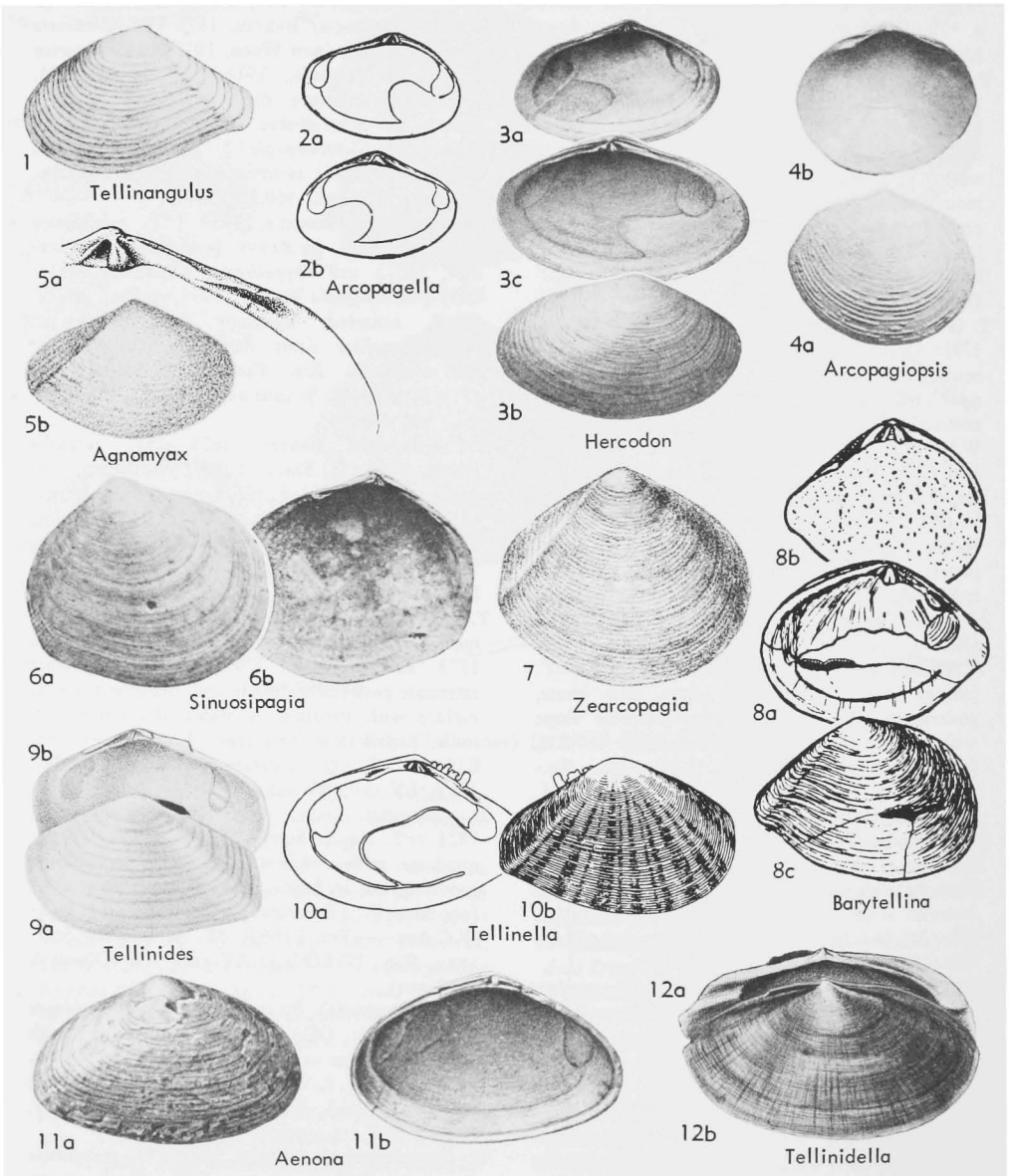


Fig. E108. Tellinidae (Tellininae) (p. *N620-N621*).

of few concentric lamellae, interspaces faintly striate radially; hinge with *AII* and *PI* wanting, *3a* short. *Rec.*, E.Afr.——FIG. E108,*1*. **T. (T.) aethiopica* THIELE & JAECKEL, E.Afr.; LV ext., ×4 (Thiele & Jaeckel).

T. (Tellinella) MÖRCH, 1853 [**T. virgata* LINNÉ, 1758; SD STOLICZKA, 1870] [=*Capsa* LAMARCK, 1799 (*non* BRUGUIÈRE, 1797) (type, *T. angulata* LINNÉ, 1767; M); *Eutellina* FISCHER, 1887 (obj.); *Maoritellina* FINLAY, 1927 (type, *T. charlottae* SMITH, 1885; OD); *Tellinota* IREDALE, 1936 (type, *T. roseola;* OD)]. Elongate, pointed behind, posterior slope with 1 or 2 radial ribs; sculpture of fine concentric lamellae. *Oligo.-Rec.*, Eu.-W.Indies-Pac.——FIG. E108,*10*. **T. (T.) virgata* LINNÉ, Rec., E.Indies; *10a,b*, RV int., ext., ×0.5 (Habe).

T. (Tellinidella) HERTLEIN & STRONG, 1949 [**Tellinides purpureus* BRODERIP & SOWERBY, 1829; OD]. Resembling *T. (Eurytellina)* in form but with a thin shell; hinge with *PI* weak. *Rec.*, W.C.Am.——FIG. E108,*12*. **T. (T.) purpurea* (BRODERIP & SOWERBY), W.C.Am.; *12a,b*, RV int., ext., ×0.6 (Gray).

T. (Tellinides) LAMARCK, 1818 [**Tellinides timorensis*; M]. Rectangular, smooth, posterior slope obliquely truncate, with a slight flexure. *Rec.*, E. Indies.——FIG. E108,*9*. **T. (T.) timorensis* (LAMARCK); *9a,b*, LV ext., RV int., ×1 (Blainville).

T. (Zearcopagia) FINLAY, 1927 [**T. disculus* DESHAYES, 1855; OD]. Lenticular, concentrically grooved; hinge with *AII* remote from cardinals; resembling *T. (Pseudarcopagia)* but without radial sculpture. *Rec.*, Pac.——FIG. E108,*7*. **T. (Z.) disculus* DESHAYES, Philip. Is.; RV ext., ×1 (Reeve).

Aenona CONRAD, 1870 [**Tellina eufaulensis* CONRAD, 1860; SD STOLICZKA, 1871]. Thin, fragile, compressed, nearly equilateral and smooth; dorsal margins of shell serving as lateral teeth; pallial sinus broad, not confluent. *U.Cret.*, N.Am.——FIG. E108,*11*. **A. eufaulensis* (CONRAD), USA (Tenn.); *11a,b*, RV ext., RV int., ×2 (Wade).

Agnomyax STEWART, 1930 [**Tellina monilifera* GABB, 1864; OD]. Resembling *Linearia* but with radial ribs on posterior slope only; posterior end diagonally truncate; hinge with cardinals directed ventrally, *3b* large and bifid. *U.Cret.*, W.N.Am.-?S.Asia-?Eu.——FIG. E108,*5*. **A. monilifer* (GABB), USA(Calif.); *5a*, RV hinge, ×5 (Stewart); *5b*, RV ext., ×2 (Gabb).

Arcopagella MEEK, 1871 [**A. mactroides*; M]. Resembling *Tellina (Arcopagia)* but with anterior and posterior teeth in both valves; surface smooth. *U.Cret.*, N.Am.——FIG. E108,*2*. **A. mactroides*, USA(Kans.); *2a,b*, RV int., LV int., ×1 (Meek).

Arcopagiopsis COSSMANN, 1886 [**Tellina pustula* DESHAYES, 1825; SD SALISBURY, 1934]. Resembling *Tellina (Arcopagia)* but pallial sinus horizontal. *Eoc.*, Eu.——FIG. E108,*4*. **A. pustula* (DESHAYES), M.Eoc., France; *4a,b*, RV ext., int., ×2 (Cossmann).

Barytellina MARWICK, 1924 [**B. crassidens*; OD]. Shell thick; hinge with posterior laterals and *3b* strong. *Plio.*, N.Z.——FIG. E108,*8*. **B. crassidens*, N.Z.; *8a-c*, RV int., LV int., RV ext., ×1 (Marwick).

Hercodon CONRAD in KERR, 1875 (issued separately, 1873) [**H. ellipticus*; M]. Elliptical, surface with irregular growth lines and numerous fine radials; hinge with *3a* angular, long, oblique, *2a* bifid, *4b* linear; pit for resilium deeply impressed; pallial sinus broad, rounded. *U.Cret.*, N.Am.——FIG. E108,*3*. **H. ellipticus*, USA(N.Car.); *3a-c*, LV int., RV ext., RV int., ×0.7 (Stephenson, 1926).

Linearia CONRAD, 1860 [**L. metastriata;* M] [=*Oene* CONRAD, 1873 (type, *O. plana;* M); *Aene*, spelling error]. Ovate, beaks nearly central; sculpture of beaded radials, strongest at ends; hinge with 2 cardinals directed forward, dorsal margins of RV beveled to serve as laterals, with double grooves in LV. *L.Cret.-U.Cret.*, Eu.-N.Am.-Afr.

L. (Linearia). Umbones rather high, inner ventral margin finely crenulate. *L.Cret.-U.Cret.*, N.Am.-Eu.-N.Afr.——FIG. E109,*11*. **L. (L.) metastriata* CONRAD, U.Cret., USA(Tenn.); *11a,b*, RV ext., int., ×2.5 (Wade).

L. (Liothyris) CONRAD in KERR, 1875 [?1873] [**L. (L.) carolinensis*; M]. Umbones lower and shell longer and smoother than in *L. (Linearia);* ventral margin smooth; pallial sinus deep. *U.Cret.*, N.Am.——FIG. E109,*7*. **L. (L.) carolinensis*, USA(Tenn.); *7a-c*, RV int., LV ext., LV int., ×0.8 (Wade).

Nelltia STEPHENSON, 1953 ("1952") [**N. stenzeli;* OD]. Resembling *Tellina* but not flexed, posterior end shorter; cardinal teeth weaker, anterior laterals distant, short, weak; pallial sinus relatively short. *U.Cret.*, N.Am.——FIG. E109,*8*. **N. stenzeli*, USA(Tex.); *8a-e*, RV ext., int., LV hinges, int., ×1 (Stephenson).

Palaeomoera STOLICZKA, 1870 [**Tellina strigata* GOLDFUSS, 1840; M]. Like *T. (Phylloda)* in form; sculpture of fine, reticulate radial ribs; hinge with one lamellar anterior cardinal in each valve, bifid in RV, posterior cardinals not traceable in either valve; laterals less distinct. *U.Cret.*, Eu.-N.Afr.——FIG. E109,*4*. **P. strigata* (GOLDFUSS), Ger.; *4a-c*, RV ext., LV int., RV int., ×1 (Holzapfel, 1889).

Solyma CONRAD, 1870 [**S. lineolatum*; M]. Ovate-quadrate, smooth; hinge in LV with one bifid cardinal, margins of shell serving as laterals.. *U. Cret.*, N.Am.——FIG. E109,*1*. **S. lineolatum;* *1a,b*, USA(N.J.), RV ext., int., ×1; *1c*, USA (Tex.), hinge, ×3 (Whitfield).

Strigilla TURTON, 1822 [**Tellina carnaria* LINNÉ, 1758; SD GRAY, 1847] [=*Limicola* GRAY, 1852, *ex* LEACH MS (*non* KOCH, 1816) (obj.); *Strigillina*, spelling error, STOLICZKA, 1870]. Lenticular, sculp-

tured with oblique riblets; shells mostly tinged with pink. *Oligo.-Rec.,* Eu.-W.Indies-Afr.-C.Am.-S.Am.

S. (Strigilla). Oblique ribbing over most of shell, with one or more lines of flexure; pallial sinus somewhat discrepant. *Mio.-Rec.,* Eu.-W.Indies. ——Fig. E109,*5*. **S. (S.) carnaria* (Linné), Rec., Carib.; LV ext., ×1 (Woodward).

S. (Aeretica) Dall, 1900 [**Tellina senegalensis* Hanley, 1844 (*non* Gmelin, 1791) =*S. polyaulax* Tomlin & Shackleford, 1915; OD]. Oblique sculpture on anterior part of shell only, posterior slope smooth; pallial line connecting adductors in one valve, falling short in the other. *Oligo. (Aquitan.)-Rec.,* Eu.-W.Afr.——Fig. E109,*10*. **S. (A.) polyaulax* Tomlin & Shackleford, Rec., W.Afr.; RV ext., ×1.5 (Nicklès).

S. (Pisostrigilla) Olsson, 1961 [**Tellina pisiformis* Linné, 1758; OD]. Small, oblique sculpture with a line of sharp flexure or zigzag bends along center of posterodorsal area. *Mio.-Rec.,* E.C.Am.-W.C.Am.——Fig. E109,*6*. **S. (P.) pisiformis* (Linné), Rec., USA(Fla.); LV ext., ×2 (Stanford Univ. specimen).

S. (Rombergia) Dall, 1900 [**S. rombergii* Mörch, 1853; OD]. Sculpture as in *S. (Strigilla)*

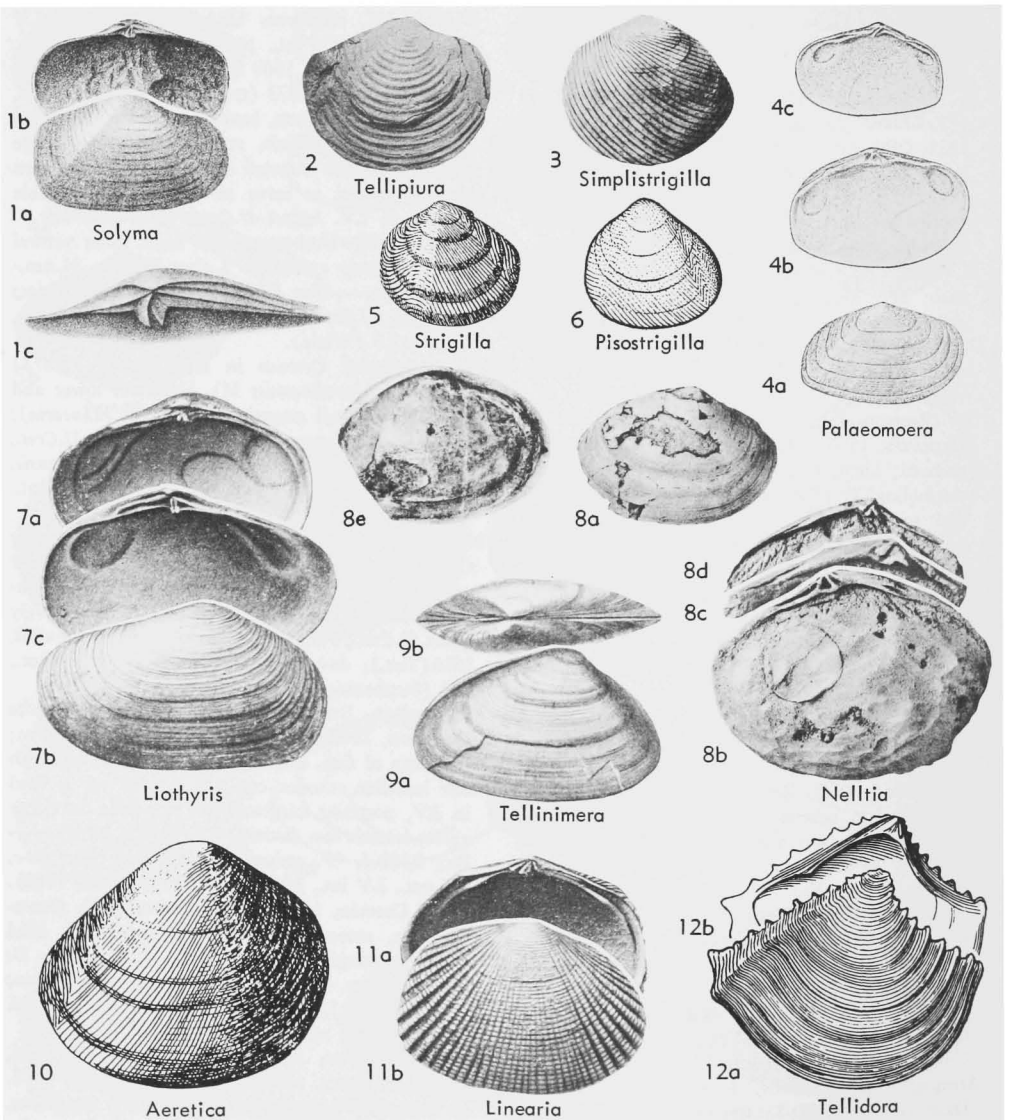


Fig. E109. Tellinidae (Tellininae) (p. *N621-N623*).

but pallial sinus alike in both valves, falling short of uniting adductors. *Rec.*, W.Indies.

S. (Simplistrigilla) Olsson, 1961 [**S. (S.) strata* (=**Strigilla serrata* Mörch, 1860); OD]. Oblique striations without any lines of flexure. *Rec.*, W.C. Am.-S.Am.——Fig. E109,*3*. **S. (S.) serrata*, Ecuador; LV ext., ×3 (Olsson).

Tellidora H. Adams & A. Adams, 1856 [**Tellina burneti* Broderip & Sowerby, 1829; SD Stoliczka, 1870] [=*Tellinodora* Paetel, 1875 (spelling error)]. Compressed, inequilateral, ovate-trigonal, surface with spaced concentric lamellae ending in marginal serrations. *Plio.-Rec.*, E.N.Am.-W.C.Am. ——Fig. E109,*12*. **T. burneti* (Broderip & Sowerby), Rec., W.C.Am.; *12a,b*, RV ext., LV int., ×1 (Chenu).

Tellinimera Conrad, 1860 [**T. eborea*; SD Gardner, 1916][=*Tellimera* Conrad, 1870, *emend. (nom. van.)*]. More compressed and inequilateral than *Aenona*, surface with sharp concentric striations; cardinal plate channeled posteriorly, with a small pit anteriorly; hinge with *2a* V-shaped, *4b* bifid. *U.Cret.*, E.N.Am.——Fig. E109,*9*. **T. eborea*, USA(Md.); *9a,b*, RV ext., both valves dorsal, ×2 (Gardner).

Tellipiura Olsson, 1944 [**Tellidora (T.) peruana*; OD]. Resembling *Tellidora* in serrate dorsal margin and hinge but outline more equilateral, with close-spaced concentric riblets or undulations. *U. Cret.*, W.S.Am.——Fig. E109,*2*. **T. peruana* (Olsson), Peru; RV ext., ×1 (Olsson).

Subfamily MACOMINAE Olsson, 1961

Sculpture generally more subdued than in Tellininae; hinge without lateral teeth. *Eoc.-Rec.*

Macoma Leach, 1819 [**M. tenera* (=*Tellina calcarea* Gmelin, 1791); M] [=*Macroma, Macrotoma*, spelling errors; *Limecola* Brown, 1844 (*ex* Leach MS) (in synonymy of *Tellina solidula* Pulteney, 1799 =*T. balthica rubra* da Costa, 1778); *Macomopsis* Sacco, 1901 (type, *Tellina elliptica* Brocchi, 1814; OD); *?Pulvinus* Scarlato, 1965 (type, *Tellina micans* Hanley, 1844; OD)]. Inequilateral, mostly thin, with deciduous periostracum; posterior end slightly twisted; pallial sinus tending to be discrepant, larger in one valve. *Eoc.-Rec.*, cosmop.

M. (Macoma). Ovate-trigonal, shell texture somewhat chalky. *Mio.-Rec.*, N.Eu.-N.Am.-NE.Asia. ——Fig. E110,*4*. **M. (M.) calcarea* (Gmelin), Rec., Arctic; *4a*, RV ext., ×0.8 (Sars); *4b*, RV int., ×0.5; *4c*, both valves, ×0.8 (Davies).

M. (Austromacoma) Olsson, 1961 [**Solen constrictus* Bruguière, 1792; OD]. Texture not chalky; pallial sinus large, high, pointed under beak, connected to anterior adductor scar at its lower end. *Plio.-Rec.*, E.N.Am.——Fig. E110,*7*. **M. (A.) constricta* (Bruguière), Rec., Carib.; *7a,b*, LV ext., int., ×1 (Philippi).

M. (Bendemacoma) Eames, 1957 [**Peronaea nigeriensis* Newton, 1922; OD]. Large, high, solid, oblique; hinge with *3a* grooved; pallial sinus tongue-shaped, narrow, confluent for half its length. *Eoc.*, Afr.——Fig. E110,*11*. **M. (B.) nigeriensis* (Newton), Nigeria; *11a-c*, LV ext., int., RV int., ×0.5 (Newton).

M. (Cymatoica) Dall, 1890 [**M. (C.) occidentalis* =*Tellina undulata* Hanley, 1844; SD Dall, 1900]. Small, elongate, with undulating oblique sculpture. *Mio.-Rec.*, E.C.Am.-W.C.Am.——Fig. E110,*5*. **M. (C.) undulata* (Hanley), Rec., W. Mex.; LV ext., ×2 (Dall).

M. (Macoploma) Pilsbry & Olsson, 1941 [**M. (M.) ecuadoriana*; OD]. Area of posterior slope near dorsal margin granulated. *Plio.-Rec.*, W.C. Am.-S.Am.——Fig. E110,*6*. **M. (M.) ecuadoriana*, Plio., Ecuador; LV ext., ×0.6 (Pilsbry & Olsson).

M. (Panacoma) Olsson, 1942 [**M. (P.) chiriquiensis*; OD]. Sculpture of a few small granules and strong raised concentric threads separated by flat interspaces; pallial sinus wide, confluent below. *Mio.-Plio.*, W.C.Am.——Fig. E110,*8*. **M. (P.) chiriquiensis*, W.Panama; *8a,b*, LV ext., RV ext., ×1 (Olsson).

M. (Pinguimacoma) Iredale, 1936 [**Pinguimacoma hemicilla*; OD]. Small, thin, resembling *Tellina (Pinguitellina)* in form but without laterals. *Rec.*, Australia.——Fig. E110,*9*. **M. (P.) hemicilla* (Iredale), E.Australia; *9a,b*, RV ext., hinge, ×3 (Iredale).

M. (Psammacoma) Dall, 1900 [**Psammotaea candida* Lamarck, 1818; OD]. Elongate, smooth, posterior flexure obsolete, periostracum delicate; ligament and resilium wholly external; pallial sinus only half confluent. *Mio.-Rec.*, E.N.Am.-Pac. ——Fig. E110,*12*. **M. (P.) candida* (Lamarck), Rec., E.Indies; *12a,b*, LV ext., int., ×0.5 (Philippi).

M. (Rexithaerus) Tryon, 1869 *ex* Conrad MS [**Tellina secta* Conrad, 1837; SD Dall, 1900]. Large, compressed, nonchalky; ligament strong, deep-set, dorsal margin produced upward behind it. *Mio.-Rec.*, W.N.Am.——Fig. E110,*10*. **M. (R.) secta* (Conrad), Rec., USA(Calif.); RV ext., ×0.5 (Reeve).

M. (Rostrimacoma) Salisbury, 1934 [**Panopea cancellata* Sowerby in Reeve, 1873; OD]. Large, anterior end produced; surface cancellate. *Rec.*, E.Atl.——Fig. E110,*3*. **M. (R.) cancellata* (Sowerby), W.Afr.; RV ext., ×0.3 (Salisbury).

M. (Salmacoma) Iredale, 1929 [**Salmacoma vappa*; OD]. Ovate, inequivalve, posterior flexure pronounced. *Rec.*, S.Pac.——Fig. E110,*2*. **M. (S.) vappa* (Iredale), Rec., NE.Australia; RV ext., ×1 (Iredale).

M. (Scissulina) DALL, 1924 [**Tellina dispar* CONRAD, 1837; OD]. With fine oblique sculpture on one valve. *Rec.*, Pac.——FIG. E110,*1*. **M. (S.) dispar* (CONRAD), USA(Hawaii); *1a*, RV ext., ×1 (Sowerby); *1b,c*, detail of posterior end (*1c*, LV; *1b*, RV), ×6 (Dall, Bartsch, Rehder).

M. (Temnoconcha) DALL, 1921 [**Psammacoma (T.) brasiliana;* OD] [=*Psammothalia* OLSSON, 1961 (type, *Tellina cognata* C. B. ADAMS, 1852; OD)]. Resembling *M. (Scissulina)* but more quadrate, with oblique sculpture on both valves. *Rec.*, W.C.Am.-E.S.Am.——FIG. E111,*8*. **M.*

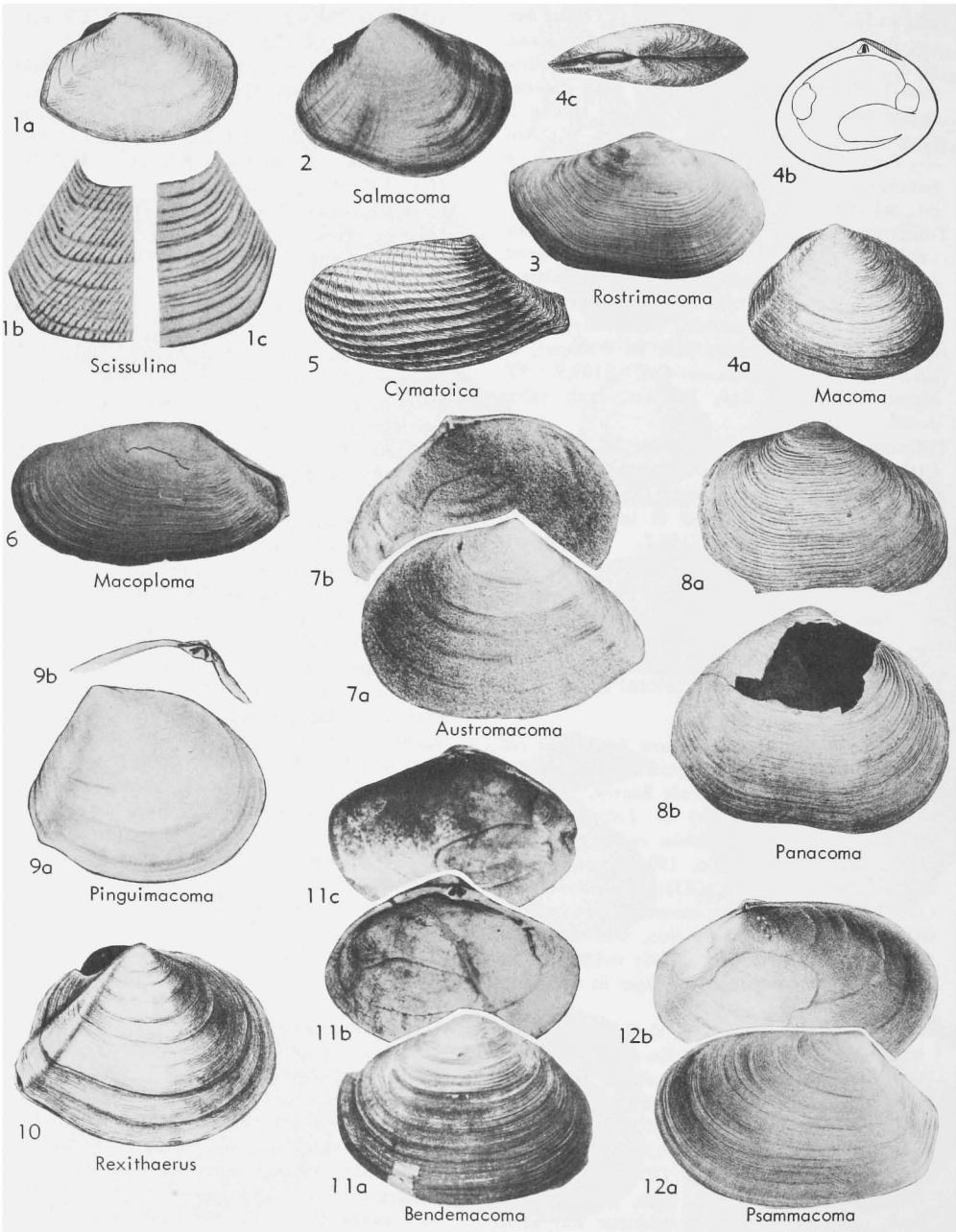


FIG. E110. Tellinidae (Macominae) (p. *N623-N624*).

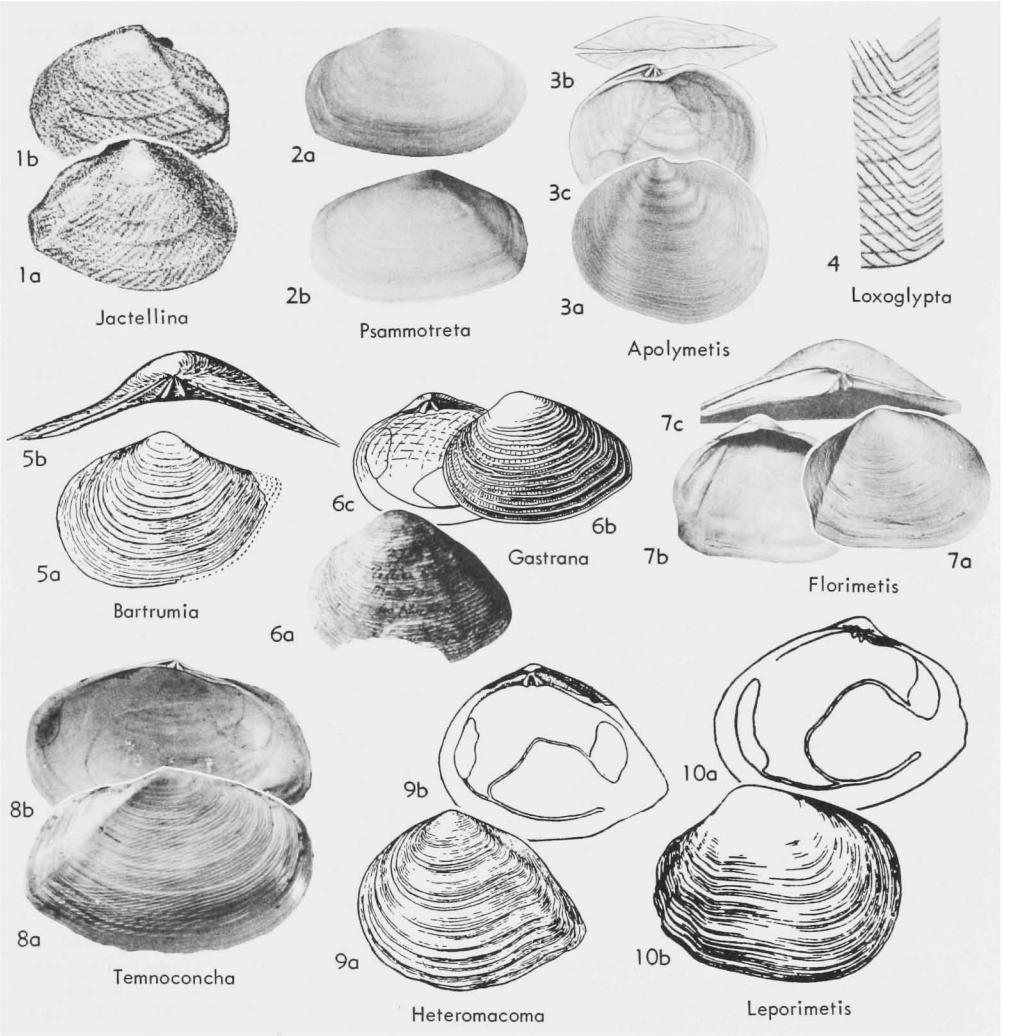


FIG. E111. Tellinidae (Macominae) (p. *N*624-*N*626).

(T.) brasiliana (DALL), Brazil; *8a,b,* RV ext., int., ×1 (Stanford spec.).——FIG. E106,*14. M. (T.) cognata* (C. B. ADAMS), Peru; *14a,d,* LV ext., int., ×1; *14b,c,* LV and RV hinges, enl. *(688).*

Apolymetis SALISBURY, 1929 [*pro Polymetis* SALISBURY, 1929 (*non* WALSINGHAM, 1908), *pro Metis* H. ADAMS & A. ADAMS, 1856 (*non* PHILIPPI, 1843)] [**Tellina meyeri* PHILIPPI, 1846, *ex* DUNKER MS; M]. Subcircular, compressed, flexure and median furrow pronounced, ligament long, embedded; sculpture of spaced concentric ribs. *Mio.-Rec.,* E.Indies.——FIG. E111,*3. *A. meyeri* (PHILIPPI), Rec., E.Indies; *3a-c,* RV ext., both valves dorsal, LV int., ×0.5 (Philippi, 1846).

Bartrumia MARWICK, 1934 [**Raeta tenuiplicata* BARTRUM, 1919; OD]. Shorter than *Macoma (Rostrimacoma),* more inflated; ligament sunken as in *Psammotreta. Mio.,* S.Pac.——FIG. E111,*5. **B. tenuiplicata* (BARTRUM), L.Mio., N.Z.; *5a,* LV ext., ×1; *5b,* hinge, enl. (Marwick, 1934).

Exotica LAMY, 1918 (*ex* JOUSSEAUME MS) [**E. exotica* (?=*Tellina triradiata* A. ADAMS, 1870); T]. Like *T. (Moerella)* in form but lacking lateral teeth; sculpture tending to be oblique, fine. *Rec.,* Pac.-Ind.O.-E.Indies.

E. (Exotica). Surface smooth or with concentric striae only. *Rec.,* Ind.O.——FIG. E112,*1. **E. (E.) triradiata* (A. ADAMS), Red Sea; RV ext., ×2 (Adams, 1870).

?E. (Jactellina) IREDALE, 1929 [**Tellina obliquaria* DESHAYES, 1855; OD]. Sculpture of fine oblique

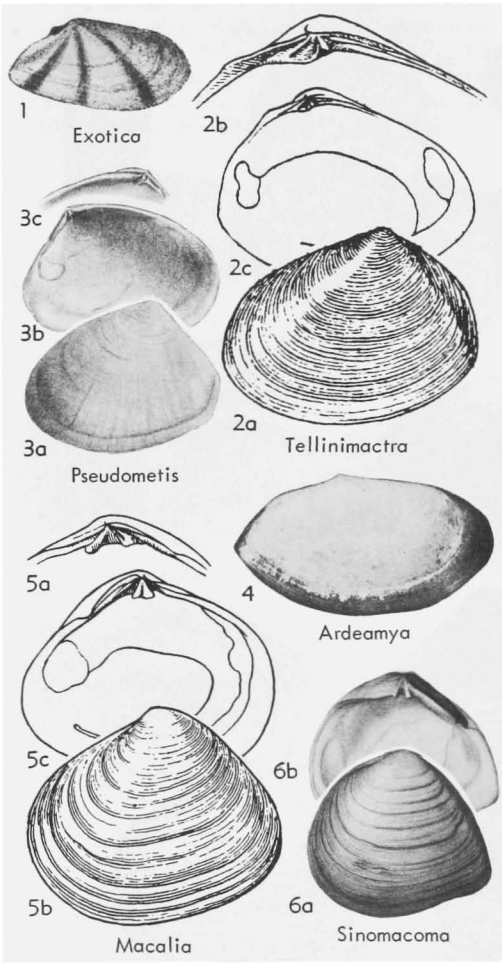


FIG. E112. Tellinidae (Macominae) (p. *N625-N628*).

ribs in both valves. *Rec.*, E.Indies.——FIG. E111, *1*. **E. (J.) obliquaria* (DESHAYES), E.Indies; *1a,b*, RV ext., LV ext., ×1.5 (Reeve, 1868).

?E. (Loxoglypta) DALL, BARTSCH, & REHDER, 1939 [**Tellina obliquilineata* CONRAD, 1837; OD]. Oblique sculpture replaced at anterior end of shell by concentric grooves. *Rec.*, Pac.——FIG. E111,*4*. **E. (L.) obliquilineata* (CONRAD), USA(Hawaii); detail of sculpture, ×12 (Dall, Bartsch, & Rehder, 1939).

Florimetis OLSSON & HARBISON, 1953 [**Tellina intastriata* SAY, 1826; OD] [=*Apolymetis* AUCTT. *(partim, see Psammotreta)*]. Quadrate, posteriorly with strong flexure, central slope with broad median furrow; sculpture of incremental lines; ligament deep; pallial sinus large. *U.Mio.-Rec.*, W.Atl.-E.Pac.-E.Indies.——FIG. E111,*7*. **F. intastriata* (SAY), Rec., USA(Fla.); *7a,b*, RV ext., LV int., ×0.5; *7c*, hinge, ×1.7 *(689)*.

Gastrana SCHUMACHER, 1817 [**G. donacina* =*Tellina abildgaardiana* SPENGLER, 1798 (=*T. matadoa* GMELIN, 1791); SD BUCQUOY, DAUTZENBERG, & DOLLFUS, 1898] [=*Diodonta* DESHAYES, 1846 (*non* HARTMAN, 1843); *Fragilia* DESHAYES, 1848 (type, *Tellina fragilis* LINNÉ, 1758; M)]. Oblique, thin, surface with irregular concentric lamellae; hinge with *3b* bifid; pallial sinus rounded, deep, not confluent. *Eoc.-Rec.*, Eu.-W.Afr.——FIG. E111, *6*. **G. matadoa* (GMELIN), Rec., W.Afr.; *6a*, LV ext., ×1 (Fischer, 1942); *6b,c*, LV ext., RV int., ×1 (Nicklès, 1950).

Heteromacoma HABE, 1952 [**Tellina irus* HANLEY, 1845; OD] [=*Gastrana* AUCTT. *(partim)*]. Ovate-trigonal, RV with lunular area, LV with corresponding emargination; ligament long, in sunken groove; adductor scars unequal; pallial sinus large, angular, slightly discrepant, about three-fourths confluent. [Type species has been confused by authors with *Macoma inquinata* (DESHAYES, 1854) from W.N.Am. and *"Gastrana" yantaiensis* (CROSSE & DEBEAUX, 1863) from China; see also *Sinomacoma*.] *Rec.*, W.Pac.——FIG. E111,*9*. **H. irus* (HANLEY), Japan; *9a,b*, LV ext., RV int., ×0.5 (Habe, 1952).

Leporimetis IREDALE, 1930 [**Tellina spectabilis* HANLEY, 1844; OD]. Oblique-trigonal, posterior strongly flexed, incremental sculpture roughened; pallial sinus nearly meeting anterior adductor scar. *Mio.-Rec.*, W.Pac.——FIG. E111,*10*. **L. spectabilis* (HANLEY), Rec., Japan; *10a,b*, RV ext., RV int., ×0.5 (Habe, 1952).

Macalia H. ADAMS, 1860 [**Tellina bruguieri* HANLEY, 1844; M] [=*Tellinungula* RÖMER, 1873 (obj.; M); *Macalina* HABE, 1952 *(nom. null.)*]. Trigonal, smooth, hinge with markedly large cardinal teeth; adductor scars unequal. *Rec.*, W.Pac. ——FIG. E112,*5*. **M. bruguieri* (HANLEY), Japan; *5a-c*, RV hinge, RV ext., LV int., ×1 (Habe, 1952).

Psammotreta DALL, 1900 [**Tellina aurora* HANLEY, 1844; OD] [=*Cydippina* DALL, 1900 (type, *T. brevifrons* SAY, 1834; OD); *Scrobiculina* DALL, 1900 (type, *Scrobicularia viridotincta* CARPENTER, 1856; OD); *Schumacheria* COSSMANN, 1902 *(nom. van. pro Scrobiculina); Apolymetis* AUCTT. *(partim, see Florimetis)*]. More elongate than *Macoma*, ligament and resilium sunken, almost internal, adductor scars unequal; pallial sinus partly confluent. *Mio.-Rec.*, C.Am.-S.Am.-W.Pac.

P. (Psammotreta). Shorter than *Macoma (Psammacoma)*; anterior end not inflated. *Rec.*, E.C.Am.-W.C.Am.-S.Am.——FIG. E111,*2*. **P. (P.) aurora* (HANLEY), W.C.Am.; *2a,b*, RV ext., LV ext., ×1 *(822)*.

P. (Ardeamya) OLSSON, 1961 [**Tellina columbiensis* HANLEY, 1844; OD]. Elongate-elliptical, beaks small, narrow, rising above dorsal margin. *Rec.*,

W.C.Am.-S.Am.——FIG. E112,*4*. **P. (A.) columbiensis* (HANLEY), Peru; RV ext., ×0.5 *(688)*.

P. (Pseudometis) LAMY, 1918 [**Tellina truncata* PHILIPPI, 1843 (*non* LINNÉ, 1767 =*T. praerupta* SALISBURY, 1934); SD SALISBURY, 1934]. Resembling *P. (Psammotreta)* but higher, anterior end more inflated; surface smooth; posterior flexure weak; ligament less immersed than in *Florimetis;* pallial sinus about one-third confluent. *Mio.-Rec.,* E. C. Am.-W. C. Am.-W. Pac.——FIG. E112,*3*. **P. (P.) praerupta* (SALISBURY), Rec., E.Indies; *3a-c,* LV ext., int., RV hinge, ×0.5 (Philippi, 1843).

P. (Tellinimactra) LAMY, 1918 [**Tellina edentula* SPENGLER, 1798; OD]. Thin, more ovate and less strongly flexed than *Florimetis,* lacking central depressed area; ligament and resilium large; pallial sinus larger than in *P. (Psammotreta). Rec.,* W.Pac.——FIG. E112,*2*. **P. (T.) edentula*

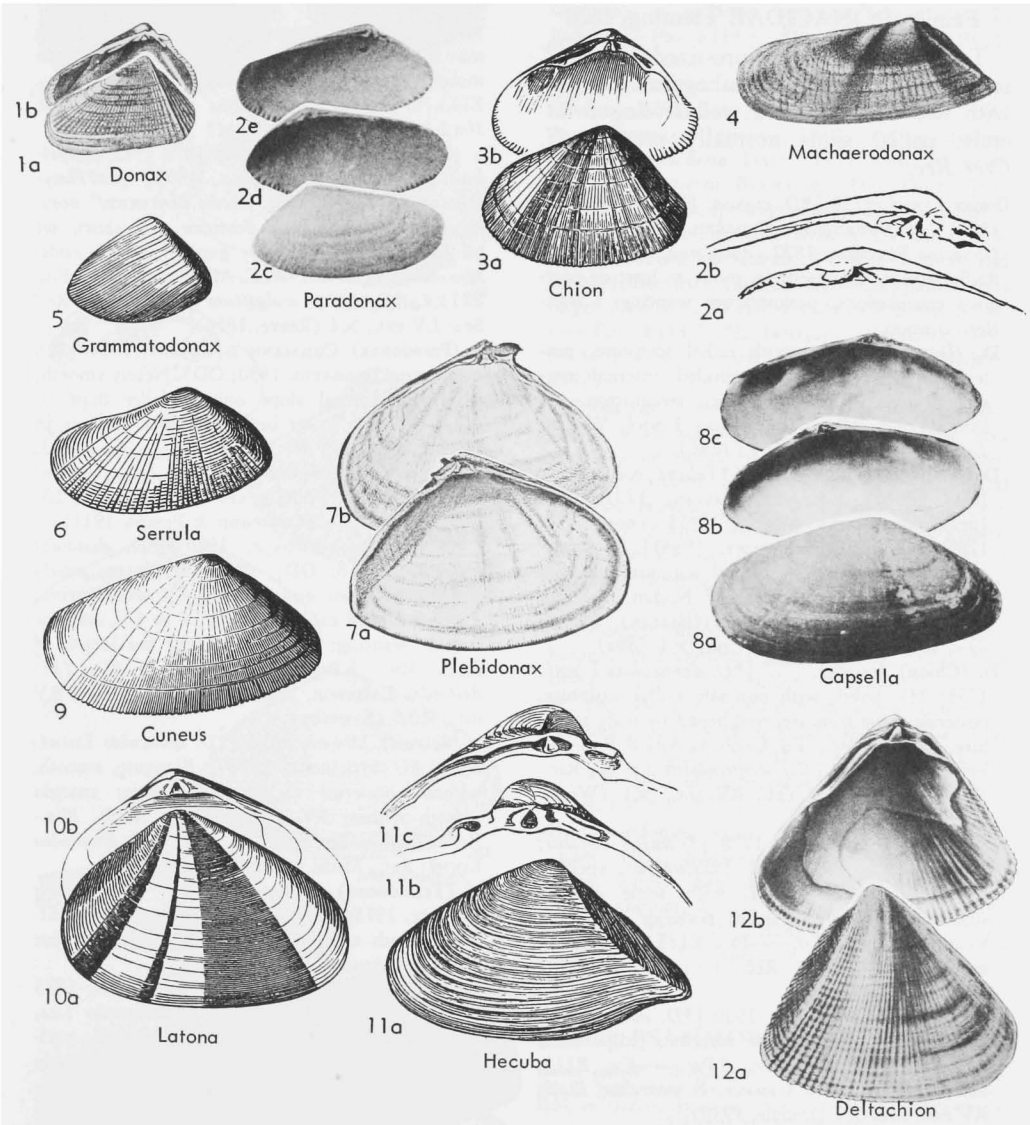


FIG. E113. Donacidae (p. *N628*).

(SPENGLER), Japan; *2a-c,* LV ext., int., hinge, ×0.7 (Habe, 1952).

Sinomacoma YAMAMOTO & HABE, 1950 [**Fragilia yantaiensis* CROSSE & DEBEAUX, 1863; OD]. Trigonal, heavy shelled, ligament in long groove; area in front of beaks beveled, wide; posterior end not twisted. *Rec.,* E.Asia.——FIG. E112,*6.* **S. yantaiensis* (CROSSE & DEBEAUX), NE.China; *6a,b,* LV ext., RV int., ×0.5 (Crosse & Debeaux, 1863).

Family DONACIDAE Fleming, 1828

Trigonal shells, medium-sized to small, solid, inequilateral, opisthogyrate; hinge with two cardinals and well-developed laterals; pallial sinus normally present. *U. Cret.-Rec.*

Donax LINNÉ, 1758 [**D. rugosa;* SD SCHUMACHER, 1871] [=*Donaciarius* DUMÉRIL, 1806 (obj.); *Donacina* FÉRUSSAC, 1822 *(nom. nud., in synon.)*]. Radial sculpture present in most, at least as marginal crenulations; periostracum wanting. *L.Eoc.-Rec.,* cosmop.

D. (Donax). Sturdy, with radial sculpture, posterior area concentrically wrinkled; internal margin strongly denticulate. *Rec.,* circumtrop.——FIG. E113,*1.* **D. (D.) rugosus* LINNÉ, W.Afr.; *1a,b,* LV ext., RV int., ×1 *(124b).*

D. (Capsella) GRAY, 1851 [**Tellina polita* POLI, 1795 (=**T. variegata* GMELIN, 1791); M] [=*Peronaeoderma* MÖRCH, 1853 (*non* POLI, 1795) (obj.; SD SALISBURY, 1934)]. Elongate-ovate, polished, without radial sculpture, internal margin smooth. *Rec.,* Eu.-W. N. Am. —— FIG. E113,*8.* **D. (C.) variegatus* (GMELIN), Medit.; *8a-c,* LV ext., LV int., RV int., ×1 *(89a).*

D. (Chion) SCOPOLI, 1777 [**D. denticulata* LINNÉ, 1758; M]. Solid, with punctate radial sculpture, posterior slope truncate, roughened by scaly sculpture. *L. Eoc.-Rec.,* Eu.-Carib.-E. Asia-S. Pac.——FIG. E113,*3.* **D. (C.) denticulatus* LINNÉ, Rec., W.Indies; *3a,b,* LV ext., RV int., ×1 (Woodward; Chenu).

D. (Cuneus) DA COSTA, 1778 [**Cuneus vittatus;* SD WINCKWORTH, 1926] [=*Cunerus,* spelling error]. Radiately ribbed, with some oblique striae crossing central slope; posterior truncation weak. *Mio.-Rec.,* Eu.——FIG. E113,*9.* **D. (C.) vittatus* (DA COSTA), Rec., Eu.; LV ext., ×1 *(124b).*

D. (Deltachion) IREDALE, 1930 [**D. virilis*; OD]. Small, high, posterior side truncate; pallial sinus 0.75 length of shell. *Rec.,* S.Pac.——FIG. E113, *12.* **D. (D.) virilis* IREDALE, E.Australia; *12a,b,* RV ext., int., ×2 (Iredale, 1930).

D. (Grammatodonax) DALL, 1900 [**D. madagascariensis* WOOD, 1828 ("Lamarck" by error); OD]. Short, compressed, surface furrowed with oblique ribs; RV with 1 cardinal, LV with 2. *Rec.,* Afr.——FIG. E113,*5.* **D. (G.) madagascariensis* WOOD, S.Afr.; LV ext., ×1 *(124b).*

D. (Hecuba) SCHUMACHER, 1817 [**Venus scortum* LINNÉ, 1758; SD HERRMANNSEN, 1847]. Large, with conspicuous posterior carina; sharp groove in dorsal margin of RV in front of *AI. Rec.,* E. Indies.——FIG. E113,*11.* **D. (H.) scortum* (LINNÉ), E.Indies; *11a-c,* LV ext., ×0.5; LV and RV hinges, enl. *(124b).*

D. (Latona) SCHUMACHER, 1817 [**D. cuneatus* LINNÉ, 1758; M]. Radials reduced to fine threadlike striae except on posterior slope, which may be rugose; interior margin smooth or with minute radial wrinkles. *Rec.,* E.Indies.——FIG. E113,*10.* **D. (L.) cuneatus* LINNÉ, E.Indies; *10a,b,* RV ext., LV int., ×1 *(124b).*

D. (Machaerodonax) ROEMER, 1870 [**D. scalpellum* GRAY, 1823; SD DALL, 1900] [=*?Platydonax* DALL, 1900 ("*D. finchii* SOWERBY," *nom. inquirend.*)]. Elongate, posterior end short, set off by ridge; shell slightly gaping at both ends. *Mio.-Rec.,* E. C. Am.-W. C. Am.-IndoPac.——FIG. E113,*4.* **D. (M.) scalpellum* GRAY, Rec., Red Sea; LV ext., ×1 (Reeve, 1854).

D. (Paradonax) COSSMANN & PEYROT, 1910 [**D. transversus* DESHAYES, 1830; OD]. Nearly smooth, radials on central slope only; smaller than *D. (Donax),* with lower beaks; posterior laterals in RV strong. *Oligo.-Rec.,* Eu.-Carib.——FIG. E113, *2.* **D. (P.) transversus* DESHAYES, Mio., France; *2a,b,* LV and RV hinges, enl.; *2c-e,* RV ext., LV int., RV int., ×1 (Cossmann & Peyrot, 1911).

D. (Plebidonax) IREDALE, 1930 [**D. deltoides* LAMARCK, 1818; OD]. Relatively large, nearly smooth, posterior end set off by a weak carina; 1 massive bifid cardinal in RV, 2 in LV, anterior laterals wanting; pallial sinus half the length of shell. *Rec.,* S.Pac.——FIG. E113,*7.* **D. (P.) deltoides* LAMARCK, Australia; *7a,b,* LV int., RV int., ×0.5 (Sowerby).

D. (Serrula) MÖRCH, 1853 [**D. trunculus* LINNÉ, 1758; SD STOLICZKA, 1870]. Elongate, smooth, without posterior carination; posterior margin smooth within; RV without lateral teeth. *Plio.-Rec.,* Eu.——FIG. E113,*6.* **D. (S.) trunculus* LINNÉ, Rec., Medit.; LV ext., ×1 *(124b).*

D. (Tentidonax) IREDALE, 1930 [**D. veruinus* HEDLEY, 1913; OD]. Small, elongate, sides slanting, smooth except for wrinkle-ridged posterior area. *Rec.,* Australia.

Egerella STOLICZKA, 1870 [*pro Egeria* LEA, 1833 (*non* ROISSY, 1805)] [**Egeria subtrigonia* LEA, 1833; SD STOLICZKA, 1871]. Thin, small, variable, radial sculpture faint, interior margins finely serrate; lateral teeth wanting. *Paleoc.-Eoc.,* Eu.-E.N.Am.——FIG. E114,*1.* **E. subtrigonia* (LEA), Eoc., USA(Ala.); *1a-c,* LV ext., int., RV int., ×3 (Harris, 1919).

Galatea BRUGUIÈRE, 1797 (Genus without species) [**Galathea radiata* LAMARCK, 1805 (=**Venus*

paradoxa Born, 1778); SM Lamarck, 1805] [=*Egeria* Roissy, 1805 (*pro Galatea*) *(nom. van.); Potamophila* Sowerby, 1821 (obj.); *Megadesma* Bowdich, 1822 (obj.); *Galateola* Fleming, 1828 *(nom. nud.); Galataea, Galathea, Galateia,* spelling errors]. Large, thick, trigonal, with a smooth, heavy periostracum; hinge plate massive; inner ventral margin smooth; pallial sinus small. *Rec.,* W.Afr.——Fig. E114,*3*. **G. paradoxa* (Born); RV int., ×1 (Nicklès, 1950).

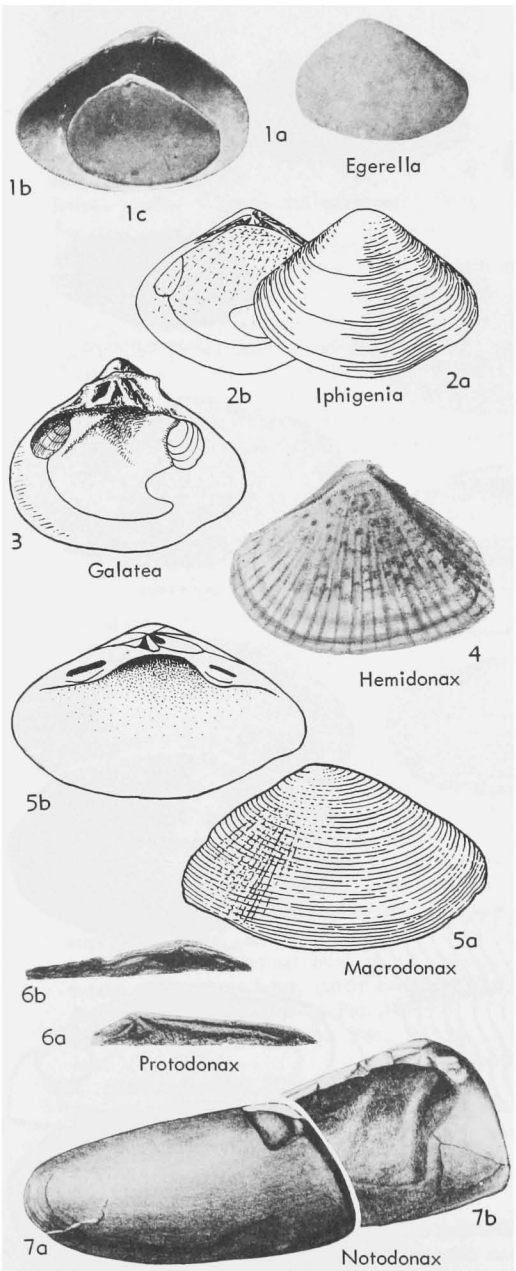


Fig. E114. Donacidae (p. *N628-N629*).

Hemidonax Mörch, 1870 [**Donax pictus* Tryon, 1870 (=**Cardium donaciforme* Bruguière, 1792); M] [=*Donacicardium* von Vest, 1875 (obj.); OD]. Sculpture of smooth but elevated radial ribs, inner margin coarsely crenate; hinge somewhat as in *Donax* but teeth larger. *Rec.,* E. Indies.——Fig. E114,*4*. **H. donaciformis* (Bruguière); LV ext., ×1 (Reeve, 1844).

Iphigenia Schumacher, 1817 [**Donax laevigata* Gmelin, 1791; M] [=*Fischeria* Bernardi, 1860 (*non* Robineau-Desvoidy, 1830; *Finlaria,* spelling error); *Profischeria* Dall, 1903 (*pro Fischeria;* type, *F. delessertii* Bernardi, 1860; OD); *Iphegenia, Ephigenia,* spelling errors]. Thin, trigonal to ovate, with a periostracum, smooth; LV with 2 subequal cardinals, no laterals, RV with *1* weak and *3b* bifid, laterals 2, elongate and weak; pallial sinus large. *Mio.-Rec.,* W.Afr.-E.C.Am.-W.C.Am.-S.Am. ——Fig. E114,*2*. **I. laevigata* (Gmelin), Rec., W.Afr.; *2a,b,* LV ext., RV int., ×1 (Nicklès, 1950).

?Macrodonax Olsson, 1944 [**M. peruviana*; OD]. Large, solid, sculpture discrepant, posterior area with nodose radial ribs, remainder of shell concentrically ribbed; hinge heavy, with anterior and posterior laterals; pallial area unknown. *U.Cret. (Senon.),* S.Am.——Fig. E114,*5*. **M. peruviana,* Peru; *5a,b,* RV ext., int., ×0.25 (Olsson, 1944).

Notodonax Feruglio, 1936 [**Donax (N.) annaeeugeniae;* OD]. Donaciform, solid, with a posterior-dorsal angulation; margin smooth within; hinge with 2 cardinals and 2 laterals; pallial sinus small. *U.Cret.,* S.Am.-N.Am.-SW.Asia.

N. (Notodonax). Surface with a few concentric furrows, lateral teeth relatively short; pallial sinus wavy to angular. *U.Cret.,* S.Am.——Fig. E114, *7*. **N. (N.) annaeeugeniae* (Feruglio), Patag.; *7a,b,* LV ext., RV int., ×1 (Feruglio, 1935).

N. (Protodonax) Vokes, 1945 [**Protodonax elongatus;* OD]. Surface smooth, lateral teeth somewhat longer than in *N. (Notodonax),* pallial sinus angular. *U.Cret.,* N.Am.-SW.Asia.——Fig. E114,*6*. **N. (P.) elongatus* (Vokes), USA (Wyo.); *6a,* LV hinge, ×1; *6b,* RV hinge, ×2 *(944)*.

Family PSAMMOBIIDAE Fleming, 1828

[*nom. correct.* Fischer, 1887 (*pro* Psammobiadae Fleming, 1828)] [=Garidae Stoliczka, 1871 (*nom. transl.* Stewart, 1930, *ex* Garinae Stoliczka, 1871); Asaphidae Winckworth, 1932 (*non* Burmeister, 1843)]

Shells inequilateral, slightly gaping in most forms, especially at posterior end; hinge with one to three cardinal teeth, lat-

erals weak to wanting; ligament on nymph; pallial sinus present. *U.Cret.-Rec.*

Subfamily PSAMMOBIINAE Fleming, 1828

[*nom. transl.* E. A. Smith, 1885 (*ex* Psammobiidae Fleming, 1828)]

Ovate-trapezoidal, gape small or absent. *U.Cret.-Rec.*

Gari Schumacher, 1817 [**G. vulgaris* (=*Solen amethystus* Wood, 1815) (ICZN pend.)] [=*Psammotaea* Lamarck, 1818 (type, *P. donacina;* SD

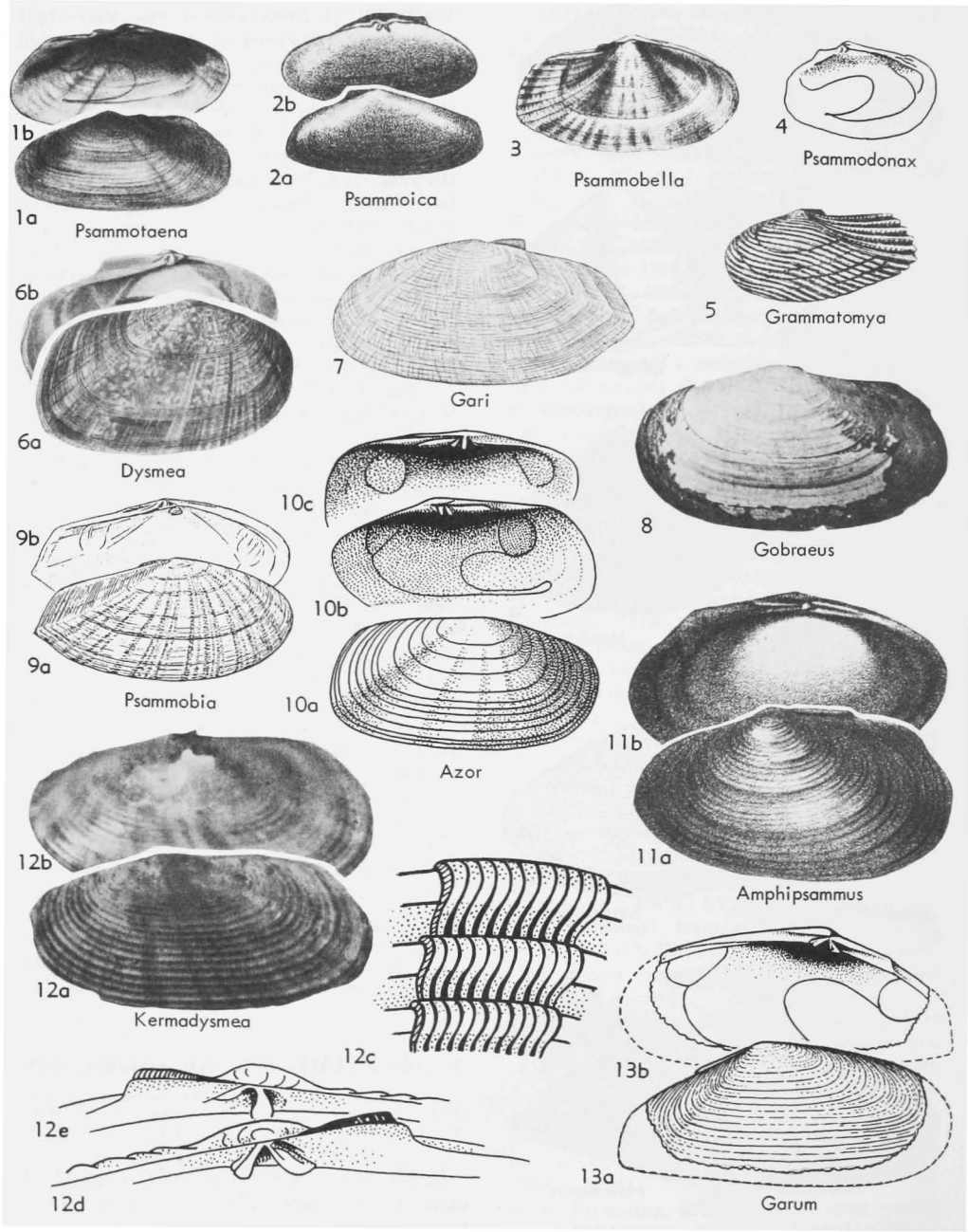


Fig. E115. Psammobiidae (Psammobiinae) (p. *N630-N631*).

CHILDREN, 1823); *Capsella* DESHAYES, 1855 (*non* GRAY, 1851); *Milligaretta* IREDALE, 1936 (type, *M. venta;* OD)]. Elongate-ovate to quadrate, smooth to strongly sculptured, posterior end wider than anterior. *Eoc.-Rec.*, cosmop.

G. (Gari). Posterior slope weakly set off; pedal muscle scars 1, oval, in front of cardinal teeth; sculpture of concentric growth lamellae, overlain by oblique striae in some. *Mio.-Rec.*, Eu.-Asia. ——FIG. E115,*7*. **G. (G.) amethystus* (WOOD), Rec., E.Indies; LV ext., ×1 (Wood, 1815).

G. (Amphipsammus) COSSMANN, 1914 [**Psammobia lamarckii* DESHAYES, 1857; M]. Posterior slope with radial riblets, shell otherwise smooth; lateral lamellae wanting; sinus free, not confluent. *Eoc.-Oligo.*, Eu.——FIG. E115,*11*. **G. (A.) lamarckii* (DESHAYES), Eoc., France; *11a,b*, LV ext., int., ×0.5 (Deshayes, 1825).

G. (Azor) J. SOWERBY, *ex* LEACH MS, 1824 [**Sanguinolaria compressa;* M]. Small, smooth, rectangular, pallial sinus rounded, pallial line not confluent. *Eoc.*, Eu.——FIG. E115,*10*. **G. (A.) compressa* (SOWERBY), Eng.; *10a-c*, RV ext., int., LV int., ×1 (Brit. Mus. Guide, 1959).

G. (Dysmea) DALL, BARTSCH, & REHDER, 1939 [**Solen occidens* GMELIN, 1791; OD]. Smooth except for concentric riblets on flaring posterior end; pallial sinus confluent for half its length. *Rec.*, IndoPac.——FIG. E115,*6*. **G. (D.) occidens* (GMELIN), E.Indies; *6a,b*, RV ext., LV int., ×0.3 (Chemnitz, 1782).

G. (Garum) DALL, 1898 [**Psammobia filosa* CONRAD, 1853; M]. Sculpture of fine concentric grooves; pallial sinus short. *Eoc.*, N.Am.-Eu.——FIG. E115,*13*. **G. (G.) filosa* (CONRAD), M.Eoc., USA(Ala.); *13a,b*, RV ext., int., ×1 (Stanford Univ. specimen).

G. (Gobraeus) BROWN, 1844 (in synon.), *ex* LEACH, MS [**Solen vespertinus* GMELIN, 1791 (=**Tellina depressa* PENNANT, 1777); M] [=*Psammocola* DE BLAINVILLE, 1825, AUCTT. (*non* DE BLAINVILLE, 1824) (obj.)]. More gaping than *G. (Gari)*, nearly smooth, concentric sculpture of growth lines only, posterior slope with superficial radial striae; 2 subequal cardinals in RV, anterior cardinal bifid in LV, posterior weak; pallial sinus large, partly confluent. *Eoc.-Rec.*, Eu.-N.Am.-S.Am.——FIG. E115,*8*. **G. (G.) depressa* (PENNANT), Rec., Medit.; LV ext., ×0.6 *(89a)*.

G. (Grammatomya) DALL, 1898 [**Psammobia squamosa* LAMARCK, 1818; M]. Entire surface obliquely grooved, coarser on dorsal posterior area. *Rec.*, IndoPac.——FIG. E115,*5*. **G. (G.) squamosa* (LAMARCK), Borneo; LV ext., ×1 (Woodward, 1854).

G. (Kermadysmea) POWELL, 1958 [**K. galatheae*; OD]. Resembling *G. (Dysmea)* but with concentric ribs, granular. *Rec.*, S.Pac.——FIG. E115, *12*. **G. (K.) galatheae* (POWELL), Kermadec Is.; *12a,b*, LV ext., RV int., ×0.7; *12c*, sculpture, enl.; *12d,e*, RV and LV hinges, enl. (Powell, 1958).

G. (Psammobella) GRAY, 1851 [**Psammobia costulata* TURTON, 1822; SD KOBELT, 1881]. Small, smooth except for radial ribs on posterior slope; hinge feeble, pallial sinus deep, partly confluent. *Rec.*, Eu.——FIG. E115,*3*. **G. (P.) costulata* (TURTON), Eng.; RV ext., ×1 (Forbes & Hanley, 1848).

G. (Psammobia) LAMARCK, 1818 [**Tellina fervensis* GMELIN, 1791; SD CHILDREN, 1822, as *T. feroensis*] [=*Haplomochlia* GISTEL, 1848 *(nom. van.)* (obj.)]. Posterior slope with strong ridge; pedal muscle scars 2 to 3, below cardinal teeth. *Rec.*, Eu.——FIG. E115,*9*. **G. (P.) fervensis* (GMELIN), Eng.; *9a,b*, RV ext., LV int., ×1 (Wood, 1815).

G. (Psammodonax) COSSMANN, 1887 [**Psammobia caillati* DESHAYES, 1857; OD]. Inequilateral, posterior end short, posterior slope radially striate; hinge without laterals; pallial sinus large, passing beaks, oval, only partly confluent. *L.Eoc.-U.Eoc.*, Eu.——FIG. E115,*4*. **G. (P.) caillati* (DESHAYES), M.Eoc., France; LV int., ×1 (Deshayes, 1864).

G. (Psammoica) DALL, 1900 [*"*Psammobia appendiculata* DESHAYES," *err. pro Solen appendiculata* LAMARCK, 1806; OD] [=*Macropsammus* COSSMANN, 1902 *(nom. van.)*]. Small, smooth, compressed, truncate behind; ligamental nymph prominent; pallial sinus long, not confluent. *Eoc.*, Eu.——FIG. E115,*2*. **G. (P.) appendiculata* (LAMARCK), M.Eoc., France; *2a,b*, RV ext., int., ×1 (Deshayes, 1825).

G. (Psammotaena) DALL, 1900 [*"*Psammobia effusa* LAMARCK" (=*Solen effusa* LAMARCK, 1806); OD]. Resembling *G. (Amphipsammus)* but with posterior slope smooth. *Eoc.*, Eu.——FIG. E115,*1*. **G. (P.) effusa* (LAMARCK), M.Eoc., France; *1a,b*, LV ext., int., ×0.7 (Deshayes, 1864).

Amphichaena PHILIPPI, 1847 [**A. kindermanni*; M] [=*Amphidona* MÖRCH, 1858 *(nom.null.)*]. Subcylindrical, inner margin arcuate at anterior end, smooth or nearly so posteriorly; pallial sinus short, not reaching mid-line. *Pleist.-Rec.*, W.C.Am. ——FIG. E116,*11*. **A. kindermanni*, Rec., W. Mexico; *11a-c*, LV int., RV int., LV ext., ×1 (R. Palmer & L. Hertlein, 1926).

Asaphinella COSSMANN, 1886 [**Capsa minima* DESHAYES, 1857; OD]. Outline as in *Gari* but less inequilateral, adult shells small. *Eoc.*, Eu.

A. (Asaphinella). Oblong, smooth. *Eoc.*, Eu.——FIG. E116,*1*. **A. (A.) minima* (DESHAYES), France; *1a-c*, LV ext., LV int., RV hinge, ×5 (Deshayes, 1857).

A. (Herouvalia) COSSMANN, 1891 [**A. semitexta* COSSMANN, 1886; OD]. Minute, sculptured strongly reticulate, especially on posterior slope. *Eoc.*, Eu.——FIG. E116,*2*. **A. (H.) semitexta*

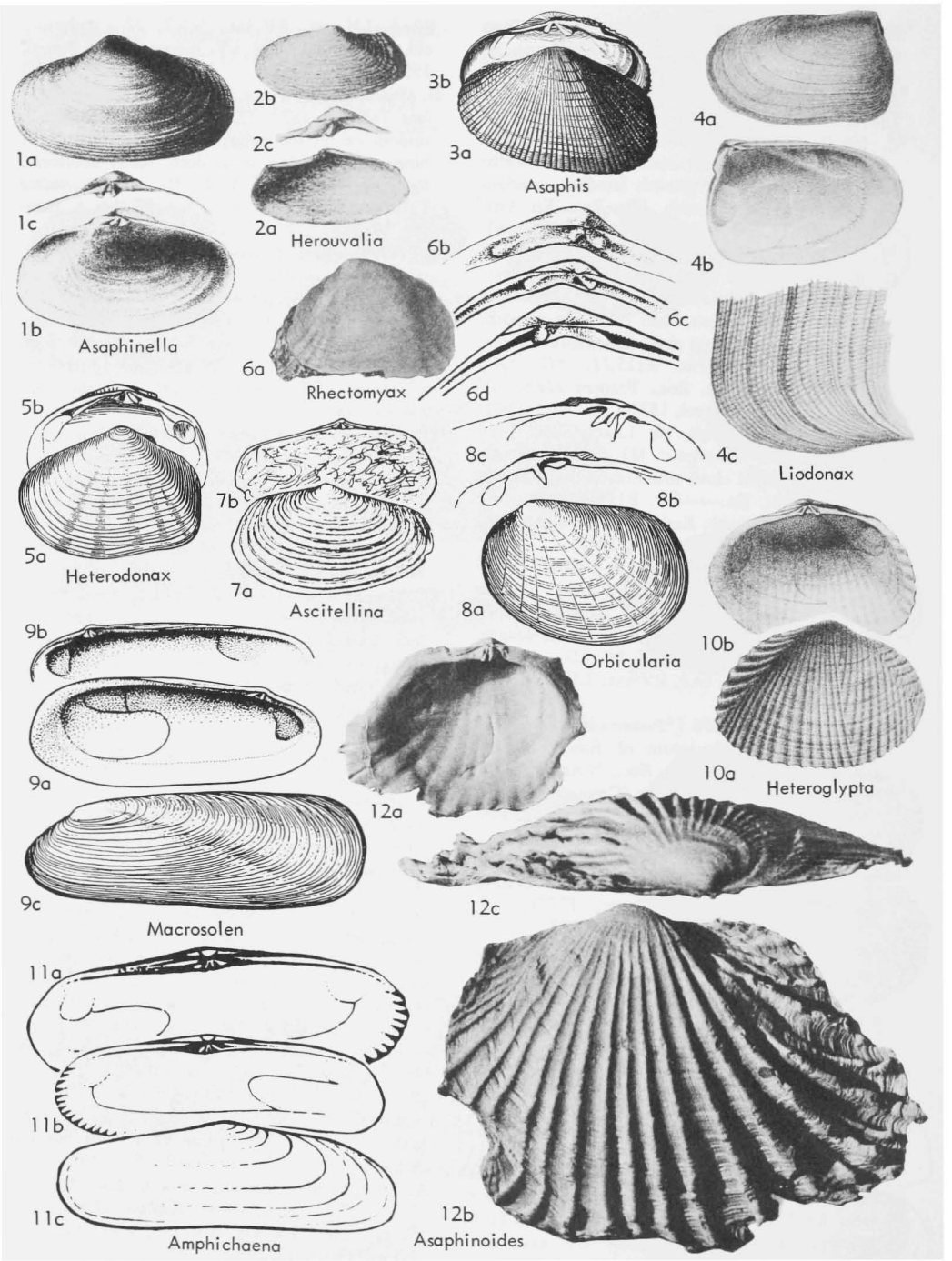


FIG. E116. Psammobiidae (Psammobiinae) (p. *N*630-*N*631, *N*633).

Cossmann, France; *2a,b,* LV int., ext., ×4; *2c,* LV hinge, enl. *(160).*

Asaphis Modeer, 1793 [**Venus deflorata* Linné, 1758; M] [=*Capsa* Bruguière, 1797 (obj.; SD Schmidt, 1818); *Corbula* Röding, 1798 (*non* Bruguière, 1797) (obj.; SD Winckworth, 1930); *Capsula* Schumacher, 1817 (obj.; M); *Psammocola* de Blainville, 1824 (obj.; SD Bucquoy, Dautzenberg, & Dollfus, 1895); *Procos* Gistel, 1848 *(nom. van. pro Capsa); Acaphis* Paetel, 1875 *(nom. null.)*]. Shells of medium size, with well-developed radial ribs, elliptical, inequilateral, not gaping; hinge plate well developed. *Mio.-Rec.,* S.Am.-IndoPac.-Indies.

A. (Asaphis). Hinge plate narrow to moderate in width; ribs numerous, rounded in section. *Rec.,* E.Indies-W.Indies.——Fig. E116,*3.* **A. (A.) deflorata* (Linné), W.Indies; *3a,b,* LV ext., RV int., ×0.5 *(124b).*

A. (Asaphinoides) Hodson, 1931 [**A. (A.) cantaurana* F. Hodson in Hodson & Hodson; OD]. Hinge plate wide, ribs few, sharply triangular in section. *L.Mio.,* S.Am.——Fig. E116,*12.* **A. (A.) cantaurana,* Venez.; *12a-c,* LV int., ext., dorsal, ×1 (Hodson & Hodson, 1931).

A. (Heteroglypta) von Martens, 1880 [**Psammobia contraria* Deshayes, 1863; M]. Anterior and posterior slopes with oblique ribs that intersect central ribs at angle, posterior ribs coarser. *Rec.,* IndoPac.——Fig. E116,*10.* **A. (H.) contraria* (Deshayes), Ind.O.; *10a,b,* RV ext., int., ×1 (Deshayes, 1863).

Ascitellina Marwick, 1928 [**A. donaciformis*; OD]. Small, posterior end short, sculpture of concentric ridges; hinge with posterior cardinals bifid, laterals weak or absent; ligament external, nymphs narrow, somewhat sunken posteriorly; pallial sinus large, nearly reaching anterior adductor, partly confluent. *Oligo.-Rec.,* S.Pac.——Fig. E116,*7.* **A. donaciformis,* Oligo., N.Z.; *7a,b,* LV ext., int., ×3 *(593).*

Heterodonax Mörch, 1853 [**Tellina bimaculata* Linné, 1758; SD Kobelt, 1881]. Rounded-quadrate to ovate, with concentric growth striae only, variously colored; hinge teeth large, laterals wanting. *Plio.-Rec.,* C.Am.-N.Am.——Fig. E116,*5.* **H. bimaculatus* (Linné), Rec., W.Indies; *5a,b,* LV ext., RV int., ×1 *(124b).*

Liodonax Fischer, 1887 [**Donax auversiensis* Deshayes, 1858; SD Cossmann & Peyrot, 1911]. Trigonal, posterior end short; sculpture of fine radial ribs except on posterior slope. *Eoc.,* Eu.——Fig. E116,*4.* **L. auversiensis* (Deshayes), France; *4a,b,* LV ext., int., ×1; *4c,* surface sculpture, enl. (Deshayes, 1860).

Macrosolen Zittel, 1883, *ex* Mayer-Eymar MS. [**Sanguinolaria hollowaysii* Sowerby, 1817; M] [=*Latosiliqua* de Gregorio, 1894 (type, *Solen plicatus* von Schauroth, 1865; OD)]. Elongate, oval, flaring behind, beaks subanterior; not gaping; posterior slope with a radial furrow; hinge with 2 diverging cardinals in either valve; ligament on a nymph; pallial sinus large. *L.Eoc.-Mio.,* Eu.-Asia-N.Afr.——Fig. E116,*9.* **M. hollowaysii* (Sowerby), Eoc., Eng.; *9a-c,* LV int., RV int., LV ext., ×0.4 (Brit.Mus.Guide, 1959).

Orbicularia Deshayes, 1850 [**Solen orbiculatus* Wood, 1828; OD] [=*Elizia* Gray, 1854 (obj.)]. Orbicular, nearly flat; pallial sinus not confluent. *Rec.,* E.Indies——Fig. E116,*8.* **O. orbiculata* (Wood), *8a,* LV ext., ×1; *8b,c,* RV and LV hinges, enl. *(124b).*

Rhectomyax Stewart, 1930 [**Asaphis undulata* Gabb, 1864; OD]. Small, ovate-quadrate, beaks nearly central; not gaping; sculpture of concentric striae except for undulating radial ribs at ends of shell; hinge with 1 cardinal in each valve and a toothlike nymph. *U.Cret.,* W.N.Am.——Fig. E116,*6.* **R. undulatus* (Gabb), USA(Calif.); *6a,b,* RV ext., RV hinge, ×4 *(892); 6c,d,* RV and LV hinges, ×5 (specimen, Univ. Calif., Los Angeles).

Subfamily SANGUINOLARIINAE Grant & Gale, 1931

[*nom. transl.* Keen, herein (*ex* Sanguinolariidae Grant & Gale, 1931)]

Smooth or nearly so, inequilateral and more or less inequivalved; pallial sinus well developed. *Mio.-Rec.*

Sanguinolaria Lamarck, 1799 [**Solen sanguinolentus* Gmelin, 1791; M] [=*Lobaria* Schumacher, 1817 (*non* Müller, 1776; obj.); *Isarcha* Gistel, 1848 *(nom.van.)* (obj.)]. Ovate; periostracum of varying development. *Mio.-Rec.,* N.Am.-S.Am.-IndoPac.

S. (Sanguinolaria). Somewhat inflated, slightly gaping, posterior end pointed; valves nearly equal in size; shell tending to be tinged with red. *Mio.-Rec.,* N.Am.-S.Am.——Fig. E117,*3.* **S. (S.) sanguinolenta* (Gmelin), *Rec.,* Carib.; LV ext., ×1 *(124b).*

S. (Hainania) Scarlato, 1965 [**S. (H.) tchangsii*; OD]. *Rec.,* E.Asia.

S. (Nuttallia) Dall, 1900 [**S. nuttallii* Conrad, 1837; OD]. Large, rounded, RV flattened; shell gaping posteriorly; hinge with posterior cardinal obsolete in LV; pallial sinus somewhat detached. *Mio.-Rec.,* E.Asia-W.N.Am.——Fig. E117,*5.* **S. (N.) nuttallii* (Conrad), Rec., USA(Calif.); RV ext., ×0.3 *(307).*

S. (Psammosphaerica) Jousseaume, 1894 [**P. psammosphaerita;* M] [=*Psammosphaerita,* spelling error]. Like *S. (Sanguinolaria)* but without any gape. *Rec.,* Ind.O.

S. (Psammotella) Herrmannsen, 1852 (*ex* de Blainville, 1826, vernac.) [**Tellina rufescens* "Chemnitz" (*nonbinom.*) (=**T. cruenta* Lightfoot, 1786; M)]. Elongate-ovate, LV flattened, somewhat rostrate posteriorly; without periostra-

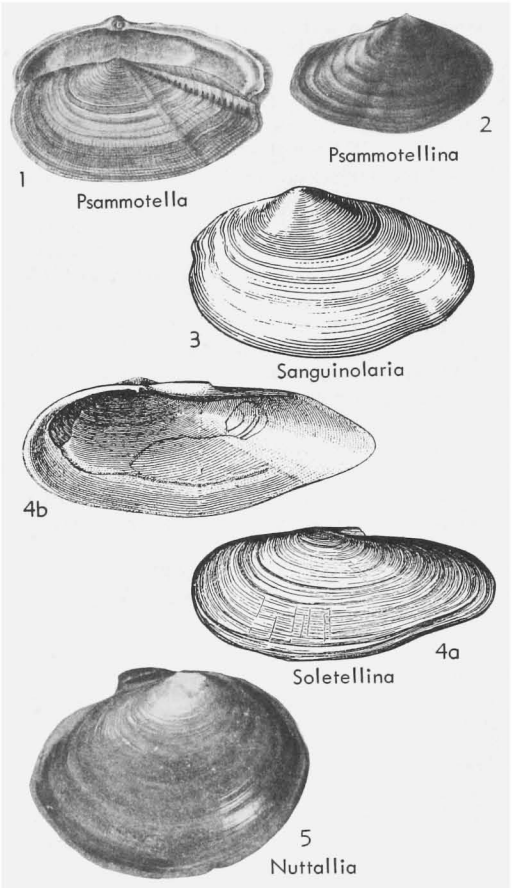


FIG. E117. Psammobiidae (Sanguinolariinae) (p. *N*633-*N*634).

cum; valves pinkish-buff in color. *Rec.*, W.C.Am. ——FIG. E117,*1*. **S. (P.) cruenta* (LIGHTFOOT), Brazil; LV ext., RV int., ×0.5 (Chemnitz, 1782).

S. (Psammotellina) FISCHER, 1887 [**Psammotella ambigua* REEVE, 1857 (*ex* DESHAYES MS); M] [=*Psammotella* H. ADAMS & A. ADAMS, 1856 (*nom. nud.*), REEVE, 1857 (*non* HERRMANNSEN, 1852); *Flavomala* IREDALE, 1936 (type, *Solen biradiatus* WOOD, 1815; OD)]. Thin, with a deciduous periostracum, asymmetrical but not rostrate posteriorly, tending to be tinged bluish-purple. *Rec.*, IndoPac.——FIG. E117,*2*. **S. (P.) ambigua* (REEVE), E.Indies; RV ext., ×0.5 (*783*).

S. (Soletellina) DE BLAINVILLE, 1824 [**S. radiata* (=**Solen diphos* LINNÉ, 1771); M] [="*Psammotaea* LAMARCK" AUCTT. (*non* LAMARCK); *Florisarka* IREDALE, 1936 (type, *F. onuphria*, =*Soletellina donacioides* REEVE, 1857; OD)]. Elongate-ovate, posterior end somewhat rostrate, ventral margin sinuate; periostracum dark-colored, shell yellowish to violet, variously rayed with darker stripes. *Mio.-Rec.*, IndoPac.——FIG. E117, *4*. **S. (S.) diphos* (LINNÉ), Rec., E.Indies; *4a*, LV ext., ×0.7; *4b*, RV int., ×0.5 (*4a, 124b; 4b, 1007*).

Family UNICARDIOPSIDAE Vokes, 1967

[=Unicardiidae FISCHER, 1887 (*partim*)] [Materials for this family prepared by ANDRÉ CHAVAN]

Shell medium-sized, transversely ovate, inflated, anteriorly produced and rounded, posteriorly truncated, very inequilateral; with prominent opisthogyrous beaks; escutcheon well marked; surface with coarse concentric ribs. Hinge showing general tellinacean tendency to develop anteriorly, with tooth *2* small oblique, *3b* tubercular and superficial, *4b* thin; semicircular resilium adjacent to prominent flat nymph; integripalliate but with superior diverticulation of posterior scar. *M.Jur.-U.Jur.*

Unicardiopsis CHAVAN, 1962 [**Unicardium aceste* D'ORBIGNY, 1850; OD]. Characters of family. *M. Jur.-U.Jur.*, Eu.——FIG. E118,*1*. **U. aceste* (D'ORBIGNY), U.Jur.(Sequan.), France; *1a*, LV int. (*112*); *1b*, LV ext., ×2 (Chavan, 1950); *1c*, RV int., *ca.* ×2 (Chavan, n).

Family QUENSTEDTIIDAE Cox, 1929

Equivalve, subequilateral, rectangular, compressed, ligament external, in long pit; hinge plate flat, narrow. *L.Jur.-M.Jur.*

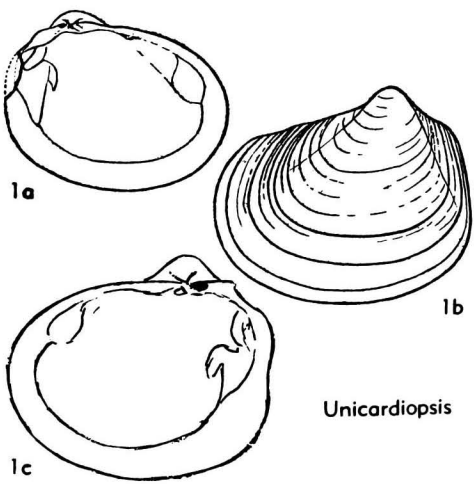


FIG. E118. Unicardiopsidae (p. *N*634).

Quenstedtia MORRIS & LYCETT, 1855 [**Pullastra oblita* PHILLIPS, 1829; SD STOLICZKA, 1871] [=*Corbicella* MORRIS & LYCETT, 1855 (type, *Corbis (C.) bathonica;* SD STOLICZKA, 1871)]. Sculpture of irregular concentric ribs; hinge with 1 cardinal in LV, socket and faint *AII* in front of it; RV with 1 socket and incipient cardinal; lateral teeth otherwise wanting; posterior adductor scars rounded, anterior elongate and sinuate; pallial sinus small, rounded. *L.Jur.-M.Jur.*, Eu.——FIG. E119,*3a*. **Q. oblita* (PHILLIPS), M.Jur., Eng.; LV ext., ×1 (Phillips, 1829).——FIG. E119,*3b,c*. *Q. rodborensis* (LYCETT, 1851), M.Jur., Eng.; *3b,c*, RV int., LV int., ×0.5 (Arkell, 1934).

Family ICANOTIIDAE Casey, 1961

Equivalve, closed, compressed, somewhat oblong, anterior and narrower; smooth to radially ribbed, especially on posterior slope; ligament on nymphs; hinge with two cardinals in either valve, no laterals; pallial sinus large, deep, rounded. *Cret.(Hauteriv.-Maastricht.)*.

Icanotia STOLICZKA, 1870 [**Psammobia impar* ZITTEL, 1865; OD]. Ovate-elongate, anterior end short; radial sculpture well-developed except on lunular and escutcheonal areas. *Cret.(Apt.-Maastricht.)*, Eu.-N.Am.-Asia.——FIG. E119,*1*. **I. impar* (ZITTEL), U.Cret., Ger.; LV ext., ×0.7 (Zittel-Eastman).

Scittila CASEY, 1961 [**S. nasuta;* OD]. Ovate-quadrate, without lunule and with incipient escutcheon; beaks subcentral, posterior margin obliquely truncate, posterior slope set off by low ridge; central slope with low radial furrow sinuating ventral margin; sculpture weak to wanting. *L.Cret. (Hauteriv.-Apt.)*, Eu.——FIG. E119,*2*. **S. nasuta*, Eng., ×1; *2a-c*, LV ext., LV and RV hinges, ×2 (Casey).

Family SCROBICULARIIDAE Adams & Adams, 1856

Resembling Semelidae, with sunken resilium, but without lateral teeth on hinge; posterior end without evident flexure *(508)*. *Eoc.-Rec.*

Scrobicularia SCHUMACHER, 1815 [**S. calcarea* (=**Trigonella plana* DA COSTA, 1778); SD BUCQUOY, DAUTZENBERG, DOLLFUS, 1898] [=*Ligula* MONTAGU, 1808 (*non* BLOCK, 1782) (obj.); *Arenaria* MEGERLE VON MÜHLFELDT, 1811 (*non* BRISSON, 1760) (obj.); *Lavignonus* FÉRUSSAC, 1821 (ex CUVIER, 1817, *vernac.*) (obj.), *Lavigno, Lavignon, Lavignona,* spelling errors; *Listera* TURTON, 1822 (obj.); *Lutricola* DE BLAINVILLE, 1824 (type, *L. compressa,* =*Trigonella plana* DA COSTA, 1778; SD KEEN, herein) (obj.); *Calcinella* DESHAYES, 1830 *(pro Ligula, partim)*; *Carinella* SOWERBY, 1839 (*non* JOHNSTON, 1833) (obj.); *Martinea* BUCQUOY, DAUTZENBERG, & DOLLFUS, 1898 (*ex* DA COSTA MS.) (obj.)]. Smooth, compressed, lenticular, with well-devloped chondrophores. *Eoc.-Rec.*, Eu.-E.Indies.——FIG. E119,*4*. **S. plana* (DA COSTA), Rec., Eu.; LV ext. showing siphons, ×1 (H. Adams & A. Adams).

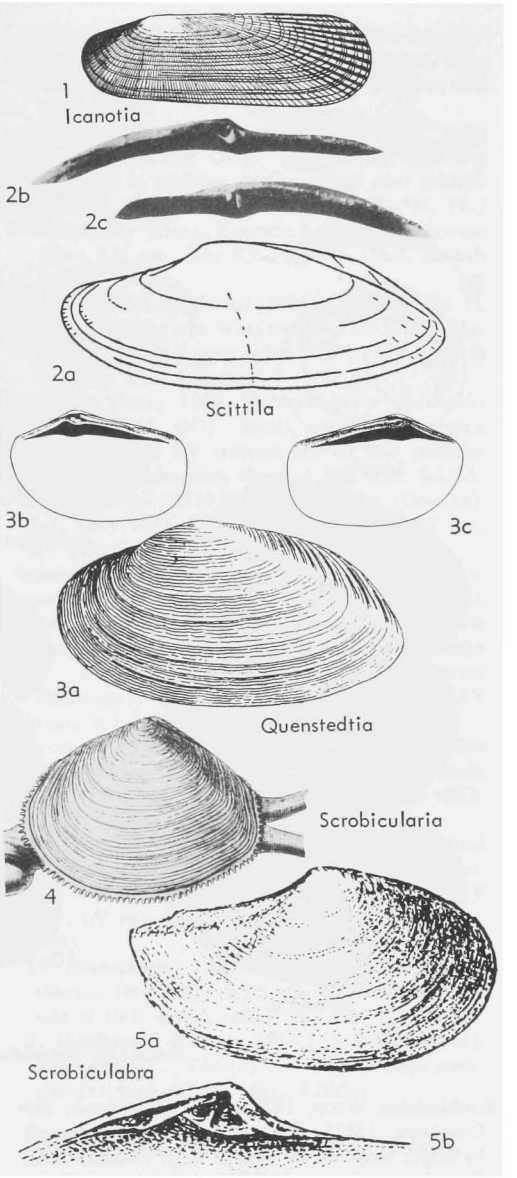


FIG. E119. Quenstedtiidae *(3)*; Icanotiidae *(1-2)*; Scrobiculariidae *(4-5)* (p. *N635-N636*).

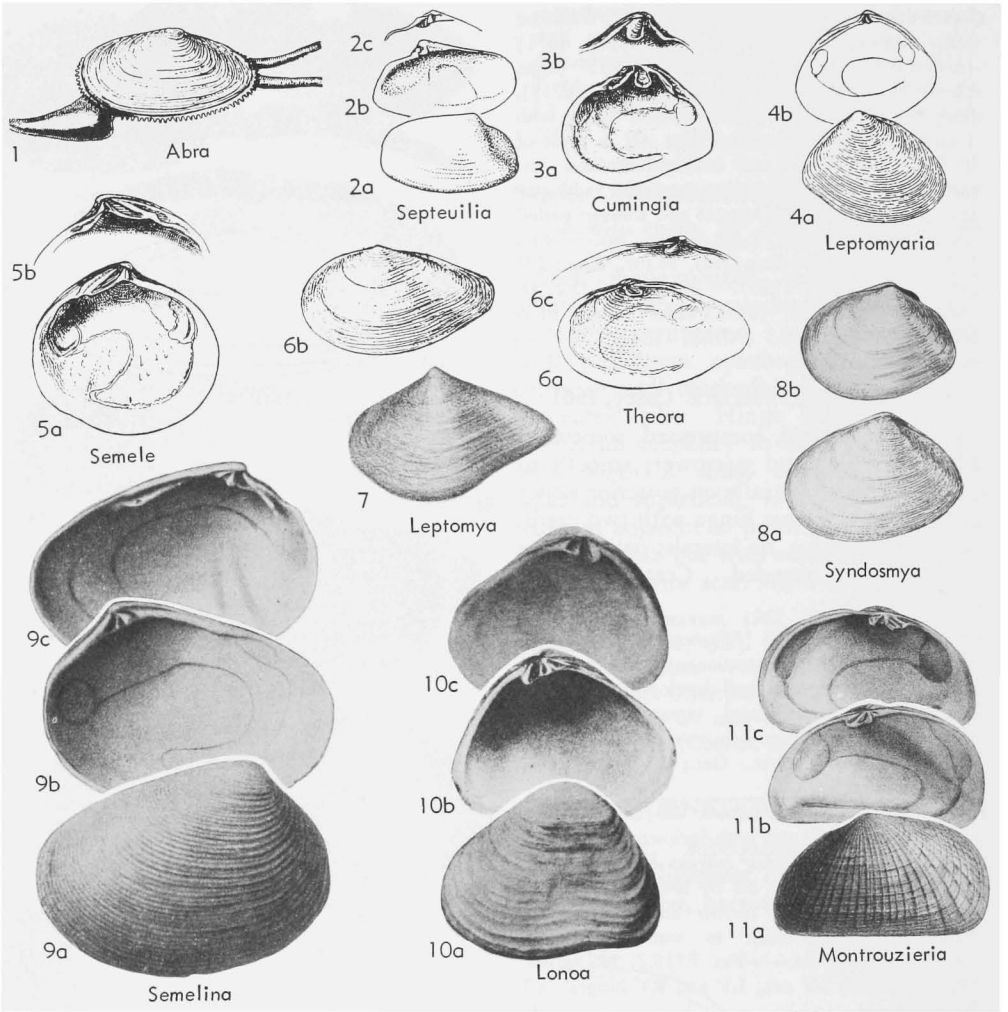


FIG. E120. Semelidae (p. *N636-N637*).

Scrobiculabra WOOD, 1877 [**S. dulwichiensis;* SD COSSMANN, 1887]. Posterior end rostrate, set off by ridge; hinge of RV with 2 large cardinal teeth. *Eoc.*, Eu.——FIG. E119,*5*. **S. dulwichiensis,* Eng.; *5a,* RV ext., ×2; *5b,* RV hinge, enl. (Wood).

Family SEMELIDAE Stoliczka, 1870

Shells mostly well sculptured, with slight posterior flexure; ligament both external and internal, resilium sunken or lodged in small chondrophore; hinge with two cardinal teeth, laterals present in most forms; pallial sinus large, rounded *(508)*. *Eoc.-Rec.*

Semele SCHUMACHER, 1817 [**S. reticulata* (=**Tellina proficua* PULTENEY, 1799); M] [=*Amphidesma* LAMARCK, 1818 (type, *A. variegata*; SD CHILDREN, 1822); *Syndesmyella* SACCO, 1901 (type, *S. plicovoides*; OD); *Elegantula* DE GREGORIO, 1884 (type, *S. fazisa,* =*Amphidesma striata* REEVE, 1853; M)]. Mostly large shells, with anterior end longer than posterior; sculpture radial, concentric, or oblique; resilium in ovoid depression of hinge plate; lateral teeth stronger in RV than in LV, cardinals subequal; pallial sinus ascending obliquely, pallial line not confluent. *Eoc.-Rec.,* N.Am.-S.Am.-Eu.-Pac.——FIG. E120,*5*. **S. proficua* (PULTENEY), Rec., Carib.; *5a,b,* LV int., RV hinge, ×1 *(7c)*.

Abra LAMARCK, 1818 (*ex* LEACH MS) (proposed in synonymy) [**Mactra tenuis* MONTAGU, 1818; SD

HERRMANNSEN, 1846] [=*Habra, nom. null.; Orixa, Dorvillea* GRAY, 1852 (*ex* LEACH, MS) (obj.; M); *Lutricularia* MONTEROSATO, 1884 (type, *Erycina ovata* PHILIPPI, 1836, *non* GRAY, 1825, =*Syndosmya segmentum* RÉCLUZ, 1843; SD CROSSE, 1885); *Abrina* HABE, 1952 (type, *Abra kanamarui* KURODA, 1951; OD)]. Thin, small resilium in a chondrophore that projects slightly into the shell cavity; pallial line partially confluent. *Eoc.-Rec.*, cosmop.

A. (Abra). Trigonal, beaks high, pointed; lateral teeth weak. *Mio.-Rec.*, Eu.-N.Am.-S.Am.-Pac.——FIG. E120,*1*. **A. (A.) tenuis* (MONTAGU), Rec., Eng.; LV ext. showing siphons and foot, ×1 *(7c)*.

A. (Iacra) H.ADAMS & A.ADAMS, 1856 [**Scrobicularia (I.) seychellarum* A.ADAMS, 1856; M] [=*Strigillina* DUNKER, 1861 (type, *S. lactea*)]. Surface divaricately sculptured; posterior flexure strong. *Rec.*, IndoPac.

A. (Syndosmya) RÉCLUZ, 1843 [**Mactra alba* WOOD, 1802; SD WOODWARD, 1854] [=*Sinodesmia, Sinodesmya, Syndesmya, Syndomya,* spelling errors]. Hinge as in *A. (Abra)* but shell more ovate; lateral teeth stronger. *Eoc.-Rec.*, E.N.Am.-Eu.——FIG. E120,*8*. **A. (S.) alba* (WOOD), Rec., Eng.; *8a,b*, LV ext., LV ext., ×1 (Forbes & Hanley, 1854).

Cumingia SOWERBY, 1833 [**C. lamellosa;* GRAY, 1847] [=*Harpax* GISTEL, 1848 *(non* PARKINSON, 1811) (obj.); *Mikrola* MEYER, 1887 (type, *M. mississippiensis*; M); *Cummingia* (spelling error)]. Outline irregular, due to nestling habit, generally rounded in front, angular posteriorly; resilifer large, cardinal teeth small, laterals large in RV, obsolescent in LV, pallial sinus partially confluent. *Eoc.-Rec.*, N.Am.-S.Am.-IndoPac.——FIG. E120,*3*. *C. mutica*, Rec., Ecuador; *3a,b*, RV int., LV hinge, ×1 (H.Adams & A.Adams, *508*).

Leptomya A. ADAMS, 1864 [**Neaera cochlearis* HINDS, 1844; SD STOLICZKA, 1871]. Smooth, posterior end more or less pointed; pallial sinus large, partially confluent. *Rec.*, S.Pac.-Japan-C.Am.

L. (Leptomya). Posterior end rostrate; lateral teeth of moderate length. *Rec.*, W.Pac-S.Pac.-W.C.Am.——FIG. E120,*7*. **L. (L.) cochlearis* (HINDS), E.Indies; LV ext., ×1 (Hanley, 1882).

L. (Leptomyaria) HABE, 1960 [**Leptomyaria trigona*; OD]. Posterior end rounded, anterior widely produced; lateral teeth long. *Rec.*, Japan.——FIG. E120,*4*. **L. (L.) trigona* (HABE); *4a,b*, RV ext., int., ×4 (Habe, 1960).

Montrouzieria SOUVERBIE, 1863 [*pro Montrouziera* SOUVERBIE, 1863 *(non* BIGOT, 1860)] [**Montrouziera clathrata;* OD] [=*Eumontrouziera* HEDLEY, 1915 (obj.)]. Small, trapezoidal, with radial striae; chondrophores triangular, external ligament short. *Rec.*, Pac.-E.Indies.

M. (Montrouzieria). Hinge with 2 cardinals in RV, 1 in LV, 1 lateral in each. *Rec.*, Pac.——FIG. 120,*11*. **M. (M.) clathrata* SOUVERBIE, Rec., N.Caledon., *11a-c*, RV ext., LV int., RV int., ×2 (Souverbie).

M. (Lonoa) DALL, BARTSCH & REHDER, 1939 [**L. hawaiiensis*; OD]. With strong concentric sculpture in addition to fine radial ribs; resilifer shelflike. *Rec.*, Pac.——FIG. E120,*10*. **M. (L.) hawaiiensis* (DALL, BARTSCH & REHDER), Hawaii; *10a-c*, LV ext., int., RV int., ×4 (Dall, Bartsch & Rehder).

M. (Thyellisca) VOKES, 1956 [*pro Thyella* H. ADAMS, 1866 (*non* WALLENGREN, 1858)] [**Thyella pulchra* H.ADAMS, 1866; OD]. Lateral teeth wanting. *Rec.*, E.Indies.

Semelina DALL, 1900 [**Amphidesma nuculoides* CONRAD, 1841; OD]. Small, sculpture concentric only; hinge of LV without laterals and posterior cardinal, chondrophore short. *L.Mio.-Rec.*, E.USA-Carib.——FIG. E120,*9*. **S. nuculoides* (CONRAD), Rec., USA(Fla.); *9a-c*, LV ext., LV int., RV int., ×4 (Gardner).

Septeuilia COSSMANN, 1914 [**Scrobicularia bezanconi* COSSMANN, 1887; SD KEEN, herein]. Small, elongate, posterior end shorter, truncate; hinge with 1 large nonbifid cardinal and a lamellar lateral in LV. *Eoc.*, Eu.——FIG. E120,*2*. **S. bezanconi* (COSSMANN), France; *2a-c*, LV ext., int., RV hinge, ×3 *(160)*.

Theora H.ADAMS & A.ADAMS, 1856 [**Neaera lata* HINDS, 1843; SD STOLICZKA, 1871]. Compressed, smooth, hyaline, with a posterior gape; hinge weak. *Rec.*, E.Indies.

T. (Theora). Adductor scars elongate; cardinal teeth present, LV with no laterals. *Rec.*, E.Indies.——FIG. E120,*6*. **T. (T.) lata* HINDS; *6a-c*, RV int., LV ext., hinge, ×1 (H.Adams & A.Adams, *508*).

T. (Endopleura) A.ADAMS, 1864 [**T. lubrica* GOULD, 1861; M]. With one cardinal bifid; inside of shell with a radial rib. *Rec.*, E.Indies.

T. (Souleyetia) RÉCLUZ, 1869 [**S. moulinsii*; M]. Resembling *T. (Theora)* but without hinge teeth; chondrophore oblique. *Rec.*, E.Indies.

Family SOLECURTIDAE d'Orbigny, 1846

[=Pharinae ADAMS & ADAMS, 1856]

Elongate-quadrate, widely gaping at both ends; hinge plate weak, narrow; pallial sinus shallow to deep *(223)*. *L.Eoc.-Rec.*

Subfamily SOLECURTINAE d'Orbigny, 1846

[*nom. transl.* GHOSH, 1920 (*ex* Solecurtidae D'ORBIGNY, 1846)]

Beaks subcentral. *L.Eoc.-Rec.*

Solecurtus DE BLAINVILLE, 1824 [**Solen strigilatus* LINNÉ, 1758; SD DESHAYES, 1829] [=*Psammosolen* RISSO, 1826 (obj.); *Macha* OKEN, 1835

(obj.); *Silex* QUOY & GAIMARD, 1835 (type, *S. albus* =*Solen rhombus* SPENGLER, 1794; M); *Cyrtosolen* HERRMANNSEN, 1848 *(nom.van. pro Solecurtus); Adasius* GRAY, 1852 (*ex* LEACH MS) (obj.); *Solecurtellus* GHOSH, 1920 (type, *Solen dombeii* LAMARCK, 1818; M]. Sculptured with

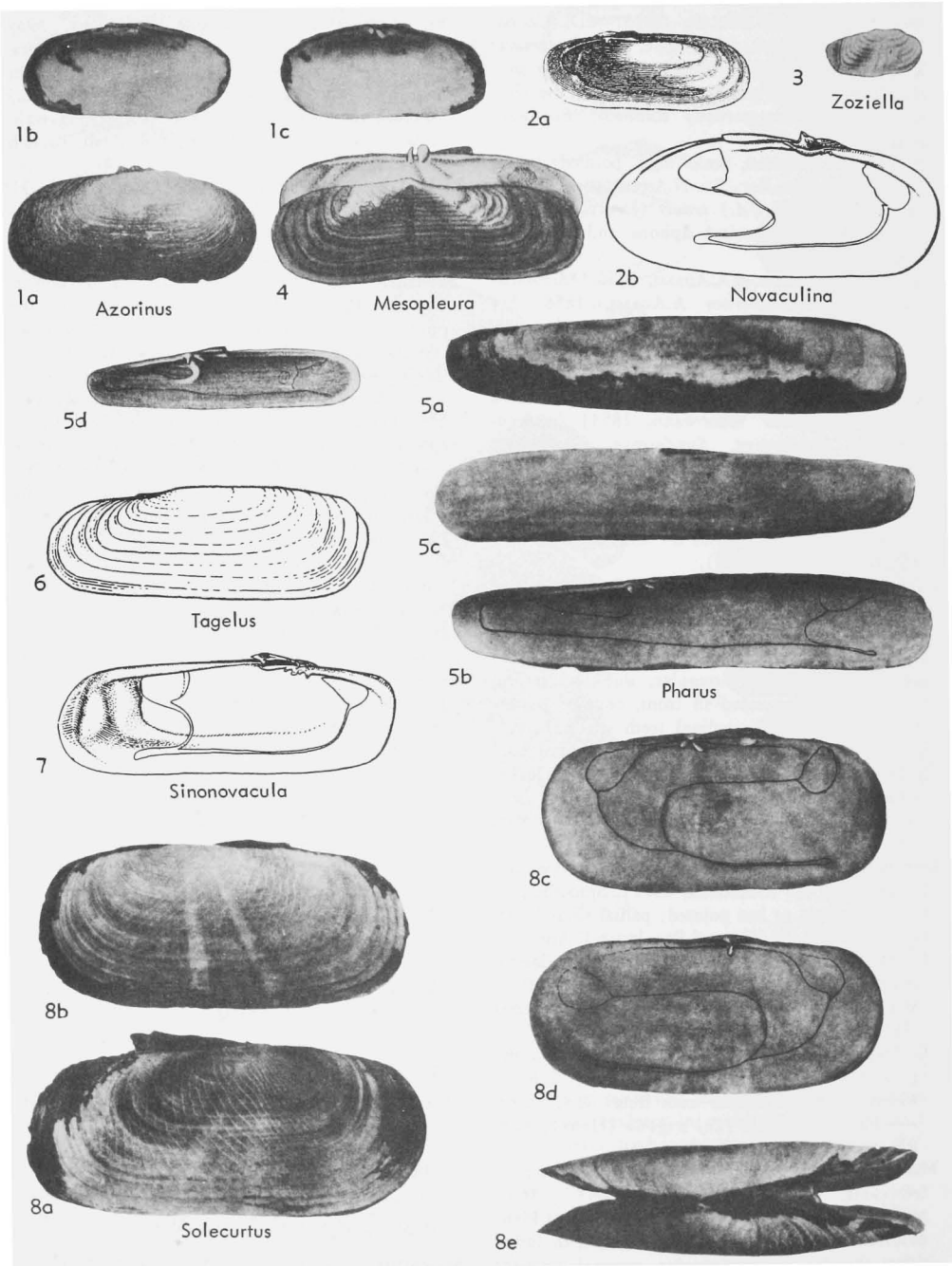


FIG. E121. Solecurtidae (Solecurtinae) *(1,3-6,8);* (Novacutininae) *(2,7)* (p. *N637-N639*).

spaced oblique striae; hinge without lateral teeth, cardinals 2 in RV, 1 in LV, pallial sinus large; ligamental nymph long. *Eoc.-Rec.,* Atl.-Pac.——Fig. E121,*8*. **S. strigilatus* (Linné), Rec., Medit.; *8a-e,* RV ext., LV ext., RV int., LV int., both valves dorsal, ×0.7 *(89a)*.

Azorinus Récluz, 1869 [**Solen coarctatus* Gmelin, 1791 (=**S. chamasolen* da Costa, 1778); M] [=*Azor* Brown, 1844 (*ex* Leach MS) (*non* Sowerby, 1824) (obj.); *Zozia* Winkworth, 1930 (obj.; OD)]. Hinge with 2 cardinal teeth in either valve. *L.Eoc.-Rec.,* Eu.-Asia.

A. (Azorinus). Surface smooth. *Plio.-Rec.,* Eu.——Fig. E121,*1*. **A. (A.) chamasolen* (da Costa), Rec., Medit.; *1a-c,* RV ext., LV int., RV int., ×0.5 *(89a)*.

A. (Zoziella) Eames, 1951 [**A. (Z.) punjabensis*; OD]. Small, with undulating concentric folds and 2 central radial furrows. *L.Eoc.,* Asia.——Fig. E121,*3*. **A. (Z.) punjabensis,* Pak., RV ext., ×1.5 *(288)*.

Pharus Brown, 1844 (in synonymy) [**Solen legumen* Linné, 1758; M] [=*Polia* d'Orbigny, 1845 (*non* Ochsenheimer, 1816) (obj.); *Ceratisolen* Forbes & Hanley, 1848 (obj.); *Erratisolen, Seratisolen* auctt. *(nom.null)*; *Artusius* Gray, 1852 (*ex* Leach MS) (obj.)]. Cylindrical, ligament subcentral, no ligamental nymph; hinge with 2 cardinals in LV, 1 in RV, long low anterior lateral and short projecting posterior lateral; pallial sinus short. *L.Mio.-Rec.,* Eu.——Fig. E121,*5*. **P. legumen* (Linné), Rec., Medit.; *5a-d,* LV ext., RV int., LV int., RV int., ×0.7 *(89a)*.

Tagelus Gray, 1847 [**"Sol. guinensis" (non Solen guinensis* Hanley, 1842) (*pro "Solen tagel* Adanson, 1757" of Gray) =**Solen adansonii* Bosc, 1801 (better known as *Solecurtus angulatus* Sowerby, 1874); OD] [=*Siliquaria* Schumacher, 1817 (non Bruguière, 1789) (type, *S. notata,* =*Solen plebeius* Lightfoot, 1786; M); *Cultellus* Conrad, 1837 (*non* Schumacher, 1817)]. Narrower than *Solecurtus,* surface smooth; periostracum present; teeth 2 in either valve, simple; pallial sinus deep, mostly reaching to or beyond vertical mid-line, partly confluent with pallial line. [Estuarine to marine.] *Oligo.-Rec.,* N.Am.-S.Am.-Eu.-W.Afr.

T. (Tagelus). Medium-sized to large, without any median rib. *Oligo.-Rec.,* N.Am.-S.Am.-Eu.-W.Afr.——Fig. E121,*6*. **T. (T.) adansonii* (Bosc), Rec., W.Afr.; RV ext., ×0.5 (Fischer-Piette, 1942).

T. (?Clunaculum) Dall, 1899 [**Solecurtus mollis* Sowerby, 1874 (*ex* Gould MS); OD]. Valves obliquely constricted; pallial sinus confluent with pallial line, not reaching beaks; posterior adductor scar triangular. *Rec.,* ?S.Am.

T. (Mesopleura) Conrad, 1868 [**Solen bidentatus* Spengler, 1794 (=**S. divisus* Spengler, 1794); SD Stoliczka, 1871] [=*Subtagelus* Ghosh, 1920 (obj.)]. Smaller and thinner than *T. (Tagelus),* with a central rib, especially in young (obsolete in some adults), showing exteriorly as dark line; pallial sinus relatively short, nymphs long. *Plio.-Rec.,* E.N.Am.-W.N.Am.-C.Am.——Fig. E121,*4*. **T. (M.) divisus* (Spengler), Rec., W.Indies; LV ext. and RV int., ×1 (Chemnitz, 1795).

Subfamily NOVACULININAE Ghosh, 1920

[*nom. correct.* Yonge, 1949 (*ex* Novaculinae Ghosh, 1920)]

Long-cylindrical, resembling Solenidae but with soft parts as in Solecurtinae; beaks nearly at anterior end, hinge with two or three cardinal teeth; pallial sinus small to large. *Rec.*

Novaculina Benson, 1830 [**N. gangetica*; M] [=*Loncosilla* Rafinesque, 1831 (type, *L. solenoides;* M); *Navaculina (nom. null.)*]. Shell width uniform throughout; periostracum present; hinge with 3 cardinals in LV, 2 in RV in most; pallial sinus of moderate depth. [Freshwater.] *Rec.,* S. Asia.——Fig. E121,*2*. **N. gangetica,* India; *2a,b,* RV int., LV int., ×1 *(1007*; Prashad, 1924).

Sinonovacula Prashad, 1924 [**Solen constrictus* Lamarck, 1818; OD]. Larger than *Novaculina,* more equivalve, beaks lower, pallial sinus shorter and broader; valves obliquely compressed near middle. [Estuarine.] *Rec.,* E.Asia.——Fig. E121,*7*. **S. constrictus* (Lamarck), IndoChina; LV int., ×0.5 (Prashad, 1924).

Family SOWERBYIDAE Cox, 1929

[=Isodontidae Arkell, 1934]

Inequilateral to oblique in outline; hinge with large lateral teeth and normally with two cardinals. *?Trias., U.Jur.*

Sowerbya d'Orbigny, 1850 [**S. crassa*; M] [=*Isodonta* Buvignier, 1851 (type, *I. deshayesia*; M); *Isodon* (*emend.* Douvillé, 1912) (*non* Say, 1822)]. Lateral teeth long and large; shell resembling *Mactra* as to form but without chondrophore; cardinal teeth 2 in either valve; pallial sinus evident, rounded. *U.Jur.(Oxford.),* Eu.——Fig. E122,*2*. **S. crassa,* France; *2a-c,* RV ext., int., LV int., ×1 (Cottreau).

?Rhaetidia Bittner, 1895 [**R. zittelii*; OD]. Resembling *Sowerbya* in outline but hinge with large lateral teeth only, no cardinals; pallial line entire. *Trias.,* Eu.——Fig. E122,*1*. **R. zittelii,* U.Trias., Alps; *1a,* RV ext., ×2; *1b,* both valves dorsal, ×2; *1c,* RV ext., ×1 (Bittner).

Family TANCREDIIDAE Meek, 1864

[Materials for this family prepared by L. R. Cox]

Shell small to medium-sized, smooth or with weak radial ornament, equivalve,

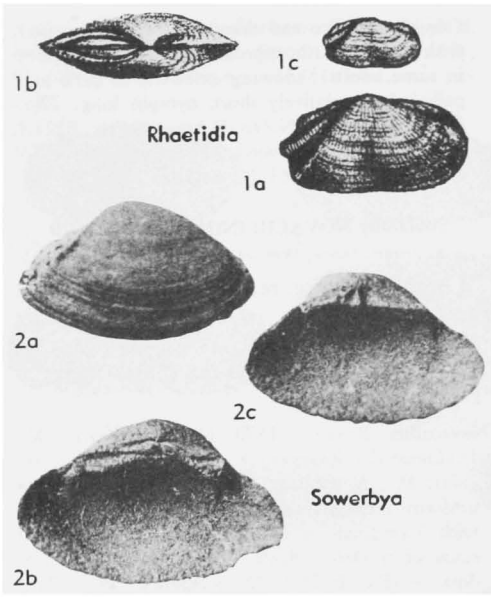


FIG. E122. Sowerbyidae (p. *N639*).

feebly to moderately inflated, ovate or subtrigonal, more or less elongate, subequilateral to strongly inequilateral, in latter case with anterior end longer; ligament external, opisthodetic, usually short; cardinal teeth fundamentally two in each valve *(2, 4b* in LV, *3a, 3b* in RV), but decreased to single tooth in one or both valves in some forms by extreme reduction of LV posterior *(4b)*, of RV anterior *(3a)*, or of both, and increased to three in some LV's of *Eodonax* by development of thin ridge *(4a?)* adjoining lunular margin; single posterior lateral *(PII)* present in LV and received, below dorsal margin of RV, in socket which may lie between two distinct lateral teeth *(PIII, PI)*; anterior laterals, if distinguishable, consisting of laminar projections from margins; adductor scars small; pallial line simple or with shallow sinus. *U.Trias.-U.Cret.*

Tancredia LYCETT, 1850, p. 407 [**T. donaciformis*; SD MORRIS & LYCETT, 1855, p. 91]. Subtrigonal, with anterior end of shell tapering to more or less acute extremity; subequilateral to strongly inequilateral; posterior margins commonly gaping; adductor scars circular or oval, subequal, placed in rather dorsal position; pallial line remote from ventral margin, bending abruptly upward posteriorly. *U.Trias.-L.Cret.*, cosmop.

T. (Tancredia) [=*Hettangia* TERQUEM in BUVIGNIER, 1852, p. 14) (type, *H. deshayesea*; SD TERQUEM, 1855, p. 290)]. Mostly rather large, subequilateral, high and obliquely truncated posteriorly, subangular anteriorly; posterior slope ridged; lunule narrow and elongate, bordered by ridge; cardinal teeth moderately strong, 2 usually distinguishable in both valves; posterior laterals relatively strong; LV anterior lateral a laminar projection of dorsal margin, RV anterior laterals rarely distinguishable. *L.Jur.(L.Lias.)-U.Jur.(Oxford.)*, cosmop.——FIG. E123,*4a-e*. **T. (T.) donaciformis* LYCETT, M.Jur.(Aalen.), France; *4a-e*, LV ext., both valves dorsal, RV int., LV int. and int. mold showing pallial line, all ×1 (Benecke, 1905).——FIG. E123,*4f,g*. *T. (T.) coxi* CHAVAN, U.Jur.(U.Oxford.), France; *4f,g*, RV int., LV int., ×10 (Chavan, 1950).

T. (Corburella) LYCETT, 1850, p. 422 [**Corbula curtansata* PHILLIPS, 1829, p. 128; OD]. Medium-sized subequilateral, high and rounded posteriorly, rostrate anteriorly, ventral margin sinuate; posterior slope not ridged; no lunule; only 1 cardinal tooth in each valve; LV posterior lateral small but elongate; anterior laterals not distinguishable. *M.Jur.-U.Jur.*, cosmop.——FIG. E123,*6*. **T. (C.) curtansata* (PHILLIPS), U.Jur.(Oxford.), Eng.; LV ext., ×1 *(19f)*.

T. (Isotancredia) CHAVAN, 1950, p. 12 [**Tancredia extensa* LYCETT, 1850, pl. 11, fig. 9; OD]. Small, elongate, subtrigonal, subequilateral, with dorsal margins straight and sloping, anterior more steeply than posterior; posterior end of shell rather low, obliquely truncated, anterior end cuneiform; posterior slope ridged; cardinal teeth 1 in each valve; posterior laterals moderately prominent; RV anterior lateral present but weak. *M.Jur.-U.Jur.*, cosmop.; *L.Cret.*, S.Afr.—FIG. E123,*2*. **T. (I.) extensa* LYCETT, M.Jur.(Bathon.), Eng.; LV ext., ×1 (Morris & Lycett, 1855).

T. (Paratancredia) CHAVAN, 1950, p. 12 [**T. (P.) brasili*; OD]. Small to medium-sized, compressed, inequilateral, less elongated than in other subgenera, high and obliquely truncated posteriorly, tapering to some extent anteriorly, although less than in other subgenera; cardinal teeth 2 in each valve, anterior ones elongated; posterior laterals small, RV anterior lateral distinct, elongate. *M.Jur.-U.Jur.*, cosmop.——FIG. E123,*1*. **T. (P.) brasili*, U.Jur.(Oxford.), France; *1a,b*, LV int., RV int., ×3, ×7 (Chavan, 1950).

T. (Palaeomya) ZITTEL & GOUBERT, 1861, p. 194 [**Palaeomya deshayesi* ZITTEL & GOUBERT, 1861 (*non* BUVIGNIER) (=**Tancredia corallina* ZITTEL, 1881, p. 97); M] [=*Rosenbuschia* RÖDER, 1882, p. 97 (type, *R. typica*; M)]. Elongate, very inequilateral, anterior end much longer than posterior end, tapering; LV anterior cardinal an elongate lamina; posterior laterals prominent; RV anterior lateral distinct, elongate. *L.Jur.-U.Jur.*, cosmop. ——FIG. E123,*3*. **T. (P.) corallina* (ZITTEL & GOUBERT), U.Jur.(Oxford.), France; *3a-c*, RV

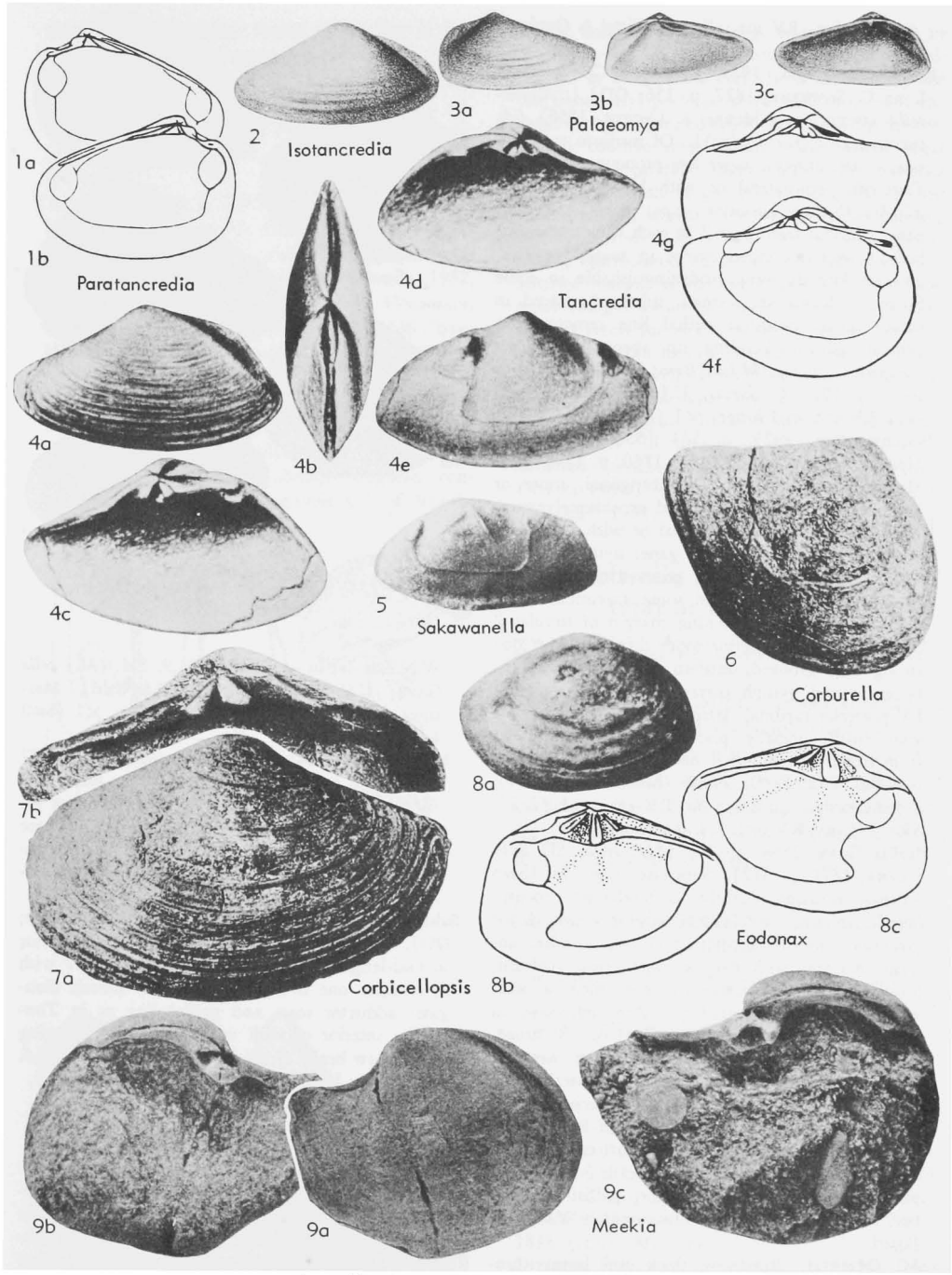


FIG. E123. Tancrediidae (p. *N640-N642*).

ext., LV int., RV int., all ×2 (Zittel & Goubert, 1861).

Corbicellopsis Cox, 1929, p. 577 [**Corbis laevis* J. DE C. SOWERBY, 1827, p. 156; OD] [=*Corbicella* AUCTT. (*non* MORRIS & LYCETT, 1855) (cf. synonymy of *Quenstedtia*)]. Of medium to large-size, ovate, anterior taper less pronounced than in *Tancredia;* equilateral or with beaks anterior to mid-length; no posterior gape; nymphs prominent; cardinal teeth 1 or 2 in each valve; posterior laterals well developed except in smaller species; anterior laterals weak, indistinguishable in some forms; adductor scars small, subequal, placed in rather dorsal position; pallial line remote from ventral margin, bending up abruptly to meet posterior adductor. *M.Jur.(Bajoc.)-L.Cret.*, Eu.——FIG. E123,*7*. **C. laevis,* U.Jur.(Oxford), Eng.; *7a,b,* RV ext. and hinge, ×1 *(19f)*.

Eodonax Cox, 1929, p. 584 [**Sowerbya dukei* MORRIS & LYCETT in DAMON, 1860, p. 172; OD]. Medium-sized, subovate or subtrigonal, more or less pointed anteriorly, rounded or obliquely truncated posteriorly; subequilateral or with beaks just posterior to mid-length; no gape; nymphs prominent; 2 moderately strong, grooved cardinal teeth in LV, also thin ridge in some specimens (possibly 3rd cardinal) adjoining margin of lunule; 2 cardinals in RV, anterior tooth thin, posterior one strong and grooved, median ridge in recess between it and nymph corresponding to groove in LV posterior cardinal; lateral teeth weak; adductor scars small, dorsally placed; pallial line remote from margin, with small sinus. *U.Jur.-L.Cret.*, Eu.——FIG. E123,*8*. **E. dukei* (MORRIS & LYCETT), U.Jur.(Portland.), Eng.; *8a,* LV ext., ×1 *(171)*; *8b,c,* LV int., RV int., ×1 (Cox, n).

Meekia GABB, 1864, p. 191 [**M. sella*; SD STOLICZKA, 1871, p. 312]. Subovate except for sharp anterior rostrum, slightly to moderately inequilateral, anterior end shorter; valve margins closed posteriorly in earlier, gaping in later species; anterior margins with narrow gape below rostrum; lunule lanceolate; surface unornamented or with weak radial lines; cardinal teeth 2 in each valve, on short hinge plate, anterior cardinal of LV broad, prominent, received in deep socket between smaller, subequal cardinals of RV; posterior cardinal of LV parallel to nymph; posterior laterals weak, 1 in LV received between 2 in RV; no anterior laterals; shelly internal buttress runs in anteroventral direction from beneath hinge plate, passing below anterior adductor, pallial line entire. *L.Cret.(Alb.)-U.Cret.(Maastricht.)*, W.N.Am.-Japan.

M. (Meekia). Relatively thick and heavy; pronouncedly rostrate, with strongly concave anterodorsal margin; inflation moderately strong; surface with more or less distinct radial ornament and with microscopic punctations; anterior cardinal of LV peglike. *Cret.(Alb.-Maastricht.)*, W.N.Am.-Japan.——FIG. E123,*9*. **M. (M.) sella* GABB, U.Cret.(Maastricht.), USA(Calif., Martinez), *9a-c,* LV ext., LV int., RV int., ×1 (Saul & Popenoe, 1962).

M. (Mygallia) SAUL & POPENOE, p. 962, p. 302 [**Meekia mygale*; OD]. Differs from *M. (Meekia)* in thinner, more elongated and less inflated shell, less marked anterior rostrum, absence of surface punctations, and more elongate anterior cardinal tooth of LV. *Cret.(Alb.-Maastricht.)*, W.N.Am.-Japan.

Sakawanella ICHIKAWA, 1950, p. 245 [**S. triadica*; OD]. Small elongate-oblong, beaks just anterior to mid-length; LV with 1 cardinal tooth, RV with 2, anterior one ill-defined; posterior laterals elongate; adductor scars and pallial line as in *Tancredia*; interior of shell with 2 grooves diverging from below beak. *U.Trias.*, Japan.——FIG. E123,*5*. **S. triadica*; LV int. mold, ×2 (Ichikawa, 1950).

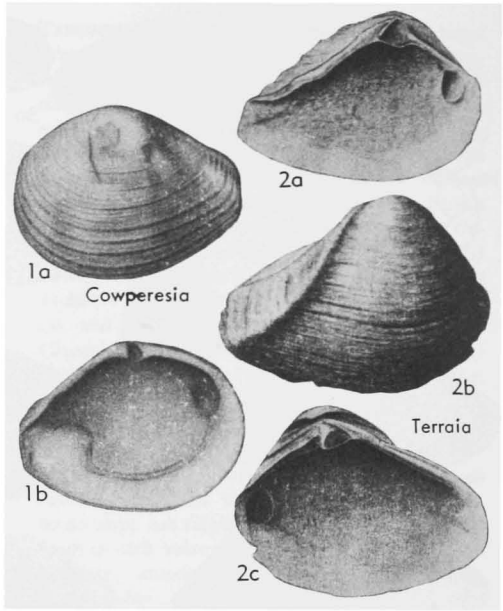


FIG. E124. Superfamily and family Uncertain (p. *N642-N643*).

Doubtful TELLINACEA

Cowperesia MENDES, 1952, p. 86 [**Pseudocorbula anceps* REED, 1935, p. 34; OD]. Suboval or subtriangular, tapering posteriorly; equivalve or slightly inequivalve; umbones low, orthogyre, submedian; surface ornamented with concentric ridges or relatively smooth; posterior umbonal ridge rounded; lunule and escutcheon obscure; dentition consisting of 1 cardinal tooth below beak of RV and corresponding socket; shallow pallial sinus present. [In view of CHAVAN, this genus is refer-

able to the Tellinidae. KEEN agrees that it may be an ancestral tellinacean but considers it inappropriately classifiable in the Tellinidae.] *Permo-Trias.*, S.Am.(S.Brazil).——FIG. E124,*1*. **C. anceps* (REED), Corumbatai, Passa Dois F., S.Brazil; *1a,b*, LV ext. and int., ×2 (Mendes, 1952). [NEWELL]

Terraia Cox, 1934, p. 269 [**Solenomorpha altissima* HOLDHAUS, 1919, p. 12; OD] [=*Jacquesia* MENDES, 1944, p. 62 (type, *Myophoriopis brasiliensis* REED, 1929; OD); *Holdhausiella* MENDES, 1952, p. 94 (type, *Sanguinolites elongatus* HOLDHAUS, 1919; OD); *Maackia* MENDES, 1954, p. 100 (type, *M. contorta;* OD); *Oliveiraia* MENDES, 1954, p. 103 (type, *Thracia pristina* REED, 1929; SD NEWELL, herein)]. Trigonally ovate, thick-shelled, equivalve, inequilateral, not greatly inflated; posterior end tapering to low, vertically truncated extremity, without gape; umbones obtusely angular, contiguous, placed at about anterior 0.3 of length; lunule and escutcheon long, narrow, limited by carinae which in most specimens are sharp, although in some shells escutcheon carina may die out posteriorly; posterior slope with prominent elevated carina, separated from escutcheon by narrow, slightly concave area; surface with growth rugae which may produce denticulations on posterior carina; RV with single blunt tooth placed just behind umbo, narrow shallow groove separating this tooth from short nymph, which supported external, opisthodetic ligament; between tooth and anterior margin is shallow triangular recess; posterior margin somewhat thickened; LV with deep median recess for reception of RV tooth, bordered by narrow weak tooth separated by shallow groove from nymph; well-defined lateral teeth lacking; anterior adductor with low reinforcing buttress (clavicle); pallial line simple. *Permo-Trias.*, S.Am.(Brazil-N.Uruguay).——FIG. E124,*2*. **T. altissima* (HOLDHAUS), Estrada Nova F., Urug. (Rivera Prov.); *2a-c*, LV int., RV ext., RV int., ×2 (Cox, 1934). [NEWELL]

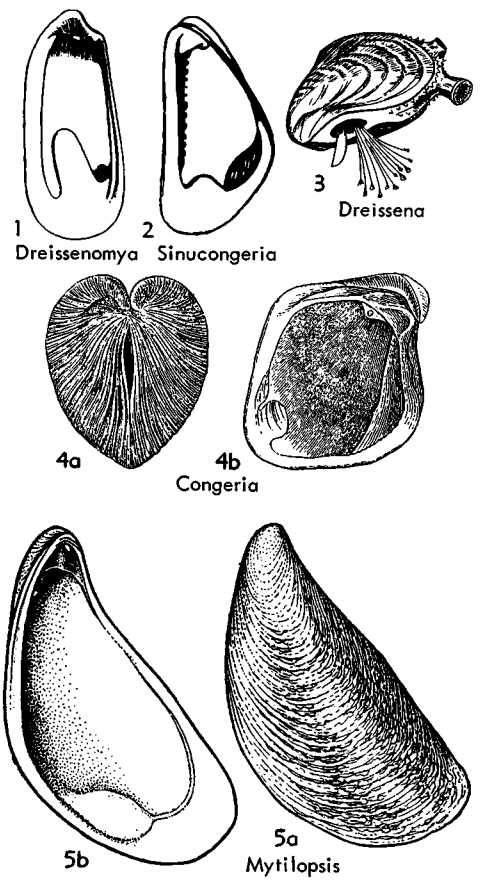


FIG. E125. Dreissenidae (p. *N*644).

Superfamily DREISSENACEA Gray in Turton, 1840

[*nom. transl.* GILL, 1871 (*ex* Dreissenidae GRAY in Turton, 1840)] [Materials for this superfamily prepared by MYRA KEEN]

Mytiliform to quadrate, beaks anterior or terminal; interior of shell not nacreous; ligament sunken, hinge edentulous; beak cavity bridged by septum or myophore; posterior adductor muscle scar long; periostracum well developed. Animal byssiferous; siphons two; gills reticulate. *Eoc.-Rec.*

Family DREISSENIDAE Gray in Turton, 1840

[*nom. correct.* GRAY, 1847 (*ex* Dreissenadae GRAY in Turton, 1840)]

Characters of superfamily. *Eoc.-Rec.*

Dreissena BENEDEN, 1835 [*nom. correct.* ICZN Op. 872 (*pro Driessena* BENEDEN, 1835)] [**Mytulus polymorphus* PALLAS, 1771 *(errore pro Mytilus)*; M] [=*Tichogonia* ROSSMAESSLER, 1835 (obj.); *Dithalmia* JAY, 1835 *(nom. nud.); Mytilina* CANTRAINE, 1837 (*non* BORY DE ST. VINCENT, 1824) (obj.); *Coelogonia* BRONN, 1837 (type, *Mytilus brardii* BRONGNIART, 1823; M); *Mytilomya* BRONN, 1838 (obj.); *Mytolimax* SCHAUFUSS, 1869 (obj.); *Dreisena, Dreisseina, Dreissencia, Dreissenia, Dreissensa, Dreissensia, Dreissina, Dreistena, Dreysseina, Dreyssena, Dreyssensia, Dreyssentia, Driessensia* AUCTT. *(nom.null.)*]. Mytiliform, anteriorly compressed, with periostracum; septum with single adductor muscle scar. *Eoc.-Rec.*, Eu.-Afr.

D. (Dreissena). Smooth, pallial line entire. *Eoc.-Rec.*, Eu.-Afr.——Fig. E125,*3*. **D. (D.) polymorpha* (Pallas), Rec., Eu.; oblique anteroventral view of entire animal, ×1 (Fischer).

D. (Dreissenomya) Fuchs, 1870 [**Dreissenomya schroeckingeri*; OD] [=*Congeriomya* Andrussov, 1897 *(nom.van.)*; *Dreissensiomya* Fischer, 1886 *(nom. null.)*; *Dreyssenomya* Neumayr, 1891 *(nom.null.)*;]. Septum obsolescent; pallial line deeply sinuate: *Plio.*, E.Eu.——Fig. E125,*1*. **D. (D.) schroeckingeri* (Fuchs), Hungary, RV int., ×0.5 (Papp).

D. (Prodreissensia) Rovereto, 1898 [**D. (P.) perrandoi*; OD]. Shell sculptured with longitudinal ribs. *Oligo.(Tongr.)*, Eu.

D. (Sinucongeria) Lörenthey, 1894 [**Congeria arcuata* Fuchs, 1870; OD]. Like *D. (Dreissenomya)* but more trigonal, septum larger, pallial sinus smaller. *Plio.*, E.Eu.——Fig. E125,*2*. **D. (S.) arcuata* (Fuchs), Hungary; RV int., ×1 (Papp).

Congeria Partsch, 1835 [**C. subglobosa*; SD Pilsbry, 1911] [=*Enocephalus* Münster, 1831 *(nom. nud.)*]. Quadrate, smooth, thick-shelled; septum with 2 scars, for anterior adductor and pedal retractor muscles; pallial line entire. *L.Oligo.-Plio.*, Eu.-W.Asia.——Fig. E125,*4*. **C. subglobosa*, Mio., Aus.; *4a,b*, ant. view of both valves, LV int., ×0.3 (Fischer).

Mytilopsis Conrad, 1858 [**Mytilus leucophaeatus* Conrad, 1831; SD Dall, 1898] [=*Praxis* H. Adams & A. Adams, 1857 (*non* Guenèe, 1852); *Mytiloides*, spelling error)]. Mytiliform, as in *Dreissena*, but septum backed by a myophore with 2 scars, as in *Congeria*. *U.Oligo.-Rec.*, W.S.Am.-Eu.-Afr.-E.Indies.——Fig. E125,*5*. **M. leucophaeatus* (Conrad), Rec. USA(Va.); *5a,b*, RV ext., LV int., ×1.5 (Keen, n).

Superfamily GAIMARDIACEA Hedley, 1916

[*nom. transl.* Fleming, herein (*ex* Gaimardiidae Hedley, 1916)] [Materials for this superfamily prepared by C. A. Fleming]

Small, thin, equivalve, ventricose, with anterior beaks, surface smooth or radially ribbed; integripalliate; anterior retractor separate from adductor. Ligament external or sunken, opisthodetic; hinge weak, basically with single LV cardinal and bifid RV cardinal (tooth *1* invariably beneath bifid *3*), LV and RV anterior laterals and LV posterior lateral varyingly reduced. Foot byssiferous, with creeping disc; mantle triforic, fry developed in gills. [Commonly attached to floating seaweed.] *(685, 908.) Mio.-Rec.*

Family GAIMARDIIDAE Hedley, 1916

[*nom. correct.* Odhner, 1924, p. 63 (*pro* Gaimardiadae Hedley, 1916, p. *26*, *nom. imperf., nom. subst. pro* Modiolarcidae, *nom. correct. pro* Modiolarcadae J. E. Gray in M. E. Gray, 1857, p. 25)] [Materials for this family prepared by C. A. Fleming, New Zealand Geological Survey]

Characters of superfamily. *Mio.-Rec.*

Gaimardia Gould, 1852, p. 459 [**Modiola trapesina* Lamarck, 1819, p. 114; M] [=*Modiolarca* Gray, 1847, p. 199 (*non* Gray, 1843, p. 259) (obj.); *Phaseolicama* Rousseau, 1854, p. 116 (type, *P. magellanica*; M); *Gaimarda* Gray, 1855, p. 108; *Phascolicama* Gray, 1855, p. 108]. Trapezoid, smooth, anteriorly rostrate, up to 32 mm. long, generally gaping anteroventrally. Teeth commonly reduced; anterior and posterior accessory marginal teeth in some species. *L.Pleist.-Rec.*, N.Z.-Patagonia-Subantarct. Is.——Fig. E126,*4*. **G. trapesina* (Lamarck), Rec., Magellan Strait; *4a-c*, RV ext., LV int., RV int., ×3 (C. A. Fleming, n).

Costokidderia Finlay, 1927, p. 457 [**Kidderia costata* Odhner, 1924, p. 68; OD]. Resembling *Kidderia* but with strong radial ribs on median and posterior parts of shell, imbricated by growth striae and crenulating margins. *U.Pleist.-Rec.*, N.Z.——Fig. E126,*2*. **C. costata* (Odhner), Rec., Auckland Is.; *2a,b*, LV ext., RV int., ×9 *(685)*.

?Eugaimardia Cotton, 1931, p. 63 [*pro Neogaimardia* Cotton, 1931, p. 341 (*non* Odhner, 1924, p. 64)] [**Neogaimardia perplexa* Cotton, 1931, p. 341; M]. Similar to *Neogaimardia* but lacking ventral sinuosity and anterior rostrum; hinge more robust, veneriform; ligament external. [Systematic position doubtful.] *Rec.*, S.Australia.——Fig. E126,*3*. **E. perplexa* (Cotton); *3a,b*, RV ext., hinge, ×9 (B. C. Cotton).

Kidderia Dall, 1876, p. 46 [**K. minuta;* M]. Small, solid, elongate-oval, lacking ventral sinuosity and gape of *Gaimardia*, with sunken subinternal ligament; some species not rostrate. *Mio.-Rec.*, N.Z.-Fuegia-Subantarctic Is.——Fig. E126,*1*. **K. minuta*, Rec., Kerguelen; *1a-c*, RV ext., RV int., LV int., ×9 (C. A. Fleming, n).

Neogaimardia Odhner, 1924, p. 64 [**Kellia rostellata* Tate, 1889, p. 63; OD]. Small, rostrate, with anteroventral sinus and gape; ligament internal; right cardinal embraced by hooklike left cardinal; accessory marginal teeth present. *L.Pleist.-Rec.*, N.Z.-S.Australia.——Fig. E126,*5*. **N. rostellata* (Tate), Rec., Victoria; *5a,b*, LV and RV hinges showing accessory marginal teeth *(a-c, a_1, b_1)* and teeth (Bernard's notation), ×9 *(685)*.

Superfamily ARCTICACEA Newton, 1891

[*nom. transl.* Habe, 1951 (*ex* Arcticidae Newton, 1891)] [=Trapezacea Habe, 1951] [Materials for this superfamily prepared by Myra Keen with additions as recorded]

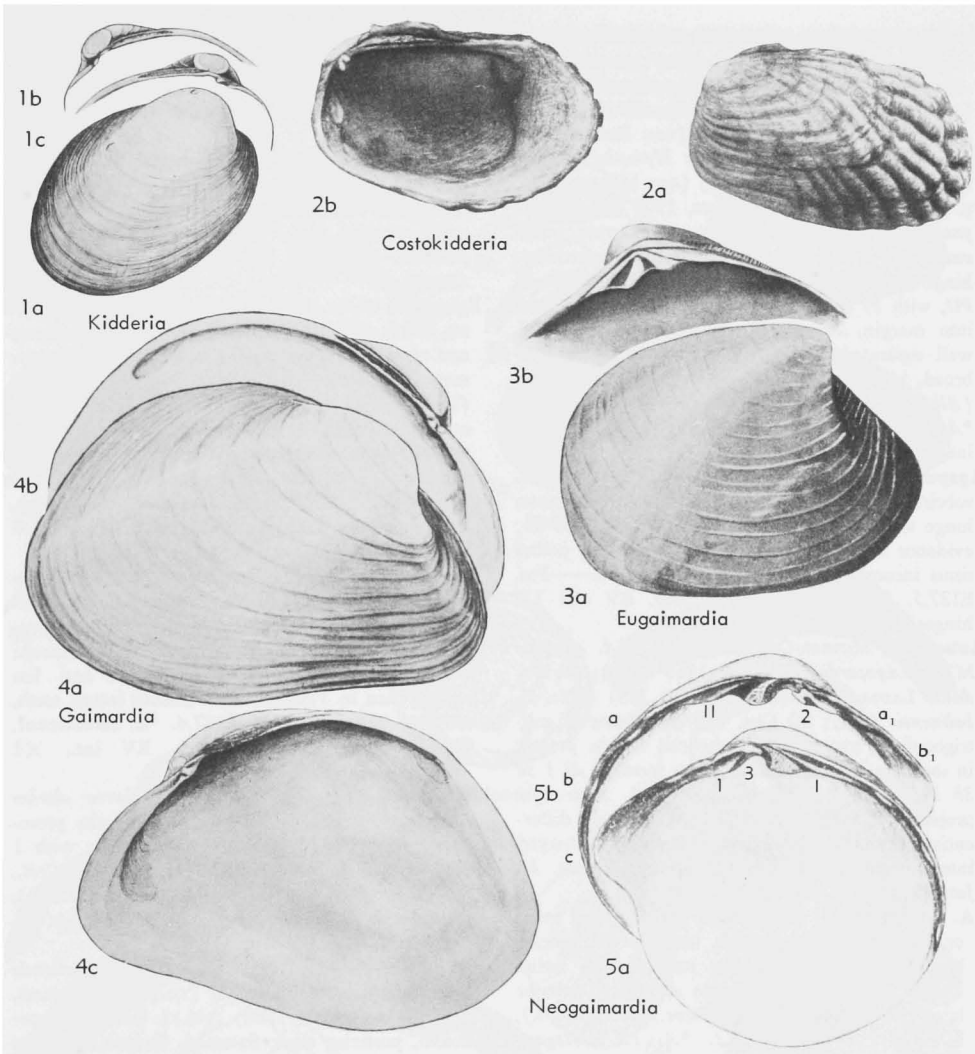


FIG. E126. Gaimardiidae (p. *N*644).

Shells inequilateral, mostly equivalve, beaks well forward, spirally twisted only in a few; surface smooth or with some concentric (rarely any radial) ribbing; ligament external; hinge of the form termed cyprinoid by authors, having two or three cardinal teeth in each valve and well-developed laterals in most; teeth tending to radiate from beaks; pallial line normally entire (sinuate in few). *M.Dev.-Rec.*

Family ARCTICIDAE Newton, 1891

[=Cyprinidae D'ORBIGNY, 1844 (*non* BONAPARTE, 1841); Venilidae DALL, 1889; Veniellinae DALL, 1895] [Family-group names based on *Cyprina* LAMARCK, 1818 and *Venilia* MORTON, 1833 are invalid (Code, Art. 11e)] [Materials for this family prepared by MYRA KEEN and RAYMOND CASEY]

Equivalve, inequilateral, closed; shell evenly inflated or with lateral carinae; sculpture, if present, mostly of fine concentric riblets (radial threads in a few); ligament on nymphs, insertion grooves incised; hinge formula=*AI AIII 3a 1 3b 5b PI PIII/AII 2a 2b 4b PII PIV,* not all teeth fully developed, especially *AII 1 5b, PI PIII 2a, PII* and *PIV;* valve margins smooth within or feebly crenulate; adductor muscle scars subequal; pallial line entire or slightly sinuate. *U.Trias.-Rec.*

Arctica SCHUMACHER, 1817 [**A. vulgaris* (=**Venus islandica* LINNÉ, 1767); M] [Not preoccupied by *Arctica* MÖHRING, 1758 (ICZN, rejected work)] [=*Cyprina* LAMARCK, 1818 (obj.; SD CHILDREN, 1823); *Armida* GISTEL, 1848 (*non* RISSO, 1826) (obj.); *Asmidia (nom. null.); Nympha* MÖRCH, 1853 (p. 36, in synon.) (obj.) (*non* MÖRCH, 1853, p. 25); *Cypriniadea* ROVERETO, 1900 *(nom. van., pro Cyprina)* (obj.)]. Solid, smooth, ovate, periostracum well developed; no lunule or escutcheon; hinge formula, *AI AIII 3a 1 3b PI/AII 2a 2b 4b PII,* with *PI* elongate, its edge striate, *PII* merged into margin, *2a* scarcely differentiated from *AII,* well separated from *2b, 1* small, tubercular, *3b* broad, bifid, *AI* and *AII* short, crenulate. *L.Cret. (Alb.)-Rec.,* Eu.-N.Atl.-N.Am.——FIG. E127,*1*. **A. islandica* (LINNÉ), Plio., Eng.; *1a,b,* RV ext., int., ×0.3 (Wood, 1853).

Agapella VOKES, 1946 [**A. rotunda*; OD]. Smooth, subcircular to subovate, with prominent umbones; hinge with narrow *3b* and large hook-shaped *2b;* evidence as to posterior lateral teeth and pallial sinus incomplete. *L.Cret.(Apt.),* SW.Asia.——FIG. E127,*5*. **A. rotunda,* Syria; *5a,b,* RV and LV hinges, ×1.5 (after *945*).

Anisocardia MUNIER-CHALMAS, 1863 [**A. elegans;* M] [=*Apocardia* DOLLFUS, 1863 (obj.); *Cardiodonta* LAUBE, 1867 (*ex* STOLICZKA MS) (type, *C. balinensis* (?M); SD COX, 1947)]. Ovate to subtrigonal or trapezoidal; superficial lunule present in some but no escutcheon; hinge formula *AI 1 3a 3b PI/AII 2a 2b PII,* with *3b* bifid, *1* strongly projecting, *2b* chevron-shaped, *2a* not well differentiated from *AI, PI* strong, elongate, *PII* merged into margin; pallial line posteriorly truncate. *M. Jur.(Bajoc.)-L.Cret.(Apt.),* Eu.-Afr.

A. (Anisocardia). Subtrigonal, posterior end more or less truncate or rostrate, umbones prominent, beaks strongly prosogyrate; surface with radial threads; inner ventral margin crenulate; anterior lateral teeth short. *M.Jur.(Bajoc.)-L.Cret.(Apt.),* Eu.-E.Afr.——FIG. E127,*3*. **A. (A.) elegans* MUNIER-CHALMAS, U.Jur.(Kimmeridg.), France; *3a,* LV ext., ×0.7 *(1026); 3b,c,* LV and RV hinges, ×1 (Cox, 1947).

A. (Antiquicyprina) CASEY, 1952 [**Cyprina loweana* MORRIS & LYCETT, 1854; OD]. Ovate, with trapezoidal tendency and obtuse posterior carina; hinge with anterior lateral teeth longer than in *A. (Anisocardia),* tooth *1* less prominent. *M.Jur.(Bathon.),* Eu.——FIG. E127,*9*. **C. sarthaloweana* (MORRIS & LYCETT), Eng.; *2a,* LV ext., ×0.7; *2b,c,* RV and LV hinges, ×0.7 *(92)*.

A. (Collignonicardia) MAHMOUD, 1955 [**A. (C.) simplex;* OD]. Sculpture of fine, serrate concentric riblets; shell trigonal, with blunt posterior carina; hinge unknown. *Cret.,* Egypt.

Coelocyprina DOUVILLÉ, 1921 [**C. sarthacensis;* OD]. Trigonal-ovate, globose, with faint radial striae, inner ventral margin crenulate; lunule deeply sunken, inhibiting development of anterior hinge teeth; posterior lateral teeth not observed. *M.Jur.(Bathon.),* Eu.——FIG. E127,*9*. **C. sarthacensis,* France; LV int., ×0.7 (after Douvillé, 1921).

Dietrichia RECK, 1921 [**D. parvula;* OD]. Ovate, smooth, evenly inflated; lunule deep; dentition imperfectly known, posterior lateral teeth apparently wanting. *Jur.,* E.Afr.——FIG. E127,*6*. **D. parvula; 6a,b,* RV int., both valves ant., ×2 (Reck).

Epicyprina CASEY, 1952 [**Venus angulata* J. SOWERBY, 1814; OD]. Ovate, with trapezoidal tendency and obtuse posterior ridge; escutcheon deep, narrow, limited by sharp carinae; hinge formula, *AI (III) 1 3a 3b PI/AII 2a 2b 4b PII,* with *1* strong, conical, anterior to *3a,* anterior laterals rugose, nymphs with interlocking rugosities; pallial line simple. *L. Cret.(Apt.-Alb.),* Eu.-Afr.-W. Indies-S. Am.——FIG. E127,*8*. **E. angulata* (SOWERBY), Alb., Eng.; *8a,* LV ext., ×0.3; *8b,c,* RV and LV hinges, ×1 *(92)*.

Etea CONRAD, 1875 [**E. carolinensis;* M]. Elongate-subovate, tapering and truncate posteriorly, umbones well forward, posterior ridge strong, posterior area flat or concave; no lunule or escutcheon; hinge longer, narrower, less massive and less arched than in *Veniella,* with smooth lateral teeth. *U.Cret.,* N.Am.——FIG. E127,*4*. **E. carolinensis,* USA(N.Car.); *4a,b,* LV ext., RV int., ×1 (Stephenson).

?Fissilunula ETHERIDGE, 1902 [**Cytherea clarkei* MOORE, 1870; M]. Large, massive, beaks prosogyrate; lunule with median sulcus; hinge with 1 cardinal in RV; pallial sinus present, small. *U.Cret.,* Australia.——FIG. E127,*11*. **F. clarkei* (MOORE), New S. Wales; *11a,b,* RV hinge, RV ext., ×0.3, ×0.2 (Etheridge, 1902).

Hartwellia KITCHIN, 1926 [**Astarte hartwellensis* J. DE C. SOWERBY, 1845; M] [=*Atalanta* SEELEY, 1864 (*non* MEIGEN, 1800) (obj.)]. Ovate or trapezoidal, posterior slope flattened, limited by ridge; beaks small and pointed; lunular area excavated, bounded by overhanging ridges; escutcheon deep, with carinate edges; sculpture *Astarte*-like in young; hinge formula, *AI AIII 1 3a 3b PIII/AII 2a 2b 4b PII,* with laterals well developed, cross-striate, *3a* and *3b* united by tuberosity, nymphs with rugose callosities; pallial line feebly sinuate. *U.Jur.-L.Cret.,* Eu.-N.Asia-N.Atl.

H. (Hartwellia). Ovate-trapezoidal, posterior ridge distinct; hinge with teeth *1* and *2b* pyramidal. *U.Jur.(Kimmeridg.)-L.Cret.(Neocom.),* NW.Eu.-N.Asia-N.Atl.——FIG. E127,*10*. **H. (H.) hartwellensis* (SOWERBY), Kimmeridg., Eng.; *10a-c,* LV ext., LV and RV hinges, ×0.5 (Casey, 1952).

H. (Tealbya) CASEY, 1952 [**Cyprina tealbiensis* WOODS, 1907; OD]. Externally like *H. (Hartwellia)* in young but becoming trigonal-ovate with ill-defined posterior ridge. *L.Cret.(Neocom.),*

Eu.——Fig. E127,7. **H. (T.) tealbiensis* (Woods), Eng.; *7a,b,* LV int., RV hinge, ×0.7 (Casey).

Isocyprina Röder, 1882 [**Cardium cyreniforme* Buvignier, 1852; SD Cossmann, 1921]. Suborbicular or ovate, evenly inflated or with feeble posterior carina; lunule superficial, mostly bounded by impressed line; escutcheon wanting; surface

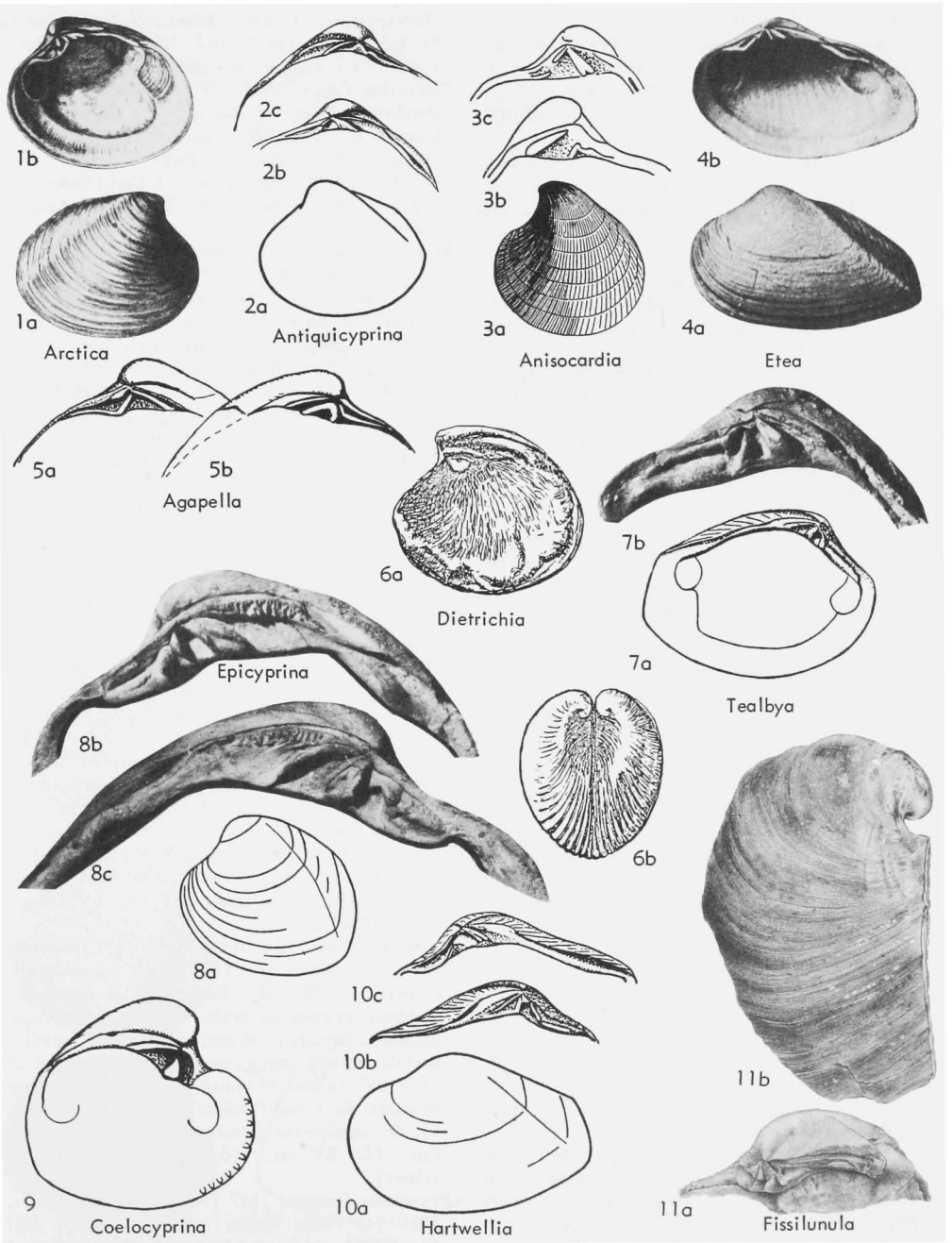


Fig. E127. Arcticidae (p. *N*646-*N*647).

smooth or with fine concentric lines; hinge formula, *AI(III) (1) (3a) 3b PI/AII (2a) 2b 4b (PII)* (teeth indicated in parentheses reduced or obsolete), lamina *AII (+2a)* joined to *2b* by vinculum, *PII* merged into margin, *PI* strong, elongate. *U. Trias.-U.Jur.*, Eu.-S.Am.

I. (Isocyprina). Hinge with tooth *2a* differentiated from *AII. Jur.(Lias.-Oxford)*, Eu.——Fig. E128, *2. *I. (I.) cyreniformis* (Buvignier), U.Jur. (Oxford), Eng.; *2a-c*, LV ext., LV and RV hinges, ×0.7 (Casey).

I. (Eotrapezium) Douvillé, 1913 [**Mesodesma germari* Dunker, 1844; OD] [=*Raetolucina* Osswald, 1929 (type, *Corbula alpina* Winkler, 1859; M)]. Suborbicular or elongate-ovate; hinge with cardinal tooth *1* scarcely differentiated from *AI*, no *2a*, lamina *AIII-3a* suppressed in most. *U.Trias.-L.Jur.(Lias.)*, Eu.-S.Am.——Fig. E128, *1. *I. (E.) germari* (Dunker), L.Jur., Ger.; *1a,b*, LV and RV hinges, ×0.7 (Cox).

I. (Venericyprina) Casey, 1952 [**I. (V.) argillacea;* OD]. Externally like *I. (Isocyprina)*, posterior end elongate or rostrate in some; hinge with lateral teeth cross-striate, lamina *AIII-3a* well developed, *2a* distinct at end of *AII. U.Jur. (Kimmeridg.)-L.Cret.(Apt.)*, Eu.——Fig. E128, *3. *I. (V.) argillacea*, U.Jur., Eng.; *3a,b*, RV int., LV hinge, ×2 (Casey).

?Izumia Ichikawa & Maeda, 1963 [**I. trapezoidalis;* OD]. Outline subtrapezoidal, surface nearly smooth but with fine radial lirae beneath outermost layer, causing crenulation of inner margins; hinge plate well developed, cardinal teeth veneroid in appearance, lateral teeth distinct; pallial line not exposed in type material. *U.Cret.*, E.Asia.——Fig. E128, *14. *I. trapezoidalis*, Japan; *4a,b*, LV int., RV int., ×2 (Ichikawa & Maeda).

?Loparia Oppenheim, 1901 [**L. katzeri;* M]. Small, obliquely trapezoidal, with angulation setting off posterior slope; surface smooth except for some thick, elevated, distant concentric ridges; hinge unknown. *Eoc.*, Eu.——Fig. E128,*6. *L. katzeri*, Bosnia; RV ext., ×3 (Oppenheim).

Microcyprina Cossmann, 1921 [**Cyprina (M.) neuvillei;* OD]. Outline cordiform, surface smooth; hinge as in *Arctica* but *AI* not crenulate, *1* bifid, *2a, 2b* thin. *Eoc.*, Eu.——Fig. E128,*4. *M. neuvillei* (Cossmann), France; *4a,b*, RV ext., int., ×1 (Cossmann, 1921).

?Mokattamia Mayer, 1890 [**M. agassizi;* M]. Rounded-ovate, resembling Mesozoic genus *Ptychomya* but shorter, with larger posterior muscle scars. *Eoc.*, Egypt. [Unfigured.]

Petalocardia Vincent, 1925 [**Venus pectinifera* Sowerby, 1823; SD Glibert, 1936]. Small, with distant spaced concentric lamellae and fine radial riblets, inner margin crenulate; hinge as in *Arctica* but with only 2 cardinal teeth in either valve. *Eoc.-Oligo.*, Eu.——Fig. E128,*5. *P. pectinifera* (Sowerby), Eoc., France; *5a,b*, RV int., LV ext., ×4 (Glibert, 1936).

Plesiocyprina Fischer, 1887 (*ex* Munier-Chalmas MS) [**P. gaudryi;* OD]. Trapezoidal, sharply carinate; surface smooth; hinge as in *Isocyprina (Eotrapezium). U.Trias.(Rhaet.)-U.Jur.(Callov.)*, Eu.-E.S.Am.——Fig. E128,*7. *P. gaudryi*, U.Jur., France; *7a,b*, LV int., RV int., ×1.7 (Fischer).

Procyprina Casey, 1952 [**P. venusta;* OD]. Trigonal-ovate, posterior end more or less truncate; hinge as in *Arctica* but *3b* narrow, anterior laterals longer. *U.Jur.(Oxford.)-L.Cret.(Valangin.)*, Eu. ——Fig. E128,*8. *P. venusta*, L.Cret.(Neocom.), Eng.; *8a*, LV ext., ×0.7; *8b,c*, LV and RV hinges, ×2 (Casey).

Pronoella Fischer, 1887 [*pro Pronoe* Agassiz, 1843 (*non* Guérin, 1838)] [**Venulites trigonellaris* von Schlotheim, 1820, auctt.; ?M]. Ovate, trigonal, or trapezoidal, evenly inflated or with posterior carina; lunule present, escutcheon absent or poorly defined; hinge formula, *AI AIII 1 3a 3b PI/AII 2a 2b 4b (PII)*, with *PII* represented only by a thickened or projected shell margin; pallial line simple or with shallow sinus. *Jur.*, Eu.

P. (Pronoella). Anterior lateral teeth strong; *1* and *2a* stoutly triangular; *2a* laminar or wedge-shaped. *Jur.(Lias.-Portland.)*, Eu.——Fig. E128, *9. *P. (P.) trigonellaris* (von Schlotheim), Ger.; *9a*, RV ext., ×0.5 (Casey); *9b,c*, LV and RV hinges, ×0.7 (Cox, 1947).

P. (Gythemon) Casey, 1952 [**P. elongata* Cox, 1944; OD]. Elongate, beaks subterminal; lunule deeply impressed; anterior lateral teeth short; hinge plate deep, with narrow, wedge-shaped cardinals. *M.Jur.(Bajoc.)*, Eu.——Fig. E128,*10. *P. (G.) elongata* Cox, Eng.; *10a*, RV ext., ×0.5; *10b,c*, RV and LV hinges, ×0.7 (Casey).

Proveniella Casey, 1952 [**Cyprina meyeri* Woods, 1913; OD]. Ovate-trapezoidal, umbones moderately to strongly prominent; hinge formula as in *Veniella*, lateral teeth cross-striate, *1* co-laminar with *AI*; pallial line entire. *Cret.*, Eu.——Fig. E128,*12. *P. meyeri* (Woods), L.Cret.(Apt.), Eng.; *12a*, LV ext., ×0.5; *12b,c*, RV and LV hinges, ×1.3 (Casey).

Pseudotrapezium Fischer, 1887 [**Cypricardia bathonica* d'Orbigny, 1850 (=**C. cordiformis* Deshayes, 1830); M]. Subtrigonal to cuneiform, umbones prominent, beaks strongly prosogyrate, posterior carination strong; hinge with anterior laterals short, *1* strong, restricting development of *2a* in LV; 3a and *3b* united into a single angulate structure. *Jur.(Lias.-Portland.)*, Eu.——Fig. E128, *13. *P. cordiforme* (Deshayes), M.Jur.(Bathon.), Eng., *13a*, RV ext., ×0.7; *13b,c*, hinges, ×0.5 (Casey).

Pygocardia Fischer, 1887 [**Cyprina tumida* Nyst, 1835 (=**Venus rustica* Sowerby, 1818); M]. Globose to quadrate; hinge with anterior lateral teeth stronger than in *Arctica*, anterior cardinal

weak, posterior laterals long, curved. *Oligo.-Plio.*, Eu.——Fig. E128,*11*. **P. rustica* (Sowerby), Plio., Eng.; *11a-c*, RV ext., LV int., RV int., ×0.5 (Wood).

Rollierella Cossmann, 1924 [*pro Rollieria* Cossmann, 1923 and Cossmann, 1924 (*non* Cossmann, 1920)] [**Isocardia laubei* Rollier, 1913 (*pro I. cordata* Laube, 1867, *non* Buckman, 1845); OD].

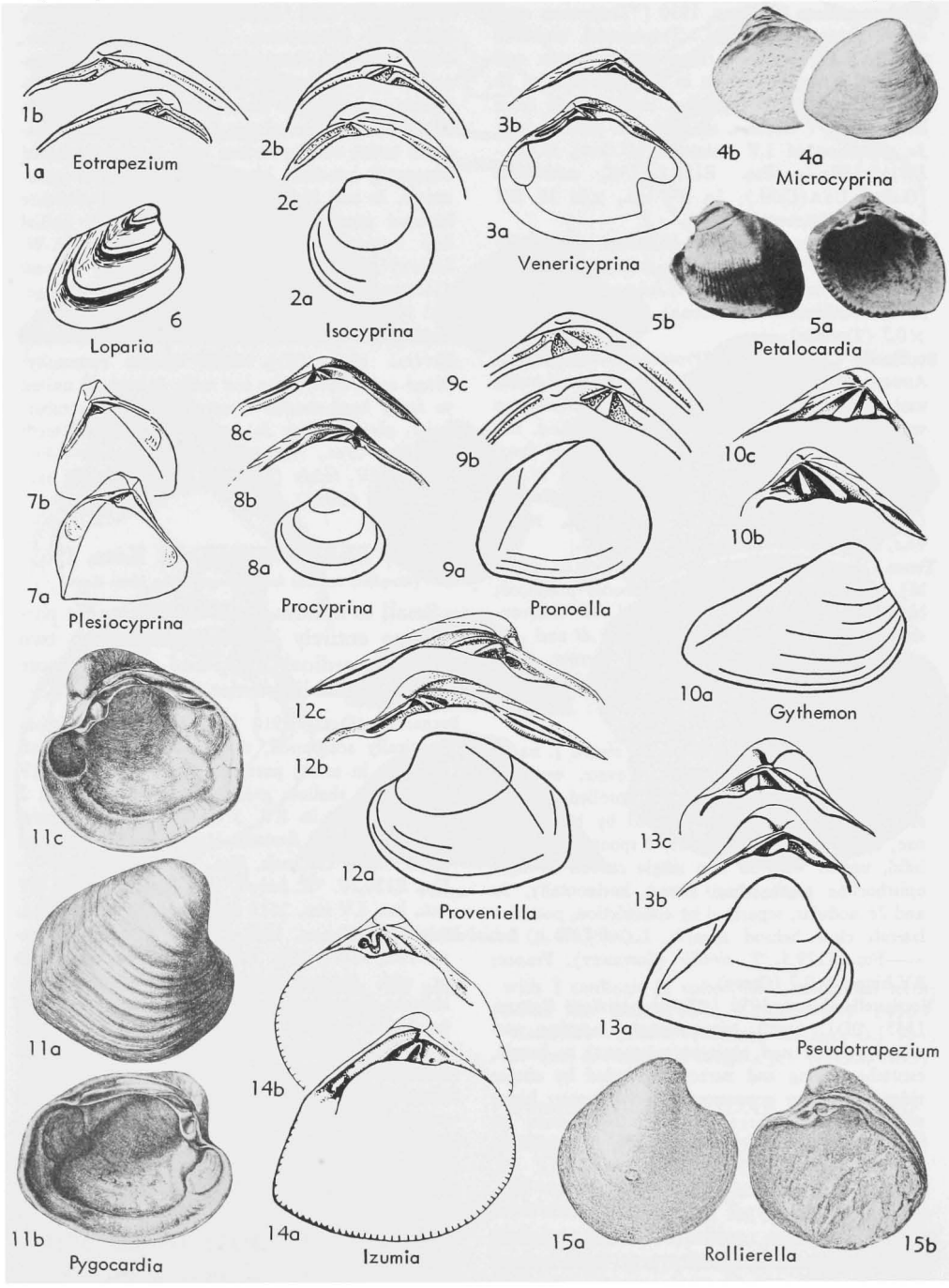


Fig. E128. Arcticidae (p. *N*648-*N*650).

Orbicular, gibbous, evenly inflated; hinge as in *Pseudotrapezium. M. Jur. (Bathon.)*, Eu.——Fig. E128,*15*. **R. laubei* (Rollier), Ger.; *15a,b*, RV ext., int., ×1 (Laube).

Schedotrapezium Stewart, 1930 [**Trapezium carinatum* Gabb, 1864; OD]. Trapezoidal, umbones well forward, posterior ridge strong; lunule and escutcheon wanting; hinge in RV with slender *3b* and laminar *3a* diverging at obtuse angle from below beak, *1* laminar, more or less parallel with *3a*, dentition of LV unknown. *U.Cret.*, N.Am.-?W.Afr.-?Eu.——Fig. E129,*1*. **S. carinatum* (Gabb), USA(Calif.); *1a*, RV ext., ×3; *1b*, RV hinge, ×8 (Stewart).

Somarctica Tamura, 1960 [**Arctica (S.) abukumensis*; OD]. Exterior as in *Arctica;* hinge with *2a* present, *3a* small. *U.Jur.*, E.Asia.——Fig. E129, *3*. **S. abukumensis* (Tamura), Japan; LV hinge, ×0.7 (Tamura).

Staffinella Casey, 1952 [**Protomiodon staffinensis* Anderson & Cox, 1948; OD]. Trigonal-ovate, umbones not prominent, lunule and escutcheon wanting; hinge like that of *Hartwellia (s.s.)*, but with teeth *1* and *2a* poorly differentiated from laterals; pallial line truncate posteriorly. *M.Jur. (Bathon.)*, Eu.——Fig. E129,*4*. **S. staffinensis* (Anderson & Cox), Scot.; *4a*, LV ext., ×0.7; *4b,c*, RV int., LV hinge, ×1.7 (Casey).

Tenea Conrad, 1870 [**Mysia parilis* Conrad, 1860; M]. Subcircular to subovate; umbones produced; hinge with *3b* broad, deeply bifid, *2b* chevron-shaped, *1* and *2a* attached to vestigial *AI* and *AII*, no posterior laterals; pallial sinus narrow, deep. *U.Cret.*, N.Am.——Fig. E129,*7*. **T. parilis* (Conrad), USA(Tex.); *7a*, LV ext., ×1; *7b,c*, RV and LV hinges, ×2 (Stephenson).

Tortarctica Casey, 1961 [**Isocardia similis* J. de C. Sowerby, 1826; OD]. Trigonal-ovate, well inflated, beaks prominent, spirally enrolled, lunular area depressed, escutcheon limited by blunt carinae; hinge with *AIII* pustular, *1* spoon-shaped, *3b* bifid, united with *3a* into single curved strongly opisthocline tooth lying almost horizontally, *2a* and *2b* nodular, separated by constriction, posterior laterals close behind nymph. *L.Cret.(Alb.)*, Eu. ——Fig. E129,*5*. *T. similis* (Sowerby), France; RV hinge, ×0.7 (Casey).

Vectianella Casey, 1952 [**Tellina vectiana* Forbes, 1845; OD]. Small, trigonal-ovate, tapering posteriorly, compressed, umbones subcentral, no lunule, escutcheon long and narrow, bounded by obtuse ridges; sculpture concrescent, finely lineate; hinge with *1* and *3a* large, laminar, *3b* minute, *2b* stoutly triangular, bifid, anterior laterals obsolescent. *L.Cret.(Apt.)*, NW.Eu.——Fig. E129,*2*. **V. vectiana* (Forbes), Eng.; *2a*, LV ext., ×0.7; *2b,c*, LV and RV hinges, ×1 (Casey).

Veniella Stoliczka, 1870 [*pro Venilia* Morton, 1833 (*non* Duponchel, 1829)] [**Venilia conradi* Morton, 1833; M] [=*Goniosoma* Conrad, 1869 (*non* Perty, 1833) (type, *G. inflata*; M); *Cicatrea* Stoliczka, 1870 (type, *Cyprina cordialis;* OD); *Roudairia* Munier-Chalmas, 1881 (type, *R. drui;* M) *(Roudaireia, nom. null.); Trigonocardia* Zittel, 1881 (in synonymy of *Roudairia*); *Platopis* Whitfield, 1891 (type, *Opis undata* Conrad, 1852; SD Woodward, 1892) *(Platopsis, nom. null.); Venetia, Venniella, nom. null.*]. Subtrapezoidal and moderately ventricose in young, obliquely subtrigonal and strongly ventricose in adult, umbones prominent, beaks prosogyrate, posterior carina strong; surface with distant thickened concentric lamellae; hinge massive, laterals cross-striate, *3a* and *3b* united in hook-shaped structure inserted posterior to tubercular tooth *1;* pallial line truncate posteriorly. *U.Cret.*, Asia-Afr.-W. Indies-N.Am.-S.Am.——Fig. E129,*6*. **V. conradi* (Morton), USA(Miss.); *6a,b*, LV int., RV hinge, ×1 (Casey, n).

Venilicardia Stoliczka, 1870 [**Cyprina bifida* Zittel, 1865; OD]. Like *Arctica* externally; hinge as in *Epicyprina* but with *3a* and *3b* united to form hook-shaped structure, *1* strong, tubercular, placed below *3a*, nymphs and lateral teeth smooth. *Cret.*, Eu.-Afr.-S. Asia-S. Am. —— Fig. E129,*8*. **V. bifida* (Zittel), Ger.; *8a,b*, RV ext., int., ×0.5 (Zittel).

Family BERNARDINIDAE Keen, 1963

[Materials for this family prepared by Myra Keen]

Small to minute shells with ligament partially to entirely internal; hinge with two or three cardinal teeth and two or more laterals; pallial line entire. *Rec.*

Bernardina Dall, 1910 [**B. bakeri;* OD]. Concentrically sculptured, thin, prodissoconch set off by ridge in some; posterior dorsal margin of RV fitting into shallow groove in LV; hinge with 2 cardinal teeth in RV, 3 in LV, anterior lateral strong in LV, 2 flexuous laterals in RV; resilium in pit behind cardinals. *Rec.*, W.N.Am.-C.Am.—— Fig. E130,*10*. **B. bakeri*, USA(Calif.); *10a-c*, RV ext., int., LV int., ×12 (specimen, Stanford coll.).

Halodakra Olsson, 1961 [**Circe subtrigona* Carpenter, 1857; OD]. Ovate, inequilateral, smooth or with concentric striae; posterior area with chevron-shaped color markings in some; ligament in shallow resilifer, somewhat sunken; hinge with 3 or more teeth in cardinal area, posterior lateral behind resilifer more or less well developed; posterior margins of shell grooved to receive opposite valve; pallial line indistinct, apparently entire. *Rec.*, W.N.Am.-S.Am.——Fig. E130,*7*. **H. subtrigona* (Carpenter), Ecuador; *7a,b*, LV and RV hinges, ×13; *7c*, LV ext., ×7 *(688)*.

Family EULOXIDAE Gardner, 1943

[Materials for this family prepared by Myra Keen]

Ovate, inequilateral, not elongate; hinge

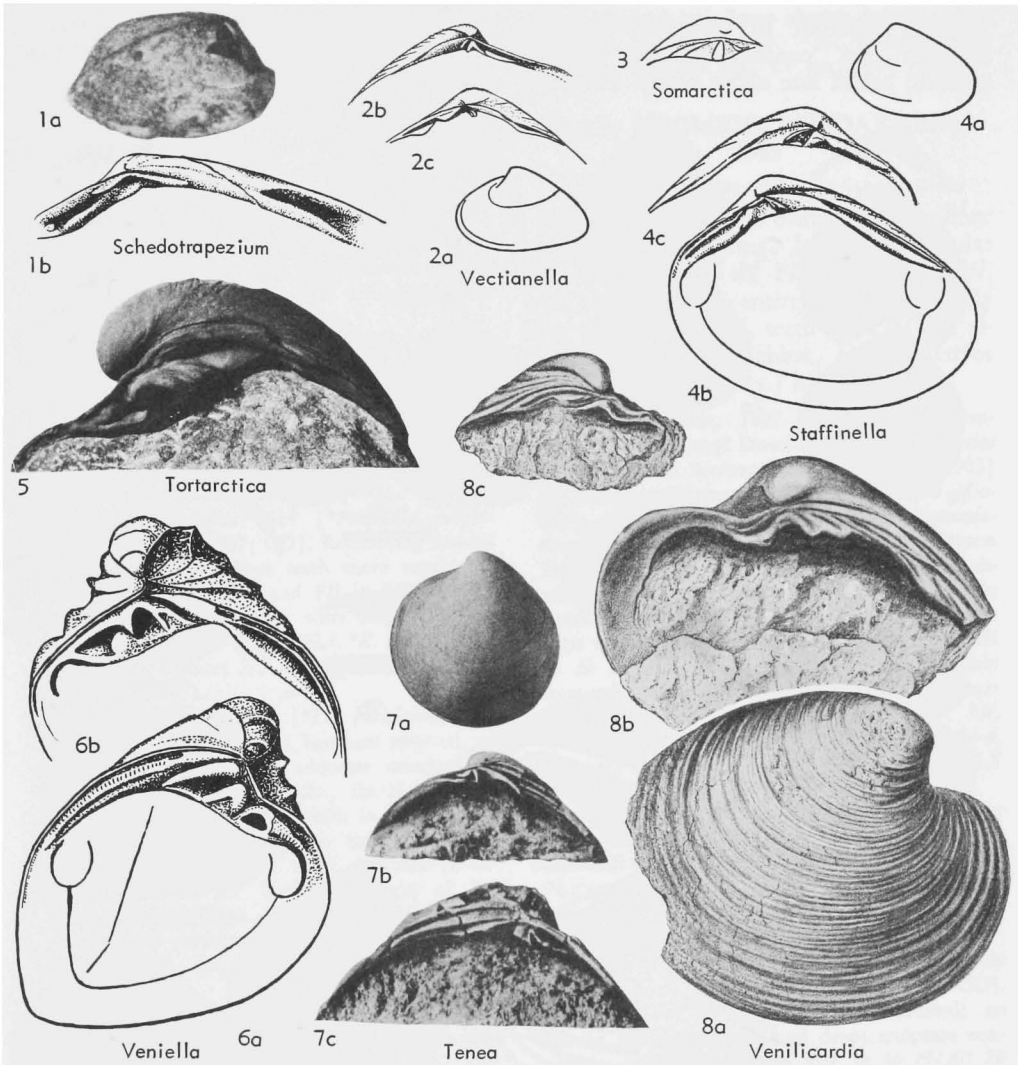


FIG. E129. Arcticidae (p. *N*650).

with two or three cardinal teeth, no posterior laterals; pallial line entire. *Mio.*

Euloxa CONRAD, 1863 [**Venus latisulcata* CONRAD, !840; M]. Sculpture of concentric undulations; posterior slope set off by radial ridge; hinge with 3 cardinals in LV, 2 in RV. *Mio.,* E.N.Am.——FIG. E130,*6*. **E. latisulcata* (CONRAD), USA(Va.); *6a-c,* LV ext., RV int., LV int., ×1 (Nicol, 1953).

Cabralista KEEN, *nom. subst.* herein [*pro Cabralia* BÖHM, 1899 (*non* MOORE, 1886)] [**Cabralia schmitzi* BÖHM, 1899; M]. Ovate to trapezoidal, with both radial and concentric sculpture; hinge with 3 cardinals in either valve, no lateral teeth; pallial line entire. *Mio.,* E.Atl.——FIG. E130,*9*. **Cabralista schmitzi* (BÖHM), Salvages Is.; *9a-c,* LV ext., LV and RV hinges, ×1 (Böhm, 1899).

Family KELLIELLIDAE Fischer, 1887

[*nom. correct.* DALL, 1900 (*pro* Kellyellidae FISCHER, 1887)]
[Materials for this family prepared by MYRA KEEN]

Small to minute, equivalve, mostly suborbicular; not gaping; ligament mostly external, some with resilium or fossette under beak; hinge incompletely developed, anterior

lamellae adjacent to cardinals, posterior lamellae not constant; inner margins smooth; pallial line entire *(854). Tert.-Rec.*

Kelliella M. SARS, 1870 [**K. abyssicola* (=**Venus miliaris* PHILIPPI, 1844); M] [=*Kelliella* M. SARS, 1865, 1868, AUCTT. *(nom. nud.); Kellyella*

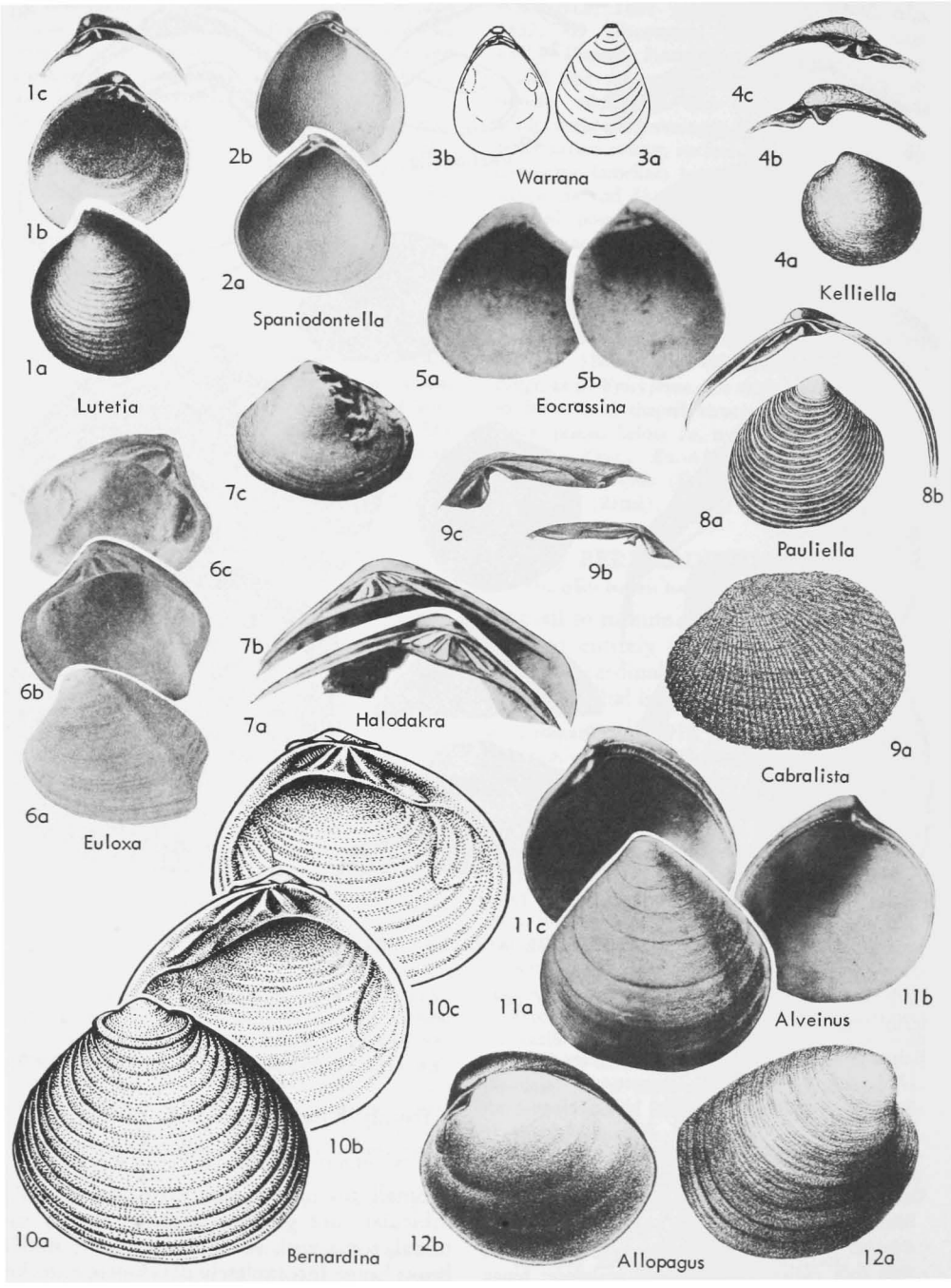


FIG. E130. Bernardinidae *(7,10);* Euloxidae *(6,9);* Kelliellidae *(1-5,8,11-12)* (p. *N650-N653*).

FISCHER, 1887 *(nom. null.)*]. Minute, rounded-ovate; lunule circumscribed; hinge with 2 teeth in LV, 1 cardinal and anterior lateral in RV. *Tert.-Rec.*, Atl.-Medit. [Deep-water.]. —— FIG. E130,*4*. **K. miliaris* (PHILIPPI), Rec., Norway; *4a*, LV ext., ×6; *4b,c*, RV and LV hinges, enl. *(829)*.

Allopagus STOLICZKA, 1871 [**Hippagus leanus* DESHAYES, 1860; OD]. Minute, thin, ovate, very inequilateral, tumid, beaks small; hinge of RV with 1 cardinal in front of beak, LV with cardinal below. *M.Eoc.*, Eu.——FIG. E130,*12*. **A. leanus* (DESHAYES), France; *12a,b*, RV ext., int., ×10 *(259)*.

Alveinus CONRAD, 1865 [**A. minutus;* M]. Smooth; ligamental nymph feeble; resilium in cavity under beaks; hinge of RV with 2 parallel teeth; LV with single tooth bent or A-shaped; posterior margin of RV grooved. *U.Eoc.-Mio.*, Eu.-N.Am.——FIG. E130,*11*. **A. minutus*, Eoc., USA(La.-Miss.); *11a-c*, LV ext., int., RV int., ×14 *(388)*.

?Eocrassina COSSMANN, 1914 [**Parisiella veneriformis* COSSMANN, 1907; OD]. Resembling *Lutetia* but nymph larger, hinge teeth more regular, *1* and *3b* in RV, *2a, 2b*, and *PII* in LV; margin even, not grooved; muscle scars large, high in shell. *U.Eoc.*, Eu.——FIG. E130,*5*. **E. veneriformis* (COSSMANN), France; *5a,b*, LV int., RV int., ×10 (Cossmann, 1907).

Lutetia DESHAYES, 1860 [**L. parisiensis;* SD STOLICZKA, 1871]. Globose, ligament external, on nymph, resilium wanting; adductor muscle scars small, equal, oval. *L.Eoc.-Mio.*, Eu.-N.Am.-Asia.

L. (Lutetia). Hinge with 3 teeth in either valve, RV with posterior tooth nearly marginal, central tooth L-shaped, anterior tooth deflected downward, teeth in LV laminar; margin of RV grooved. *L.Eoc.-Oligo.*, Eu.-N.Am.——FIG. E130, *1*. **L. (L.) parisiensis* DESHAYES, Eoc., France; *1a-c*, LV ext., int., RV hinge, ×10 (Deshayes, 1858).

L. (Spaniodontella) ANDRUSSOV in GOLUBIATNIKOV, 1902 [*pro Spaniodon* REUSS, 1867 (*non* PICTET, 1851)] [**Spaniodon nitidus* REUSS, 1867; M] [=*Davidaschvilia* MERKLIN, 1950 (type, *Spaniodontella intermedia* "ANDRUSSOV" GOLUBIATNIKOV, 1902; OD)]. Slightly larger than *L. (Lutetia)*, hinge teeth relatively larger, especially central teeth; hinge plate wider. *Mio.*, Eu.-SW.Asia. ——FIG. E130,*2*. **L. (S.) nitida* (REUSS), Ger.; *2a,b*, RV int., LV int., ×7 (Reuss, 1867).

Pauliella MUNIER-CHALMAS, 1895 [**P. bernardi;* M]. Ovate, sculpture concentric; hinge with 3 cardinal teeth in either valve, 2 posterior laterals, 3 anterior lateral laminae. *Rec.*, Ind.O.——FIG. E130,*8*. **P. bernardi*, St. Paul I.; *8a*, RV ext., ×5; *8b*, RV hinge, ×10 *(44)*.

Warrana LASERON, 1953 [**W. dielasma;* OD]. High-ovate, with concentric sculpture; prodissoconch distinct; ligament internal; hinge of LV with thin arched cardinal and linear obscure laterals. *Rec.*, Australia.——FIG. E130,*3*. **W. dielasma*, SE. Australia; *3a,b*, RV ext., LV int., ×18 *(531)*.

Family NEOMIODONTIDAE Casey, 1955

[Materials for this family prepared by RAYMOND CASEY]

Shells subtrigonal to ovate, smooth, inner margins smooth; hinge lucinoid, formula: *AI AIII 3a 3b 5b PI PIII/AII 2b 4b PII*, with cardinal teeth entire, laterals typically long and corbiculoid, teeth *5b, PIII* not always developed. [Habitat, fresh-water or seas of reduced salinity.] *L.Jur.-U.Cret.*

Neomiodon FISCHER, 1887 [*pro Miodon* SANDBERGER, 1871 (*non* DUMÉRIL, 1859)] [**Cyclas medius* J. DE C. SOWERBY, 1826; SD DALL, 1903] [=*Bidentina* OPPENHEIM, 1895 (obj.; *pro Miodon*); *Miodontopsis* DALL, 1903; *Protomiodon* ANDERSON & COX, 1948 (type, *Cyrena brycei* TATE, 1873; OD)]. Subtrigonal, ovate to suborbicular, with no definite lunule or escutcheon; smooth or with weak concentric sculpture, posterior slope more or less ridged; hinge formula, *AI AIII 3a 3b PI PIII/AII 2b 4b PII*, laterals minutely cross-striate; pallial line entire. *M.Jur.(Bathon.)-L.Cret.(Weald.)*, Eurasia.——FIG. E131,*8*. **N. medius* (SOWERBY), U.Jur.(Purbeck.), Eng.; *8a-d*, LV ext., RV int., LV hinge, LV dorsal, ×1.5 (Casey).

Crenotrapezium HAYAMI, 1958 [**C. kurumense;* OD]. Externally resembling a cuneiform *Neomiodon* but with hinge of *Eomiodon*. *L.Jur.(Lias.), ?L.Cret.(Weald.)*, E.Asia.——FIG. E131,*1*. **C. kurumense*, Lias, Japan; *1a-c*, LV ext., dorsal, hinge, ×1; *1d*, RV hinge, ×2 (Hayami).

Cyrenopsis ETHERIDGE, 1902 [**Mactra meeki* =*Unicardium meeki* ETHERIDGE, 1892; OD]. Subtrigonal to suborbicular, evenly inflated; no lunule, escutcheon long and deep; sculpture concentric; hinge-formula, *AI AIII 3a 3b PI/AII 2b 4b PII*, with smooth laterals; pallial line entire. *L.Cret.(Apt.)*, Australia.——FIG. E131,*3*. **C. meeki* (ETHERIDGE); *3a,b*, RV ext., LV int., ×0.7 (Jack and Etheridge).

Eomiodon COX, 1935 [**E. indicus;* OD] [=*Protocyprina* VOKES, 1946 (type, *Astarte libanotica* FRAAS, 1878; OD)]. Gibbous-trigonal, cuneiform, or suborbicular, lunule and escutcheon impressed, smooth, lunule limited by furrow, escutcheon by ridge; sculpture concrescent *Astarte*-like in young; hinge as in *Neomiodon* except for presence of small *5b* and absence of *PIII*; pallial line truncate posteriorly. *L.Jur.(Lias.)-U.Cret.(?Cenoman.)*, Eu.-N.Afr.-Asia-N.Am.——FIG. E131,*6*. **E. indicus*, M.Jur., India; *6a,b*, LV and RV hinges, ×1 (Cox).

Musculiopsis MACNEIL, 1939 [**M. russelli;* OD].

Subrectangular, posteriorly truncate; lunular area excavated, escutcheon wanting; young with posterior carina; surface nearly smooth; hinge of LV with strong *2b*, slender *4b*, short *AII* and long *PII* adpressed to margin, dentition of RV imperfectly known; pallial line apparently entire. *L.Cret.*, N. Am.——Fig. E131,*7*. **M. russelli*, USA(Nev.); *7a*, RV ext., ×2; *7b*, LV int., ×3 (MacNeil).

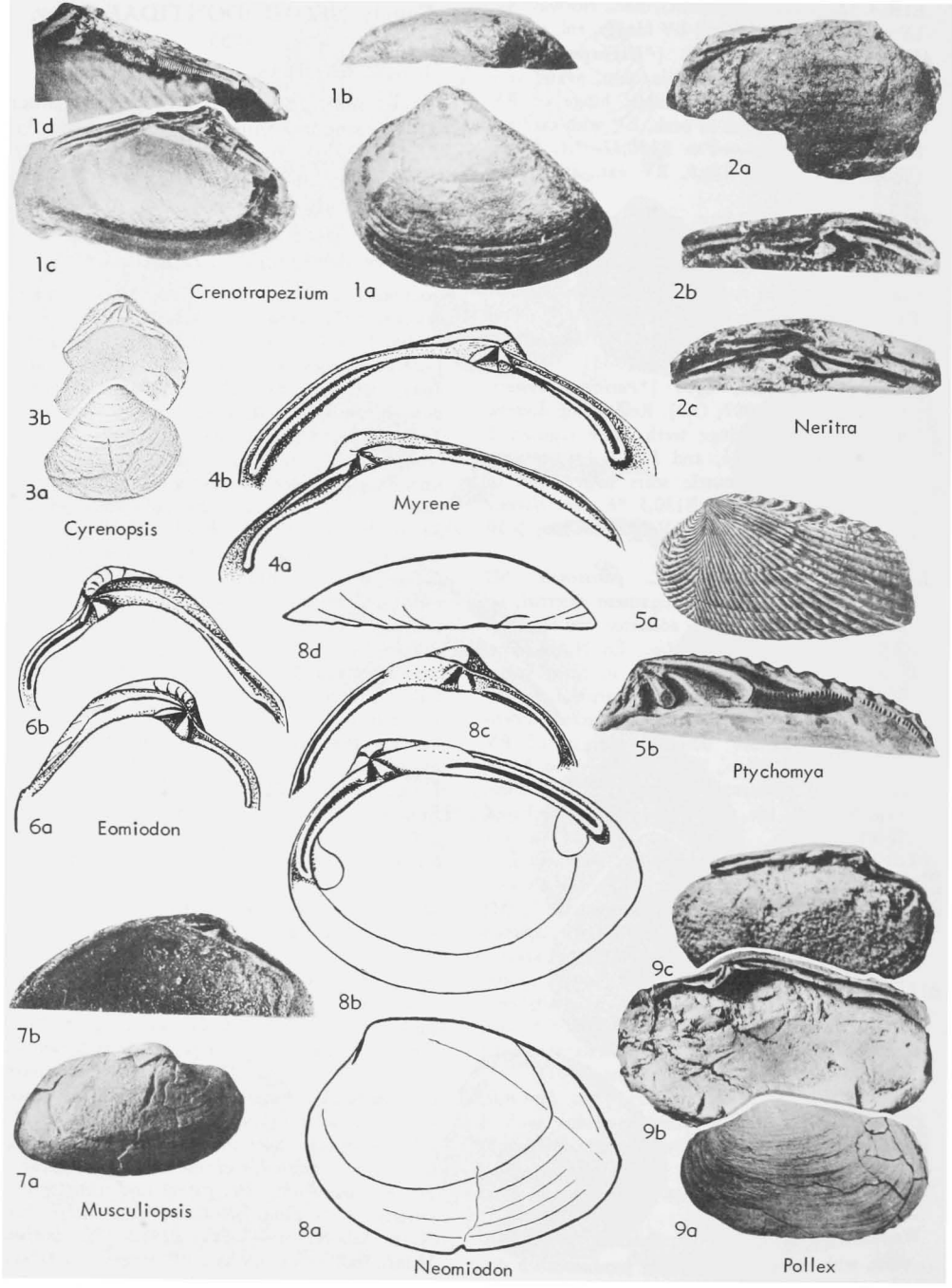


Fig. E131. Neomiodontidae *(1,3-4,6-8)*; Pollicidae *(2,9)*; Ptychomyidae *(5)* (p. *N653-N655*).

Myrene CASEY, 1955 [**M. fittoni*; OD]. Cuneiform, trigonal-ovate, or trapezoidal; lunule and escutcheon not clearly defined; posterior slope ridged or carinate, posterior area flattened, with or without second ridge or carina; surface smooth or with concentric riblets; hinge formula, *AI AIII 3a 3b 5b PI/AO AII 2b 4b PO PII*, laterals cross-striate in most; pallial line entire. *U.Jur.(Oxford.)-L.Cret. (Ryaz.)*, Eu.-NE.Asia.——FIG. E131,*4*. **M. fittoni*, L.Cret., Eng.; *4a,b*, RV and LV hinges, ×2 (Casey).

Family POLLICIDAE Stephenson, 1953

[Materials for this family prepared by MYRA KEEN]

Elongate, plump, subelliptical, ligament external, opisthodetic; inner margins of shell smooth, shape of muscle scars and pallial line unknown. *U.Cret.*

Pollex STEPHENSON, 1953 [**P. obesus;* OD]. Sculpture of faint radial lines, hinge with 3 cardinal teeth in either valve; anterior cardinal with 2 cusps; posterior lateral tooth long, lamellar. *U. Cret.*, N.Am.——FIG. E131,*9*. **P. obesus*, Cenoman., USA(Tex.); *9a*, LV ext., ×1; *9b*, RV int., ×1.3; *9c*, LV int., ×3 (Stephenson).

Neritra STEPHENSON, 1954 [**N. polliciformis;* OD]. Resembling *Permophorus* (Permophoridae) in form but with hinge somewhat more like that of *Pollex*, except that anterior cardinal in RV is narrower and central cardinal broader. *U.Cret.*, N.Am.——FIG. E131,*2*. **N. polliciformis*, USA(N.J.); *2a*, RV ext., ×1; *2b,c*, int., LV and RV hinges, ×3 (Stephenson).

Family PTYCHOMYIDAE Keen, new family

Elongate-ovate shells of solid texture, with well-developed radial sculpture; hinge of somewhat veneroid aspect but also with astartoid resemblances, the formula, *AIII 3a 1 3b PIII/AII 2a 2b 4b PII. ?U.Jur., L.Cret.-U.Cret.*

Ptychomya AGASSIZ, 1842 [**P. plana;* M] [=*Radioconcha* CONRAD, 1869 (type, *Crassatella robinaldina* D'ORBIGNY, 1844 [=*P. plana*]; SD KEEN, herein)]. Ovate-trapezoidal; ligamentary depression broad and long; hinge with *2a-2b* joined above; pallial line truncate. *?U.Jur., L.Cret.-U.Cret.*, Eu.-N.Am.-S.Am.-Afr.

P. (Ptychomya). Radial sculpture becoming divaricate on anterior and posterior slopes, rib ends showing as crenulations of inner margins. *?U. Jur., L.Cret.-U.Cret.*, Eu.-N.Am.-S.Am.-Afr.——FIG. E131,*5*. **P. (P.) plana* AGASSIZ, L.Cret., Eng.; *5a*, LV ext., ×0.5; *5b*, RV hinge, ×1 (Woods, 1907).

P. (Pleuroconcha) CONRAD, 1872 [**Crassatella "gallieni"* (i.e., **Crassatella gallienni* D'ORBIGNY, 1844); M]. Radial sculpture not divaricate, *U. Cret.*, Eu.

Family TRAPEZIIDAE Lamy, 1920

[=Lithophagellidae COSSMANN, 1910; Libitinidae THIELE, 1924] [Materials for this family prepared by MYRA KEEN]

Elongate, beaks near anterior end; hinge plate narrowed, normally with two cardinals in either valve, one posterior and one small anterior lateral; pallial line mostly entire. *?L.Cret., U.Cret.-Rec.*

Trapezium MEGERLE VON MÜHLFELD, 1811 [**T. perfectum* (=*Chama oblonga* LINNÉ, 1758); SD STEWART, 1930] [=*Libitina* SCHUMACHER, 1817 (type, *L. bicarinata;* M); *Cypricardia* LAMARCK, 1819 (type, *C. guinaica,* =*Chama oblonga* LINNÉ; SD CHILDREN, 1823)]. Oblong, solid, ligament external. Nestling in crevices. *Eoc.-Rec.*, N.Am.-Eu.-IndoPac.-Ind.O.

T. (Trapezium). Surface with radiating striae; inner margin smooth. *Eoc.-Rec.*, E.N.Am.-Eu.-E. Indies.—FIG. E132,*9*. **T. (T.) oblongum* (LINNÉ), Rec., E.Indies; *9a,b*, LV ext., RV int., ×1 (de Blainville, 1825).

T. (Glossocardia) STOLICZKA, 1870 [**Cypricardia obesa* REEVE, 1843; OD]. More quadrate than *T. (Trapezium)*, radial striae not present; hinge teeth more strongly developed. *Rec.*, IndoPac.——FIG. E132,*1*. **T. (G.) obesum* (REEVE); *1a,b*, RV int., LV int., ×0.5 *(305)*.

T. (Neotrapezium) HABE, 1951 [**Cardita sublaevigata* LAMARCK, 1819; OD]. Radial sculpture wanting; shell quadrangular, compressed, distorted by nestling habit; posterior lateral teeth weak and small. *Rec.*, IndoPac.——FIG. E132,*2*. **T. (N.) sublaevigatum* (LAMARCK), Ind.O.; *2a,b*, LV ext., RV int., ×1.5 *(512)*.

Coralliophaga DE BLAINVILLE, 1824 [**C. carditoidea* (=**Chama coralliophaga* GMELIN, 1791); M] [=*Lithophagella* GRAY, 1854 (type, *Cardita dactyla* BRUGUIÈRE, 1792; OD)]. Thin, translucent, sculpture of radiating striae or granules; hinge reduced. *Eoc.-Rec.*, Eu.-W.Indies-E.Indies-N.Am.

C. (Coralliophaga). Posterior end with elevated concentric ridges; pallial line sinuate. *Eoc.-Rec.*, Eu.-W.Indies-E.Indies.——FIG. E132,*6*. **C. (C.) coralliophaga* (GMELIN), Rec., W.Indies; *6a-c*, RV int., ext., LV hinge, ×1 *(7)*.

C. (Oryctomya) DALL, 1898 [**C. (O.) claibornensis;* OD]. Surface granular; hinge with 1 cardinal in either valve; pallial sinus distinct, angular. *Eoc.-Mio.*, E.N.Am.——FIG. E132,*4*. **C. (O.) claibornensis*, Eoc., USA(Ala.); *4a*, LV ext., ×1; *4b*, enl. *(223)*.

?Corbiculopsis WHITFIELD, 1891 [**C. birdi;* M]. Trapezoidal, wider posteriorly, somewhat carinate;

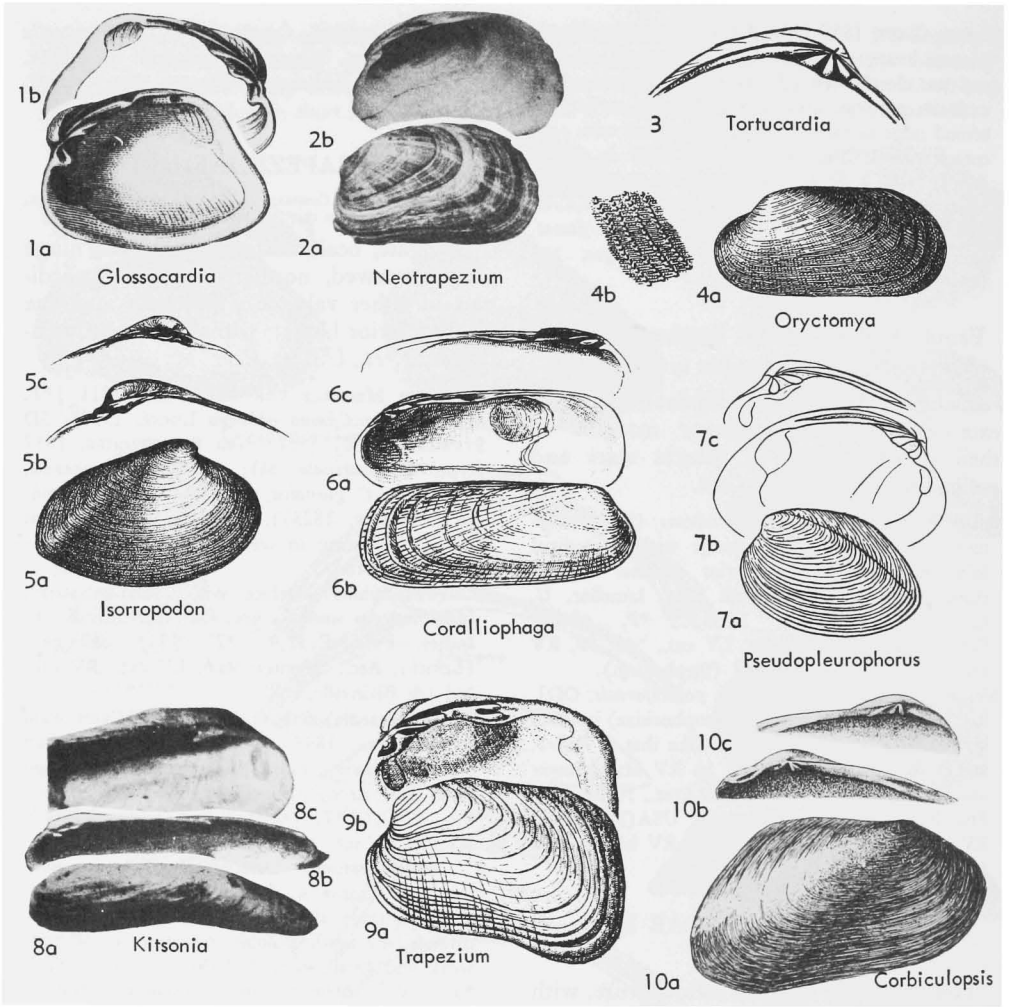


FIG. E132. Trapeziidae (p. *N655-N657*).

hinge imperfectly known, *2a* and *3b* bifid. *L.Cret. (Apt.)*, SW.Asia.——FIG. E132,*10*. **C. birdi*, Syria; *10a-c*, RV ext., RV and LV hinges, ×0.7 (Whitfield).

?Isorropodon STURANY, 1896 [**I. perplexum*; M]. Ovate, inequivalve, LV smaller than RV; posterior area set off by radial ridge. [Deep-water.] *Rec.*, Medit.——FIG. E132,*5*. **I. perplexum*, off Egypt; *5a-c*, RV ext., RV and LV hinges, ×2.5 (Sturany, 1896).

Kitsonia EAMES, 1957 [**Coralliophaga eocenica* NEWTON, 1922; OD]. Thin, elongate, smooth, ligament external, long; hinge with larger teeth than in *Coralliophaga*, 2 cardinals in RV, posterior bifid, 1 lamellar cardinal in LV; adductor impressions large; pallial sinus 0.4 of shell length. *Eoc.*, W.Afr.——FIG. E132,*8*. **K. eocenica* (NEWTON), Nigeria; *8a,b*, LV ext., RV int., ×2.5; *8c*, LV hinge, ×5 (Eames, 1957).

Pseudopleurophorus CHAVAN, 1954 [**P. rochi*; OD]. Ovate-trapezoidal, surface with growth rugae only, posterior area set off by ridge; hinge with strong posterior lateral in RV received between duplicate laterals in LV, *3a* wanting. *U.Cret.*, C.Afr.——FIG. E132,*7*. **P. rochi*, Tchad; *7a-c*, LV ext., int., RV hinge, ×1.5 (Chavan).

Tortucardia OLSSON, 1944 [**Glossocardia (T.) stephensoni*; OD]. Oblong, with strong posterior carina, beaks small; escutcheon narrow; hinge with *2a*, *2b*, and *4b* stout, subequal, *All* close to

margin, dentition of RV imperfectly known. *U. Cret.(Maastricht.),* S.Am.——Fig. E132,*3*. **T. stephensoni* (Olsson), Peru; LV hinge, ×1 (Olsson).

Family MECYNODONTIDAE Haffer, 1959

[Materials for this family prepared by Aurèle LaRocque]

Characters of *Mecynodon. M.Dev.*

Mecynodon Keferstein, 1857 [**Megalodus carinatus* Goldfuss, 1837; SD Haffer, 1859] [=*Mecinodon* French, 1889; *Mecynodus* Beushausen, 1895 (obj.)]. Rhomboidal, with strong postumbonal ridge; surface concentrically striate or smooth; dental formula: *1 3 1 III/2a 2p II. M.Dev.,* Eu.(Ger.-Eng.); *M.Dev.(Onondag.),* N.Am.——Fig. E133,*1*. **M. carinatus* (Goldfuss), Dev. (*Stringocephalus* Ls.), Ger.; *1a,b,* RV ext., int., approx. ×1 *(47); 1c,d,* LV and RV hinges (diagram.) (Haffer, 1959); *1e,* RV int., ×1 (Haffer, 1959).

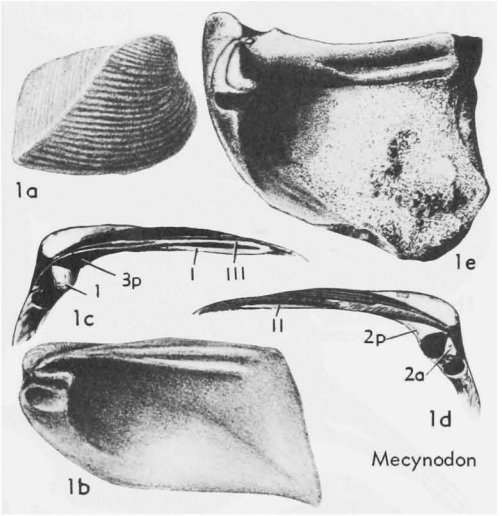


Fig. E133. Mecynodontidae (p. *N657*).

Superfamily GLOSSACEA Gray, 1847

[*nom. transl.* Habe, 1951 (*ex* Glossidae Gray, 1847)] [=Isocardiacea Gray, 1842 (*nom. transl. et correct.* Dall, 1895, *ex* Isocardiadae Gray, 1842); Arcticacea auctt. *(partim)*] [Family-group names based on *Isocardia* Lamarck, 1799, are invalid (Code, Art. 11e)] [Materials for this superfamily prepared by Myra Keen and Raymond Casey with additions as recorded]

Shells inequilateral, mostly equivalve, beaks well forward, spirally twisted in most; surface smooth or with some concentric (rarely any radial) ribbing; ligament external; hinge of the form termed cyprinoid by authors, having 2 or 3 cardinal teeth in each valve and well-developed laterals in most; teeth tend to be parallel to hinge margins; pallial line normally entire (sinuate in a few). *U.Trias.-Rec.*

Family GLOSSIDAE Gray, 1847

[=Isocardiadae Gray, 1842] [Materials for this family prepared by Myra Keen and Raymond Casey]

Rotund to cordiform, not gaping, with prosogyrate to gyrate beaks; no lunular groove; ligament and resilium in deep groove; hinge with two lamellar cardinals in either valve, variable in form, laterals inconstant; adductor scars equal; internal margin smooth; pallial line entire. *Paleoc.-Rec.*

Glossus Poli, 1795 [**G. rubicundus* (=*Cardium humanum* Linnè, 1758); M] [=*Cuculla* Seba, 1781 *(nonbinom.); Glossoderma* Poli, 1795 (obj.); *Isocardia* Lamarck, 1799 (obj.; SD Children, 1823); *Buccardium* Megerle von Möhlfeld, 1811 (obj.); *Bucardia* Schumacher, 1817 (obj.); *Tychocardia* Roemer, 1868 (obj.)]. Beaks gyrate, lunular area depressed. *Paleoc.-Rec.,* Eu.-N.Atl.-W.Asia-IndoPac.

G. (Glossus). Cordiform, smooth, ligament long. *L.Oligo.-Rec.,* Eu.-N.Atl.——Fig. E134,*4*. **G. (G.) humanus* (Linné), Rec., N.Atl.; *4a,* LV ext., ×0.5; *4b,c,* RV and LV hinges, ×1 *(124b)*.

G. (Aralocardia) Vyalov, 1937 [**Isocardia eichwaldiana* Romanovsky, 1890; OD]. Beaks strongly coiled; concentric sculpture strong especially on umbones. *U.Eoc.-L.Oligo.,* Eu.-W.Asia.——Fig. E134,*1*. *G. (A.) multicostatus* (Nyst, 1845), Oligo., Ger.; *1a,b,* LV ext., hinge, ×0.5 (Von Koenen, 1893).

G. (Cytherocardia) Sacco, 1900 [**Isocardia cytheroides* Mayer, 1868; OD]. Smaller than *G. (Glossus)*, more ovate, beaks less twisted, hinge thinner. *Eoc.-Mio.,* Eu.——Fig. E134,*9*. **G. (C.) cytheroides* (Mayer), Mio., France; LV ext., ×1 (Mayer, 1868).

G. (Meiocardia) H.Adams & A.Adams, 1857 [**M. moltkiana* "Spengler" (=**Chama moltkiana* Gmelin, 1791); SD Stoliczka, 1870] [=*Miocardia (nom.null.)*]. Surface concentrically grooved. *Paleoc.-Rec.,* Eu.-IndoPac.——Fig. E134, *7*. **G. (M.) moltkianus* (Gmelin), Rec., E.Indies; LV ext., ×1 *(124b)*.

G. (Miocardiella) Sacco, 1904 [**M. taurinensis*; OD]. Small, subtrigonal, beaks prosogyrate, not coiled. *Tert.,* Eu.——Fig. E134,*3*. **G. (M.) taurinensis* (Sacco), Neog., Italy; *3a,b,* LV ext., RV ext., ×3 (Sacco, 1904).

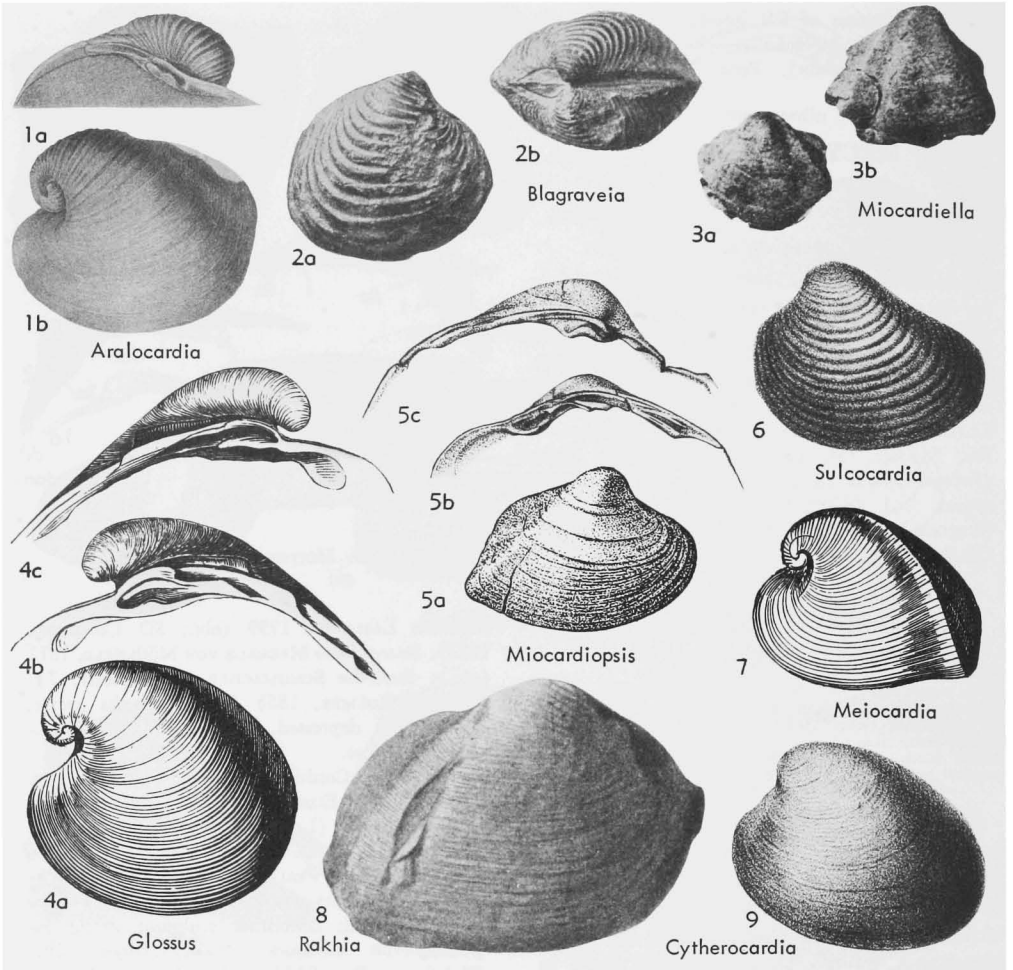


FIG. E134. Glossidae (p. *N657-N658*).

G. (Miocardiopsis) GLIBERT, 1936 [**Anisocardia eocaenica* BAYAN, 1873; OD]. Ovate, beaks not twisted; hinge with 1 cardinal absent in RV and only 1 anterior lateral. *Eoc.*, Eu.——FIG. E134,*5*. **G. (M.) eocaenicus* (BAYAN), Belg.; *5a*, RV ext., ×2; *5b,c*, RV and LV hinges, ×3 (Glibert, 1936).

G. (Sulcocardia) ROVERETO, 1898 [**Isocardia justinensis* MAYER, 1893; OD]. Small, oblique, not carinate, with incised concentric grooves, no lunule; hinge of LV with 2 cardinals, *2a* medium-sized, *2b* stronger, obliquely arcuate. *Oligo.*, Eu. ——FIG. E134,*6*. **G. (S.) justinensis* (MAYER), Italy; LV ext., ×2 (Mayer, 1893).

?Blagraveia Cox, 1933 [**B. corrugata*; OD]. Trigonally ovate, inequilateral, shell thin; sculpture of concentric undulations; lunule deeply set, forming lamina within shell cavity; hinge with 2 cardinal teeth in either valve, no laterals; pallial line and muscle scar outlines not evident in type material. *Eoc.*, Asia.——FIG. E134,*2*. **B. corrugata*, M.Eoc., India; *2a,b*, RV ext., both valves dorsal, ×1 (Cox, 1933).

?Rakhia EAMES, 1951 [**R. trapezoidalis*; OD]. Quadrate, thin-shelled, umbones with concentric undulations; hinge and interior unknown. *L.Eoc.*, Asia.——FIG. E134,*8*. **R. trapezoidalis*, Pak.; RV ext., ×1 *(288)*.

Family DICEROCARDIIDAE Kutassy, 1934

[Materials for this family prepared by L. R. Cox]

Shell medium-sized to large, equivalve,

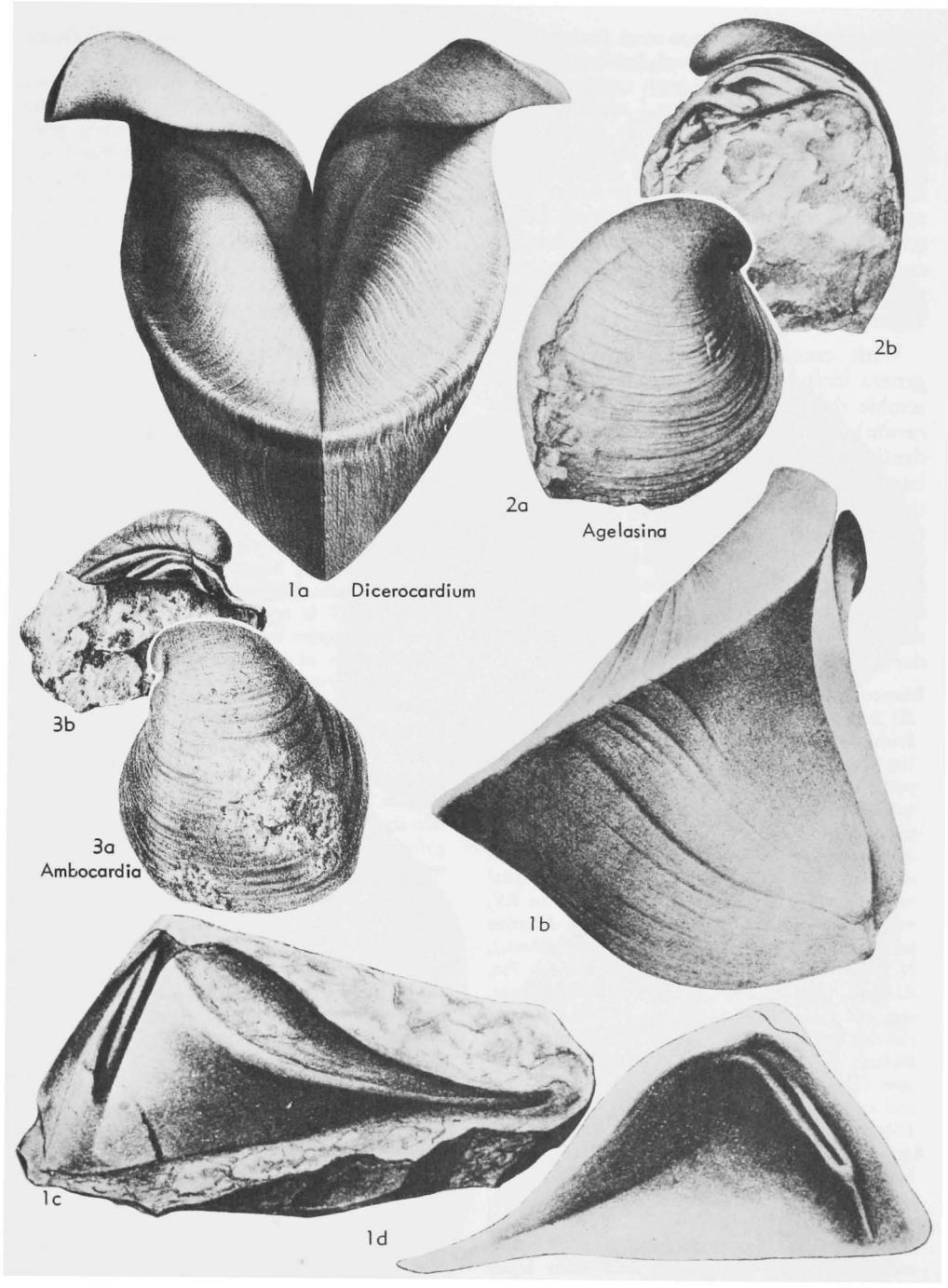


FIG. E135. Dicerocardiidae (p. *N660*).

with prominent umbones and prosogyrous, more or less anteriorly placed beaks; ligament external, opisthodetic; cardinal teeth usually two in both valves, but in some genera only one is present in one or other valve; teeth mostly oriented more or less longitudinally (i.e., parallel to hinge line) and well elongated; no posterior lateral teeth; pallial line entire; adductor scars inconspicuous, not observed so far in most genera; surface smooth or with growth rugae only. *U.Trias.-U.Cret.*

With exception of *Dicerocardium,* the genera included in this family strongly resemble the Cenozoic genus *Glossus* (=*Isocardia*) both in external characters and in dentition, except that they lack posterior lateral teeth. Separation of the family from the Glossidae is based partly on the view that the two groups originated independently during different geological periods and that the resemblances between them are due to convergence. The Dicerocardiidae are thought to be derived from the Megalodontidae.

Dicerocardium STOPPANI, 1865, p. 248 [**D. jani*; SD STOLICZKA, 1871, p. 229] [=*Diceratocardium* FISCHER, 1887 *(nom.van.)*]. Medium-sized to large, trigonal, with angular and usually sharply pointed ventral margin; truncated anteriorly, attenuated and in some specimens sharply rostrate posteriorly; umbones narrow, widely separated and even out-turned in some specimens; each valve with sharp carina running from beak to angle of ventral margin; hinge teeth elongate, 1 in LV, 2 in RV, extending posteriorly from below beak in direction parallel with hinge margin. *U.Trias.(Nor.-Rhaet.)*, N. Alps-S. Alps-Hung.-Sicily-Himalayas. —— FIG. E135,*1a*. **D. jani,* Nor., N.Italy; viewed from ant. end, ×0.3 (Stoppani, 1865),——FIG. E135,*1b*. *D. curionii* STOPPANI, Nor., Sicily; LV ext., ×0.5 (Di Stefano, 1912).——FIG. E135,*1c,d*. *D. dolomiticum* (LORETZ), Nor., N.Italy, *1c,d,* LV int. mold and cast from it showing dentition, ×1 (Frech, 1904).

Agelasina RIEDEL, 1932, p. 57 [**A. plenodonta;* M]. Medium-sized, ovate, higher than long, with strongly prosogyrous and incoiled, terminal beaks; moderately and evenly inflated, without umbonal ridges; both valves with 2 longitudinally elongated cardinal teeth extending posteriorly from below beak, more posterior (upper) one slightly narrower; those of LV received respectively in recesses behind those of RV; muscle scars and pallial line not observed. *U.Cret.(Coniac.-Maastricht.)*, W.Afr.——FIG. E135,*2*. **A. plenodonta,* Senon., Cameroons; *2a,b,* RV ext., RV int., ×0.7 (Riedel, 1932).

Ambocardia BERINGER, 1949, p. 212 [**Isocardia planidorsata* ZITTEL, 1865, p. 140; OD]. Medium-sized, rectangularly ovate, with strongly prosogyrous and incoiled, almost terminal beaks; with weak posterior and anterior umbonal ridges persisting to ventral margin but not forming distinct carinae; LV with stout, arcuate, longitudinally elongated main cardinal tooth adjoining lower margin of hinge plate in median position and lamellar posterior cardinal close to nymph; RV with strong, cuneiform anterior cardinal and slightly oblique, lamellar posterior cardinal; lateral teeth not observed. *U.Cret.(Senon.)*, Eu.——FIG. E135,*3*. **A. planidorsata* (ZITTEL), Senon., Aus.; *3a,b,* LV ext. and dentition, ×1 (Zittel, 1865).

Cornucardia KOKEN, 1913, p. 34 [**Craspedodon hornigii* BITTNER, 1901, p. 8; M] [=*Craspedodon* BITTNER, 1901 *(non* DOLLO, 1883); *Conucardia* DIENER, 1923 *(nom.null.)*]. Medium-sized, ovate, higher than long, with strongly prosogyrous and incoiled beaks; valves not carinate but with posterior radial sulcus; hinge plate massive; RV with median arcuate, longitudinally elongated tooth received by LV in recess between 2 similarly elongated teeth, upper weak, lower strong and situated along margin of hinge plate; posterior adductor scar not observed. *U.Trias.*, N.Alps-S.Alps-Hung.-Timor.——FIG. E136,*4*. **C. hornigii* (BITTNER), Hung.; *4a-c,* LV int., RV int., RV ext., ×0.7 *(60)*.

Megalocardia BERINGER, 1949, p. 212 [**Isocardia merrilli* HAMLIN, 1884, p. 43; OD]. Large medium-sized, trigonally ovate, with strongly prosogyrous and incoiled, terminal beaks; valves with weak posterior carina; known only as internal mold, so that details of dentition are uncertain. *L.Cret.(Alb.)*, Syria.

Physocardia WÖHRMANN, 1894, p. 671 [**P. ogilviae*; M]. Medium-sized, ovate, inequilateral; beaks strongly prosogyrous and slightly incoiled; no posterior carina; 2 more or less elongate, parallel, longitudinal teeth in each valve, extending on both sides of beak, upper tooth in RV relatively weak. *U.Trias.(Carn.)*, N.Alps.-S.Alps.——FIG. E136,*3*. **P. ogilviae,* S.Tyrol; *3a,* broken shell viewed from right side; *3b,c,* LV int., RV int., showing dentition, ×0.7 (Wöhrmann, 1894).

Platycardia BERINGER, 1949, p. 212 [**Isocardia zitteli* BÖHM, 1883, p. 502; OD]. Medium-sized, obliquely ovate, with very strongly prosogyrous and incoiled beaks; not carinate posteriorly; LV with 2 arcuate, longitudinally elongated teeth extending back from below beak and separated by recess for reception of single tooth of RV. *U.Jur. (Tithon.)*, Czech.——FIG. E136,*2*. **P. zitteli* (BÖHM); *2a,b,* RV ext., LV dentition, ×1 (Böhm, 1883).

Pseudisocardia DOUVILLÉ, 1913, p. 459 [**Isocardia cordata* BUCKMAN in MURCHISON, 1844, p. 98; OD] [=*Ankistrocardia* BERINGER, 1949, p. 212 (obj.)]. Medium-sized, ovate, evenly inflated, with strongly prosogyrous and incoiled beaks which are placed well anteriorly but are not terminal; RV with elongate, arcuate, longitudinal posterior cardinal tooth joined at its anterior end to apex of short anterior cardinal, base of which lies along margin of hinge plate; these teeth are received in LV in recess between 2 arcuate teeth, lower one bordering margin of hinge plate. [Thickening of the lunular margin has been regarded by DOUVILLÉ as an anterior lateral tooth.] *M.Jur.*, EU.——FIG.

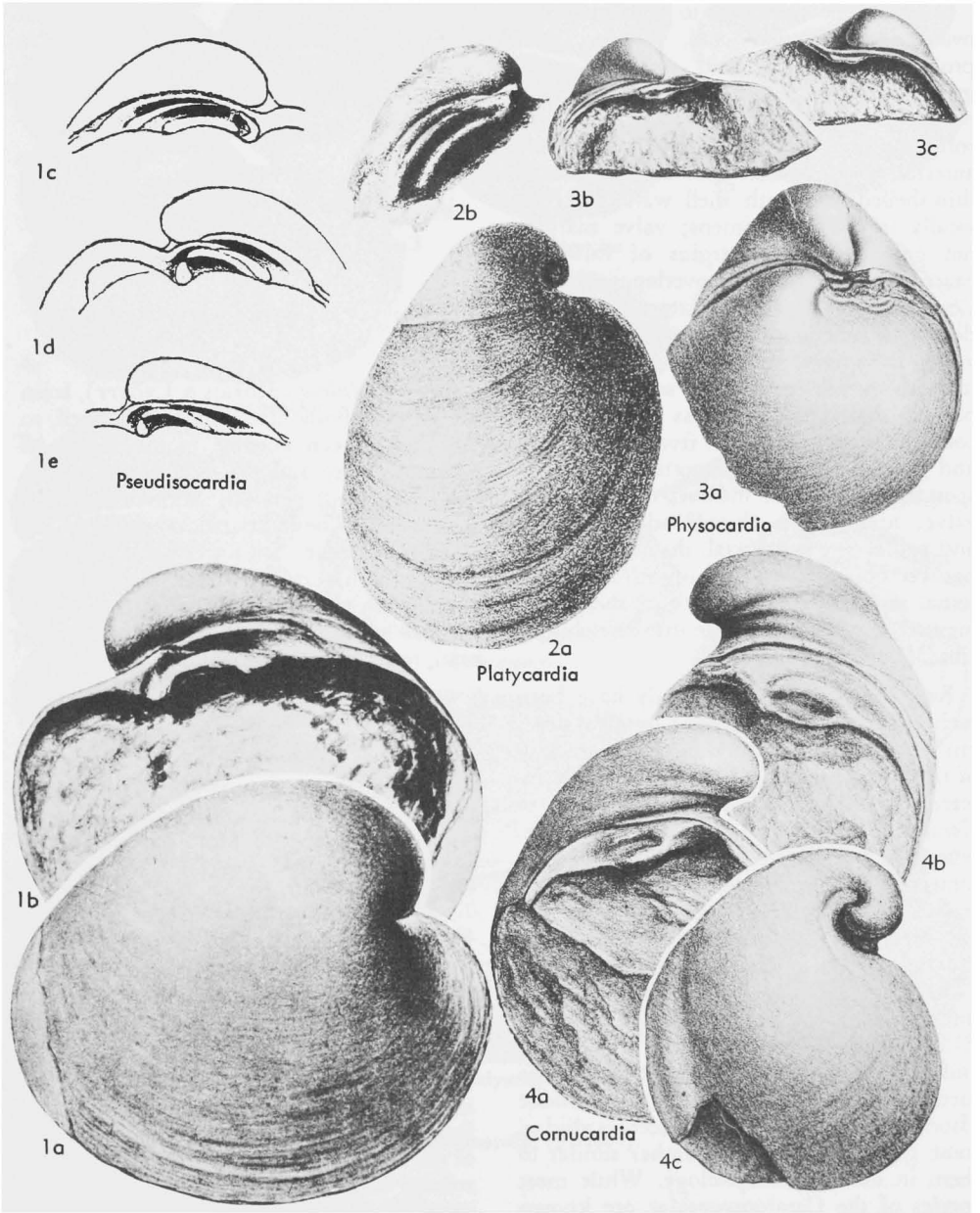


FIG. E136. Dicerocardiidae (p. *N660-N662*).

E136,*1*. **P. cordata* (BUCKMAN); *1a,b*, Bajoc., Eng., RV ext., RV int., ×1 (Benecke, 1905); *1c-e*, Aalen., France; LV, RV, and RV hinges, ×1 *(277)*.

Family CERATOMYOPSIDAE Cox, 1964

[Materials for this family prepared by L. R. Cox]

Shell small, medium- to medium-sized, ovate or subtrigonal, tall, gibbose, with prominent umbones and strongly prosogyrous, incoiled and outturned beaks; valves equally inflated but slightly dissimilar in some specimens, RV beak situated in more anterior position than that of LV; mostly thin-shelled, but with shell wall thickened locally in some specimens; valve margins not gaping; dorsal margins of valves in exact juxtaposition, not overlapping as in Ceratomyidae; ligament external, opisthodetic, its functional part inserted in each valve in groove adjoining posterodorsal margin, which groove is so deeply impressed that its track forms internal ridge coiling around to margin from below beak and giving rise in many specimens to corresponding groove on internal mold of each valve; hinge teeth absent; adductor scars and pallial line superficial, their impressions not yet observed on any of numerous internal molds studied; surface of shell ornamented with weak concentric or oblique ribs. *M.Jur.-U.Jur.*

Representatives of this family have been included in the Ceratomyidae by most modern authors, although before the erection of the type genus its species were mostly referred to *Glossus* [*Isocardia*] and not to *Ceratomya* [*Ceromya*]. The hinge structure, with the juxtaposed posterodorsal margins joined by a simple external but deeply inserted, opisthodetic ligament, is quite different from that characteristic of the Ceratomyidae, in which the margin of the right valve overlaps that of the left and a subinternal ligament lies between them (Fig. E137,*1;* F18,*1f*). The lack of hinge teeth and the usually thin shell distinguish the members of this family from the Glossidae [Isocardiidae] and the Dicerocardiidae, some genera of which are rather similar to them in external morphology. While most species of the Ceratomyopsidae are known only as internal molds, specimens of *Ceratomyopsis undulata* (MORRIS & LYCETT), from the English Bathonian, retain their shell, so that it has been possible to investigate its hinge structure and to confirm the conclusions of various previous workers that it is edentulous. The systematic position of the Ceratomyopsidae is uncertain, but (by analogy with certain Lucinacea which lack hinge teeth) it is suggested that they are edentulous Glossacea with a purely superficial resemblance to the Ceratomyidae.

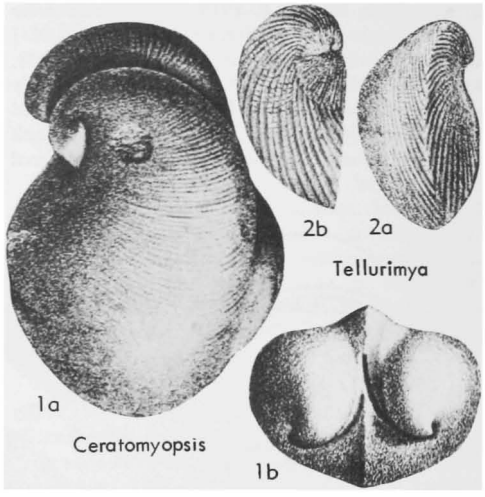


FIG. E137. Ceratomyopsidae (p. *N662*, *N664*).

Ceratomyopsis COSSMANN, 1915, p. 7 [*nom. subst. pro Ceromyopsis* DE LORIOL, 1897 (*non* MEEK, 1872)] [**Ceromyopsis helveticus (sic)* DE LORIOL, 1897, p. 80; SD ROLLIER, 1913, p. 269]. Shell oval, with small posterior lobe separated from main part of flank by sulcus; ornament of concentric or oblique undulations of small amplitude; other characters as defined for family. *M.Jur.-U.Jur. (Bajoc.-Kimmeridg.)*, Eu.-Asia-Afr.——FIG. E137, *1*. **C. helvetica* (DE LORIOL), U.Jur.(U.Oxford.), Switz.; *1a,b*, lat. and dorsal views of int. molds showing impressions of ligamental grooves, ×1 (de Loriol, 1897).

Tellurimya Cox, 1964, p. 41 [**Cardium telluris* LAMARCK, 1819, p. 19; OD]. Shell small medium-sized, subtrigonal, higher than long, with prominent, almost median ridge dividing its surface into 2 parts, each bearing series of flattened, oblique ribs separated by narrow furrows; 2 series of ribs meeting along ridge at acute, downward-pointing angle; regularly spaced growth furrows commonly divide ribs into rectangular or rhomboid segments. *M.Jur.(Bathon.-Callov.)*, France-

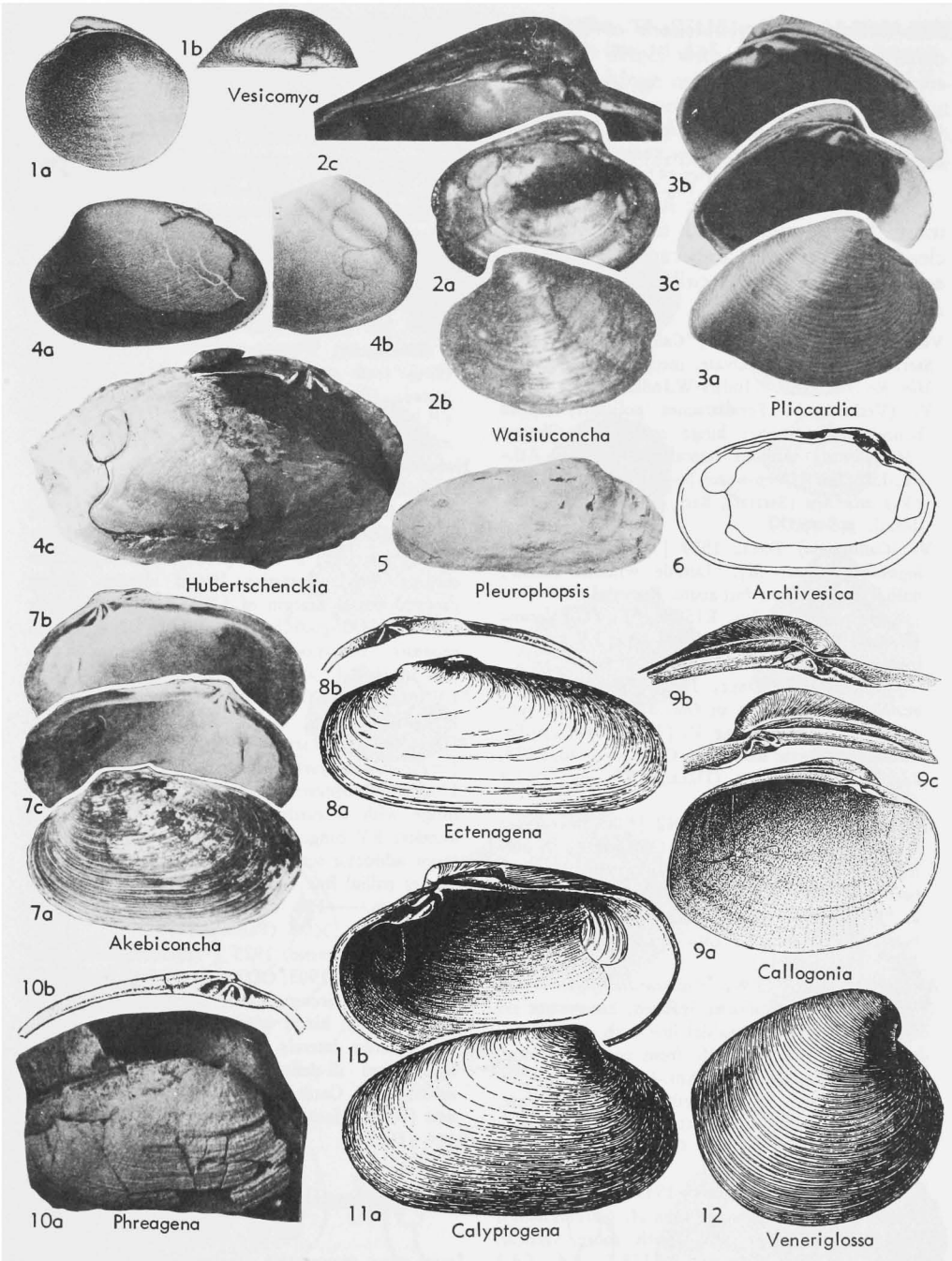


FIG. E138. Vesicomyidae (p. *N664*).

NE.Afr.-E.Afr.——Fig. E137,*2*. **T. telluris* (Lamarck), Callov., E.Afr.; *2a,b*, lat. and ant. views, ×1 (Müller, 1900).

Family VESICOMYIDAE Dall, 1908

[*nom. correct.* Keen, herein (*pro* Vesicomyacidae)]
[Materials for this family prepared by Myra Keen]

Shell ovate to elongate; lunule incised in most; hinge with up to three teeth, not clearly differentiated into cardinals and laterals; with or without pallial sinus. *Oligo.-Rec.*

Vesicomya Dall, 1886 [**Callocardia atlantica* Smith, 1885; OD[. Ovate, inequilateral, smooth. *Mio.-Rec.*, Atl.-Eu.-E.Indies-W.Indies.

V. (Vesicomya). Periostracum polished; lunule bounded by groove; hinge resembling *Glossus (Meiocardia)* without laterals. *Mio.-Rec.*, Atl.-Eu.-E.Indies. [Deep-water.]——Fig. E138,*1*. **V. (V.) atlantica* (Smith), Rec., Atl.; *1a,b*, RV int., dorsal, ×5 *(852)*.

V. (Callogonia) Dall, 1889 [**Callocardia (Callogonia) leeana*; M]. Lunule without border; pallial sinus shallow but acute. *Rec.*, Atl.-W.Indies. [Deep-water.]——Fig. E138,*9*. **V. (C.) leeana* (Dall), W.Indies; *9a*, LV int., *9b,c*, LV and RV hinges, ×2 *(217)*.

V. (Veneriglossa) Dall, 1886 [**Cytherea (V.) vesica*; M]. Beaks as in *Glossus* but hinge veneroid, young resembling *V. (Vesicomya)*; pallial sinus of moderate size. *Rec.*, Carib.——Fig. E138, *12*. **V. (V.) vesica* (Dall); RV ext., ×1.5 (Dall, 1890).

V. (Waisiuconcha) Beets, 1942 [**W. alberdinae*; OD]. Resembling *Lioconcha* (Veneridae) in outline; LV with 3 cardinal teeth; pallial line entire. *Mio.-Rec.*, W.N.Am.-E.Indies——Fig. E138, *2*. **V. (W.) alberdinae* (Beets), Mioplio., Celebes; *2a,b*, LV int., LV ext., ×1.5; *2c*, LV hinge, ×2.5 (Beets, 1942).

Archivesica Dall, 1908 [**Callocardia gigas* Dall, 1890; OD]. Modioliform, inflated, lunule not set off; hinge plate short; pallial line with small sinus, descending almost vertically from posterior adductor scar. *Neog.-Rec.*, W.C.Am.-Japan.

A. (Archivesica). Hinge teeth tending to radiate. *Rec.*, W.C.Am. [Deep-water.]——Fig. E138,*6*. **A. (A.) gigas* (Dall), Gulf Calif.; LV int., ×0.3 (Dall, 1908).

A. (Akebiconcha) Kuroda, 1943 [**Akebiconcha kawamurai*; M]. Smaller than *A. (Archivesica)*, less inflated; hinge with teeth more vertical. *Neog.-Rec.*, Japan.——Fig. E138,*7*. **A. (A.) kawamurai* (Kuroda); *7a-c*, LV ext., RV int., LV int., ×0.5 (Kuroda, 1943).

Calyptogena Dall, 1891 [**C. pacifica*; M]. Elongate, smooth, of earthy texture, with periostracum; escutcheon present, no lunule; ligament external, deep-seated; pallial line entire. *Mio.-Rec.*, N.Am.-Japan.

C. (Calyptogena). Hinge with 1 anterior and 1 posterior lateral tooth in either valve, RV cardinal triangular, LV cardinal hook-shaped. *Mio.-Rec.*, W.N.Am.-Japan.——Fig. E138,*11*. **C. (C.) pacifica*, Dall, Rec., USA(Alaska); *11a,b*, RV ext., int., ×0.7 (Dall, 1895).

C. (Ectenagena) Woodring, 1938 [**C. elongata* Dall, 1916; M]. Shell thinner and longer than *C. (Calyptogena)*, anterior tooth wanting in RV. *Rec.*, W.N.Am.——Fig. E138,*8*. **C. (E.) elongata* Dall, USA(Calif.); *8a,b*, LV ext., RV hinge, ×1 (Dall, 1921; Woodring, 1938).

C. (Phreagena) Woodring, 1938 [**P. lasia;* OD]. Hinge teeth more vertical than in *C. (Calyptogena)*. *Plio.*, W.N.Am.——Fig. E138,*10*. **C. (P.) lasia* (Woodring), USA(Calif.); *10a,b*, RV ext., LV hinge, ×1 (Woodring, 1938).

Hubertschenckia Takeda, 1953 [**Tapes ezoensis* Yokoyama, 1890; OD]. Thick, elongate; prosogyrate beaks well forward; escutcheon present; hinge of LV with two cardinals and posterior lateral; RV with 2 teeth parallel to margin, one cardinal bifid, posterior lateral slender, fitting grooved dorsal margin of LV; pallial line slightly sinuate. *U.Oligo.*, Japan.——Fig. E138,*4*. **H. ezoensis* (Yokoyama), Hokkaido; *4a,b*, LV ext., part int. mold, ×0.5; *4c*, part RV int. mold and LV int., ×0.7 (Yokoyama, 1890; specimen, Univ. Hokkaido).

Pleurophopsis Palmer, 1919 [**P. unioides*; M] [=*Pleurophoropsis* Cossmann, 1920 *(nom.van.)*]. Elongate, sculpture of concentric growth lines, LV hinge with 2 cardinals, posterior large, anterior slender; RV hinge with 2 subequal cardinals; anterior adductor scar embedded, bordered by flange above; pallial line entire. *Oligo.*, W.Indies-C.Am.-NW.S.Am.——Fig. E138,*5*. **P. unioides*, Trinidad; RV ext., ×0.5 (Palmer, 1919).

Pliocardia Woodring, 1925 [**Anomalocardia bowdeniana* Dall, 1903; OD]. Resembling *Vesicomya*, with lunule circumscribed, but posterior end of shell rostrate; hinge with double anterior laterals, no posterior laterals, 1 cardinal in either valve, broad and ill-defined; pallial line with small sinus. *Mio.*, Carib.——Fig. E138,*3*. **P. bowdeniana* (Dall), Jamaica; *3a-c*, RV ext., int., LV int., ×4 *(1005)*.

Superfamily CORBICULACEA Gray, 1847

[*nom. transl.* Tryon, 1882 (*ex* Corbiculidae Gray, 1847)]
[=Cyrenacea Gray, 1840] [Materials for this superfamily prepared by Myra Keen and Raymond Casey]

Rounded-trigonal to ovate, porcelaneous; sculpture concentric, striate; ligament external; hinge with up to three cardinal teeth

in either valve, pivotal cardinal in RV; pallial line entire or with small sinus. *?L. Jur., M.Jur.-Rec.*

Family CORBICULIDAE Gray, 1847

[*nom. correct.* Dall, 1889 (*pro* Corbiculadae Gray, 1847, ICZN pend.)] [=Cyrenidae Gray, 1840] [Materials for this family prepared by Myra Keen and Raymond Casey]

Small to moderately large shells; shell material dense, with well-developed periostracum; hinge commonly with strong posterior and anterior lateral teeth, somewhat serrate. [Recent forms in brackish to fresh water; fossil forms also in marine environments.] *?L.Jur., M.Jur.-Rec.*

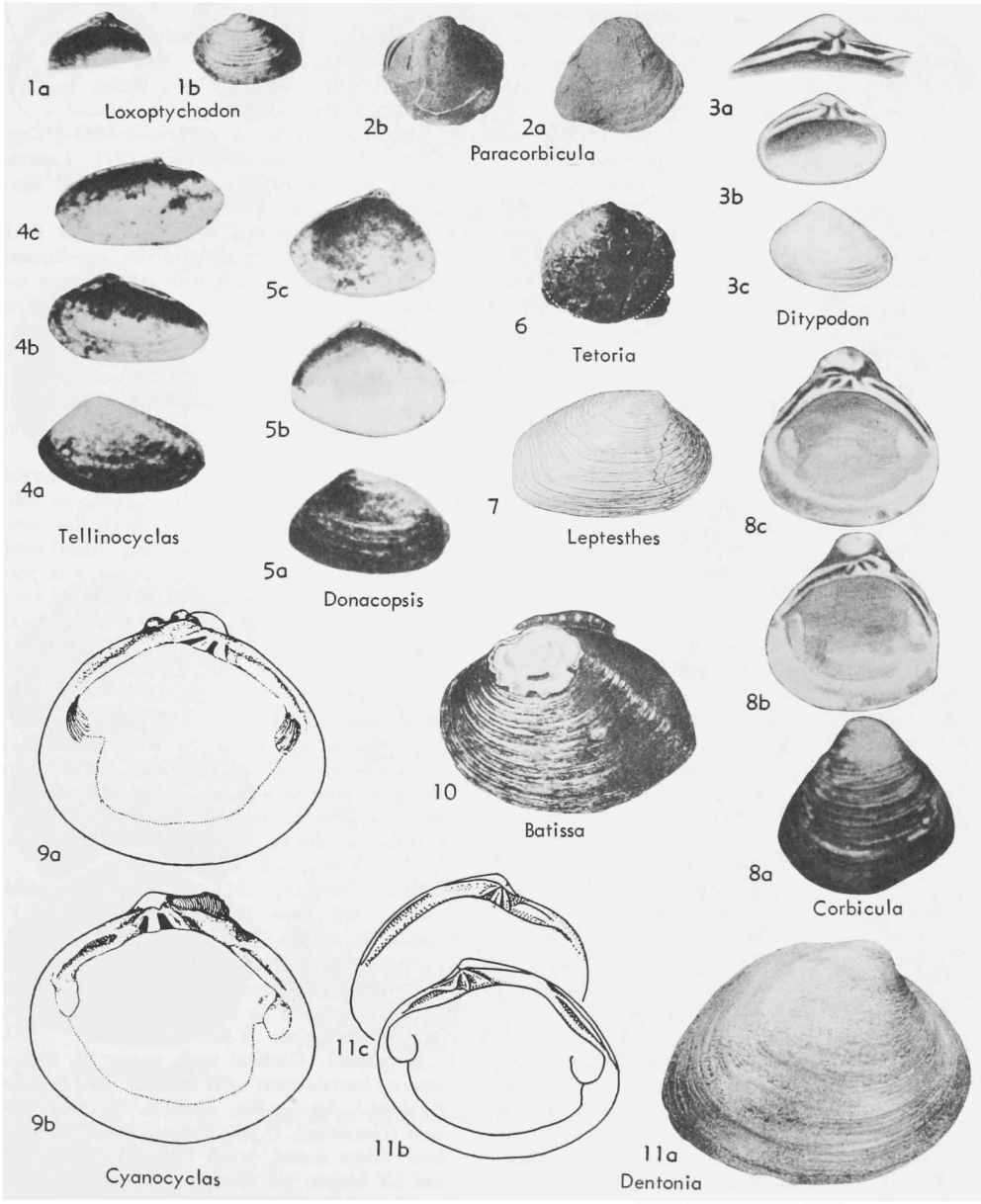


Fig. E139. Corbiculidae (p. *N666*).

Corbicula MERGELE VON MÜHLFELD, 1811 [**Tellina fluminalis* MÜLLER, 1774 (designated ICZN, 1955)] [=*Cyrena* LAMARCK, 1818 (type, *C. cor*; SD CHILDREN, 1823); *Eucorbicula* CROSSE & FISCHER, 1894 (genus without cited species); *Serrilaminula* LINDHOLM, 1933 (type, *Corbicula minima* VON MARTENS, 1874; OD)]. Rounded-trigonal; concentric sculpture present; lateral teeth mostly serrate. *L.Cret.-Rec.*, cosmop.

C. (Corbicula). Lateral teeth long, pallial line entire. *U.Cret.-Rec.*, Asia-Afr.-Eu.-N.Am.-W.Pac. ——FIG. E139,*8*. **C. (C.) fluminalis* (MÜLLER), Rec., Asia Minor; *8a-c*, LV ext., RV int., LV int., ×1 (Kennard & Woodward).

C. (Corbiculella) VON IHERING, 1907 [**Corbicula (C.) tenuis*; M]. Ovate, hinge weak, laterals short, not serrate. *?U.Mio., Plio.-Pleist.*, S.Am.

C. (Corbiculina) DALL, 1903 [**Corbicula angasi* PRIME, 1864; OD]. Small; viviparous; living in fresh water. *Rec.*, Orient.

C. (Cyanocyclas) DE BLAINVILLE, 1818 [**Tellina limosa* MATON, 1811; SD DALL, 1903] [=*Neocorbicula* FISCHER, 1887 (type, *Cyrena variegata* D'ORBIGNY, 1835; OD)]. With small pallial sinus; animal viviparous. *?Eoc., Plio.-Rec.*, S.Am. ——FIG. E139,*9*. **C. (C.) limosa* (MATON), Rec., Brazil; *9a,b*, LV int., RV int., ×2 (Parodiz & Hennings, 1965).

C. (Cyrenodonax) DALL, 1903 [**C. formosana*; OD]. Small, thin, trigonal, beak at posterior 3rd; smooth, inflated. *Pleist.-Rec.*, E.Asia.

C. (Donacopsis) SANDBERGER, 1872 [**Cyrena acutangularis* DESHAYES, 1858; SD DALL, 1903]. Donaciform, posterior end shorter; pallial sinus short, wide. *Paleoc.-Eoc.*, Eu.——FIG. E139,*5*. **C. (D.) acutangularis* (DESHAYES), Eoc., France; *5a-c*, LV ext., RV int., LV int., ×1 (Cossmann & Pissarro).

C. (Leptesthes) MEEK, 1871 [**Cyrena fracta* MEEK, 1870; OD]. Subtrigonal to long-ovate; lunule defined by incised line; pallial sinus short, wide, triangular. *U.Cret.*, C.USA.——FIG. E139, *7*. **C. (L.) fracta* (MEEK), USA(Wyo.); RV ext., ×0.5 (Meek).

C. (Loxoptychodon) SANDBERGER, 1872 [**Cyrena intermedia* MELLEVILLE, 1843; SD DALL, 1903]. Subtrigonal, anterior end shorter; cardinals 2 in LV; anterior laterals shorter than posterior; pallial line broadly sinuous. *Paleoc.-L.Eoc.*, Eu.——FIG. E139,*1*. **C. (L.) intermedia* (MELLEVILLE), L.Eoc., Eng.; *1a,b*, LV int., ext., ×1 (Morris).

C. (Paracorbicula) KOBAYASHI & SUZUKI, 1939 [**Corbicula sanchuensis* YABE & NAGAO, 1926; OD]. Obliquely ovate to subcircular; posterolateral teeth long and crenulate; pallial line distinctly sinuate. *L.Cret.("Wealden")*, Japan.——FIG. E-139,*2*. **C. (P.) sanchuensis* YABE & NAGAO; *2a,b*, RV ext., int. mold, ×0.5 (Yabe & Nagao).

C. (Tellinocyclas) DALL, 1903 [**Cyrena tellinella* DESHAYES, 1825; OD]. Like *C. (Donacopsis)* but with short, distant lateral teeth. *Paleoc.-Eoc.*, Eu.——FIG. E139,*4*. **C. (T.) tellinella* (DESHAYES), Sparnac., France; *4a-c*, LV ext., RV int., LV int., ×1 (Cossmann & Pissarro).

Acyrena LEBEDEV, 1958 [**A. jenissijensis*; OD?]. *M.Jur.*, USSR(W.Sib.).

Batissa GRAY, 1853 [**Cyrena tenebrosa* HINDS, 1842; SD STOLICZKA, 1871]]. Large, heavy, ovate; lateral teeth serrate to crenulate. *M.Jur.-Rec.*, Orient.

B. (Batissa). Pallial line entire or nearly so. *U.Jur.-Rec.*, Asia-E.Indies.——FIG. E139,*10*. **B. (B.) tenebrosa* (HINDS), Rec., Philip. Is.; LV ext., ×0.5 (Hinds).

B. (Cyrenobatissa) SUZUKI & OYAMA, 1943 [**Corbicula subsulcata* CLESSIN, 1878; OD]. Laterals shorter than in *B. (Batissa)*, nymph and ligament not so large. *Eoc.-Rec.*, Orient.

B. (Tetoria) KOBAYASHI & SUZUKI, 1937 [**B. (T.) yokoyamai*; OD]. Of medium size, subelliptical to subcircular; pallial line with deep, narrow ascending sinus. *M.Jur.*, Japan-China.——FIG. E139,*6*. **B. (T.) yokoyamai*, Japan; RV ext., ×0.5 (Kobayashi & Suzuki).

Costocyrena HAYAMI, 1965, *ex* MATSUMOTO & KANMERA, 1952, MS [**C. matsumotoi*; OD]. Shell radially ribbed; hinge resembling that in *Eomiodon*. *L.Cret.*, Japan.

Dentonia STEPHENSON, 1953 [**Cytherea leveretti* CRAGIN, 1893; OD]. Broadly subovate to subtrigonal; lunule long, bounded by feeble line; umbonal ridge weak; escutcheon wanting; lateral teeth smooth, anterior teeth short; pallial line with posterior truncation. *U.Cret.(Cenoman.)-Eoc.*, N.Am.-France.——FIG. E139,*11*. **D. (C.) leveretti* (CRAGIN), U.Cret., USA(Tex.); *11a*, RV ext., ×1 (Stephenson); *11b,c*, RV int., LV int., ×1 (Casey, after Stephenson).

Ditypodon SANDBERGER, 1875 [**Cyrena suesii*; M]. Oval, anterior end shorter; 1 stout cardinal in either valve; lateral teeth smooth, anterior short and stout, posterior longer; pallial line obtusely sinuous. *U.Mio.-L.Plio.*, Eu.——FIG. E139,*3*. **D. suesii* (SANDBERGER), Plio., Italy; *3a-c*, LV hinge, LV int., LV ext., ×2 (Sandberger).

Eocallista DOUVILLÉ, 1921 [**Venus brongniarti* RÖMER, 1836 (*non* PAYRAUDEAU, 1826) (=*V. caudata* GOLDFUSS, 1840); SD FRIZZELL, 1936]. Trigonal-ovate; no lunule or escutcheon; lateral teeth smooth, *PII* merged into margin, *PIII* absent; *2a* and *1* attached to laterals; pallial line with posterior truncation. *M.Jur.-U.Jur.*, Eu.

E. (Eocallista). Cardinal teeth, except *3b*, entire; anterior laterals short, *AIII* wanting. *Jur.(Bathon-Portland.)*, Eu.——FIG. E140,*10*. **E. (E.) caudata* (GOLDFUSS), U.Jur., France; *10a,b*, LV ext., both valves dorsal, ×0.5 (Romer); *10c,d*, RV and LV hinges, ×1 (Casey, from specimens).

E. (Hemicorbicula) CASEY, 1955 [**Cyclas parva* J. DE C. SOWERBY, 1836; OD]. Cardinal teeth *1*,

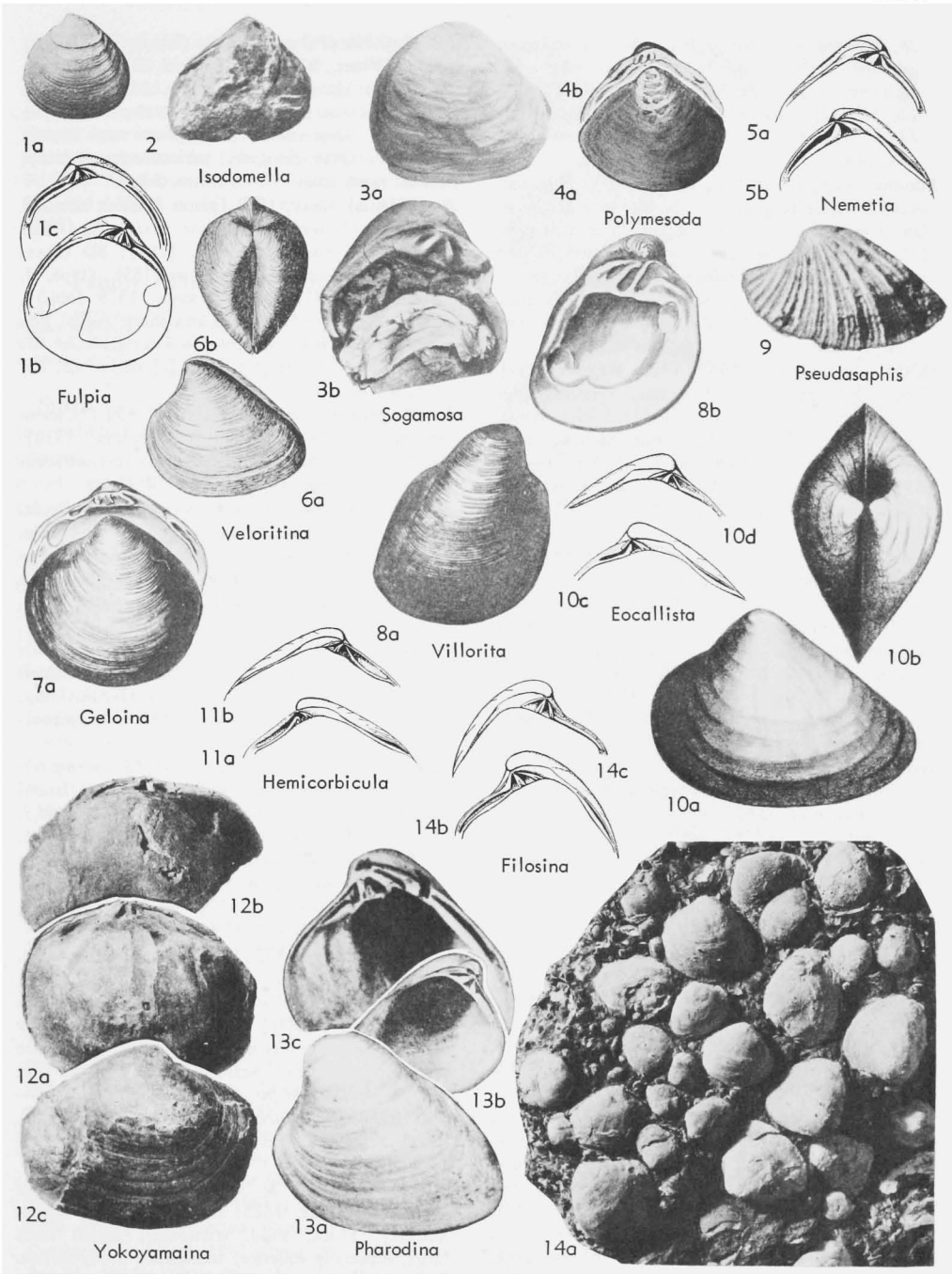


FIG. E140. Corbiculidae (p. *N666*, *N668-N669*).

3b, 2b, and *4b* more or less bifid; *2a* entire or grooved; anterior laterals moderately long, *AIII* incipient. *U.Jur.-(Purbeck.)*, Eu.——Fig. E140, *11*. **E. (H.) parva* (Sowerby), U.Jur., Eng.; *11a,b,* RV and LV hinges, ×2 (Casey, from specimens).

Filosina Casey, 1955 [**F. gregaria*; OD]. Trigonal-ovate or subrectangular; no lunule or escutcheon; lateral teeth finely striate, *PII* merged into margin, *PIII* wanting; pallial line truncate posteriorly but not sinuate. *L.Cret.(Wealden-Apt.)*, Eu.-Syria.——Fig. E140,*14*. **F. gregaria,* L.Cret.(Wealden), Eng.; *14a-c,* slab, ×1, RV and LV hinges, enl. (Casey).

Fulpia Stephenson, 1946 [**F. pinguis*; OD]. Trigonal-ovate; umbo subangular; posterior ridge weak; lunule bounded by impressed line; lateral teeth finely striate; pallial sinus narrow, deep, ascending. *U.Cret.(Cenoman.)*, N.Am.——Fig. E140,*1*. **F. pinguis,* USA(Tex.); *1a,* LV ext., ×1 (Stephenson); *1b,c,* LV int., RV int,. ×1 (after Stephenson).

Isodomella Kobayashi & Suzuki, 1939 [**Cyrena shiroensis* Yabe & Nagao, 1926 (=**C. naumanni* Neumayr, 1890); OD]. Subtrapezoidal, rounded in front, truncate behind; posterior-lateral teeth longer than anterolaterals; *2b* and *1* long, wedge-shaped; *3b* very thin; pallial line simple. *L.Cret. ("Wealden")*, Japan.——Fig. E140,*2*. **I. naumanni* (Neumayr); RV ext., ×1 (Kobayashi & Suzuki).

Nemetia Casey, 1955 [**Platopis triangularis* Whitfield, 1891; OD]. Subtrigonal, with strong posterior angulation; no lunule or escutcheon; cardinal teeth entire, *1* and *2a* attached to laterals; *PIII* wanting. *L.Cret.(Apt.)*, Syria.——Fig. E140,*5*. **N. triangularis* (Whitfield), Syria; *5a,b,* LV and RV hinges, ×2 (after Vokes).

?**Pharodina** Stephenson, 1953 [**P. ferrana*; OD]. Obliquely trigonal; posterior slope subangular; umbo prominent, rounded; beaks strongly prosogyrate; hinge as in *Nemetia* but with anterior laterals shorter and distinctly separated from *2a* and *1*. *U.Cret.(Cenoman.)*, N.Am.——Fig. E140, *13*. **P. ferrana,* USA(Tex.); *13a-c,* LV ext., LV int., RV int., ×1 *(890)*.

Polymesoda Rafinesque, 1828 [**Cyclas caroliniana* Bosc. 1801; OD] [=*Egetaria* Mörch, 1860 (type, *P. (E.) pullastra*; M); *Cyprinella* Gabb, 1864 (*non* Girard, 1856); *Diodus* Gabb, 1868 (*pro Cyprinella*) (type, *Cyprinella tenuis* Gabb, 1864; M); *Leptosiphon* Fischer, 1872 (obj.); *Americana* Clessin, 1879 (obj.)]. Medium-sized to large; beaks prominent, inturned; inequilateral; cardinal teeth 3, LV with 1 anterior and 1 long posterior lateral against 2 in RV. *Eoc.-Rec.*, C.Am.-Japan-S.Am.-Carib.

P. (Polymesoda). Pallial line with deep, narrow sinus. *Rec.*, E.N.Am.-E.C.-Am.-W.C.Am.——Fig. E140,*4*. **P. (P.) caroliniana* (Bosc), USA(Fla.); *4a,b,* RV ext., LV int., ×1 (Bosc, 1801).

P. (Egeta) H.Adams & A.Adams, 1858 [**Cyrena anomala* Deshayes, 1858; SD Baker, 1930] [*pro Anomala* Deshayes, 1855 (*non* von Block, 1799)]. Ovate-elongate, periostracum velvety; pallial sinus small. *Rec.*, C.Am.-S.Am.

P. (Geloina) Gray, 1842 [genus without nominal species] [**Cyrena zeylanica* Lamarck, 1818 (=**Venus coaxans* Gmelin, 1791); SD Gray, 1847)] [=*Isodoma* Deshayes, 1858 (type, *I. cyprinoides*; M); *Indica* Clessin, 1879 (obj.)]. Large, lateral teeth smooth and short; pallial line entire. *Eoc.-Rec.*, Orient.——Fig. E140,*7*. **P. (G.) coaxans* (Gmelin), Rec., E.Indies; *7a,b,* LV ext., RV int., ×0.25 *(124)*.

P. (Neocyrena) Crosse & Fischer, 1894 [**Cyrena nicaraguana* Prime, 1869; SD Baker, 1930]. Surface concentrically corrugated, periostracum smooth, shining. *Rec.*, E.C.Am.-W.C.Am.

P. (Pseudocyrena) Bourguignat, 1854 [**Cyclas maritima* d'Orbigny in Sagra, 1842; OD] [=*Cyrenocapsa* Fischer, 1872 (type, *Cyrena floridana* Conrad, 1816; M)]. Thin-shelled, pallial sinus minute; living in brackish to salt water. *Rec.*, Carib.

?**Pseudasaphis** Matsumoto, 1938 [**P. japonicus*; OD]. Small, elongate, subtrigonal; lunular region excavated; surface with radial costae; laterals long, smooth. *Cret.*, Japan.——Fig. E140,*9*. **P. japonicus*; LV ext., ×1 (Matsumoto).

Sogamosa Pilsbry & Olsson, 1935 [**S. cyrenoides*; OD]. Like *Polymesoda* but hinge with no lateral teeth on flat plate. *U.Eoc.*, S.Am.——Fig. E140,*3*. **S. cyrenoides,* Colomb.; *3a,b,* RV ext., LV hinge, ×1 (Pilsbry & Olsson).

?**Soleilletia** Bourguignat, 1885 [**S. abbadiana;* SD Pilsbry & Bequaert, 1927]. Shell thin, fragile; lateral teeth wanting. *Rec.*, Afr.

Veloritina Meek, 1872 [**Cyrena durkeei* Meek, 1870; OD] [=*Mesocorbicula* Suzuki & Oyama, 1943 (type, *Corbicula tetoriensis* Kobayashi & Suzuki, 1939; OD)]. Gibbous trigonal; lunular and ligamentary areas deeply depressed; pallial line posteriorly truncate. Scarcely sinuate; hinge like that of *Filosina*. *M.Jur.-U.Cret.*, Japan-N.Am.——Fig. 140,*6*. **V. durkeei* (Meek), U.Cret., USA (Mont.); *6a,b,* LV ext., both valves dorsal, ×0.5 (White).

Villorita Griffith & Pidgeon, 1834 [**Cyrena cyprinoides* Gray, 1825; OD] [=*Velorita* Gray, auctt.]. Thick, solid, triangular; lateral teeth large, especially anterior, triangular, finely striate. *Rec.*, Orient.——Fig. E140,*8*. **V. cyprinoides* (Gray); *8a,b,* RV ext., LV int., ×1 (Chenu).

?**Yokoyamaina** Hayami, 1958 [**Cyrena elliptica* Yokoyama, 1904 (*non* Dunker, 1843, =*Y. hayamii* Keen & Casey, herein, new name); OD]. Valves inequilateral, elliptical, inflated; surface

nearly smooth, few radial threads ventrally; hinge formula, *AI 3a 3b PI/AII 2 4b PII*, with *2* and *3b* conical, *3a* and *4b* close to nymph, anterior laterals tubercular, posterior short and weak; adductor scars small, subequal, impressed, pallial line distinctly sinuate. *Jur.(Hettang.)*, E.Asia.——Fig. E140,*12*. **Y. hayamii* Keen & Casey, Japan; *12a-c*, RV and LV int. molds, RV ext., ×0.7 (Hayami, 1958).

Family PISIDIIDAE Gray, 1857

[*nom. correct.*, ICZN, 1955, *ex* Pisidiadae; =Cycladidae Forbes & Hanley, 1853; Sphaeriidae Jeffreys, 1862] [Materials for this family prepared by Myra Keen, with advice on technical details of classification from Mr. Peter Dance, British Museum (Natural History)]

Small to minute shells, oval or quadrate to subtriangular; shell texture thin to opaque, some forms appearing porous. Ligament partially to completely immersed (rarely external); hinge curved, narrow, with anterior and posterior lateral teeth in both valves; cardinal teeth small, not more than two, those of RV straight or united into inverted V, of LV wholly separate. [Fresh-water.] *?U.Jur., Cret.-Rec.*

Pisidium Pfeiffer, 1821 [**Tellina amnica* Müller, 1774; SD Gray, 1847 (+ICZN, Op. 335, 1955)] [=*Euglesa* Gray, 1840, auctt. *(nom. invalid., in synon.); Galileja* da Costa, 1840, auctt. (type, *G. tenebrosa, spec. dub.;* M); *Pera* Sowerby, 1842, *ex* Alder, 1831 [*in synon.*] (obj.; M); *Pisum* "Megerle" Gray, 1847, *et* auctt. (*non* Megerle von Mühlfeld, 1811, *nom. dub.*); *Cordula* Gray, 1852 (*ex* Leach MS) (obj.); *Cycladina* Clessin, 1871 (*non* Cantraine, 1835); *Fossarina* Clessin in Westerlund, 1873 (*non* Adams & Angas, 1864); *Fluminina* Westerlund, 1873 (obj.); *Flumininea, Fluminea (nom. null.); Rivulina* Clessin in Westerlund, 1873 (type, *Pisidium supinum* Schmidt, 1851; SD Clessin, 1879); *Amnicana* Fagot, 1892 (obj.; SD Boettger, 1961); *?Pusillana* Fagot, 1892 (type, *Tellina pusilla* Gmelin, 1791, SD Boettger, 1961, *spec. dub.*); *Roseana* Fagot, 1892 (type, *Pisidium roseum* Scholtz, 1843; SD Boettger, 1961); *Casertiana* Fagot, 1892 (type, *Cardium casertanum* Poli, 1795; SD Boettger, 1961); *Henslowiana* Fagot, 1892 (type, *Tellina henslowana* Sheppard, 1825; SD Boettger, 1961); *Cyclocalyx* Dall, 1903 (type, *P. scholtzii* Clessin, 1873; OD); *Cymatocyclas* Dall, 1903 (type, *P. compressum* Prime, 1851; OD); *Tropidocyclas* Dall, 1903 (type, *Tellina henslowana* Sheppard, 1825; OD); *Clessinia* Piaget, 1913 (*non* Döring, 1877); *Pseudeupera* Germain, 1913 (type, *Pisidium landeroini* Germain, 1909; OD); *Lacustrina* Sterki, 1916 (type, *Pisidium idahoense* Roper, 1890; M); *Fontinalina* Sterki, 1916 (type, *Cyclas fontinalis* Draparnaud, 1801 (=*Cardium casertanum* Poli, 1795); M); *Eupisidium* Odhner, 1921 (obj.; SD Boettger, 1961); *Cletella* Strand, 1928 (*pro Clessinia* Piaget) (type, *Pisidium profundum* Clessin, 1877; OD); *Australpera* Iredale, 1943 (type, *P. etheridgii* Smith, 1882; OD); *Glacipisum* Iredale, 1943 (type, *G. kosciusko;* OD *nom. nud.*); *Speleopisidium* Zhadin, 1952 (type, *P. subterraneum* Zhadin, 1932; SD Boettger, 1961)]. Small, globose or subtriangular, inequilateral, beaks nearer posterior end; lateral teeth double in RV, single in LV; cardinals 2 in LV, 1 in RV; animal with single siphon. *U.Cret.-Rec.*, cosmop.

P. (Pisidium). Animal with 2 pairs of gills. *U. Cret.-Rec.*, N.Am.-Eurasia.——Fig. E141,*1*. **P. (P.) amnicum* (Müller), Rec., Eu.; *1a-c*, RV ext., int., LV int., ×3 *(294)*.

P. (Afropisidium) Kuiper, 1962 [**P. lepus* Kui-

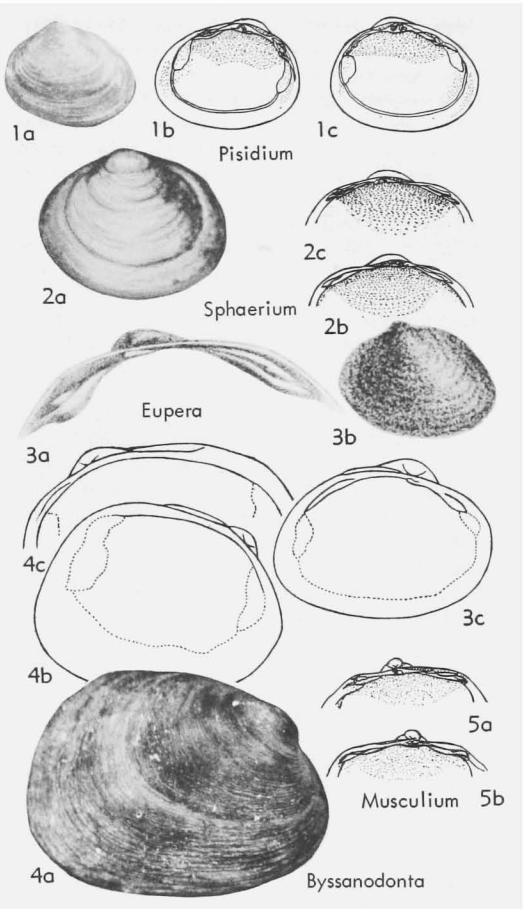


Fig. E141. Pisidiidae (p. *N669-N670*).

PER, 1957 (=**P. pirothi* JICKELI, 1881); OD]. With one pair of gills; ligament external, its fossette turned outward. *Rec.*, Afr.-Asia-N.Z.

P. (Neopisidium) ODHNER, 1921 [**P. torquatum* STELFOX, 1918 (=**P. moitessierianum* PALADILHE, 1866); SD HABE, 1951)]. Gills reduced to one pair, ligament internal, enclosed in fossette. *Rec.*, E.Afr.-N.Asia-N.Eu.-?N.Am.

P. (Odhneripisidium) KUIPER, 1962 [**P. stewarti* PRESTON, 1909; OD]. Shell and animal as in *P. (Neopisidium)* but ligament deeply immersed. *Rec.*, Asia-W.Eu.

Byssanodonta D'ORBIGNY, 1846 [**B. paranensis;* M]. Rhomboidal, very inequilateral, cardinal teeth evanescent, anterior lateral tooth present, low. *Rec.*, S.Am.——FIG. E141,*4*. **B. paranensis*, Argentina; *4a-c*, RV ext., LV int., RV hinge, ×3 (*4a*, U.S. Natl. Museum specimen; *4b*, Klappenbach, 1960; *4c*, unpublished drawing).

Eupera BOURGUIGNAT, 1854 [**Pisidium (E.) moquinianum* (=*?Cyclas modioliformis* ANTON, 1837); M] [=*Limosina* CLESSIN, 1872 (*non* MACQUART, 1835); *Clessinella* WAAGEN, 1905 (type, *Sphaerium sturanyi;* M)]. Resembling *Byssanodonta* but with cardinal teeth evident in at least LV. *Eoc.-Rec.*, Eurasia-N.Am.-S.Am.-Afr.——FIG. E141,*3a,b*. **E. moquiniana* (BOURGUIGNAT), Rec., Brazil, *3a,b*, RV hinge, LV ext., ×4 (Bourguignat, 1854).——FIG. E141,*3c*. *E. platensis* DOELLO-JURADO, Rec., Argentina; LV int., ×4 (Klappenbach, 1960).

Sphaerium SCOPOLI, 1777 [**Tellina cornea* LINNÉ, 1758 (fixed, ICZN Opinion 94)] [=*Cyclas* BRUGUIÈRE, 1798 (genus without named species; type, *C. rivicola* LAMARCK, 1818; SD CHILDREN, 1823); *Cornea* MEGERLE VON MÜHLFELD, 1811 (obj.); *Corneocyclas* DE BLAINVILLE, 1818 (type, *Cyclas cornea* "DRAPARNAUD" (=*C. rivicola* LAMARCK, 1818); SD PILSBRY & BEQUAERT, 1927); *Amesoda* RAFINESQUE, 1820 (type, *Cyclas similis* SAY, 1819; SD HANNIBAL, 1912); *Cycladites* KRUEGER, 1823 (obj.); *?Euglesa* GRAY, 1852 *ex* LEACH MS (type, *E. henslowiana; spec. dub.*); *Cyrenastrum* BOURGUIGNAT, 1854 (type, *Cyclas solida* NORMAND, 1844; M); *Cycladella* CARPENTER, 1865 (type, *C. papyracea;* M); *Corneola* WESTERLUND, 1873 (*non* HELD, 1837); *Serratisphoerium* GERMAIN, 1909 (type, *Sphaerium courteti*; M); *Trigonosphaerium* KOBELT, 1913 (type, *S. alticola;* M); *Sphaerinova* IREDALE, 1943 (type, *Sphaerium macgillivrayi* SMITH, 1882; OD)]. Oval, quadrate, bluntly triangular in some, shell moderately solid, concentrically striate; beaks nearly median; animal with 2 siphons. *?U.Jur.; Cret.-Rec.*, Eu.-N.Am.-Holarctic-Afr. [=*Sphaeriastrum* BOURGUIGNAT, 1854 (type, *Cyclas rivicola* LAMARCK, 1818; SD KOBELT, 1881).]

S. (Sphaerium). Beaks rounded, not set off by projecting caps. *?U.Jur., Cret.-Rec.*, Holarctic-Afr.——FIG. E141,*2a-c*. **S. (S.) corneum* (LINNÉ), Rec., Eng.; *2a*, LV ext., ×2 (Jeffreys); *2b,c*, LV and RV hinges, ×2 *(294)*.

S. (Musculium) LINK, 1807 [**Tellina lacustris* MÜLLER, 1774; M] [=*Phymesoda* RAFINESQUE, 1820 (obj.); *Calyculina* CLESSIN, 1872 (obj.); *Carneola* WESTERLUND, 1873 (obj.); *Primella* COOPER, 1890 (obj.) (type, *Cyclas calyculata* DRAPARNAUD, 1805 =*Tellina lacustris* MÜLLER, 1774; SD KEEN, herein)]. Hinge plate weak, embryonal shell prominent, commonly set off by a groove. *Mio.-Rec.*, Eu.-N.Am.——FIG. E141, *5*. **S. (M.) lacustre* (MÜLLER), Rec., Eng.; *5a,b*, LV and RV hinges, ×2 *(294)*.

S. (Pseudocorbicula) DAUTZENBERG, 1908 [**P. alluaudi;* M]. Like *Corbicula* in form but with hinge of *Sphaerium*. *Rec.*, Afr.

S. (Sulcastrum) STERKI, 1930 [**Sphaerium sulcatum* LAMARCK, 1818; OD]. Densely microscopically rugulose. *Rec.*, N.Am.-Eu.

Superfamily VENERACEA Rafinesque, 1815

[*nom. correct.* MENKE, 1830 (*pro* Veneridia RAFINESQUE, 1815)] [Materials for this superfamily prepared by MYRA KEEN]

Ovate shells, ornamentation predominantly concentric but also radial in some, with spines or lamellae, especially near posterior slope; beaks anterior, prosogyrate. Ligament external, opisthodetic. Cardinal hinge teeth generally three in either valve; pallial sinus usually present. *L.Cret.-Rec.*

Family VENERIDAE Rafinesque, 1815

[*nom. transl. et correct.* LEACH, 1819 (*ex* Veneridia RAFINESQUE, 1815)]

Lunule and escutcheon usually well developed. Cardinal teeth three in either valve, with *1* and *2b* commonly thicker than *3a* and *2a;* posterior lateral teeth feeble or wanting, anterior laterals present in some groups, absent in others; pallial sinus varying in size and shape. *L.Cret.-Rec.*

This family probably is polyphyletic in origin. Subfamily divisions here used do not necessarily reflect genetic relationships but are adopted for convenience in arrangement.

Subfamily VENERINAE Rafinesque, 1815

[*nom. transl. et correct.* SWAINSON, 1840 (*ex* Veneridia RAFINESQUE, 1815)]

Sculpture usually both radial and concentric. Anterior lateral tooth *(All)* present in left valve. *M.Eoc.-Rec.*

Venus LINNÉ, 1758 [**V. verrucosa;* SD GRAY, 1847 (ICZN, 1950)] [=*Venusarius* DUMÉRIL, 1805 (obj.); *Clausina* BROWN, 1827 (obj.); *Ventricola* RÖMER, 1867 (obj.)]. Escutcheon smooth, large, beveled in LV; hinge with *AII* small to pustular; pallial sinus short. *Oligo-Rec.*, Eu.-Afr.-E.Indies-N.Am.

V. (Venus). Sculpture of concentric ribs intersected over part of surface by divaricate radial ribs; *AII* minute *(711)*. *Oligo.(Aquitan.)-Rec.*,

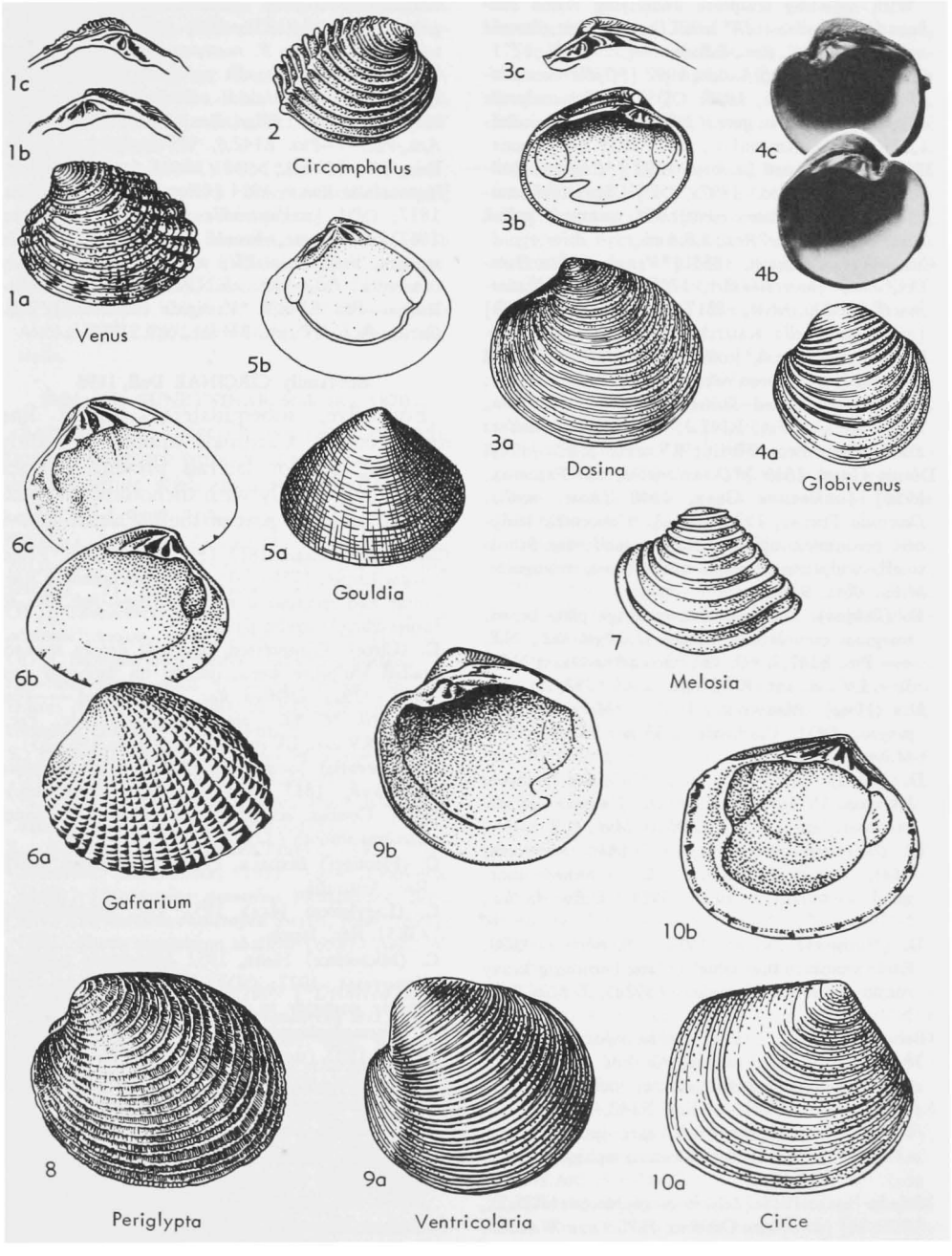


FIG. E142. Veneridae (Venerinae) *(1-4,7-9)* (Circinae) *(5-6,10)* (p. *N671-N673*).

S.Eu.-N.Afr.——Fig. E142,*1*. **V. (V.) verrucosa* Linné, Rec., Medit.; *1a-c*, LV ext., RV and LV hinges, ×0.5 *(124b)*.

V. (Antigona) Schumacher, 1817 [**A. lamellaris;* OD] [=*Omphaloclathrum* Mörch, 1853 (obj.)]. With radiating sculpture underlying raised concentric lamellae; *All* small but evident; lunule sunken *(329a)*. *Rec.*, E.Indies.

V. (Ventricoloidea) Sacco, 1900 [**Cytherea multilamella* Lamarck, 1818; OD]. Radial sculpture wanting; *All* elongate *(329a)*. *Oligo.-Rec.*, Eu.-E.Indies-E.N.Am.

?Ameghinomya von Ihering, 1907 [**Chione argentina* von Ihering, 1897; OD]. Sculpture concentric to cancellate; escutcheon wanting; pallial sinus small. *Tert., ?Rec.*, S.S.Am.

Circomphalus Mörch, 1853 [**Venus plicata* Gmelin, 1791 (*non* Barbut, 1788) (=**V. foliaceolamellosa* Dillwyn, 1817); SD Sacco, 1900] [=*Mioclausinella* Kautsky, 1936 (invalidly proposed)]. Trigonal, compressed, cordate, lunule impressed, escutcheon well defined, larger in LV; sculpture of raised lamellae *(329a)*. *Mio.-Rec.*, Eu.-W.Afr.——Fig. E142,*2*. **C. foliaceolamellosa* (Dillwyn), Rec., Medit.; RV ext., ×0.5 *(124)*.

Dosina Gray, 1835 [**D. zelandica;* SD Frizzell, 1936] [=*Dorsina* Gray, 1840 *(nom. null.)*; *Dosinula* Finlay, 1926 (obj.)]. Concentric sculpture predominating; *All* small to moderate; lunule small, sculptured; pallial sinus short, triangular. *M.Eoc.-Rec.*, S.Pac.

D. (Dosina). Medium in size; hinge plate broad; marginal crenulations strong. *U.Oligo.-Rec.*, N.Z. ——Fig. E142,*3*. **D. (D.) zelandica* Gray, N.Z.; *3a-c*, LV ext., int., RV hinge, ×0.5 *(592)*.

D. (Hina) Marwick, 1927 [**Marama (H.) pinguis;* OD]. Cardinals *2a-2b* not joined *(592)*. *M.Eoc.-L.Mio.*, N.Z.

D. (Kuia) Marwick, 1927 [**Chione vellicata* Hutton, 1873; OD]. Like *D. (Dosina)* but *All* markedly larger *(592)*. *L.Oligo.-Mio.*, N.Z.

D. (Marama) Marwick, 1927 [**M. murdochi;* OD]. Hinge plate narrow, *2a-2b* joined; marginal crenulations fine *(592)*. *U.Eoc.-L.Plio.*, N.Z.

D. (Plurigens) Finlay, 1930 [**P. phenax;* OD]. Early sculpture thin lamellae later becoming heavy sulcations at ends of shell *(392a)*. *U.Mio.-Rec.*, N.Z.

Globivenus Coen, 1934 [**Venus effossa* Philippi, 1836; M]. Like *Ventricolaria* but with lunule also channeled, escutcheon not beveled in LV *(329a)*. *Rec.*, Medit.——Fig. E142,*4*. **G. effossa* (Philippi), Italy; *4a-c*, LV ext., int., RV int., ×1 (Specimen, Station Oceanographique, Monaco).

Melosia Dall, 1915 [**Cytherea glyptoconcha* Dall, 1903; M] [=*Artena* Conrad, 1870 (*non* Walker, 1858); *Netara* Frizzell, 1936 (*pro Artena*) (type, *Cytherea staminea* Conrad, 1839; OD)]. Trigonal, escutcheonal area large, nearly smooth, equal in both valves; sculpture of concentric lamellae. *Mio.*, E.N.Am.——Fig. E142,*7*. **M. glyptoconcha* (Dall), USA(Fla.); LV ext., ×1 (Dall, 1900).

Periglypta Jukes-Browne, 1914 [*pro Cytherea* Röding, 1798 (*non* Fabricius, 1794)] [**Venus puerpera* Linné, 1758; OD] [=*Proxichione* Iredale, 1929 (type, *P. materna*, OD); *Tigammona* Iredale, 1930 (type, *T. persimilis*; OD)]. Quadrate, heavy, pallial sinus rounded; sculpture cancellate *(455a)*. *Oligo.-Rec.*, Eu.-E.N.Am.-W.N.Am.-Pac.——Fig. E142,*8*. **P. puerpera* (Linné), Rec., Pac.; LV ext., ×0.5 *(124b)*.

Ventricolaria Keen, 1954 [**Venus rigida* Dillwyn, 1817; OD] [=*Ventricola* auctt. (*non* Römer, 1867)]. Globose, lunule depressed, escutcheon smooth, beveled in LV; sculpture predominantly concentric. *Oligo.-Rec.*, E.N.Am.-W.N.Am.-Medit.-Pac.——Fig. E142,*9*. **V. rigida* (Dillwyn), Rec., Carib.; *9a,b*, LV ext., RV int., ×0.5 *(711)*.

Subfamily CIRCINAE Dall, 1896

Equivalve, subequilateral; pallial line nearly entire. Cardinals smooth or faintly grooved; anterior laterals present. Surface sculptured, usually with dichotomous radial ribbing on some part of shell. *Paleoc.-Rec.*

Circe Schumacher, 1817 [**C. violacea* (=**Venus scripta* Linné, 1758); M]. Trigonal, umbones low; lunule and escutcheon narrow. *Oligo.-Rec.*, Eu.-E. Indies-Pac.-Australia-Japan.

C. (Circe). Compressed, ligament deeply sunken, radial sculpture weak, usually on umbonal area only *(329a)*. *L.Oligo.-Rec.*, Eu.-E.Indies.——Fig. E142,*10*. **C. (C.) scripta* (Linné), Rec., Pac.; *10a,b*, RV ext., LV int., ×1 (Sowerby, 1851-53).

C. (Circentia) Jousseaume, 1888 [**Venus arabica* Dillwyn, 1817 (*ex* Chemnitz, nonbinom.); OD]. Convex, sculpture feebly concentric, inner margins smooth *(329a)*. *Rec.*, Pac.

C. (Fluctiger) Iredale, 1924 [**F. royanus;* OD]. *Rec.*, Australia.

C. (Laevicirce) Habe, 1951 [**L. soyoae;* OD] *(365)*. *Rec.*, Japan.

C. (Microcirce) Habe, 1951 [**Meretrix gordonis* Yokoyama, 1927; OD]. Small, *All* long, with groove posterior to it *(365)*. *Pleist.-Rec.*, Japan.

C. (Parmulophora) Dall, 1915 [*pro Parmulina* Dall, 1902 (*non* Pénard, 1902)] [**Venus corrugata* Dillwyn, 1817; OD]. Inner margins finely crenulate *(329a)*. *Rec.*, Pac.

C. (Privigna) Dall, Bartsch, & Rehder, 1938 [**C. (P.) pilsbryi;* OD] *(659)*. *Rec.*, Hawaii.

C. (Redicirce) Iredale, 1936 [**R. mistura;* OD] *(659)*. *Rec.*, Australia.

Gafrarium Röding, 1798 [**Venus pectinata* Linné; SD Dall, 1902] [=*Crista* Römer, 1857 (obj.)]. Sculpture of nodose radial ribs dichotomous medial-

ly; pallial sinus small. *L.Mio.-Rec.,* Pac.——Fig. E142,*6*. **G. pectinatum* (Linné), Rec., E.Indies; *6a-c,* LV ext., int., RV int., ×1 *(711)*.

Gouldia C. B. Adams, 1847 [**Thetis cerina* Adams, 1845; SD von Martens, 1882]. Small, lunule long, escutcheon wanting; pallial sinus small. *Paleoc.-Rec.,* Eu.-N. Am.-Carib.-Japan-Pac.-Australia.

G. (Gouldia). Sculpture fine, concentric or reticulate. *Paleoc.-Rec.,* Eu.-E.N.Am.——Fig. E142,*5*. **G. (G.) cerina* (Adams), Rec., Carib.; *5a,b,* RV ext., int., ×2 *(217)*.

G. (Crenocirce) Habe, 1960 [**Dorisca (C.) picta;* OD]. With crenulate inner ventral margin; otherwise like *Dorisca. Rec.,* Japan.

G. (Dorisca) Dall, Bartsch, & Rehder, 1938 [**D. cookei;* OD]. Radial sculpture stronger, more divergent *(659)*. *Rec.,* Pac.

G. (Gouldiopa) Iredale, 1924 [**G. australis* Angas, 1865; OD]. Smooth *(329a)*. *Rec.,* Australia.

Subfamily SUNETTINAE Stoliczka, 1870

Ligament in a deeply excavated escutcheon; shell surface smooth or with concentric ribbing; hinge with elongate *All. Eoc.-Rec.*

Sunetta Link, 1807 [**Donax scripta* Linné, 1758; SD Dall, 1902] [=*Cuneus* Megerle von Mühlfeld, 1811 (*non* da Costa, 1778); *Meroë* Schumacher, 1817 (type, *Venus meroë* Linné, 1758; OD); *Sunemeroë* Iredale, 1930 (type, *Sunetta adelinae* Angas, 1868, ?=*S. scripta* (Linné); OD)]. Elongate-oval, beaks commonly posterior to mid-line; hinge with *4b* short, *3b* smooth and entire; pallial sinus ample, rounded; inner margin crenulate. *U.Oligo.-Rec.,* W.Pac.-Eu.

S. (Sunetta). Elongate, sculpture concentric. *U. Oligo.-Rec.,* Eu.-W.Pac.-S.Pac.——Fig. E143,*10*. **S. (S.) scripta* (Linné), Rec., Pac.; *10a,b,* RV ext., LV int., ×1 (Sowerby, 1851-53).

S. (Cyclosunetta) Fischer-Piette, 1939 [*pro Sunettina* Jousseaume, 1891 (*non* Pfeiffer, 1869)] [**Sunettina sunettina* Jousseaume, Sept. 1891 (=**Sunetta contempta* Smith, June, 1891); OD]. Short, escutcheon shallow *(659)*. *Rec.,* W. Pac.

S. (Sunettina) Pfeiffer, 1869 [**Cytherea solanderii* Gray, 1825; M] [=*Solanderina* Dall, 1902 (obj.)]. Inflated, smooth *(659)*. *Rec.,* Pac.

Meroena Jukes-Browne, 1908 [**Cytherea trigonula* Deshayes, 1825; OD]. Nearly equilateral, ligament only moderately deep; hinge with *3b* deeply grooved; inner margin smooth *(455)*. *Eoc.,* Eu. ——Fig. E143,*9*. **M. trigonula* (Deshayes), France; *9a,* RV ext., ×1; *9b,c,* RV and LV hinges, ×1.5 (Cossmann & Pissarro, 1904).

Subfamily MERETRICINAE Gray, 1847

[*nom. correct.* Fischer, 1887 (*pro* Meretricina Gray, 1847)]

Elongate-ovate; sculpture subdued or wanting; hinge with cardinal teeth tending to radiate, anterior lateral teeth in RV commonly flanked with denticles above and below. *U.Cret.-Rec.*

Meretrix Lamarck, 1799 [**Venus meretrix* Linné, 1758; T] [=*Cytherea* Lamarck, 1805 (*non* Fabricius, 1794); *Nympha* Mörch, 1853 (*non* Fitzinger, 1826)]. Large, trigonal, smooth, lunule and escutcheon faint; teeth large; pallial sinus broad. *U.Mio.-Rec.,* E.Indies.——Fig. E143,*1*. **M. meretrix* (Linné), Rec., E.Indies; *1a-c,* RV int., LV int., RV ext., ×0.5 *(711)*.

Aeora Conrad, 1870 [**A. cretacea;* M]. Smooth, hinge with nymphs smooth or weakly rugose, *All* distant from *2a;* pallial sinus deep, rounded, somewhat ascending. *U.Cret.,* E.N.Am.——Fig. E143, *3*. **A. cretacea,* Cret., USA(N.J.); *3a-c,* LV ext., RV int., LV int., ×1 *(711)*.

Bassinaria Marwick, 1928 [**B. macclurgi;* OD]. Resembling *Bassina* but RV with deep pit for reception of *All. M.Plio.,* N.Z.——Fig. E143,*11*. **B. macclurgi;* RV int., ×0.7 *(593)*.

Eomeretrix Turner, 1938 [**Pitaria martini* Dickerson, 1914; OD]. Like *Meretrix* but with V-shaped pallial sinus and a well-defined lunule *(695)*. *Eoc.,* W.N.Am.

Grateloupia Desmoulins, 1828 *(emend.)* [**G. donaciformis* (=**Donax irregularis* Basterot, 1825)] [=*Gratelupia* Desmoulins, 1828 *(nom. imperf.)*]. With parallel ridges on nymphs. *Eoc.-Mio.,* Eu.-N.Am.-S.Am.

G. (Grateloupia). Pallial sinus long and acute. *Oligo. (Aquitan.)-Mio. (Helvet.),* Eu. —— Fig. E143,*7*. **G. (G.) irregularis* (Basterot), Mio., France; RV int., ×1 *(1007)*.

G. (Cytheriopsis) Conrad, 1865 [**Cytherea hydana* Conrad, 1833; OD] [=*Grateloupina* Dall, 1902 (obj.)]. Pallial sinus small *(711)*. *Eoc.-Mio.,* E.N.Am.-S.Am.

G. (Xenoloupia) Clark & Durham, 1946 [**X. carmenensis;* OD]. With a flangelike escutcheon *(695)*. *Eoc.,* S.Am.

Meretrissa Jukes-Browne, 1908 [**Cytherea depressa* Deshayes, 1858; OD]. Small, nearly smooth; hinge weak; pallial sinus short, rounded *(455)*. *Oligo.,* Eu.——Fig. E143,*6*. **M. depressa* (Deshayes), France; *6a,b,* LV int., RV int., ×4 (Keen, n, Stanford Univ. Coll.).

Tivela Link, 1807 [**Venus tripla* Linné, 1771; SD Kobelt, 1881] [=*Trigona* Megerle von Mühlfeld, 1811 (*non* Jurine, 1807)]. Medium-sized to large, trigonal, smooth; nymph bifid or trifid, resembling cardinal tooth. *Eoc.-Rec.,* N.Am.-C. Am.-S.Am.-Afr.-Ind.O.

T. (Tivela). Medium in size, inner margin smooth. *Mio.-Rec.,* E.N.Am.-W.C.Am.-W.Afr.-Ind.O.—— Fig. E143,*4*. **T. (T.) tripla* (Linné), Rec., W. Afr.; *4a,b,* LV ext., RV int., ×1 *(124b; 1007)*.

T. (Comus) Cox, 1930 [**Venus platyaulax* Tomlin, 1924; OD]. Sculptured with heavy concentric undulations *(329a)*. *Pleist.-Rec.*, SE.Afr.

T. (Eutivela) Dall, 1891 [**T. perplexa* (*ex* Stearns, MS) (=**Venus isabelleana* d'Orbigny, 1846); OD]. Inner margins crenulate *(329a)*. *Rec.*, E.S.Am.

T. (Pachydesma) Conrad, 1854 [*pro Trigonella*

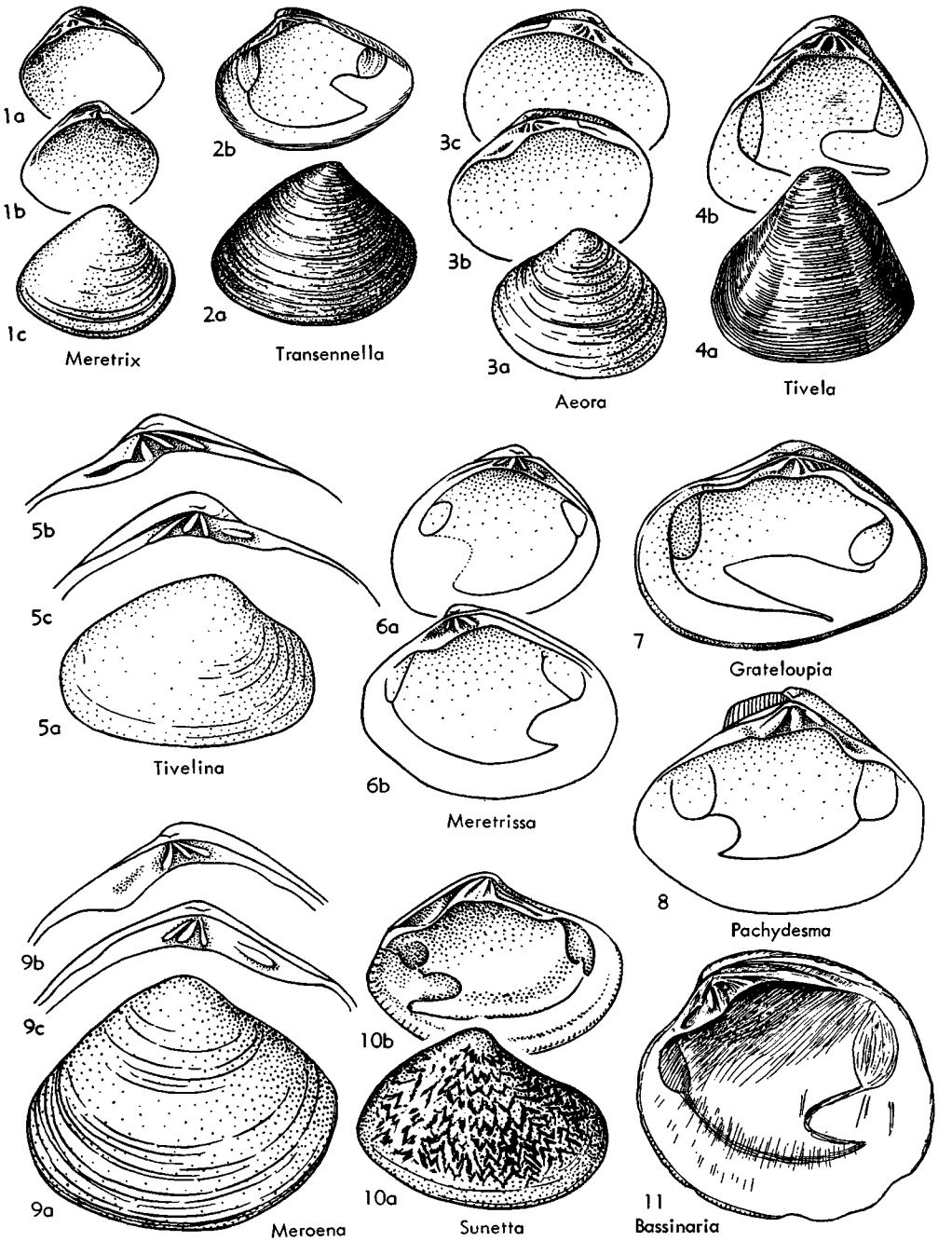


Fig. E143. Veneridae (Sunettinae)*(9-10)*, (Meretricinae) *(1-8,11)* (p. *N673-N675*).

CONRAD, 1837 (*non* DA COSTA, 1778)] [**Cytherea crassatelloides* CONRAD, 1837 (=*Donax stultorum* MAWE, 1823);M]. Large and heavy, inner margins smooth; nymph not bifid but set off from *4b*. *L. Eoc.-Rec.*, E. N. Am.-W. N. Am.——FIG. E143,*8*. **T. (P.) stultorum* (MAWE), Rec., USA (Calif.); LV int., ×0.25 *(711;* Keen, n, Stanford Univ. Coll.).

T. (Planitivela) OLSSON, 1961 [**Cytherea planulata* BRODERIP & SOWERBY, 1829; OD]. Compressed, lunule elliptical, nymphal area forming high plate set off by deep groove. *Rec.*, W.C.Am.-S.Am.

Tivelina COSSMANN, 1886 [**Cytherea rustica* DESHAYES, 1825; SD CROSSE, 1886]. Small, compressed cardinal teeth short; pallial sinus small, rounded, ascending *(329a)*. *L.Eoc.-L.Mio.*, Eu.——FIG. E143,*5*. **T. rustica* (DESHAYES), Eoc., France; *5a-c*, RV ext., RV and LV hinges, ×2 (Cossmann & Pissarro, 1904).

Transennella DALL, 1883 [**Cytherea (T.) conradina* DALL, 1883; OD]. Small, pallial sinus rounded; valve margins tangentially grooved *(711)*. *Eoc.-Rec.*, E.N.Am.-W.N.Am.-S.Am.——FIG. E143,*2*. **T. conradina* (DALL), Rec., Carib.; *2a,b*, RV ext., int., ×2 *(222;* Dall, 1900, 1904).

Subfamily PITARINAE Stewart, 1930

Inequilateral, beaks anterior. Cardinal teeth not tending to radiate, anterior laterals well developed. *L.Cret.-Rec.*

Pitar RÖMER, 1857 [**Venus tumens* GMELIN, 1791; M] [=*Caryatis* RÖMER, 1862 (*non* HÜBNER, 1816); *Pitaria* DALL, 1902 *(nom. van.)*]. Oval or subtrigonal, smooth or finely concentrically lamellate; lunule superficial, escutcheon not defined; hinge with *2b* triangular, joined to a thin *2a, 3a* and *1* separate. *Eoc.-Rec.*, cosmop.

P. (Pitar). Smooth or finely striate, pallial sinus deep and pointed; *4b* confluent with nymph. *Eoc.-Rec.*, N.Am.-W.Afr.-Pac.——FIG. E144,*10*. **P. (P.) tumens* (GMELIN), Rec., W.Afr.; *10a,b*, RV ext., int., ×1 *(711)*.

P. (Calpitaria) JUKES-BROWNE, 1908 [**Cytherea sulcataria* DESHAYES, 1825; OD]. With fine concentric lamellae; nymphs striate; pallial sinus short, rounded *(455)*. *Eoc.*, Eu.-W.N.Am.-SE. Asia.

P. (Costellipitar) HABE, 1951 [**Caryatis chordata* RÖMER, 1876; OD]. Small, concentric ribs evident *(365)*. *Rec.*, Pac.-Japan.

P. (Hyphantosoma) DALL, 1902 [**Cytherea carbasea* GUPPY, 1866; OD]. With zigzag concentric grooves *(228)*. *Oligo.-Plio.*, W.Indies-N.Z.

P. (Hysteroconcha) DALL, 1902 [*pro Dione* GRAY, 1847 (*non* HÜBNER, 1819)] [**Venus dione* LINNÉ, 1758; OD]. Like *P. (Lamelliconcha)* but with posterior area bordered by spines *(228)*. *U.Oligo.-Rec.*, C.Am.——FIG. E144,*9*. **P. (H.) dione* (LINNÉ), Rec., Carib.; *9a,b*, LV ext., RV int., ×1 *(1007)*.

P. (Katherinella) TEGLAND, 1929 [**Callocallista arnoldi* WEAVER, 1916; OD]. Lunule pouting; *All* bladelike, buttressed under upper margin of hinge plate *(329a)*. *Oligo.-Rec.*, W.N.Am.

P. (Lamelliconcha) DALL, 1902 [**Cytherea concinna* SOWERBY, 1835; OD]. With thin concentric lamellae; hinge plate excavated and attenuated behind, nymphs logitudinally striate; pallial sinus obtuse *(711)*. *Eoc.-Rec.*, N.Am.-W.N.Am.-S.Am.

P. (Meisenia) MAKIYAMA, 1936 [**M. tateiwai;* OD]. Lunule wanting *(329a)*. *Mio.*, Korea.

P. (Nanopitar) REHDER, 1943 [**P. (N.) pilula;* OD]. Small, smooth, rounded, inner margins smooth *(695)*. *Rec.*, Carib.

P. (Omnivenus) PALMER, 1927 [**Cytherea discoidalis* CONRAD, 1833; OD]. Resembling *P. (Tinctora);* nymphs rugose *(711)*. *Eoc.*, E.N.Am.

P. (Pitarella) PALMER, 1927 [**Callocardia gatunensis* DALL, 1903; OD]. *All* much reduced *(711)*. *Eoc.-Mio.*, Carib.

P. (Pitarenus) REHDER & ABBOTT, 1951 [**Pitaria cordata* SCHWENGEL, 1951; OD]. Ventral margin crenulate; hinge as in *P. (Pitarella) (695)*. *Rec.*, Carib.

P. (Pitarina) JUKES-BROWNE, 1913 [**Cytherea citrina* LAMARCK, 1818; OD]. Nymphs smooth; *4b* wholly free and oblique; pallial sinus short *(329a)*. *Rec.*, Pac.

P. (Rhabdopitaria) PALMER, 1927 [**Callocardia astartoides* GARDNER, 1923; OD]. Shell smooth but middle layer radially ribbed; inner ventral margin finely crenulate; nymphs smooth *(711)*. *M.Eoc.*, E.N.Am.

P. (Tinctora) JUKES-BROWNE, 1914 [*pro Callizona* JUKES-BROWNE, 1913 (*non* DOUBLEDAY, 1846-50)] [**Cytherea vulnerata* BRODERIP, 1835; OD] [=*Jukes-Brownia* COSSMANN, 1920 (obj.); *Callizonata* STRAND, 1926 (obj.)]. Thick-shelled, round, glosssy; valve margins crenulate *(455a)*. *Rec.*, W.C.Am.

Amiantis CARPENTER, 1864 [**Cytherea callosa* CONRAD, 1837; M]. Large, thick-shelled; nymphs rugose; pallial sinus generally pointed. *Eoc.-Rec.*, N.Am.-S.Am.

A. (Amiantis). Concentric ribs commonly anastomosing *(711)*. *U.Oligo.-Rec.*, E.N.Am.-W.N.Am.——FIG. 39,*1*. **A. (A.) callosa* (CONRAD), Rec., USA (Calif.); *1a,b*, RV int., LV ext., ×0.5 (Keen, n; Stanford Univ.Coll.).

A. (Eucallista) DALL, 1902 [**Cytherea purpurata* LAMARCK, 1818; OD]. Thinner than *A. (Amiantis)*, ribs weak on posterior *(711)*. *Rec.*, E.N. Am.-S.Am.

A. (Venidia) CLARK & DURHAM, 1946 [**V. steinekei;* OD]. Smooth, escutcheon stronger than in *A. (Amiantis)*, lunule weaker *(695)*. *Eoc.*, W.S. Am.

Anofia REYMENT, 1955 [**A. aro;* OD]. Lenticular,

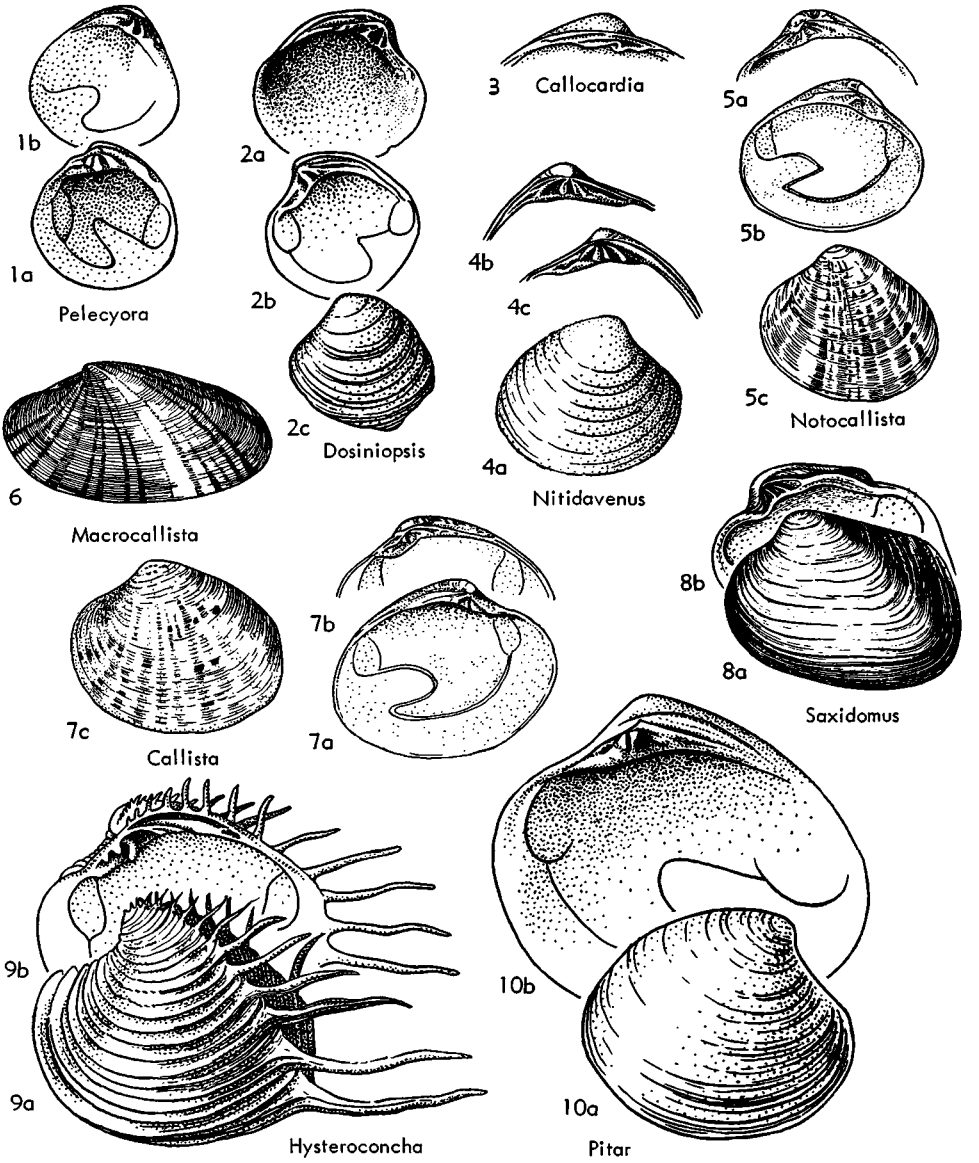


FIG. E144. Veneridae (Pitarinae) (p. *N675*, *N677-N679*).

resembling *Naulia* but with cardinals more separated; an excavated ligamental pit in front of nymph. *U.Cret.*, W.Afr.

Aphrodina CONRAD, 1869 [**Meretrix tippana* CONRAD, 1858; OD] [=*Callistina* JUKES-BROWNE, 1908 (type, *Venus plana* SOWERBY, 1813; OD)]. Cardinal teeth divergent, *All* rugose; pallial sinus deep, ascending. *L.Cret.-U.Eoc.*, S.Am.-N.Z.-N.Am.-Eu.-Afr.

A. (Aphrodina). Escutcheon wanting. *L.Cret.-U. Eoc.*, Eu.-Afr.-N.Am.-S.Am.——FIG. E145,*4*. **A. (A.) tippana* (CONRAD), U.Cret., USA(N.Car.); *4a-c*, RV ext., int., LV hinge, ×0.5 *(887)*.

A. (Sechurina) OLSSON, 1944 [**A. (S.) australis*; OD]. With well-marked escutcheon *(695)*. *Cret.*, S.Am.(Peru).

A. (Tikia) MARWICK, 1927 [**Callista thomsoni* WOODS, 1917; OD]. With strong concentric

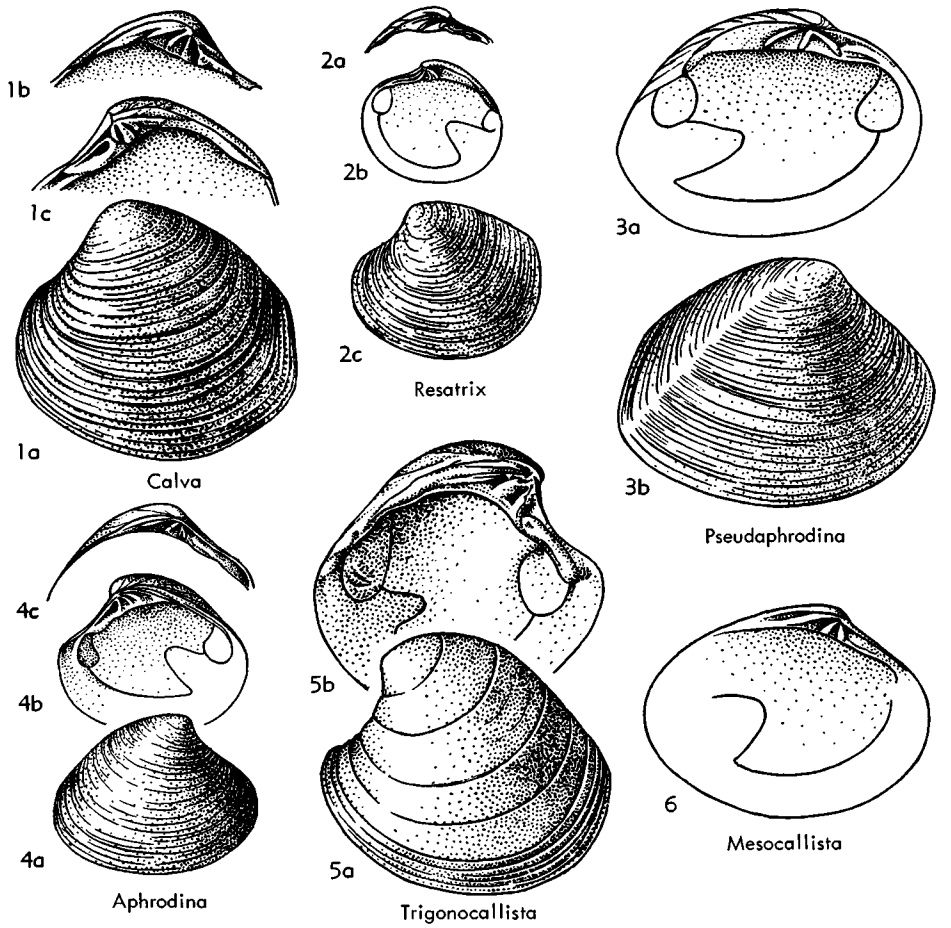


FIG. E145. Veneridae (Pitarinae) (p. *N678-N679*).

ridges; *All* extremely long, with a knobbed posterior end *(592)*. *Cret.*, N.Z.

Callista POLI, 1791 [**Venus chione* LINNÉ, 1758; SD MEEK, 1876] [=*Callistoderma* POLI, 1795 (obj.)]. Glossy, with or without sculpture; pallial sinus wide, horizontal, pointed; *3b* narrow. *Paleoc.-Rec.*, Eu.-N.Am.-C.Am.-Carib.-Asia-N.Z.-E.Indies.

C. (Callista). Smooth, ovate; *3b* with a slight groove *(711)*. *Eoc.-Rec.*, E.N.Am.-Eu.——FIG. E144,7. **C. (C.) chione* (LINNÉ), Rec., Medit.; *7a-c*, LV ext., int., RV int., ×0.5 *(592)*.

C. (Chionella) COSSMANN, 1886 [*pro Chione* GRAY, 1838 (*non* MEGERLE VON MÜHLFELD, 1811)]. [**Cytherea ovalina* DESHAYES, 1858; SD CROSSE, 1886] [=*Paradione* DALL, 1909 (obj.)]. Small, nearly smooth, with obsolete concentric folds *(392a)*. *Eoc.-Oligo.*, Eu.-C.Am.

C. (Costacallista) PALMER, 1927 [**Venus erycina* LINNÉ, 1758; OD]. Sculpture strong, of flat concentric ridges; hinge plate excavated, *2a* grooved *(711)*. *Paleoc.-Rec.*, E.N.Am.-W.N.Am.-Asia-Eu.-N.Z.

C. (Macrocallista) MEEK, 1876 [**Venus gigantea* GMELIN, 1791 (=**V. nimbosa* LIGHTFOOT, 1786)]. Elongate-ovate, smooth or with concentric grooves; *3b* not grooved *(711)*. *Eoc.-Rec.*, E.N.Am.-W.N.Am.-E.Indies.——FIG. E144,6. **C. (M.) nimbosa* (LIGHTFOOT), Rec., Carib.; LV ext., ×0.25 *(124b)*.

C. (Microcallista) STEWART, 1930 [**Cytherea proxima* DESHAYES, 1858; OD]. No groove on *2a (892)*. *Eoc.*, Eu.-E.N.Am.-W.N.Am.

Callocardia A.ADAMS, 1864 [**C. guttata;* M] [="*Callocallista* Adams," WEAVER, 1916 *(nom. null.)*]. Thin; hinge plate narrow, excavated, 2 cardinals in each valve united as curved arches. *Eoc.-Rec.*, N.Am.-Asia-E.Indies-Eu.

C. (Callocardia). Very thin-shelled, pallial sinus

nearly obsolete. *Rec.*, E.N.Am.-W.N.Am.-E.Asia. ——Fig. E144,*3*. **C. (C.) guttata* Adams, Rec., Korea; LV hinges, ×2 *(711)*.

C. (Agriopoma) Dall, 1902 [**Cytherea texasiana* Dall, 1892; OD] [=*Agriodesma* Dall, 1916 (*nom. null.; non* Dall, 1909)]. Dull white, thicker than *C. (Callocardia);* pallial sinus sharply angular *(711)*. *M.Eoc.-Rec.*, E.N.Am.

C. (Aphrodora) Jukes-Browne, 1914 [*pro Leucothea* Jukes-Browne, 1913 (*non* Mertens, 1833)] [**Callista birtsi* Preston, 1905; OD]. Hinge teeth weak *(455a)*. *Rec.*, Ceylon.

C. (Atopodonta) Cossmann, 1886 [**Venus conformis* Deshayes, 1858; SD Crosse, 1886]. Small but not extremely thin; pallial line entire *(329a)*. *Eoc.-Mio.*, Eu.-E.Indies.

C. (Nitidavenus) Vokes, 1939 [**Cytherea nitida* Deshayes, 1858; OD]. Lunule large, impressed, escutcheon wanting; pallial sinus well developed. *L.Eoc.*, Eu.-W.N.Am.——Fig. E144,*4*. **C. (N.) nitida* (Deshayes), Eoc., France; *4a-c*, RV ext., RV and LV hinges, ×1 (Vokes, 1939).

Calva Popenoe, 1937 [**C. regina;* OD]. Resembling *Trigonocallista* but more elongate, with bifid *3b*, nymph smooth, laterals close to cardinals. *L.Cret.-U.Cret.*, Eu.-N.Am.

C. (Calva). With escutcheon or depressed dorsal area. *L.Cret.-U.Cret.*, Eu.-N.Am. *(92)*.——Fig. E145,*1*. **C. (C.) regina* Popenoe, U.Cret., USA Calif.); *1a-c;* LV ext., LV and RV hinges, ×1 *(748)*.

C. (Chimela) Casey, 1952 [**Venus caperata* J. de C. Sowerby, 1826; OD]. Dorsal area not depressed *(92)*. *L. Cret.(Alb.)*, Eu.

Dollfusia Cossmann, 1886 [**D. crassa;* M]. Resembling *Pelecyora* in outline but small, hinge with *3b* bifid; pallial sinus short, rounded, wide *(329a)*. *Eoc.*, Eu.

Dosiniopsis Conrad, 1864 [**D. meeki;* SD Tate, 1868]. Large, smooth, lenticular; anterior lateral teeth and sockets rugose, near cardinals, *3b* deeply bifid; pallial sinus deep and angular, not ascending. *Paleoc.-Eoc.*, E. N. Am.-W. N. Am.-Eu. —— Fig. E144,*2*. **D. meeki*, Eoc., USA(Md.); *2a-c*, LV int., RV int., LV ext., ×0.5 *(711)*.

Gilbertharrisella F. Hodson & H. Hodson, 1927 [**Pitaria lynei;* OD]. Like *Pitar* but thick-shelled, sculpture of concentric folds; lunule large; *All* peglike; heavy ridge behind anterior muscle scar *(695)*. *U.Cret.*, S.Am.(Venez.).

Lepidocardia Dall, 1902 [**Chione floridella* Gray, 1838; OD]. Small, compressed, smooth, posteriorly attenuated; hinge short, teeth crowded *(228)*. *Rec.*, W.Afr.

Lioconcha Mörch, 1853 [**Venus castrensis* Linné, 1758; SD Stoliczka, 1870]. Hinge strong, resembling *Pitar;* lunule present; pallial sinus shallow. *Plio.-Rec.*, Pac.-E.Indies.

L. (Lioconcha). Surface smooth, with zigzag streaks or spots of color *(329a)*. *Plio.-Rec.*, Pac.

L. (Sulcilioconcha) Habe, 1951 [**Cytherea philippinarum* Hanley, 1844; OD]. With concentric ribs *(365)*. *Rec.*, Japan.-E.Indies.

Loxo Dailey & Popenoe, 1966 [**L. decore;* OD]. Smaller, longer than *Calva*. *U.Cret.*, N.Am.

Marwickia Finlay, 1930 [*pro Finlaya* Marwick, 1927 (*non* Theobald, 1903)] [**Finlaya parthiana* Marwick, 1927; OD]. Oval, lunule concave, sculpture of weak concentric grooves; *2b* large, *All* distant from *2a (329a)*. *U.Cret.*, N.Z.

Megapitaria Grant & Gale, 1931 [**Cytherea aurantica* Sowerby, 1831; OD]. Like *Pitar* but much larger and heavier *(329a)*. *Plio.-Rec.*, W.C.Am.

Mesocallista Cox, 1952 [**Meretrix andersoni* Newton, 1909; OD]. Ovate, lunule shallow, narrow, incised; hinge as in *Aphrodina* but *All* not corrugated. *U.Cret.*, Afr.-Asia-Eu.-S.Am.-N.Am.

M. (Mesocallista). Small, sculpture weak, concentric *(695)*. *U.Cret.*, W.Afr.-India-Eu.-W.S.Am. ——Fig. E145,*6*. **M. (M.) andersoni* (Newton), W.Afr.; LV int., ×1 (Cox, 1952).

M. (Larma) Stephenson, 1953 [**Callistina (L.) munda;* OD]. Larger, with irregular concentric ribs bearing secondary threads and some fine radial lines *(695)*. *U.Cret.(Cenoman.)*, E.N.Am.

Nagaoella Hayami, 1965 [**Dosiniopsis corrugata* Nagao, 1934; OD]. Near *Dosiniopsis* but smooth margined within. *L.Cret.*, Japan.

Naulia Cox, 1952 [**N. orbicularis;* OD]. More orbicular than *Aphrodina;* hinge with *3b* not so conspicuously bifid, *4b* down-curved distally, hinge plate flattened behind *4b;* pallial sinus shallower *(695)*. *U.Cret.*, W.Afr.

Notocallista Iredale, 1924 [**Cytherea kingi* Gray, 1827; OD]. Sculptured with irregular concentric grooves and ridges; otherwise like *Callista*. *Oligo.-Rec.*, Australia-N.Z.

N. (Notocallista). Large, periostracum thick. *Rec.*, Australia.——Fig. E144,*5*. **N. (N.) kingi* (Gray); *5a-c*, RV hinge, LV int., ext., ×0.5 *(597)*.

N. (Fossacallista) Marwick, 1938 [**Paradione parki* Marwick, 1926; OD]. Ligament deeply sunken *(597)*. *Oligo.-Mio.*, N.Z.

N. (Striacallista) Marwick, 1938 [**Cytherea multistriata* Sowerby, 1852; OD]. Small, periostracum thin, extremities of shell concentrically grooved *(597)*. *Oligo.-Rec.*, N.Z.-Australia.

Pelecyora Dall, 1902 [**Cytherea hatchetigbeensis* Aldrich, 1886: OD] [=*Sinodia* Jukes-Browne, 1908 (type, *Artemis trigona* Reeve, 1850; OD)]. Ovately trigonal, inflated, lunule faint. *Eoc.-Rec.*, Eu.-Asia-N.Am.-Afr.

P. (Pelecyora). Pallial sinus long, angular, ascending; cardinal teeth divergent, *All* well removed, near lower margin of hinge plate. *Eoc.-Rec.*, Eu.-Asia-N.Am.——Fig. E144,*1*. **P. (P.) hatchetigbeensis* (Aldrich), Eoc., USA(Ala.); *1a,b*, RV int., LV int., ×1 *(711)*.

P. (Cordiopsis) Cossmann, 1910 [**Venus incras-*

sata SOWERBY, 1817 (*non* BROCCHI, 1814) =*V. suborbicularis* GOLDFUSS, 1841; OD] [=*?Cyprinopsis* CONRAD, 1869 (*non* FITZINGER, 1832) (type, *Artemis elliptica* SOWERBY in SMITH, 1847 =*Cyprina isocardioides* LAMARCK, 1818; OD; Mio., Eu.)]. Pallial sinus moderate to short, rounded, cardinal teeth not markedly divergent, *AII* near *2a*, not marginal *(912)*. *Eoc.-Mio.*, Eu.-Afr.-Asia.

P. (Sinodiopsis) EAMES, 1957 [**S. coxi;* OD]. Hinge plate thinner than in *P. (Pelecyora)*, *2a* not grooved. *Eoc.*, W.Afr.

Pseudamiantis KURODA, 1933 [**Meretrix tauyensis* YOKOYAMA, 1927; OD]. Resembling *Amiantis* but concentric sculpture more regular, intersected by fine radial lines; pallial sinus rounded *(365)*. *Plio.*, Japan.

Pseudaphrodina CASEY, 1952 [**Venus ricordeana* D'ORBIGNY, 1845; OD]. Compressed, with carinate escutcheon; cardinals widely diverging. *L.Cret.*, Eu.——FIG. E145,*3*. **P. ricordeana* (D'ORBIGNY), Eng.; *3a,b*, LV int., RV ext., ×1 *(92)*.

Resatrix CASEY, 1952 [**R. dolabra;* OD]. Trigonally ovate, smooth or concentrically striate, lunule faint; hinge with *AII* scarcely detached from or joined to *2a*. *L.Cret.*, Eu.

R. (Resatrix). *AII* and *AIII* long, laminar, *PII* also present. *L.Cret.*, Eu.——FIG. E145,*2*. **R. (R.) dolabra* (CASEY), Eng.; *2a-c*, LV hinge, RV int., LV ext., ×1 *(92)*.

R. (Dosiniopsella) CASEY, 1952 [**R. (D.) cantiana;* OD]. With *2b* bifid, *AII* striate *(92)*. *L. Cret.*, Eu.

R. (Vectorbis) CASEY, 1952 [**Venus vectensis* FORBES, 1845; OD]. Laterals present in young but weak to absent in adults *(92)*. *L.Cret.*, Eu.

Rohea MARWICK, 1938 [**Paradione trigonalis* MARWICK, 1927; OD]. Sculpture of concentric grooves; hinge plate flat, *3a* long, *AII* distant from cardinals *(597)*. *Oligo.*, N.Z.

Saxidomus CONRAD, 1837 [**S. nuttalli;* M] [=*Ezocallista* KAMADA, 1962 (*ex* KIRA, 1955, *nom. invalid.*) (type, *S. brevisiphonatus* CARPENTER, 1865; OD)]. Large, oval, concentrically corrugated, without lunule or escutcheon; hinge curved, with irregular teeth *(228)*. *U.Oligo.-Rec.*, W.N.Am.-Japan.——FIG. E144,*8*. **S. nuttalli*, Rec., USA (Calif.); *8a,b*, LV ext., RV int., ×0.5 *(124b)*.

Trigonocallista RENNIE, 1930 [**Meretrix umzambiensis* WOODS, 1906; OD]. Trigonal; lunule and large escutcheon well marked; *3b* entire, *AII* very long, nymph rugose *(92)*. *U.Cret.*, S.Afr.——FIG. E145,*5*. **T. umzambiensis* (WOODS); *5a,b*, LV ext., int., ×0.5 (Woods, 1906).

Subfamily SAMARANGIINAE Keen, new subfamily

Shells inequilateral, quadrate, resembling some Arcticidae, surface unsculptured; hinge veneroid, with *AII* pustular, *2b* tending to be deeply bifid; pallial line entire. *Rec.*

Samarangia DALL, 1902 [**Venus quadrangularis* ADAMS & REEVE, 1850; OD] [=*Petroderma* KURODA, 1945 (type, *P. thaanumi;* OD)]. Periostracum present, encrusted with agglutinated sandy material. *Rec.*, E.Indies.——FIG. E146,*7*. **S. quadrangularis* (ADAMS & REEVE), E.China Sea; *7a-c*, LV int., RV int., RV ext., ×0.5 (Kuroda, 1945).

Subfamily DOSINIINAE Deshayes, 1853

[*nom. correct.* ADAMS & ADAMS, 1858 (*ex* Dosiniana DESHAYES, 1853)]

Equivalve, lenticular, concentrically striate; hinge strong, with *AII* present. *U.Cret.-Rec.*

Dosinia SCOPOLI, 1777 [**Chama dosin* ADANSON, 1757 (=**Venus concentrica* BORN, 1778, fide FISCHER-PIETTE, 1942); M] [=*Dosinidia* DALL, 1902 (obj.); *Bonartemis* IREDALE, 1929 (type, *B. stabilis;* OD); *Pardosinia* IREDALE, 1929 (type, *P. colorata;* OD); *Fallartemis* IREDALE, 1930 (type, *F. armina;* OD); *Meridosinia* IREDALE, 1930 (type, *M. nedigna;* OD); *Semelartemis* IREDALE, 1930 (type, *S. aetha;* OD)]. Compressed, nearly orbicular; lunule well defined. *L.Eoc.-Rec.*, cosmop.

D. (Dosinia). With periostracum; escutcheon wanting; sculpture of concentric grooves, none lamellose. *L.Oligo.-Rec.*, tropics-Atl.-Pac.——FIG. E146,*3*. **D. (D.) concentrica* (BORN), Rec., USA(Fla.); *3a,b*, LV ext., int., ×0.5 *(711)*.

D. (Asa) BASTEROT, 1825 [**Venus lincta* PULTENEY, 1799 (=*V. lupinus* LINNÉ, 1758, fide FISCHER-PIETTE, 1942); M?] [=*Arctoë* RISSO, 1826 (obj.); *Dosinia, s.s.*, AUCTT. (*non* SCOPOLI)]. Lunule deep, escutcheon narrow, bordered by lamellose sculpture *(329a)*. *Mio.-Rec.*, Eu.-W.Afr.

D. (Austrodosinia) DALL, 1902 [**Cytherea anus* PHILIPPI, 1848; OD]. Escutcheon with strong crest; pallial sinus horizonal *(228)*. *U.Oligo.-Rec.*, N.Z.

D. (Dosinella) DALL, 1902 [**Cytherea angulosa* PHILIPPI, 1847; OD]. Lunule shallow; pallial sinus deep *(228)*. *Rec.*, SW.Pac.

D. (Dosinisca) DALL, 1902 [**Artemis alata* REEVE, 1859; OD]. Lunule and escutcheon pouting; radial sculpture sometimes present *(288)*. *Rec.*, N.Pac.-S.Pac.

D. (Dosinorbis) DALL, 1902 [**Artemis bilunulata* GRAY, 1838; OD]. Lunule bounded by raised cords *(228)*. *Rec.*, Japan.

D. (Kakahuia) MARWICK, 1927 [**D. (K.) suteri;* OD]. Roundly trigonal; lunule shallow *(592)*. *M.Eoc.*, N.Z.

D. (Kaneharaia) MAKIYAMA, 1936 [**D. kaneharai* YOKOYAMA, 1926; OD]. Cardinal teeth not bifid *(392a)*. *Mio.*, Korea.

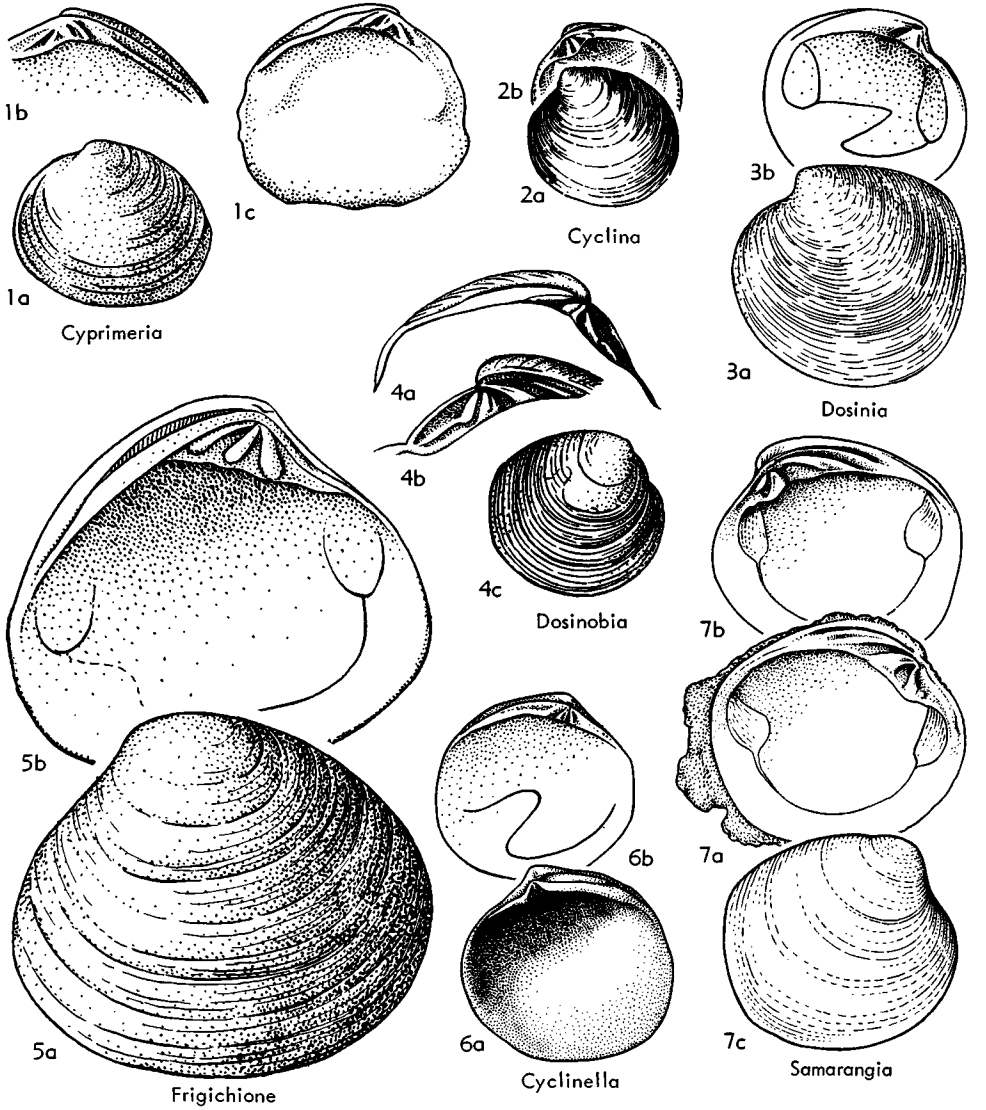


FIG. E146. Veneridae (Samarangiinae) *(7)*, (Dosiniinae) *(3-4)*, (Cyclininae) *(1-2,5-6)* (p. *N679-N681*).

D. (Kereia) MARWICK, 1927 [**D. greyi* ZITTEL, 1864; OD]. Sculpture of spaced sharp lamellae *(592)*. *L.Eoc.-Rec.*, N.Z.

D. (Pectunculus) DA COSTA, 1778 [**P. capillaceus* (=**Venus exoleta* LINNÉ, 1758; SD JUKES-BROWNE, 1911)] [=*Arthemis, Arthemiderma* POLI, 1795 (obj.; M) (*Artemis* AUCTT., *nom. van.*); *Orbiculus* MEGERLE VON MÜHLFELD, 1811 (obj.; SD DALL, 1902); *Exoleta* BROWN, 1827 (obj.; T); *Cerana* GISTEL, 1848 (obj.; *pro Artemis*); *Ampithaea* GRAY (*ex* LEACH MS), 1852 (obj.; M)]. Escutcheon wanting; pallial sinus narrow. *Oligo.-Rec.*, S.Eu.

D. (Phacosoma) JUKES-BROWNE, 1912 [**Artemis japonica* REEVE, 1850; OD]. Escutcheon pouting, defined by raised ridges; margins of RV grooved posteriorly *(329a)*. *Rec.*, N.Pac.-S.Pac.

D. (Raina) MARWICK, 1927 [**D. (R.) bensoni;* OD]. Lunule shallow; *3b* much broader than *1 (592)*. *M.Oligo.-M.Plio.*, N.Z.

Dosinobia FINLAY & MARWICK, 1937 [**Dosinia ongleyi* MARWICK, 1927; OD]. Resembling *Dosinia* but with less sunken lunule; hinge teeth are more spread out, *AII* scarcely separate from *2a (695)*. *U.Cret.*, N.Z.——FIG. E146,*4*. **D ongleyi* (MARWICK), Cret., N.Z.; *4a-c*, LV and RV hinges, RV ext., ×1 *(592)*.

Subfamily CYCLININAE Frizzell, 1936

Like Dosiniinae in form but without anterior lateral teeth or incised lunule; sculpture concentric with few faint radial traces. *L.Cret.-Rec.*

Cyclina DESHAYES, 1850 [**Venus sinensis* GMELIN, 1791; SD DALL, 1902] [=*Eocyclina* DALL, 1908 (obj.)]. Sculpture weak; lunule faint or absent. *Oligo.-Rec.*, Asia.

C. (Cyclina). No lunule or escutcheon; inner ventral margin crenate. *Oligo.-Rec.*, Asia *(228)*.——FIG. E146,*2*. **C. (C.) sinensis* (GMELIN), Rec., China; *2a,b*, LV ext., RV int., ×0.5 *(124b)*.

C. (Cyclinorbis) MAKIYAMA, 1926 [**C. (C.) lunulata;* OD]. With faint lunular area, beaks more central than in *C. (Cyclina)*, sculpture finer, entirely concentric; inner ventral margin smooth *(329a)*. *L.Mio.*, Korea.

Cyclinella DALL, 1902 [**Dosinia tenuis* RÉCLUZ, 1852; OD]. Margins smooth, faint lunular area present; *3b* bifid. *Eoc.-Rec.*, E.N.Am.-W.N.Am.——FIG. E146,*6*. **C. tenuis* (RÉCLUZ), Rec., Carib.; *6a,b*, RV int., LV int., ×1 *(711)*.

Cyprimeria CONRAD, 1864 [**Cytherea excavata* MORTON, 1833; M]. Subcircular, valves flattened, bent to left posteriorly; lunule wanting, escutcheon deep; sculpture weakly concentric; cardinal teeth diverging, nymphs rugose; pallial line hardly sinuated; inner margins smooth. *L.Cret.-Eoc.*, N.Am.-Eu.——FIG. E146,*1*. **C. excavata* (MORTON), Cret., USA(N.J.); *1a-c*, LV ext., RV hinge, LV int., ×0.5 (Weller, 1907).

Frigichione FLETCHER, 1938 [**Chione permagna* TATE, 1900; OD]. Concentric sculpture strong but not lamellar; middle layer of shell with radial riblets; pallial sinus shallow. *U.Tert.*, Antarctic.

F. (Frigichione). Hinge relatively heavy and massive, *2a* stronger than *2b (695)*. *U.Tert.*, Antarctic.——FIG. E146,*5*. **F. (F.) permagna* (TATE); *5a,b*, LV ext., int., ×0.8 (Fletcher, 1938).

F. (Paleomarcia) FLETCHER, 1938 [**P. tatei;* OD]. Hinge thinner than in *F. (Frigichione)* (Fletcher, 1938). *U.Tert.*, Antarctic.

Luciploma OLSSON, 1942 [**L. panamensis;* OD]. Margins smooth; no lunule; hinge as in *Cyclina* but without ligamental nymphs *(695)*. *L.Plio.*, C.Am.

Subfamily GEMMINAE Dall, 1902

Small, polished, with marginal grooves and denticles simulating posterior and anterior lateral teeth; inner ventral margin crenulate. *Eoc.-Rec.*

Gemma DESHAYES, 1853 [**Venus gemma* TOTTEN, 1834; T] [=*Totteniana* PERKINS, 1869 (obj.)]. Ovate, pallial sinus triangular *(695)*. *Eoc.-Rec.*, E.N.Am.——FIG. E147,*6*. **G. gemma* (TOTTEN), Rec., W.Atl.; *6a,b*, RV ext., int., ×10 (Dall, 1900).

Parastarte CONRAD, 1862 [**Astarte triquetra* CONRAD, 1846; OD] [=*Callicistronia* DALL, 1883 (obj.)]. Trigonal, ligament high, beneath beaks; pallial sinus small *(711)*. *Mio.-Rec.*, E.N.Am.——FIG. E147,*1*. **P. triquetra* (CONRAD), Rec., W.Atl.; *1a-c*, LV int., ext., RV int., ×16 (Dall, 1883).

Plesiastarte FISCHER, 1887 [*pro Anomala* COSSMANN, 1886, *non* VON BLOCK, 1799] [**Cyrena crenulata* DESHAYES, 1858; OD]. Subtrigonal, concentrically striate; inner margins minutely crenulate; pallial line hardly flexuous. *Eoc.*, Eu.——FIG. E147,*5*. **P. crenulata* (DESHAYES), France; *5a-c*, RV ext., RV int., LV hinge, ×7 (Deshayes, 1858).

?Rohini SEMPER, 1862 *(nom. dub.)* [**"Woodia lamellosa* SANDBERGER" (*?nom. nud.*; =*Venus woodiaeformis* SANDBERGER, 1863); M]. Resembling *Digitaria* in Astartidae but with a veneroid hinge and small pallial sinus; shell surface striate to cancellate. *Oligo.*, Eu.

Subfamily CLEMENTIINAE Frizzell, 1936

[*nom. transl.* KEEN, 1951 (*ex* Clementiidae FRIZZELL, 1936)]

Shell thin, inequilateral; without escutcheon; sculpture subdued or wanting; inner ventral margin smooth; hinge without lateral teeth. *U.Cret.-Rec.*

Clementia GRAY, 1842 [**Venus papyracea* GRAY, 1825; SD GRAY, 1847] [=*Blainvillia* HUPÉ, 1854 (*non* ROBINEAU-DESVOIDY, 1830)]. Ovate, concentrically waved; no lunule; pallial sinus deep. *Eoc.-Rec.*, N.Am.-Eu.-Asia-Afr.-Pac.

C. (Clementia). Hinge thin with deep niche in front of anterior cardinals; pallial sinus wide *(711)*. *Eoc.-Rec.*, N.Am.-Eu.-Asia-Afr.——FIG. E147,*2*. **C. (C.) papyracea* (GRAY), Rec., Pac.; *2a,b*, LV ext., RV int., ×0.5 *(124b)*.

C. (Egesta) CONRAD, 1845 [**Venus inoceriformis* WAGNER, 1840; M]. Like *C. (Clementia)* but larger, heavier, pallial sinus narrower; posterior slope truncate *(711)*. *Mio.-Rec.*, E.N.Am.-W.N.Am.-Japan.

C. (Terentia) JUKES-BROWNE, 1914 [**C. granulifera* SOWERBY, 1852; OD] [=*Euterentia* COSSMANN, 1920 (obj.)]. With irregular divaricate or reticulate striae *(455a)*. *Rec.*, Pac.

Compsomyax STEWART, 1930 [**Clementia subdiaphana* CARPENTER, 1864; OD]. Shell thicker than in *Clementia*, undulating sculpture wanting; hinge with *3b* strongly bifid. *Eoc.-Rec.*, W.N.Am.-S.Am.-Japan.——FIG. E147,*7*. **C. subdiaphana* (CARPENTER), Rec., USA(Wash.); *7a,b*, RV int., ext., ×0.5 (*219*; Jukes-Browne, 1913).

Psathura DESHAYES, 1858 [**Erycina fragilis* LAMARCK, 1805; M]. Hinge teeth small, *3b* bifid and *1* grooved; pallial sinus wanting. *Eoc.*, Eu.——FIG. E147,*4*. **P. fragilis* (LAMARCK), France; *4a-c*, RV and LV hinges, LV ext., ×1 *(124b)*.

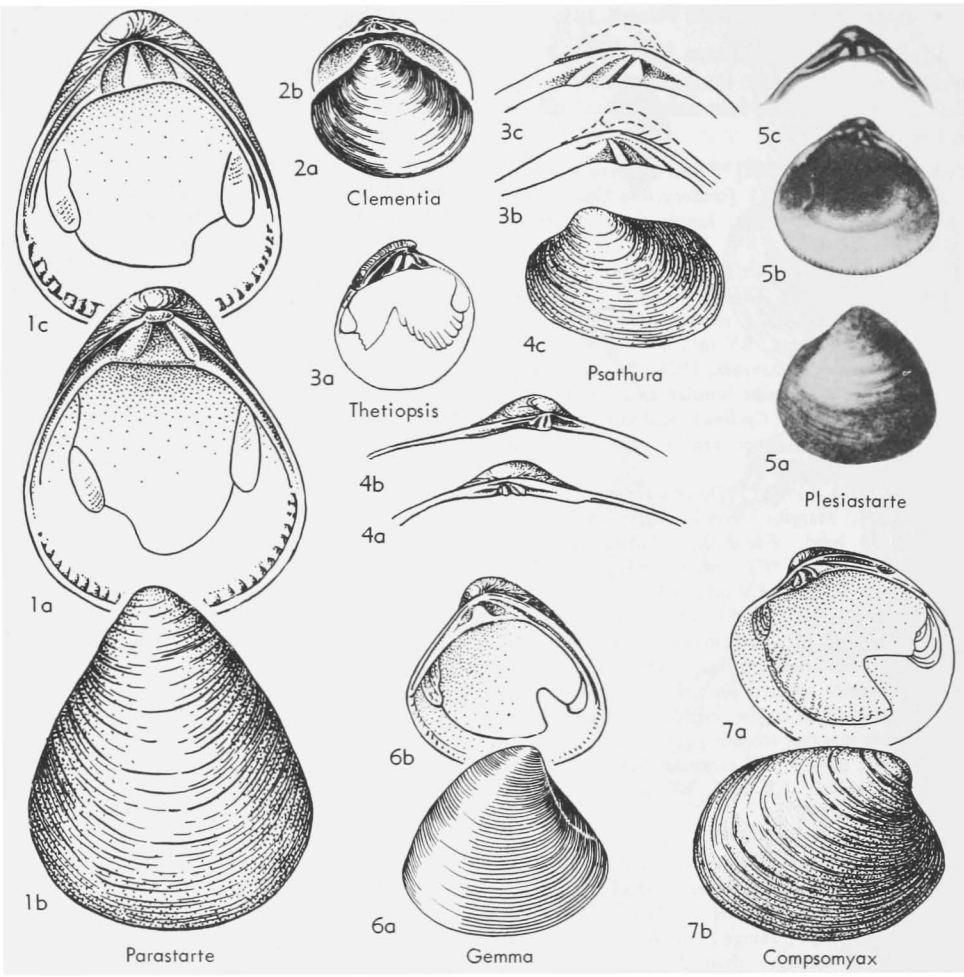


FIG. E147. Veneridae (Gemminae) *(1,5-6)*, (Clementiinae) *(2-4,7)* (p. *N*681-*N*682).

Thetiopsis MEEK, 1875 [**Venus circularis* MEEK & HAYDEN, 1856; M]. Small, sculpture faint, concentric only; pallial sinus sharply ascending; hinge with *2b* stout. *U.Cret.*, N.Am.——FIG. E147,*3*. **T. circularis* (MEEK & HAYDEN), USA(Mont.); *3a-c*, LV int., RV and LV hinges, ×1 (Keen,n, Stanford Univ. Coll.; Meek, 1876).

Subfamily TAPETINAE Adams & Adams, 1857

Ovate to elongate, shell surface somewhat polished, inner margins smooth on at least posterior third; hinge plate narrow, with cardinals *3a* entire, *3b* normally entire, others frequently bifid; lateral teeth wanting. *L.Cret.-Rec.*

Tapes MEGERLE VON MÜHLFELD, 1811 [**Venus literata* LINNÉ, 1758; M] [=*Parembola* RÖMER, 1857 (obj.; M)]. Oblong, rhomboidal, somewhat compressed, higher posteriorly; sculpture weak; lunule incised, escutcheon bordered by low carina. *Mio.-Rec.*, E.Indies-Afr.-Eu.-Pac.-Asia.

T. (Tapes). Surface concentrically grooved. *Pleist.-Rec.*, W.Pac.——FIG. E148,*4*. **T. (T.) literatus* (LINNÉ), Rec., E.Indies; *4a-c*, LV ext., RV and LV hinges, ×0.5 *(124b)*.

T. (Myrsopsis) SACCO, 1900 [**Venerupis pernarum* BONELLI in MICHELOTTI, 1839; OD]. Ovoid; sculpture irregular; ligament in deep pit excavated in nymph. *Mio.-Plio.*, Eu.

T. (Ruditapes) CHIAMENTI, 1900 [**Venus decussata* LINNÉ; SD DALL, 1902] [=*Amygdala* RÖMER, 1857 (*non* GRAY, 1825); M]. Sculpture weakly decussate posteriorly, obscure anteriorly. *Mio.-Rec.*, Eu.-W.Pac.

T. (Siratoria) OTUKA, 1937 [**Paphia siratoriensis* OTUKA, 1934; OD]. Radial and concentric ribs coarse, of equal strength. *Mio.*, Japan.

T. (Taurotapes) SACCO, 1900 [**Venus craverii* MICHELOTTI, 1847; OD]. Elongate, concentrically with irregular striae; left cardinal teeth not joined above, *1* bifid, *3b* widely divergent. *Mio.*, Italy.

Cyclorisma DALL, 1902 [*pro Cyclothyris* CONRAD, 1875 (*non* M'COY, 1844)] [**Cyclothyris carolinensis* CONRAD, 1875; M]. Ovate to subcircular, concentrically striate; hinge with *2a* and *2b* of equal size, *3b* deeply bifid; pallial sinus narrow, deep. *U.Cret.*, E.N.Am.——FIG. E148,*10*. **C. carolinensis* (CONRAD), U.Cret., USA(N.Car.); *10a,b*, LV int., ext., ×0.5 (Dall).

Cyclorisimina MARWICK, 1927 [**C. woodsi*; OD]. Like *Dosinia* but without anterior lateral teeth; anterior cardinals divergent. *U.Cret.*, N.Z.——FIG. E148,*9*. **C. woodsi*; *9a-c*, RV, LV, and RV hinges, ×1 *(592)*.

Eumarcia IREDALE, 1924 [**Venus fumigata* SOWERBY, 1853; OD]. Moderate in size to large; lunule weakly incised, escutcheon not defined; inner margins smooth, pallial sinus ample. *L.Oligo.-Rec.*, N.Z.-Australia.

E. (Eumarcia). Surface smooth. *M.Oligo.-Rec.*, N.Z.-Australia.

E. (Atamarcia) MARWICK, 1927 [**E. (A.) sulcifera*; OD]. Concentric grooves well spaced, polished. *L.Oligo.-M.Plio.*, N.Z.——FIG. E148, *6a,b*, **E. (A.) sulcifera*, U.Oligo.; *6a,b*, LV ext., RV hinge, ×0.5 *(592)*.——FIG. E148,*6c*. *E. (A.) curta* (HUTTON), U.Oligo.; LV hinge, ×0.5 *(592)*.

E. (Opimarcia) MARWICK, 1948 [**E. (O.) healyi*; OD]. Markedly inflated; sculpture fine and wavy. *Plio.*, N.Z.

Eurhomalea COSSMANN, 1920 [*pro Rhomalea* JUKES-BROWNE, 1914 (*non* KOCH, 1837)] [**Venus rufa* LAMARCK, 1818; OD]. Quadrate, nearly smooth, with faint radial striae; inner margins smooth. *Rec.*, W.S.Am.

Flaventia JUKES-BROWNE, 1908 [**Venus ovalis* SOWERBY, 1827; OD]. Ovate, lunule well defined; *3b* long and deeply bifid, its laminae of unequal length *(228)*. *U.Cret.*, Eu.-W.N.Am.——FIG. E148, *2*. **F. ovalis* (SOWERBY), Eng.; *2a-d*, RV int., LV ext., both valves dorsal, LV hinge, ×1 *(1008)*.

Gomphina MÖRCH, 1853 [**Venus undulosa* LAMARCK, 1818; M]. Trigonal, nearly equilateral, smooth; dorsal margins grooved and beveled beyond hinge plate; pallial sinus short, rounded. *L.Plio.-Rec.*, W.Pac.-Australia-N.Z.-Japan-S.Atl.

G. (Gomphina). Valves relatively solid, tumid; hinge with *4b* and right nymph rugose *(228)*. *Rec.*, W.Pac.-Australia.

G. (Gomphinella) MARWICK, 1927 [**G. maorum* SMITH, 1902; OD]. Small, beaks subcentral. *L.Plio.-Rec.*, N.Z.——FIG. E148,*3*. **G. (G.) maorum* SMITH, Rec.; *3a-c*, RV ext., RV int., LV int., ×4 *(592)*.

G. (Jukesena) IREDALE, 1915 [*pro Acolus* JUKES-BROWNE, 1913 (*non* FÖRSTER, 1856)] [**Psephis foveolata* COOPER & PRESTON, 1910; OD]. Small, pallial line only slightly flexed. *Rec.*, S.Atl.

G. (Macridiscus) DALL, 1902 [**Donax aequilatera* SOWERBY, 1825; OD]. Thinner than *G. (Gomphina)*; nymphs smooth. *Pleist.-Rec.*, Japan.

Irus SCHMIDT, 1818 [*ex* OKEN, 1815; nonbinom., ICZN Op. 417] [**Donax irus* LINNÉ, 1758; T]. Subquadrate, with raised concentric lamellae intersected by weaker radial ribs; hinge weak, cardinals *1, 2a, 2b, 3b* bifid; shell commonly distorted by growth in crevices. *Oligo.-Rec.*, Eu.-C.Am.-N.Am.-N.Z.

I. (Irus). Lamellae well spaced. *Oligo.-Rec.*, Eu.-W.N.Am.——FIG. E148,*8*. **I. (I.) irus* (LINNÉ), Rec., France; *8a*, LV ext., ×1; *8b,c*, RV and LV hinges, ×2 *(124b;* Keen, n, Stanford Univ. Coll.).

I. (Notirus) FINLAY, 1928 [*pro Irona* FINLAY, 1927 (*non* SCHIÖDTE & MEINERT, 1883)] [**Venerupis reflexa* GRAY, 1843; OD]. Concentric lamellae closely spaced. *Pleist.-Rec.*, N.Z.

I. (Notopaphia) OLIVER, 1923 [**Venerupis elegans* DESHAYES, 1854; OD]. Radial sculpture fine, concentric lamellae closely spaced; lunule incised; inner ventral margin crenulate anteriorly; pallial sinus nearly horizontal, angular. *Pleist.-Rec.*, N.Z.

I. (Paphonotia) HERTLEIN & STRONG, 1948 [**Petricola* SOWERBY, 1834; OD]. Like *I. (Notopaphia)* but radial sculpture coarser, concentric lamellae wider spaced; hinge with *2a* large; pallial sinus ascending. *Rec.*, W.C.Am.

Katelysia RÖMER, 1857 [**Venus scalarina* LAMARCK, 1818; SD KOBELT, 1881] [=*Catelysia* AUCTT., *nom. null.*]. Concentric ribbing irregular anteriorly, radial sculpture weak; pallial sinus medium-sized to short; cardinal teeth radiating. *?Paleoc.; Eoc.-Rec.*, Eu.-N.Am.-Pac.-Japan-Australia.

K. (Katelysia). Compressed, markedly inequilateral; pallial sinus short. *?Paleoc.; Eoc.-Rec.*, Eu.-E.N.Am.-Pac.——FIG. E148,*5*. **K. (K.) scalarina* (LAMARCK), Rec., Australia; *5a-c*, LV ext., RV int., LV int., ×1 *(711)*.

K. (Nipponomarcia) IKEBE, 1941 [**K. (N.) nakamurai*; OD]. Hinge as in *K. (Katelysia)* but otherwise resembling *Eumarcia*. *Mio.*, Japan.

K. (Textivenus) COSSMANN, 1886 [**Venus texta* LAMARCK, 1905; SD DALL, 1902]. Sculpture reticulate to zigzag. *Eoc.*, Eu.-E.N.Am.

Legumen CONRAD, 1858 [**L. ellipticus*; SD STOLICZKA, 1871] [=*Baroda* STOLICZKA, 1870 (type, *Venus fragilis* D'ORBIGNY, 1845; *non* FABRICIUS, 1780; OD)]. Elongate, slender, subelliptical, beaks at anterior fourth; sculpture concentric only; no lunule or escutcheon; hinge plate narrow; pallial sinus moderate. *L.Cret.-U.Cret.*, E.N.Am.-W.N.Am.-India-Eu.——FIG. E148,*1*. **L. ellipticus*, U.Cret., USA(Miss.); *1a,b*, LV and RV hinges, ×1; *1c*, RV ext., ×0.5 *(889)*.

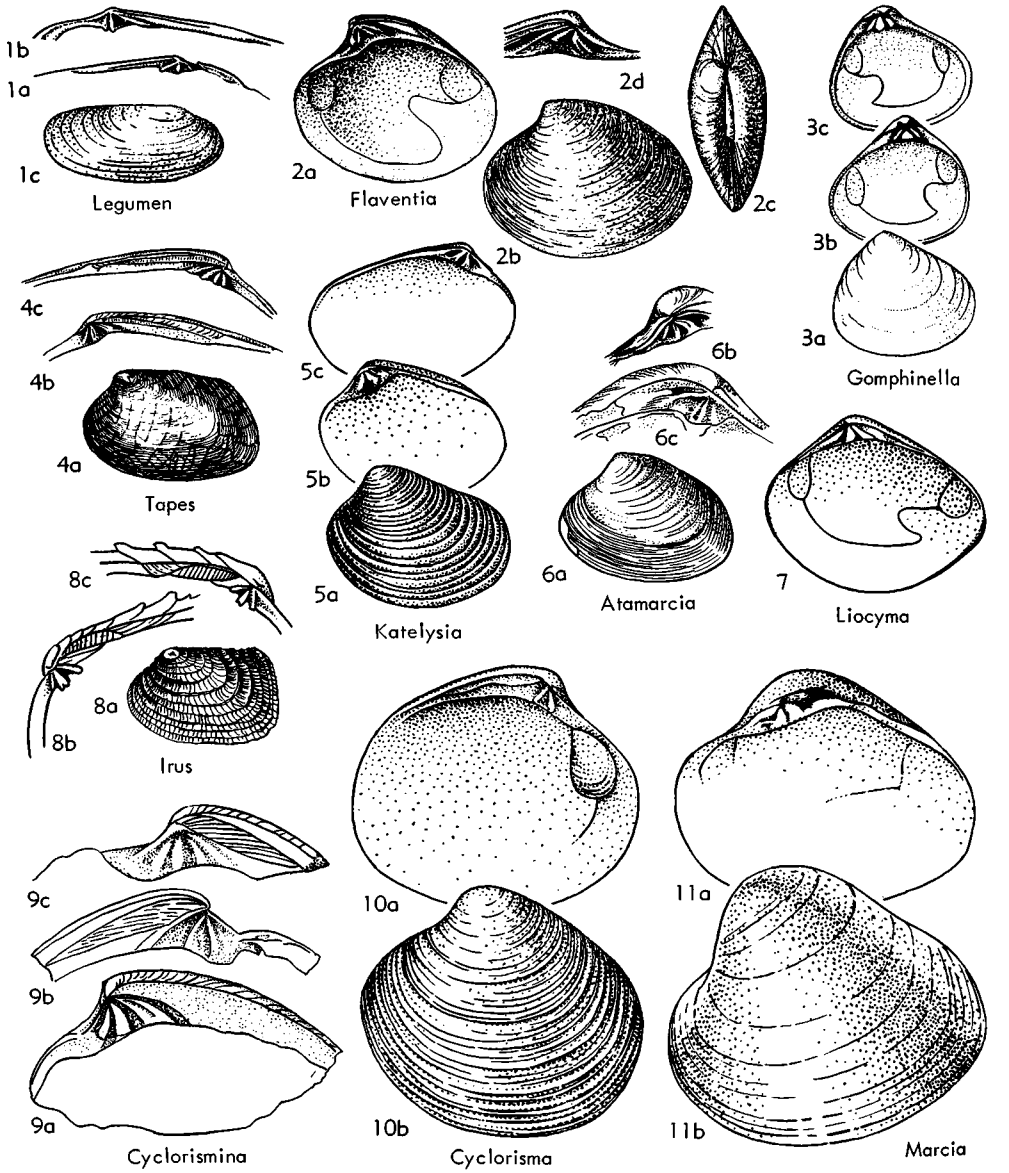


FIG. E148. Veneridae (Tapetinae) (p. *N*682-*N*685).

Liocyma DALL, 1870 [**Venus fluctuosa* GOULD, 1841; OD]. Oblique-oval, surface concentrically striate; hinge with *1* and *2b* feebly grooved, nymphs smooth; pallial sinus short, rounded. *Pleist.-Rec.*, N.Atl.-N.Pac.——FIG. E148,*7*. **L. fluctuosa* (GOULD), Rec., NW.Atl.; RV int., ×1 (Jukes-Browne, 1913).

Marcia H.ADAMS & A.ADAMS, 1857 [*"*Venus pinguis* CHEMNITZ" *(nonbinom.)* (=**V. opima* GMELIN, 1791); SD KOBELT, 1881] [=*Hemitapes* RÖMER, 1864 (obj.; SD STOLICZKA, 1870); *Levimarcia* Cox, 1927 (obj.; OD)]. Ovate-cordate, inflated, smooth; lunule convex, escutcheon depressed but not sharply delimited; cardinal teeth radiating, *1*, *2b*, *3b* bifid; pallial sinus oval, horizontal. *Eoc.-Rec.*, N.Am.-Afr.-E.Indies-Australia-Eu.

M. (Marcia). Of medium size; pallial sinus well developed. *L.Mio.-Rec.*, Afr.-E.Indies.——FIG. E148,*11*. **M. (M.) opima* (GMELIN), Rec.,

E.Indies; *11a,b,* RV int., LV ext., ×1 (Jukes-Browne, 1913).

M. (Gomphomarcia) KAUTSKY, 1929 [**G. abeli;* OD]. Subtrigonal, lunule and escutcheon well defined. *Mio.,* Eu.

M. (Granicorium) HEDLEY, 1906 [**G. indutum;* OD]. Lunule not well defined. *Rec.,* Australia.

M. (Mercimonia) DALL, 1902 [**Venus bernayi* COSSMANN, 1886; OD]. Hinge with *2b* weak; pallial sinus small. *Eoc.-Mio.,* Eu.-E.N.Am.-W.N.Am.

M. (Similivenus) COSSMANN, 1910 [**Venus solida* DESHAYES, 1824 (*non* SCHRÖTER, 1802) (=*S. insolida* KEEN, 1954); OD]. Small, lunule lanceolate, escutcheon beveled, teeth crowded. *Eoc.-Oligo.,* Eu.

Paphia RÖDING, 1798 [**P. alapapilionis* (=*Venus rotundata* LINNÉ, 1758); SD DALL, 1902] [=*Textrix* RÖMER, 1857 (*non* SUNDEVALL, 1833; obj., SD STOLICZKA, 1870); *Paratapes* STOLICZKA, 1870 *(pro Textrix); Eutapes* CHIAMENTI, 1900 (obj.; OD); *Acritopaphia* IREDALE, 1936 (type, *A. transfusa;* OD)]. Elongate, compressed, surface glossy. *Oligo.-Rec.,* Pac.-N.Z.-Asia-Eu.

P. (Paphia). Nearly smooth, with faint concentric ribbing. *Plio.-Rec.,* W.Pac.——FIG. E149,*2*. **P. (P.) rotundata* (LINNÉ), Rec.; *2a-c,* LV ext., RV and LV hinges, ×0.5 (Marwick, Chenu).

P. (Callistotapes) SACCO, 1900 [**Venus vetula* BASTEROT, 1825; OD] [=*Hemitapes* AUCTT., *non* RÖMER]. Concentric ridges close, well defined. *Oligo.(Aquitan.)-Rec.,* Eu.-Asia-N.Z.

P. (Protapes) DALL, 1902 [**Venus gallus* GMELIN, 1791; OD]. Concentric ribs evident; shell shorter and more tumid than *P. (Paphia). Rec.,* W.Pac.

Paraesa CASEY, 1952 [**Venus faba* J. DE C. SOWERBY, 1827; OD]. Ovate, concentrically striate, lunule faint; resembling *Flaventia* but with *3b* less deeply bifid, *2a* not wedge-shaped, *2b* reaching base of hinge plate. *L.Cret.(U.Alb.)-U.Cret. (Senon.),* Eu.——FIG. E149,*1*. **P. faba* (SOWERBY), L.Cret., Eng.; *1a-c,* LV and RV hinges, LV ext., ×1 *(92)*.

Psephidia DALL, 1902 [*pro Psephis* CARPENTER, 1865 (*non* GUENÉE, 1854)] [**Chione lordi* BAIRD, 1863; OD] [*non Psephidia* POMEL, 1872 *(nom. nud.)*]. Small, ovate-trigonal, polished, sculpture faint, concentric; lunule narrow, feeble; escutcheon wanting; pallial sinus distinct, angular. *Plio.-Rec.,* W.N.Am.——FIG. E149,*4*. **P. lordi* (BAIRD), Rec., USA(Wash.); *4a-c,* LV ext., RV int., LV int., ×3 *(228)*.

Sinonia STEPHENSON, 1953 [**S. levis;* OD]. Elongate-ovate, nearly smooth, with irregular concentric ridges; no lunule or escutcheon; pallial sinus small, directed upward. *U.Cret.(Cenoman.),* USA(Tex.).——FIG. E149,*5*. **S. levis; 5a-c,* RV int., LV hinge, ext., ×1 (Stephenson, 1953).

Venerella COSSMANN, 1886 [**Venerupis hermonvillensis* DESHAYES, 1858; SD CROSSE, 1886]. Like *Marcia* but hinge teeth divergent, extending beyond edge of narrow hinge plate *(329a)*. *Eoc.,* Eu.-Asia.

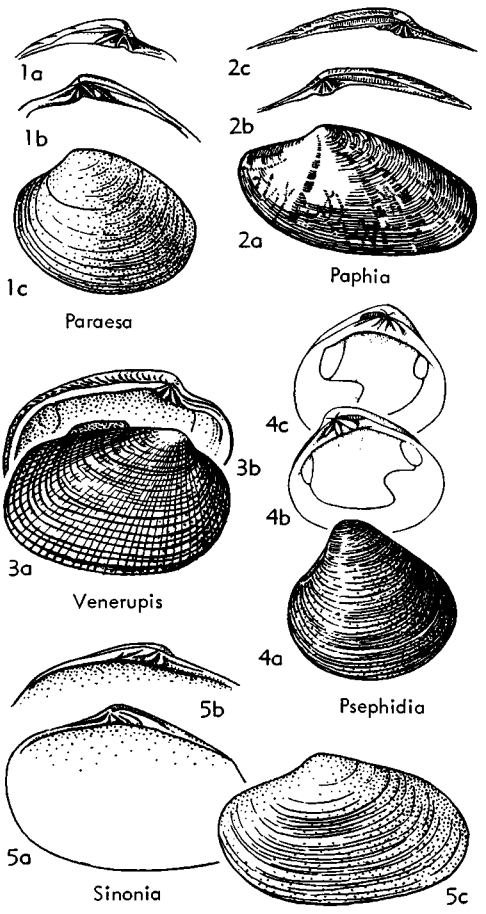


FIG. E149. Veneridae (Tapetinae) (p. *N685-N686*).

Veneritapes COSSMANN, 1886 [**Psammobia bervillei* DESHAYES, 1858; M]. Smooth, anteriorly attenuated; teeth small, *3a* weak or obsolete *(329a)*. *Eoc.,* Eu.

Venerupis LAMARCK, 1818 [**Venus perforans* MONTAGU, 1803 (=*Venus saxatilis* FLEURIAU DE BELLEVUE, 1802); SD CHILDREN, 1823] [=*Pullastra* SOWERBY, 1826 (type, *Venus pullastra* MONTAGU, 1803; *T*); *Myrsus* H. ADAMS & A. ADAMS, 1853 (type, "*M. corrugata* DESHAYES," =*Venus corrugata* GMELIN, 1791; SD STOLICZKA, 1870); *Polititapes* CHIAMENTI, 1900 (type, *Venus aurea* GMELIN, 1791; SD DALL, 1900); *Aureitapes, Cyaneitapes* CHIAMENTI, 1900 (type, *V. aurea* GMELIN, 1791; SD KEEN, 1954)]. Ovate-elliptic; sculpture of irregular radial and concentric or

slightly zigzag riblets, with stronger concentric lamellae at ends. *L.Eoc.-Rec.*, Eu.-Afr.-N.Z.

V. (Venerupis). Sculpture present throughout; distortion, due to growth in crevices, common. *Plio.-Rec.*, Eu.-W.Afr.——FIG. E149,*3*. **V. (V.) saxatilis* (FLEURIAU DE BELLEVUE), Rec., Eu.; *3a,b*, RV ext., LV int., ×1 (Brown).

V. (Paphirus) FINLAY, 1927 [**Venus largillierti* PHILIPPI, 1847; OD]. Radial sculpture absent on posterior slope. *L.Eoc.-Rec.*, N.Z.

Subfamily CHIONINAE Frizzell, 1936

[*nom. transl.* KEEN, 1951 (*ex* Chionidae FRIZZELL, 1936)]

Ovate-trigonal, inequilateral, sculpture cancellate; lunule normally present; escutcheon, if present, beveled; inner margins usually crenulate; hinge plate and teeth well developed, cardinals *2a* and *1* large; pallial sinus mostly short, ascending. *M.Eoc.-Rec.*

Chione MEGERLE VON MÜHLFELD, 1811 [**Venus dysera* LINNÉ (of GMELIN, 1791) (*non* LINNÉ, 1758) (=**V. cancellata* LINNÉ, 1767); SD GRAY, 1847]. Cordate; lunule and escutcheon mostly well defined; concentric sculpture strong, frilled in some forms. *Oligo.-Rec.*, N.Am.-S.Am.-C.Am.-N.Z.

C. (Chione). Pallial sinus small; cardinal teeth smoothly or only faintly grooved. *U.Oligo.-Rec.*, E.N.Am.-W.N.Am.-S.Am.——FIG. E150,*1*. **C. (C.) cancellata* (LINNÉ), Rec., Carib.; *1a-c*, RV ext., int., LV int., ×1 *(711)*.

C. (Austrovenus) FINLAY, 1927 [*"**Venus stutchburyi* GRAY" (=**V. stutchburii* WOOD, 1828); OD]. Sculpture of low radial ribs crossed by irregular concentric lamellae *(695)*. *M.Plio.-Rec.*, N.Z.

C. (Chionista) KEEN, 1958 [**Venus fluctifraga* SOWERBY, 1853; OD]. Lunule and escutcheon wanting; concentric sculpture irregular, beaded. *Pleist.-Rec.*, W.N.Am.

C. (Chionopsis) OLSSON, 1932 [**Venus amathusia* PHILIPPI, 1844; OD] [=*Gnidiella* PARKER, 1949 (type, *Venus gnidia* BRODERIP & SOWERBY, 1829; OD)]. Pallial sinus well developed; one or more cardinal teeth in each valve bifid or strongly grooved *(329a)*. *Mio.-Rec.*, E.N.Am.-W.N.Am.

C. (Iliochione) OLSSON, 1961 [**Venus subrugosa* WOOD, 1828; OD] [=*Anomalocardia* AUCTT. (*non* SCHUMACHER)]. Sculpture of undulating concentric folds, mostly obsolete toward ventral margin. *Rec.*, W.C.Am.-S.Am.

C. (Lirophora) CONRAD, 1863 [**Circomphalus athleta* (=**Venus latilirata* CONRAD, 1841); SD DALL, 1902]. Concentric lamellae of broad thickened rolls that may coalesce medially. *Oligo.-Rec.*, E.N.Am.-W.N.Am.——FIG. E150,*2*. **C. (L.) latilirata* (CONRAD), Mio., USA(Md.); RV ext., ×1 (Glenn, 1904).

C. (Panchione) OLSSON, 1964 [**Grateloupia mactropsis* CONRAD, 1865; OD]. Intermediate between *C. (Lirophora)* and *C. (Iliochione)*, with foliaceous posterior area of former and outline of latter. *Mio.*, C.Am.——FIG. E150,*3*. **C. (P.) mactropsis* (CONRAD), Panama; LV ext., ×1 (Olsson, 1964).

C. (Securella) PARKER, 1949 [**Venus securis* SHUMARD, 1858; OD]. Ligament deeply sunken; concentric sculpture underlain by radical, appearing cancellate on eroded surfaces; *2b* deeply grooved with posterior part larger and higher than anterior *(695)*. *Oligo.-Plio.*, NW.N.Am.

Anomalocardia SCHUMACHER, 1817 [**Venus flexuosa* LINNÉ, 1767; OD] [=*Triquetra* DE BLAINVILLE, 1828 (type, *Venus flexuosa* LINNÉ, 1767; SD ANTON, 1839); *Cryptogramma* MÖRCH, 1853 (obj.); *Murcia* RÖMER, 1857 (*non* KOCH, 1835)]. Shell thick, with undulating concentric folds crossed by radial riblets; lunule large, impressed. *Mio.-Rec.*, C.Am.-S.Am.-Afr.-E.Indies-W.Pac.

A. (Anomalocardia). Radial sculpture subordinate; *4b* rugose. *Mio.-Rec.*, E.C.Am.-S.Am.-W.Afr.——FIG. E150,*5*. **A. (A.) flexuosa* (LINNÉ), Rec., W.Afr.; *5a,b*, LV int., LV ext., ×1 *(711)*.

A. (Anomalodiscus) DALL, 1902 [*"*Cytherea squamosa* LAMARCK" (=**Venus squamosa* LINNÉ, 1758); OD]. Sculpture reticulate, ventral margin crenulate, hinge teeth without rugosities *(228)*. *U.Mio.-Rec.*, E.Indies.

A. (Cryptonemella) KURODA & HABE, 1951 [*pro Cryptonema* JUKES-BROWNE, 1914 (*non* BIGSBY, 1868)] [**A. (C.) producta* (*pro Venus impressa* ANTON, 1839; *non* DE SERRES, 1829); OD]. Sculpture weak, radial, internal margin nearly smooth *(695)*. *Rec.*, W.Pac.

Bassina JUKES-BROWNE, 1914 [**Venus paucilamellata* "SOWERBY" (i.e., *Mercenaria paucilamellata* DUNKER, 1858) (=**V. pachyphylla* JONAS, 1839); OD]. Resembling *Chione* but without escutcheon; inner margins crenate; *2b* large, *3b* grooved. *Oligo.-Rec.*, E.Indies-Australia-N.Z.

B. (Bassina). Thick-shelled; sculpture of thin, spaced concentric lamellae *(592)*. *Mio.-Rec.*, E. Indies-S.Australia.

B. (Callanaitis) IREDALE, 1917 [**Venus yatei* GRAY, 1835; OD] [=*Salacia* JUKES-BROWNE, 1914 (*non* LAMOUROUX, 1816) (type, *Venus lamellata* LAMARCK, 1818; OD); *Eusalacia* COSSMANN, 1920 *(pro Salacia)*]. Thin-shelled, somewhat quadrate, compressed, cencentric lamellae strong. *Oligo.-Rec.*, N.Z.——FIG. E150,*9*. **B. (C.) yatei* (GRAY), Rec., N.Z.; *9a-c*, LV int., ext., RV hinge, ×0.5 *(592)*.

Chamelea MÖRCH, 1853 [**Venus gallina* LINNÉ, 1758; SD BUCQUOY, DAUTZENBERG, & DOLLFUS, 1893] [=*Ortygia* BROWN, 1827 (*non* BOIE, 1826) (obj.; SD HERRMANNSEN, 1847); *Hermione* GRAY, 1852, *ex* LEACH MS (*non* MEIGEN, 1800)]. With narrow close concentric lamellae, no radial sculp-

ture; cardinal teeth not bifid. *Oligo.-Rec.*, E.N.Am.-Eu.——Fig. E150,*7*. **C. gallina* (Linné), Rec., Medit.; *7a-c*, LV ext., LV and RV hinges, ×1 *(711)*.

Clausinella Gray, 1851 [*"*Chione fasciata*" (i.e., **Pectunculus fasciatus* da Costa, 1778); M] [=*Zucleica* Gray, 1852, *ex* Leach MS (obj.); *Anaitis* Römer, 1857 (*non* Duponchel, 1778)]. Sculpture of recurved, spaced concentric ridges; inner margins crenate. *Oligo.-Rec.*, Eu.-E.N.Am.-N.Z.——Fig. E150,*4*. **C. fasciata* (da Costa), Rec., Medit.; *4a-c*, LV ext., RV and LV hinges, ×1 *(711)*.

Hinemoana Marwick, 1927 [**Chione accuminata*

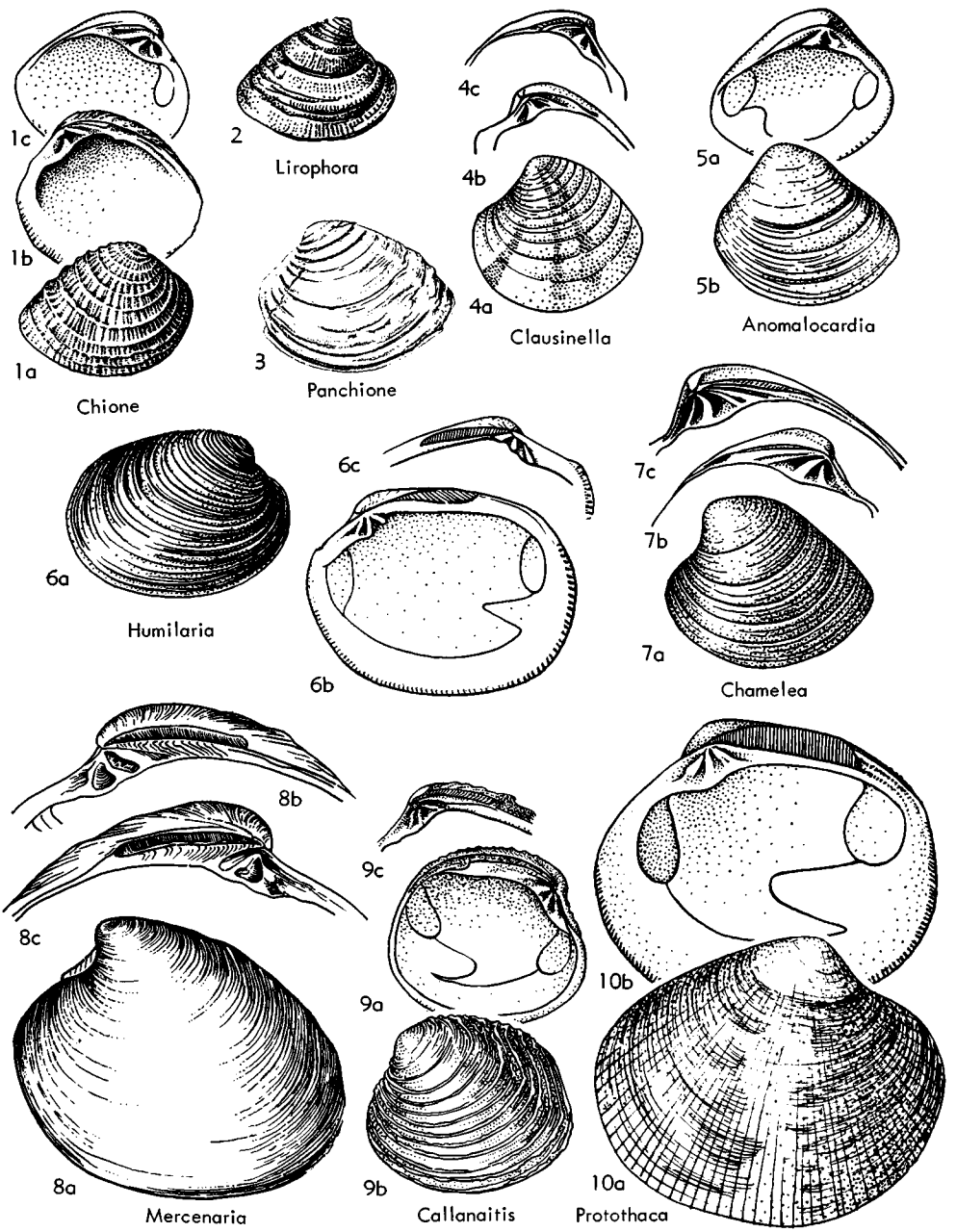


Fig. 150. Veneridae (Chioninae) (p. *N686-N688*).

HUTTON, 1873; OD]. Sculpture concentric, with fine subsurface radial threads; RV with grooved margin simulating posterior lateral tooth *(592)*. *?Oligo.*, N.Z.

Humilaria GRANT & GALE, 1931 [**Venus kennerleyi* REEVE, 1863; OD]. With heavy concentric ribs, no radial sculpture; inner margins crenate; *2a* large, bifid in some; pallial sinus short, angular. *Plio.-Rec.*, W.N.Am.——FIG. E150,*6*. **H. kennerleyi* (REEVE), Rec., USA (Wash.); *6a-c*, RV ext., int., LV hinge, ×0.5 *(288;* Keen, n, Stanford Univ. Coll.).

Mercenaria SCHUMACHER, 1817 [**M. violacea* (=*Venus mercenaria* LINNÉ, 1758); T] [=*Crassivenus* PERKINS, 1869 (obj.)]. Like *Chione* in in form but larger, radial sculpture obsolete; ligamental nymphs rugose. *Oligo.-Rec.*, N.Am.-Japan. ——FIG. E150,*8*. **M. mercenaria* (LINNÉ), Rec., W.Atl.; *8a-c*, LV ext., RV and LV hinges, ×0.5 *(711)*.

Placamen IREDALE, 1925 [**Venus placida* PHILIPPI, 1844; OD]. Concentric sculpture as in *Lirophora;* lunule deep, heart-shaped *(329a)*. *Mio.-Rec.*, Australia.

Protothaca DALL, 1902 [**Chama thaca* MOLINA, 1782; OD]. Ovate, convex, sculpture reticulate; lunule normally present; escutcheon absent or in LV only; *2b* and *1* bifid; pallial sinus moderate in size, pointed. *Mio.-Rec.*, N.Am.-S.Am.-Asia-Carib.-C.Am.

P. (Protothaca). Radial sculpture predominating on anterior and middle slopes, concentric on posterior; inner margins crenate *(228)*. *Mio.-Rec.*, N.Am.-S.Am.-Japan.——FIG. E150,*10*. **P. (P.) thaca* (MOLINA), Rec., W.S.Am.; *10a,b*, RV ext., int., ×0.7 (Philippi, 1847).

P. (Antinioche) OLSSON, 1961 [**Nioche (A.) beili;* OD]. Sculpture as in *Periglypta* but hinge and escutcheon as in *P. (Leukoma)*. *Rec.*, W.C.Am.-S.Am.

P. (Callithaca) DALL, 1902 [**Tapes tenerrima* CARPENTER, 1857; OD]. Sculpture uniformly reticulate; lunule feeble, escutcheon wanting; inner margins smooth *(228)*. *Mio.-Rec.*, W.N.Am.-Japan.

P. (Colonche) OLSSON, 1961 [**C. ecuadoriana;* OD]. Resembling *P. (Antinioche)* but lunule and escutcheon are wanting. Valves inflated. *Rec.*, W.S.Am.

P. (Leukoma) RÖMER, 1857 [**Venus granulata* GMELIN, 1791; SD KOBELT, 1881] [=*Nioche* HERTLEIN & STRONG, 1948 (type, *Venus asperrima* SOWERBY, 1835; OD); not preoccupied by *Leucoma* HÜBNER, 1822]. Radial ribs fine, concentric sculpture reduced; lunule radially ribbed, incised; left valve with beveled escutcheon *(329a)*. *Mio.-Rec.*, Carib.-E.C.Am.-W.C.-Am.

P. (Notochione) HERTLEIN & STRONG, 1948 [**Venus columbiensis* SOWERBY, 1835; OD]. Ribs heavy, predominantly radial; shell rounded-trigonal *(695)*. *Neog.-Rec.*, Japan-W.C.Am.-S. Am.

P. (Novathaca) HABE, 1951 [**Chione euglypta* SOWERBY, 1914; OD]. Radial sculpture weak, absent at ends of shell *(365)*. *Rec.*, Japan.

P. (Protocallithaca) NOMURA, 1937 [**Venus adamsi* REEVE, 1863; OD]. Sinus shorter and more pointed than in *P. (Callithaca) (365)*. *Plio.-Rec.*, Japan.

P. (Tropithaca) OLSSON, 1961 [**Venus grata* SAY, 1830; OD]. Resembling *P. (Protothaca)* but smaller, sculpture weaker, escutcheon reduced; color variability extreme. *Rec.*, W.C.Am.-S.Am.

P. (Tuangia) MARWICK, 1927 [**Venus crassicosta* DESHAYES, 1835; OD]. Radial ribs heavy, shell elongate to rounded-quadrate *(592)*. *Plio.-Rec.*, Japan-N.Z.

Tawera MARWICK, 1927 [**Venus spissa* DESHAYES, 1835; OD]. Resembling *Chamelea* but lunule less deeply sunken; cardinal teeth more divergent. *L.Eoc.-Rec.*, N.Z.

T. (Tawera). Sculpture of levelled smooth ridges. *L.Eoc.-Rec.*——FIG. E151,*7*. **T. (T.) spissa* (DESHAYES), Rec., N.Z.; *7a-c*, LV int., RV int., LV ext., ×1 *(592)*.

T. (Turia) MARWICK, 1927 [**Turia chattonensis*; OD]. Small, sculpture of thin, spaced concentric lamellae with irregular crests *(592)*. *L.Eoc.-L.Mio.*, N.Z.

Timoclea BROWN, 1827 [**Venus ovata* PENNANT, 1777; M] [=*Pasiphaë* GRAY (*ex* LEACH, MS), 1852 (obj.); *Parvivenus* SACCO, 1900 (type, *Venus marginata* HÖRNES, 1861; OD); *Veremolpa* IREDALE, 1930 (type, *V. ethica;* OD)]. Small, rather compressed, sculpture predominantly radial; escutcheon smooth. *U.Oligo.-Rec.*, Eu.-C.Am.-W. Pac.-Australia-E.Indies.

T. (Timoclea). Concentric sculpture present as nodes on ribs. *U.Oligo.(Aquitan.)-Rec.*, Eu.-E.C.Am.-W.C.Am.-W.Pac.——FIG. E151,*5*. **T. (T.) ovata* (PENNANT), Rec., Medit.; *5a-b*, RV int., LV int., ×2; *5c-e*, RV ext., RV and LV hinges, ×1.3 *(711;* Keen, n, Stanford Univ. Coll.).

T. (Chioneryx) IREDALE, 1924 [**Venus striatissma* SOWERBY, 1853 (=*Erycina cardioides* LAMARCK, 1818); M]. Subrostrate posteriorly; lunule striate, colored *(329a)*. *Rec.*, Australia.

T. (Glycydonta) COTTON, 1936 [**Venus marica* LINNÉ, 1758; OD]. Concentric sculpture of raised lamellae on posterior slope *(695)*. *Pleist.-Rec.*, E.Indies-Australia.

Family PETRICOLIDAE Deshayes, 1839

Oval, with no lunule or escutcheon; sculpture radial or obsolete. Hinge without lateral teeth; three cardinals in left valve, *2b* bifid, right valve with *1* and *3b* only; pallial sinus well developed. *Eoc.-Rec.*

Petricola LAMARK, 1801 [**P. costata* (=**Venus lapicida* GMELIN, 1791); SD SCHMIDT, 1818] [=*Naranio* GRAY, 1853 (obj.; SD LAMY, 1922)]. With radial sculpture, at least in young; commonly distorted by nestling. *Eoc.-Rec.*, N.Am.-W.Pac.-Australia-Asia-Eu.-Carib.

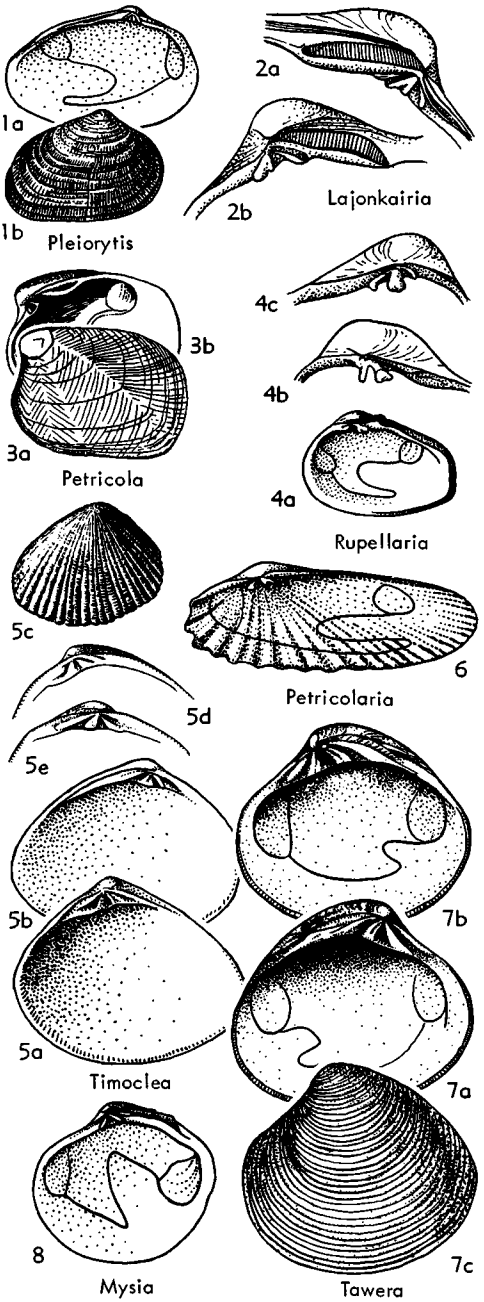


FIG. E151. Veneridae (Chioninae) *(5,7)*; (Petricolidae) *(1-4,6,8)* (p. *N*688-*N*689).

P. (Petricola). Sculpture of fine radial, divaricate, or zigzag riblets *(515)*. *Rec.*, E.N.Am.-W.N.Am.-W.Pac.——FIG. E151,*3*. **P. (P.) lapicida* (GMELIN), Carib.; *3a,b*, LV ext., RV int., ×1 (Brown, 1844).

P. (Claudiconcha) FISCHER, 1887 [**Venus monstrosa* GMELIN, 1791; M]. Sculpture cancellate, lamellose posteriorly; posterior margin thick; RV may overlap LV ventrally. *Rec.*, W.Pac.-Australia.

P. (Lajonkairia) DESHAYES, 1854 [**Venerupis decussata* (=**V. lajonkairii* PAYRAUDEAU, 1826); T] [=*Lajonkairea* AUCTT. *(nom. null.)*]. Sculpture cancellate; boring habit not developed. *Oligo.-Rec.*, Eu.-Japan.——FIG. E151,*2*. **P. (L.) lajonkairii* (PAYRAUDEAU), Rec., Medit.; *2a,b*, LV and RV hinges, ×2 *(515)*.

P. (Petricolaria) STOLICZKA, 1870 [**P. pholadiformis* LAMARCK, 1818; OD] [=*Gastranella* VERRILL, 1872 (type, *G. tumida;* M)]. Elongate, with nodose radial sculpture; hinge plate narrow, teeth small, *2a* may be obsolete *(515)*. *Oligo. (Aquitan.)-Rec.*, Eu.-E.N.Am.-W.N.Am.——FIG. E151,*6*. **P. (P.) pholadiformis* (LAMARCK), Rec., E.N.Am.; RV int., ×1 *(1007)*.

P. (Petricolirus) HABE, 1951 [**P. aequistriata* SOWERBY, 1874; OD]. Radial striae subequal, numerous, over entire shell; posterior end truncate *(365)*. *Rec.*, Japan.

P. (Pseudoirus) HABE, 1951 [**P. mirabilis* DESHAYES, 1853; OD]. Shell thick, compressed, not burrowing *(365)*. *Rec.*, Japan.

P. (Rupellaria) FLEURIAU, 1802 [**Venus lithophaga* RETZIUS, 1786; M] [=*Choristodon* JONAS, 1844 (type, *C. typicum;* M)]. Sculpture of coarse radial riblets. *Eoc.-Rec.*, Eu.-E.N.Am.-W.N.Am.-W.Pac.-Japan.——FIG. E151,*4*. **P. (R.) lithophaga* (RETZIUS), Rec., Medit.; *4a*, RV int., ×1; *4b,c*, RV and LV hinges, ×2 *(515, 1007)*.

P. (Velargilla) IREDALE, 1931 [**Naranio rubiginosa* ADAMS & ANGAS, 1863; OD]. Thinner than *P. (Petricola);* burrowing in ooze, not boring *(695)*. *Rec.*, Australia.

Mysia LAMARCK, 1818 (*ex* LEACH MS) [**Venus undata* PENNANT, 1777; M] [=*Lucinopsis* FORBES & HANLEY, 1848 (obj.)]. Smooth, resembling *Cyclinella* but with only 2 cardinal teeth in RV *(515)*. *Rec.*, Eu.-Australia.——FIG. E151,*8*. **M. undata* (PENNANT), Rec., Eu.; RV int., ×1 *(695)*.

Pleiorytis CONRAD, 1862 [**P. ovata* (=*Petricola centenaria* CONRAD, 1833); M]. Shell thin, hinge with *3b* weak to obsolete. *Mio.*, E.N.Am.——FIG. E151, *1*. **P. centenaria* (CONRAD), USA(Md.); *1a,b*, LV int., RV ext., ×0.5 (Glenn, 1904).

Family COOPERELLIDAE Dall, 1900

Shell thin, ovate-quadrate, moderately inflated; hinge without lateral teeth, right

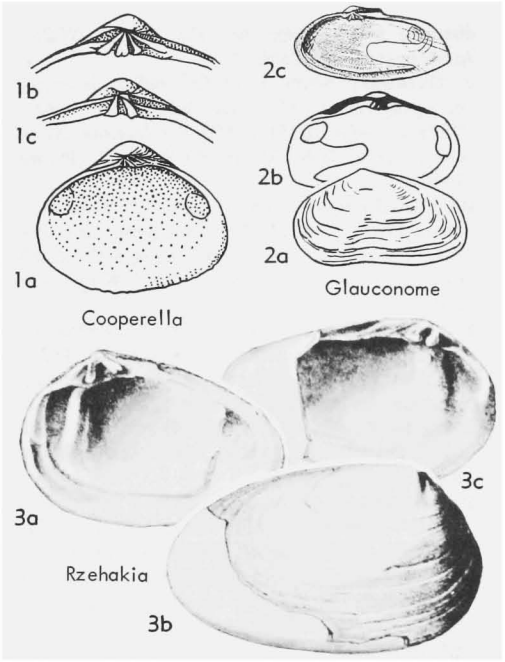


FIG. E152. Cooperellidae *(1)*; Glauconomidae *(2)*; Rzehakiidae *(3)* (p. *N690*).

valve with two thin cardinals, *1* and bifid *3b;* left valve with three cardinals, *2b* bifid; ligament depressed, seated on laminar nymph; pallial sinus wide. *Mio.-Rec.*

Cooperella CARPENTER, 1864, p. 639 [**Oedalia (C.) scintillaeformis,* p. 639 (=**O. subdiaphana,* p. 639); M (synonymy of generic and specific names established by first reviser, DALL, 1900] [=*Oedalia* CARPENTER, 1864 *(non Oedalea* MEIGEN, 1820); *Oedalina* CARPENTER, 1865 *(pro Oedalia)*]. *Mio.-Rec.*

C. (Cooperella). Hinge with *2b* deeply divided; pallial sinus deep, its apex rounded. *Mio.-Rec.,* E.N.Am.-W.N.Am.-S.Am.——FIG. E152,*1*. **C. (C.) subdiaphana* (CARPENTER), Rec., USA (Calif.); *1a,* RV int., ×1.3; *1b,c,* LV and RV hinges, ×2 *(515*; Arnold, 1903).

C. (Cooperellopsis) WOODRING, 1925 [**C. (C.) thaumasta;* OD]. More quadrate and inflated than *C. (Cooperella); 2b* not deeply bifid; pallial sinus obscure *(695). Mio.,* Carib.

Family GLAUCONOMIDAE Gray, 1853

[=Glauconomyidae CHENU, 1862; Glaucomyidae, Glauconomeidae (spelling errors)]

Elongate shells, smooth, with conspicuous periostracum; hinge with three cardinal teeth in either valve, lateral teeth wanting. *Rec.*

Glauconome GRAY, 1828 [**G. chinensis;* M] [=*Glauconomya* BRONN, 1838 (obj.); *Glaucomya* WOODWARD, 1854 *(nom. van.); Glauconoma* CHENU, 1862 *(nom. null.); Glauconometta* IREDALE, 1936 (type, *G. plankta;* OD); *Glauconomella* ALLAN, 1950 *(nom. null.)*]. Periostracum light to dark green, smooth or wrinkled. [Habitat, marine to brackish water.] *Rec.,* IndoPac.-Australia. ——FIG. E152,*2*. **G. chinensis,* E.Indies; *2a,b,* LV ext., int., ×1 (Habe, 1954); *2c,* RV int., ×1 *(305)*.

Family RZEHAKIIDAE Korobkov, 1954

[=Onchophoridae DAVIDASCHVILI, 1934]

Ovate, moderately small, strongly inequilateral, nearly smooth, beaks low; hinge lacking lateral teeth, with two cardinals in right valve *(1* and *3b),* and three in left *(2a, 2b,* and *4b);* anterior adductor muscle scar deeply sunken, bordered by ridge posteriorly; pallial sinus shallow *(716)*. [Apparently aberrant brackish-water descendants of marine Tapetinae.] *M.Mio.-U.Mio.*

Rzehakia KOROBKOV, 1954 [*pro Oncophora* RZEHAK, 1882 (*non* DIESING, 1851)] [**Oncophora socialis* RZEHAK, 1882; OD]. Cardinal teeth slightly bifid. *M.Mio.-U.Mio.,* E.Eu.——FIG. E152,*3*. **R. socialis* (RZEHAK), Mio., Czech.; *3a-c,* RV int., ext., LV int., ×1 (Rzehak).

Order MYOIDA Stoliczka, 1870

[*nom. correct.* NEWELL, 1965 (*ex* order Myacea STOLICZKA, 1870)] [Adapedonta AUCTT., in part] [Diagnosis by N. D. NEWELL]

Thin-shelled, burrowing forms with well-developed siphons; strongly inequilateral, equivalve or inequivalve; isomyarian or anisomyarian; one cardinal tooth in each valve, or edentulous; lunule and escutcheon absent, or poorly developed; shell not nacreous. *Carb.-Rec.*

Suborder MYINA Stoliczka, 1870

[*nom. transl. et correct.* NEWELL, 1965 (*ex* order Myacea STOLICZKA, 1870)] [Diagnosis by N. D. NEWELL]

Hinge edentulous or with one cardinal tooth on each valve; ligament external, borne on well-marked nymphs, in some forms with internal resilium; sinupalliate. *Perm.-Rec.*

Superfamily MYACEA Lamarck, 1809

[*nom. transl.* GILL, 1871 (*ex* family Myacea GOLDFUSS, 1820) (=myaires LAMARCK, 1809)] [Materials for this superfamily prepared by MYRA KEEN]

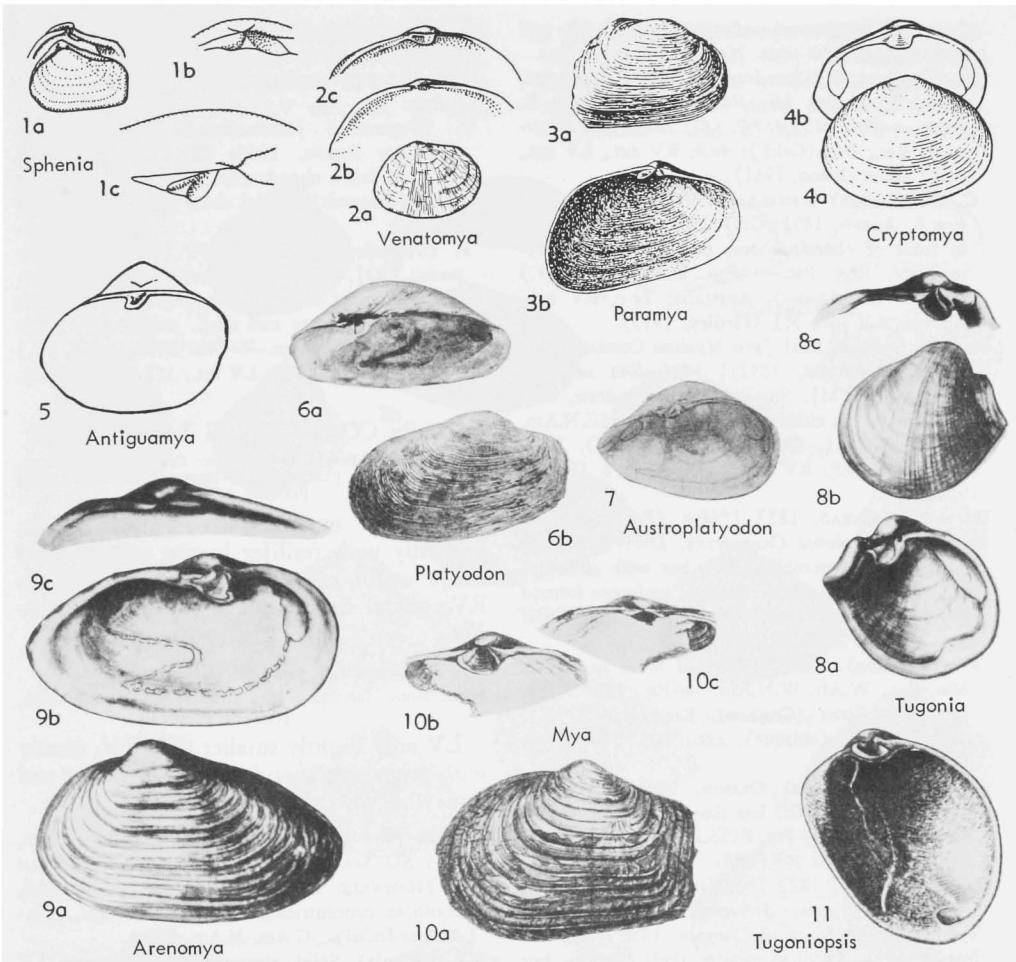


FIG. E153. Myidae (p. *N*691-*N*692).

Valves elongate or ovate, subequal, porcelaneous to chalky, with thin periostracum; hinge margin mostly without teeth; ligament mainly internal; valve margins smooth; pallial sinus, with some exceptions, well developed. *U.Jur.-Rec.*

Family MYIDAE Lamarck, 1809

[*nom. correct.* BRODERIP, 1839 (*pro* family Myacea GOLDFUSS, 1820) (=myaires LAMARCK, 1809)] [=Myacidae D'ORBIGNY, 1845]

Elongate, chalky, mostly burrowing forms with wide posterior gape; chondrophore present in LV. *Paleoc.-Rec.*

Mya LINNÉ, 1758 [**M. truncata;* SD CHILDREN, 1822 (ICZN Op. 94, Dir. 72)] [=*Hiatula* MODEER, 1793; SD WINCKWORTH, 1935 (obj.); *Myarius* DUMÉRIL, 1806 *(nom. van.); Myes,* AUCTT. *(nom. van.)*]. Of medium size, chondrophore in LV large; sculpture of concentric growth lines. *Oligo.-Rec.,* Eu.-N.Am.-Japan.

M. (Mya). Chondrophore with triangular anterior portion in front of anterior ridge. *Oligo.-Rec.,* Eu.-N.Am.-Japan.——FIG. E153,*10.* **M. (M.) truncata* LINNÉ, Rec., Eng.; *10a-c,* LV ext., LV and RV hinges, ×1 (Jeffreys).

M. (Arenomya) WINCKWORTH, 1930 [**M. arenaria* LINNÉ, 1758; OD]. Chondrophore bounded anteriorly by ridge; posterior end of shell elongate-ovate. *Mio.-Rec.,* Eu.-N.Am.-Japan.——FIG. E153, *9.* **M. (A.) arenaria* LINNÉ, Rec., N.Atl.; *9a-c,* LV ext., int., RV hinge, ×0.5 (H. Adams & A. Adams).

Cryptomya CONRAD, 1848 [**Sphaenia californica* CONRAD, 1837; M]. Hinge as in *Mya,* shell narrowly gaping, somewhat compressed; chondro-

phore in RV appressed under beaks; shell thin and nearly smooth. *Mio.-Rec.*, N.Am.-S.Am.-Asia-Pac.

C. (Cryptomya). Chondrophore smooth in front; pallial line entire. *Mio.-Rec.*, W.N.Am.-S.Am.-E. Asia.——Fig. E153,*4*. **C. (C.) californica* (Conrad), Rec., USA(Calif.); *4a,b*, RV ext., LV int., ×0.7 (after Olsson, 1961).

C. (Venatomya) Iredale, 1930 [**Sphaenia elliptica* A. Adams, 1851; OD]. Hinge with small *2a* in front of chondrophore; pallial sinus of varying size. *Rec.*, Pac.——Fig. E153,*2*. **C. (V.) elliptica* (A. Adams), Australia; *2a-c*, RV ext., RV int., LV int., ×1 (Hedley, 1913).

Paramya Conrad, 1861 [*pro Myalina* Conrad, 1845 (*non* de Koninck, 1842)] [**Myalina subovata* Conrad, 1845; M]. Small, smooth, quadrate, with chondrophore in either valve. *Mio.-Rec.*, SE.N.Am. ——Fig. E153,*3*. **P. subovata* (Conrad), Mio., USA(Va.); *3a,b*, RV ext., LV int., ×5 (Glenn, 1904).

Platyodon Conrad, 1837 [**Mya (P.) cancellata;* M] [=*Cryptodonta* Carpenter, 1864 (obj.) (in synonymy)]. Resembling *Mya* but with chondrophore smaller and with concentric sculpture formed by raised growth striae; pallial sinus large and deep. *Mio.-Rec.*, Afr.-N.Am.-S.Am.

P. (Platyodon). Shell 30 mm. or more in length. *Mio.-Rec.*, W.Afr.-W.N.Am.——Fig. E153,*6*. **P. (P.) cancellatus* (Conrad), Rec., USA(Calif.); *6a,b*, LV int. (oblique), ext., ×0.5 (Grant & Gale).

P. (Austroplatyodon) Olsson, 1961 [**P. (A.) australis;* OD]. Shell less than 6 mm. in length. *Rec.*, W.S.Am.——Fig. E153,*7*. **P. (A.) australis*, Ecuador; LV int., ×5 *(688)*.

Sphenia Turton, 1822 [**S. binghami;* SD Gray, 1847] [=*Sphaena, Sphaenia,* spelling errors; *Tyleria* H. Adams & A. Adams, 1854 (type, *T. fragilis;* M)]. Small to minute, shell quadrate but apt to be distorted by nestling habit; pallial sinus small to large. *Paleoc.-Rec.*, Eu.-N.Am.-E.Asia.—— Fig. E153,*1*. **S. binghami*, Rec.; Eng.; *1a*, LV and RV hinge; ×1 (Woodward); *1b,c*, RV and LV hinges, ×4, ×6 (Lamy).

Tugonia Récluz, 1846 [**Mya anatina* Gmelin, 1791 (*ex* "Le Tugon" Adanson, 1757); SD Gray, 1847] [=*Tagonia,* spelling error]. Globose, gaping posteriorly; posterior area set off by constriction; chondrophores subequal; pallial sinus shallow. *Eoc.-Rec.*, Eu.-N.Am.-IndoPac.-Asia-Australia.

T. (Tugonia). Sculpture reticulate; shell of moderate size. *Oligo.-Rec.*, Eu.-IndoPac.——Fig. E153,*8*. **T. (T.) anatina* (Gmelin), Rec., W. Afr.; *8a-c*, LV int., ext., RV hinge, ×1 (H. Adams & A. Adams).

T. (Antiguamya) Effinger, 1938 [**Saxicava arnoldi* Dickerson, 1917; OD]. Umbonal grooves marked, posterior area sharply set off, larger than in *T. (Tugonia)*. *Eoc.-L.Oligo.*, W.N.Am.—— Fig. E153,*5*. **T. (A.) arnoldi* (Dickerson), Oligo., USA(Ore.); LV int., ×1.5 (Effinger).

T. (Distugonia) Iredale, 1936 [**D. inopinata;* OD]. Sculpture weak, of concentric growth lines; posterior area small, attenuated. *Rec.*, Australia-E.Asia.

T. (Tugonella) Jousseaume, 1891 [**Tugonia divaricata* Reeve, 1863; M]. Inflated, small, sculpture faint; chondrophore in RV smaller than in *T. (Tugonia);* pallial sinus small. *Rec.*, Indo-Pac.

T. (Tugoniopsis) Dall, 1898 [**T. (T.) compacta;* OD]. Small to minute, short, chondrophore in front of dentiform projection; posterior adductor scar large and deep; pallial sinus moderate. *Mio.*, SE.N.Am.——Fig. E153,*11*. **T. (T.) compacta*, USA(Fla.); LV int., ×3 (Dall, 1898).

Family CORBULIDAE Lamarck, 1818

[*nom. correct.* Broderip, 1839 (*ex* Corbulidées Lamarck, 1818, vernac.)] [=Corbularia Gray, 1823; Corbuladae Fleming, 1828]

Small to moderate-sized sturdy shells, normally with resilifer in one valve; valves inequilateral, LV tending to be smaller than RV; pallial sinus small to wanting. *U.Jur.-Rec.*

Subfamily CORBULINAE Gray, 1823

[*nom. transl.* Stoliczka, 1870 (*ex* family Corbularia Gray, 1823)]

LV only slightly smaller than RV, mostly with projecting chondrophore; posterior end somewhat rostrate. *U.Jur.-Rec.*

Corbula Bruguière, 1797 [**C. sulcata* Lamarck, 1801; SD Schmidt, 1818] [=*Aloidis* Megerle von Mühlfeld, 1811 (obj.)]. Moderately inflated, smooth to concentrically ribbed. *Cret.- Rec.*, Afr.-Eu.-Asia-IndoPac.-C.Am.-N.Am.-S.Am.

C. (Corbula). Solid, strongly ribbed, rostrate, LV without projecting chondrophore but with posterior cardinal tooth and ligamental pit, RV with posterior lateral. *Rec.*, W.Afr.——Fig. E154,*5*. **C. (C.) sulcata* Lamarck, Senegal; *5a*, RV ext., ×1; *5b*, LV ext., ×1; *5c,d*, RV int., LV int., ×1 *(944)*.

C. (Anisocorbula) Iredale, 1930 [**Corbula macgillivrayi* Smith, 1885; OD]. Elongate-quadrate, with sharp umbonal keel, ventral margin sinuous; pallial sinus obsolete. *Rec.*, IndoPac.——Fig. E154,*8*. **C. (A.) macgillivrayi* Smith, New Guinea; *8a,b*, RV int., ext., ×1 *(944)*.

C. (Bicorbula) Fischer, 1887 [**C. gallica* Lamarck, 1801; M]. Large, inequivalved, keel obsolescent; sculpture weak; pallial sinus broad and shallow. *Paleoc.-Rec.*, Eu.-Afr.-Asia.——Fig. E154,*10*. **C. (B.) gallica* Lamarck, Eoc., France; *10a-e*, RV ext., int., dorsal, LV ext., int., ×1 *(944)*.

C. (Bothrocorbula) Gabb, 1873 [**C. viminea* Guppy, 1866; M]. Moderately large, thick, sculpture of concentric waves and sparse radial threads;

ligamental pit broad in RV, one small dentiform projection and deep lunular pit in LV. *Mio.*, E.C. Am.-W.Indies.——Fig. E154,7. **C. (B.) viminea* Guppy, Jamaica; *7a-c*, LV ext., int., RV int., ×1.5 *(944)*.

C. (Caryocorbula) Gardner, 1926 [**Corbula alabamiensis* Lea, 1833; OD]. Subquadrate, both valves acutely keeled posteriorly, concentrically rugose; pallial sinus short. *Eoc.-Rec.*, N.Am.-S. Am.-E.Asia.——Fig. E154,2. **C. (C.) alabami-*

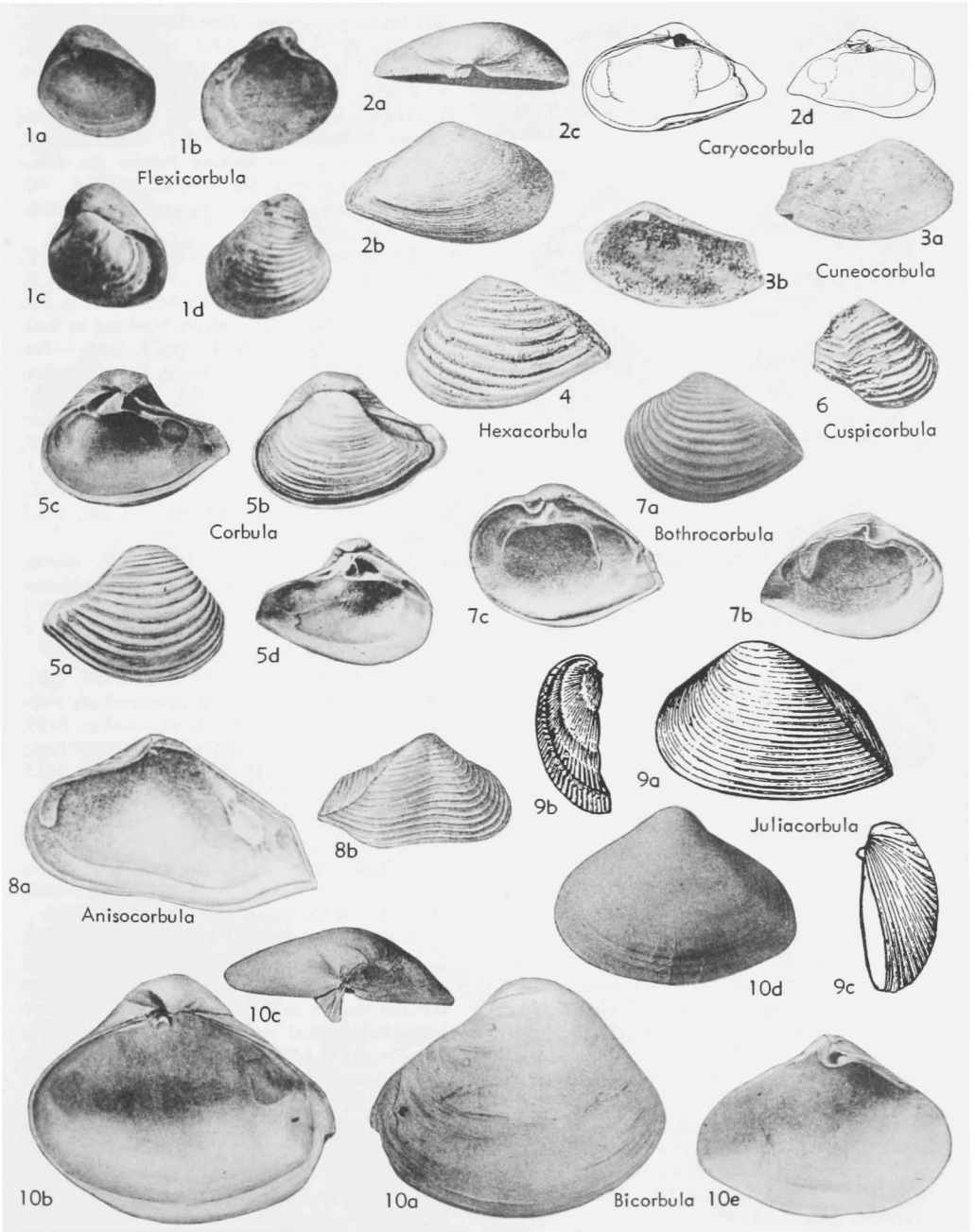


Fig. E154. Corbulidae (Corbulinae) (p. *N692-N694*).

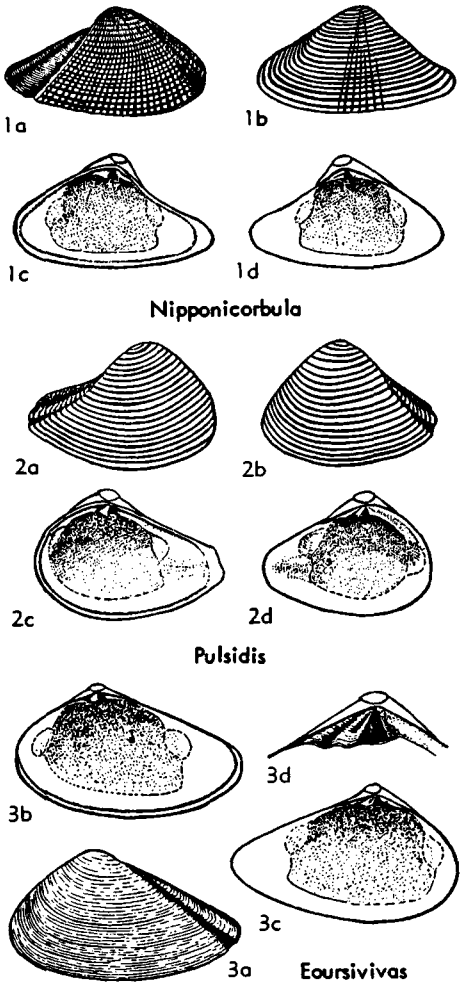


FIG. E155. Corbulidae (Corbulinae) (p. *N*694).

ensis LEA, Eoc., USA(Ala.); *2a,b,* LV dorsal, RV ext., ×1.5 *(944); 2c,d,* RV int., LV int., ×1 *(944;* Stenzel *et al.,* 1957).

C. (Cuneocorbula) COSSMANN, 1886 [**Corbula biangulata* DESHAYES, 1857; SD DALL, 1898]. Small, thin, birostrate, concentric sculpture weak, valves subequal; pallial sinus small. *Eoc.,* Eu.-N.Am.——FIG. E154,*3.* **C. (C.) biangulata* DESHAYES, France; *3a,b,* RV ext., int., ×2.5 *(944).*

C. (Cuspicorbula) OLSSON, 1928 [**Corbula busera;* OD]. Solid, inflated, coarsely sculptured, posterior end contracted and set off by deep sinus. *Eoc.,* S.Am.——FIG. E154,*6.* **C. (C.) busera* OLSSON, Peru; RV ext., ×1.5 *(944).*

?C. (Eoursivivas) OTA, 1964 [**C. matsumotoi* HABE, 1960; OD]. Hinge lacking dorsolateral ridge on chondrophore. *Cret.(L.Neocom.),* Japan. ——FIG. E155,*3.* **C. (E.) matsumotoi* HABE, Kumamoto Pref.; *3a-d,* LV ext., RV int., LV int., hinge, ×1.5 (Ota, 1964).

C. (Flexicorbula) CHAVAN, 1947 [**Varicorbula (F.) vokesi;* OD]. Resembling *C. (Varicorbula)* but beaks prosogyrate. *Cret.(Campan.),* W.Asia. ——FIG. E154,*1.* **C. (F.) vokesi* (CHAVAN), Palestine; *1a-d,* RV int., LV int., both valves (LV view), RV ext., ×1.5 *(105).*

C. (Hexacorbula) OLSSON, 1932 [**C. hexacyma* BROWN & PILSBRY, 1913; OD]. Resembling *C. (Bothrocorbula)* but lacking lunular pit. *Mio.-Rec.,* E.C.Am.-W.C.Am.——FIG. E154,*4.* **C. (H.) hexacyma* BROWN & PILSBRY, Mio., E.Panama; LV ext., ×3 *(944).*

C. (Juliacorbula) OLSSON & HARBISON, 1953 [**C. cubaniana* D'ORBIGNY, 1853 (=*C. knoxiana* C. B. ADAMS, 1852); OD]. Valves solid, similar in size and shape, rectangular, rostrum bordered by keel. *Mio.-Rec.,* E. C. Am.-W. C. Am.-S. Am.——FIG. E154,*9.* **C. (J.) knoxiana* ADAMS, Rec., W.Indies; *9a-c,* LV ext., post., ant., ×2.5 (Dall, 1889).

?C. (Nipponicorbula) OTA, 1964 [**N. mifunensis;* OD]. Sculpture discrepant, cancellate in RV, concentric in LV. *U.Cret.,* Japan.——FIG. E155,*1.* **C. (N.) mifunensis* (OTA), Kumamoto Pref.; *1a-d,* RV ext., LV ext., RV int., LV int., ×2.5 (Ota, 1964).

C. (Notocorbula) IREDALE, 1930 [**N. vicaria;* OD]. Large, chondrophore bipartite; adductor scars large. *Rec.,* Pac.——FIG. E156,*1.* **C. (N.) vicaria* (IREDALE), Australia; *1a-c,* RV ext., LV ext., RV int., ×1 *(944).*

?C. (Pulsidis) OTA, 1964 [**P. nagatoensis;* OD]. Resembling *Caryocorbula* but chondrophore without median ridge. *L.Cret.,* Japan.——FIG. E155, *2.* **C. (P.) nagatoensis* (OTA), Yamaguchi Pref.; *2a-d,* RV ext., LV ext., RV int., LV int., ×2.5 (Ota, 1964).

C. (Serracorbula) OLSSON, 1961 [**S. tumaca;* OD]. Solid, heavy, subequivalve, convex, ventral margin evenly serrate; adductor scars large. *Rec.,* W.C.Am.-S.Am.——FIG. E156,*4.* **C. (S.) tumaca* (OLSSON), W.Colombia; LV int., ×2.2 *(688).*

C. (Solidicorbula) HABE, 1949 [**C. erythrodon* LAMARCK, 1818; OD]. Heavy, convex, solid; LV with knob at posterior end; chondrophore in LV and resilifer in RV divided by ridge; muscle scars deep, pallial sinus wanting. *Rec.,* W.Pac. ——FIG. E157,*1.* **C. (S.) erythrodon* LAMARCK, Japan; *1a-c,* LV ext., RV int., LV int., ×1 (Habe, 1949).

C. (Tenuicorbula) OLSSON, 1932 [**C. tenuis* SOWERBY, 1833; OD]. Thin, subequilateral, posterior end set off by keel; sculpture strong, of concentric threads. *Mio.-Rec.,* E.C.Am.-W.C.Am.-W.S.Am.——FIG. E156,*3.* **C. (T.) tenuis* SOWERBY, Rec., W.Colom.; *3a,b,* LV ext., RV dorsal, ×1 *(688).*

C. (Varicorbula) GRANT & GALE, 1931 [**Tellina gibba* OLIVI, 1792; OD] [=*Corbula* AUCTT. (*non* BRUGUIÈRE)]. Small, sculpture discrepant, RV with concentric ribbing, LV with faint radials and concentric growth striae; pallial sinus small or wanting. *L.Eoc.-Rec.*, E.N.Am.-Eu.-E.Pac.-W. Pac.——FIG. E156,*8*. **C. (V.) gibba* (OLIVI), Rec., Eng.; *8a-d*, RV ext., int., LV int., both valves (LV view), ×2 *(944)*.

C. (Vokesula) STENZEL & TWINING in STENZEL,

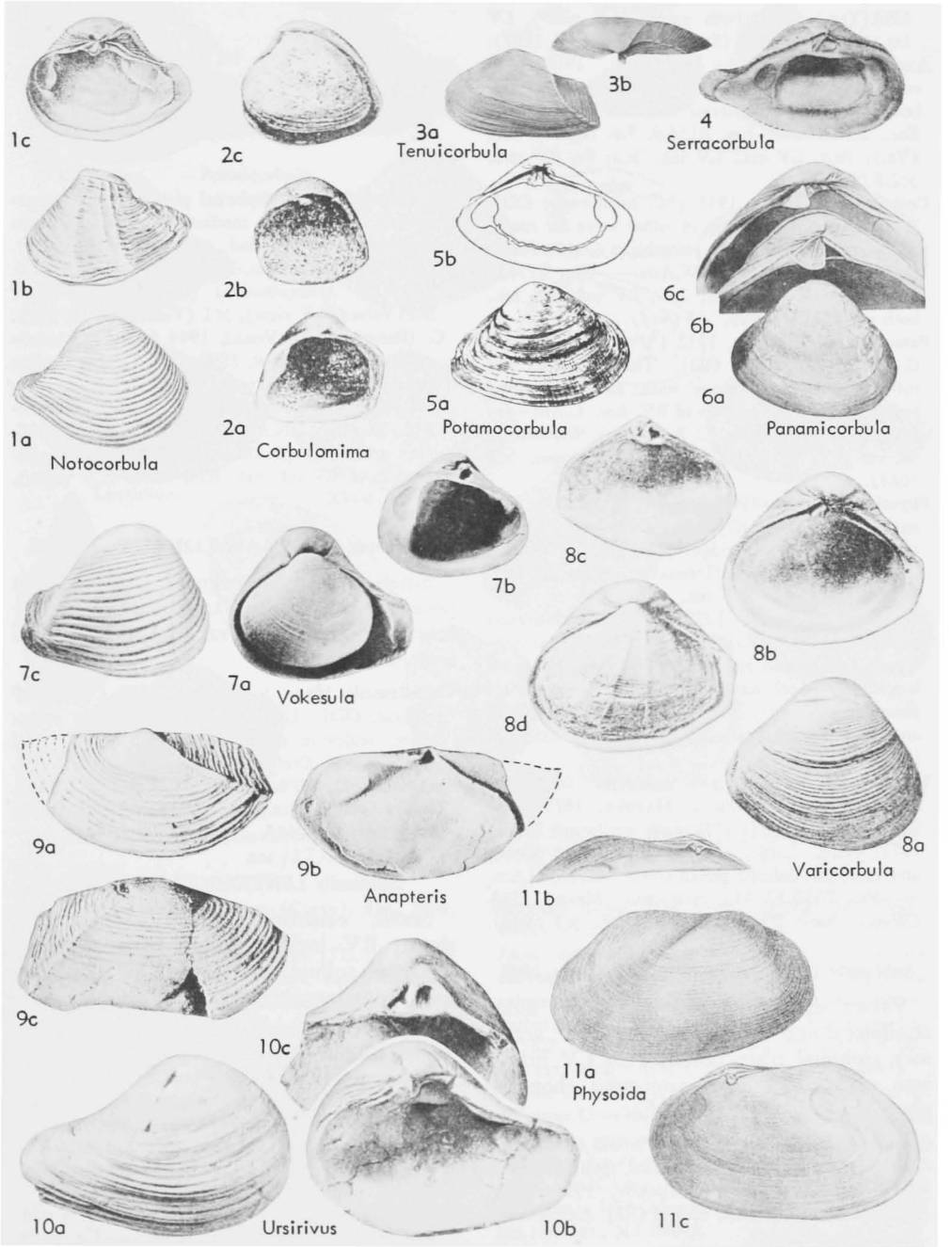


FIG. E156. Corbulidae (Corbulinae) (p. *N694-N696*).

KRAUSE & TWINING, 1957 [**C. aldrichi* MEYER, 1885, var. *smithvillensis* HARRIS, 1895; OD]. Inflated, valves discrepant, RV larger, concentrically ribbed, LV nearly smooth; pallial sinus small, nearly vertical. *L.Eoc.-L.Oligo.*, E.N.Am.——FIG. E156,*7*. **C. (V.) smithvillensis* HARRIS, M.Eoc., USA(Tex.); *7a-c*, both valves (LV view), LV int., RV ext., ×2.5 (Stenzel & Twining, 1957).

Anapteris VAN WINKLE [PALMER], 1919 [**A. regalis*; M]. LV with winglike flare anteriorly; both valves with posterior area set off by keel. *Eoc.*, E.N.Am.——FIG. E156,*9*. **A. regalis*, USA (Va.); *9a,b*, LV ext., LV int., ×3; *9c*, RV ext., ×2.8 *(944)*.

Corbulomima VOKES, 1945 [**C. nuciformis*; OD]. Without special structures in either valve for reception of resilifer, otherwise resembling *C. (Corbula)*. *U.Jur.-L.Cret.(Apt.)*, Eu.-W.Asia.——FIG. E156,*2*. **C. nuciformis*, Lebanon; *2a-c*, LV int., RV int., both valves (LV view), ×2 *(944)*.

Panamicorbula PILSBRY, 1932 [**Potamomya inflata* C. B. ADAMS, 1852; OD]. Thin, inflated, not rostrate posteriorly; hinge with toothlike lateral buttresses to dorsal grooves of RV. *Rec.*, C.Am.——FIG. E156,*6*. **P. inflata* (C. B. ADAMS), W.Panama; *6a*, ext. RV, ×1; *6b,c*, LV and RV hinges, ×2 *(688)*.

Physoida PALLARY, 1900 [**Corbula physoides* DESHAYES, 1845-48; OD]. Small, smooth, fragile, with low umbonal ridge. *Rec.*, N.Afr.——FIG. E156,*11*. **P. physoides* (DESHAYES), Algeria; *11a-c*, RV ext., LV hinge, RV int., ×3 *(944)*.

Potamocorbula HABE, 1955 [**Corbula amurensis* SCHRENCK, 1867; OD]. Hinge of RV with strongly projecting tooth in front of deep pit; LV with longitudinal keel on chondrophore; periostracum present, thick. *Rec.*, NE.Asia.——FIG. E156,*5*. **P. amurensis* (SCHRENCK), Korea; *5a,b*, RV ext., LV int., ×1 (Habe, 1955).

Ursirivus VOKES, 1945 [*nom. subst. pro Anisorhynchus* CONRAD in MEEK & HAYDEN, 1871 (*non* SCHOENHERR, 1842)] [**Corbula pyriformis* MEEK, 1871; OD]. Large, pyriform, with deep lunule and small but definite pallial sinus. *U.Cret.*, N.Am.——FIG. E156,*10*. **U. pyriformis* (MEEK), USA (Wyo.); *10a-c*, RV ext., int., LV int., ×1 *(944)*.

Subfamily CAESTOCORBULINAE Vokes, 1945

Valves discrepant in shape, LV more equilateral and less rostrate than RV; accessory siphonal plate posterior to LV fitting into rostrum of RV; projecting chondrophore of hinge of LV. *Cret.-Eoc.*

Caestocorbula VINCENT, 1910 [**Corbula henckeliusiana* NYST, 1836 (as *C. henckeliusi*, spelling error); OD] [=*Ficusocorbula* KOROBKOV, 1954 (type, *Corbula ficus* SOLANDER, 1766); OD]. *L.Cret.-Eoc.*, Eu.-N.Am.-Asia-Afr.

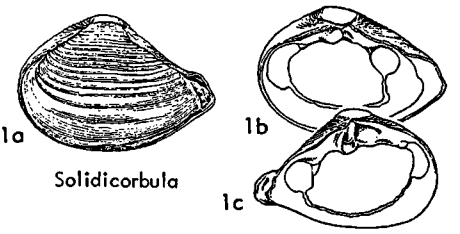


FIG. E157. Corbulidae (Corbulinae) (p. *N694*, *N696*).

C. (Caestocorbula). Siphonal plate obliquely trapezoidal, with distinct median ridge; pallial sinus well developed, broad and rounded. *L.Cret. (Apt.)-Eoc.*, E.N.Am.-Eu.-Asia.——FIG. E158,*6*. **C. (C.) henckeliusiana* (NYST), Eoc., Belg.; both valves (LV view), ×1 (Vincent, 1910; *944*).

C. (Parmicorbula) VOKES, 1944 [**Corbula neaeroides* BLANCKENHORN, 1890; OD]. Siphonal plate small, rectangular, with faint median groove; otherwise resembling *C. (Caestocorbula)*. *U.Cret.-Eoc.*, Eu.-Asia-E.N.Am.-Afr.——FIG. E158,*3*. **C. (P.) neaeroides* (BLANCKENHORN), U.Cret., Lebanon; *3a-d*, RV int., ext., both valves (LV views), ×1.5 *(944)*.

Subfamily CORBULAMELLINAE Vokes, 1945

Small, valves subtrigonal, lacking both posterior rostrum and umbonal ridge. Posterior adductor on raised, spoon-shaped lamella. *Cret.*

Corbulamella MEEK & HAYDEN, 1857 [**Corbula? gregaria*; OD]. Umbones inflated, slightly prosogyrate; sculpture of fine concentric lines; pallial sinus shallow. *Cret.*, N.Am.——FIG. E158,*1*. **C. gregaria* (MEEK & HAYDEN), U.Cret., USA(S. Dak.); *1a-d*, RV int., ext., both valves (LV view), ant. view, ×5 *(944)*.

Subfamily LENTIDIINAE Vokes, 1945

Small, essentially tellinid in external shape, RV lacking hinge plate; cardinal tooth on subumbonal thickening that projects from interior of valve. *Paleoc.-Rec.*

Lentidium CRISTOFORI & JAN, 1832 [genus without named species] [**L. maculatum* (=**Tellina mediterranea* COSTA, 1829); SM] [=*Corbulomya* NYST, 1844 (type, *Corbula complanata* SOWERBY, 1822; SD HERRMANNSEN, 1847)]. Shell thin, chondrophore projecting; muscle scars small and impressed, pallial sinus broad and shallow. *Paleoc.-Rec.*, Eu.-Asia-Atl.-Medit.

L. (Lentidium). Beaks central or posterior to midline. *Paleoc.-Rec.*, Eu.-E.Atl.-Medit.——FIG. E158,

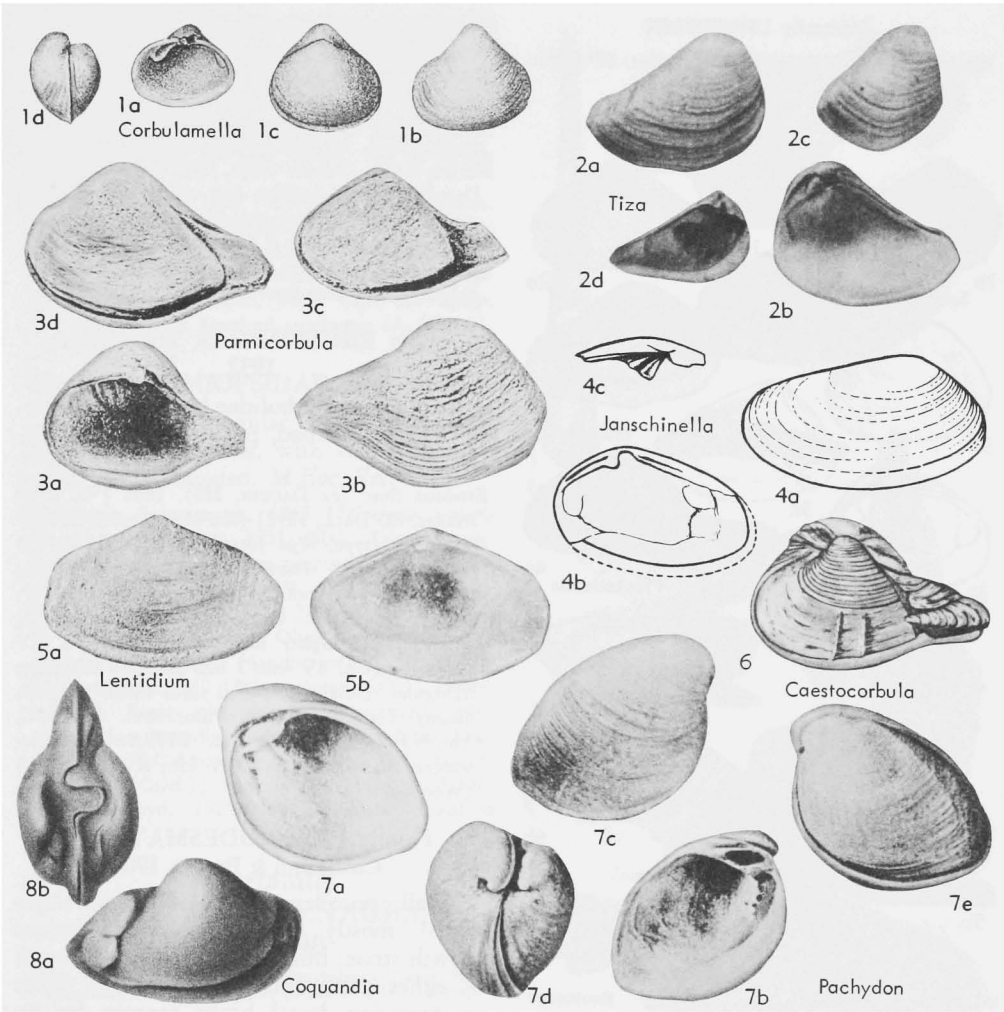


FIG. E158. Corbulidae (Caestocorbulinae) *(3,6)*, (Corbulamellinae) *(1)*, (Lentidiinae) *(4-5)*, Pachydontinae *(2,7)*, Subfamily Uncertain *(8)* (p. *N*696-*N*698).

*5. *L. (L.) mediterraneum* (COSTA), Rec., Italy; *5a,b*, RV ext., int., ×4 *(944)*.

L. (Janschinella) MERKLIN, 1961 [**L. (J.) garetzkii;* OD]. Anterior end short, beaks well forward of mid-line. *M.Oligo-L.Mio.*, C.Asia-W.Eu. ——FIG. E158,*4*. **L. (J.) garetzkii*, Oligo., USSR; *4a-c*, RV ext., int., LV hinge, ×2 (Merklin).

Subfamily PACHYDONTINAE Vokes, 1945

Valves tending to be twisted and distorted, ligamental area attaching resilium to lateral rather than dorsal face of resilifer. *Oligo.-Plio.*

Pachydon GABB, 1868 [**P. obliqua;* SD VOKES, 1944] [=*Anisothyris* CONRAD, 1871 (obj.); *Pachyodon, nom. van.*, MEEK, 1878 (*non* VON MEYER, 1838)]. Sculpture of weak concentric ridges; outline cordate, umbonal ridge narrow; pallial sinus broad, shallow. *Plio.*, S.Am.——FIG. E158,*7*. **P. obliquus*, Peru, *7a-e*, RV int., LV int., RV ext., both valves ant., LV view, ×2 *(944)*.

Tiza DE GREGORIO, 1890 [**Corbula? amara* (=**C. aliformis* CONRAD, 1885); M]. More quadrate than *Pachydon*, somewhat donaciform; pallial line angular at junction with posterior adductor scar. *Oligo.*, E.N.Am.——FIG. E158,*2*. **T. aliformis* (CONRAD), USA(Miss.); *2a-d*, RV ext., int., RV ext., LV int., ×1 *(944)*.

Subfamily UNCERTAIN

?Coquandia Seguenza, 1882 [**C. italica;* SD Keen, herein]. Relatively large, hinge with a *Mya*-like chondrophore, known only from internal molds; pallial line with a small sinus; shell not gaping. *U.Cret.(Cenoman.),* Eu.——Fig. E158,*8*. **C. italica,* Italy; *8a,b,* RV int. mold, both valves int. molds dorsal, ×0.7 (Seguenza, 1882).

Harlea, Raleta, Tomala Gray, 1842 *(nomina nuda).* Described as Corbulidae but without citation of species names. Unrecognizable from descriptions.

Semicorbula Cossmann & Peyrot, 1909 [**S. nadali;* OD]. *Oligo.(Aquitan.),* Eu. Based on single RV, indeterminate from figure.

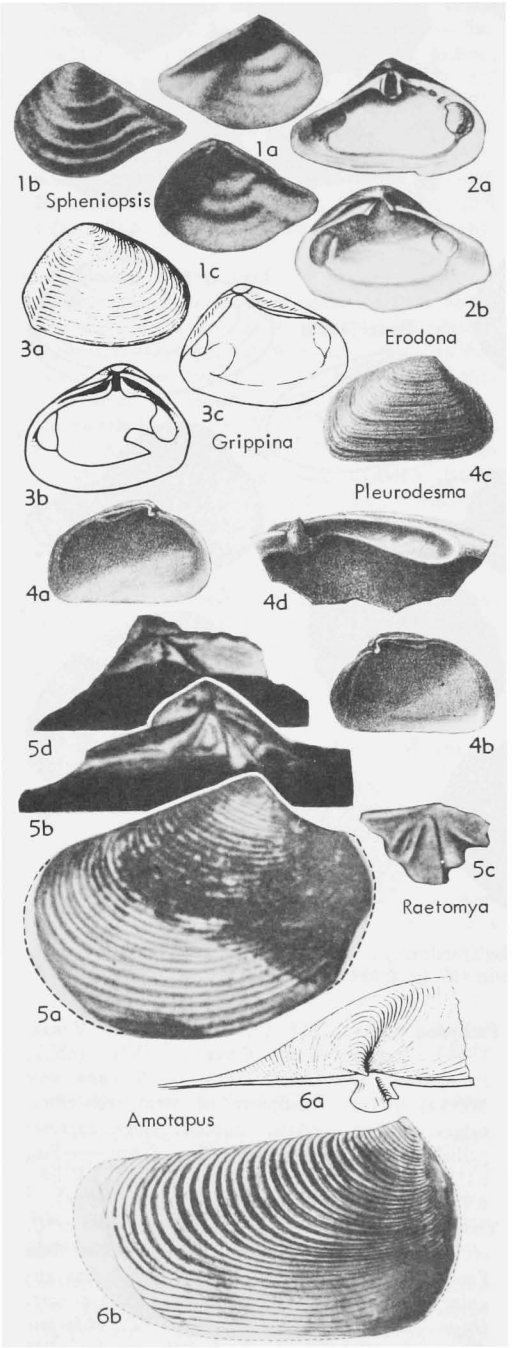


Fig. E159. Erodonidae *(2);* Pleurodesmatidae *(4),* Raetomyidae *(5-6);* Spheniopsidae *(1,3)* (p. *N*698-*N*699).

Family ERODONIDAE Winckworth, 1932

Resembling Corbulidae but with chondrophore of LV broad, projecting, as in *Mya*. *U.Eoc.-Rec.*

Erodona Bosc (*ex* Daudin, MS), 1801 [**E. mactroides;* SD Dall, 1898] [=*Potamomya* J. Sowerby, 1835 (type, *Mya plana* Sowerby, 1814; SD Keen, herein); *Azara* d'Orbigny, 1842 (obj.); *Phaenomya* Weaver & Palmer, 1922 (type, *P. vaderensis;* OD)]. Ovate-trapezoidal in outline; umbo of LV higher than RV; inequivalve, RV larger; hinge of RV with 2 thin cardinals bordering triangular resilial pit; pallial sinus small. [Habitat mainly brackish-water.] *U.Eoc.-Rec.,* N.Am.-C. Am.-N.Eu.-SE.S.Am.——Fig. E159,*2*. **E. mactroides,* Rec., Arg.; *2a,b,* LV int., RV int., ×0.6 (Woodward).

Family PLEURODESMATIDAE Cossmann & Peyrot, 1909

Small, porcelaneous, quadrate to trapezoidal, mostly smooth or with laminar growth striae; hinge with one cardinal tooth in either valve and long excavated cavity on posterior dorsal hinge margin for resilium; pallial line entire. *U.Oligo.-Mio.*

Pleurodesma Hörnes, 1859 [**P. mayeri;* M]. Beaks prosogyrate; resilifer bordered by low lamina below; muscle scars and pallial line inconspicuous. *U. Oligo.(Aquitan.)-Mio.(Burdigal.),* Eu.——Fig. E159,*4*. **P. mayeri,* Mio., Austria; *4a-c,* LV int., RV int., LV ext., ×1; *4d,* RV hinge, ×5 (after Hörnes, 1859).

Family RAETOMYIDAE Newton, 1919

[=Amotapidae Olsson, 1928]

Ovate, thin, sculptured with undulating concentric ribs, posteriorly compressed and gaping; hinge with large projecting chondrophore in LV, smaller sunken chondrophore in RV entering umbonal cavity vertically. Resembling mactrid group *Raeta* exteriorly but with myacean hinge. *Eoc.*

Raetomya NEWTON, 1919 [**Lovellia schweinfurthi* MAYER-EYMAR, 1887; OD]. Ovate-quadrate, chondrophore in LV 3-lobed. *Eoc.*, NE.Afr.-W.C.Afr. ——FIG. E159,*5*. **R. schweinfurthi* (MAYER-EYMAR), U.Eoc., Nigeria; *5a*, RV ext., ×0.5; *5b,c*, LV hinge, ×1; *5d*, RV hinge, ×1 (Newton, 1919).

Amotapus OLSSON, 1928 [**Perna arbolensis* WOODS, 1922; OD]. Elongate-ovate, posterior end short; chondrophore in LV rounded, not conspicuously lobed. *Eoc.*, W.S.Am.——FIG. E159,*6*. **A. arbolensis* (WOODS), M.Eoc., Peru; *6a,b*, LV hinge, RV ext., 0.5 (*6a*, Stanford specimen; *6b*, Olsson).

Family SPHENIOPSIDAE Gardner, 1928

Small, ovate-triangular, RV with 2 hinge teeth, LV edentulous, with resilial socket; pallial sinus rounded. *M.Eoc.-Rec.*

Spheniopsis SANDBERGER, 1863 [**Corbula scalaris* BRAUN in WALCHNER, 1851; OD]. Trigonal, posteriorly rostrate; smooth to concentrically undulate; anterior hinge tooth in RV triangular, posterior lamellar. *M.Eoc.-Mio.*, Eu.-E.N.Am.——FIG. E159, *1*. **S. scalaris* (BRAUN), Oligo., Aus.; *1a-c*, LV int., ext., RV int., ×5 (Sandberger).

Grippina DALL, 1912 [**G. californica;* OD]. Ovate-trigonal, finely concentrically sculptured, with radial ridges bounding lunule and escutcheon. *Rec.*, W.N.Am.-W.C.Am.——FIG. E159,*3*. **G. californica*, USA(Calif.); *3a-c*, RV ext., int., LV int., ×8 (Oldroyd, 1925, and specimen, Stanford Univ.).

Superfamily GASTROCHAENACEA Gray, 1840

[*nom. trans.* THIELE, 1934 (*ex* Gastrochaenidae GRAY, 1840)]
[Materials for this superfamily prepared by MYRA KEEN]

Burrowing shells, lying free within linear cavity; hinge edentate, valves broadly gaping, porcelaneous *(517)*. *U.Jur.-Rec.*

Family GASTROCHAENIDAE Gray, 1840

[*nom. correct.* ADAMS & ADAMS, 1856 (*pro* Gastrochaenadae GRAY, 1840)]

Characters of superfamily. *U.Jur.-Rec.*

Gastrochaena SPENGLER, 1783 [**G. cuneiformis;* SD CHILDREN, 1822] [=*Chaena* PHILIPSSON, 1788 (*ex* RETZIUS, MS) *(nom. van.); Rocellaria* DE BLAINVILLE, 1829 (type, *Gastrochaena modiolina* LAMARCK, 1818, =*Mya dubia* PENNANT, 1777, M); *Gastrochaenolites* LEYMERIE, 1842 *(nom. van.); Gastrochaenoecium, Gastrochaenites* BRONN, 1848 *(nom. van.); Cucurbitula* GOULD, 1861 (type, *Fistulana lagenula* LAMARCK, 1801, =*Gastrochaena cymbium* SPENGLER, 1783; M); *Dufoichaena* LAMY, 1925 (*ex* JOUSSEAUME, MS) (type, *Gastrochaena dentifera* DUFO, 1840; M)]. Cavity flask-shaped, in rock or shell; shell triangular to quadrate in outline. *?U.Jur., U.Cret.-Rec.*, N.Am.-W. Indies-Eu.-E.Indies.

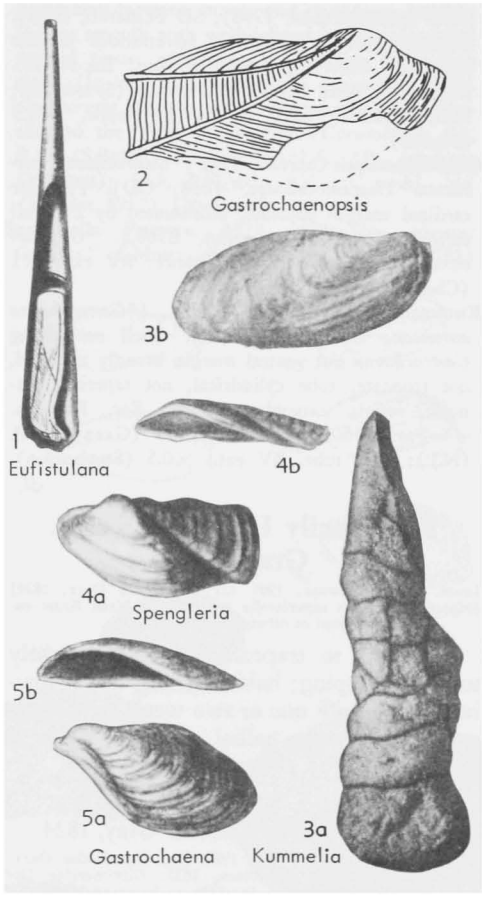


FIG. E160. Gastrochaenidae (p. *N699-N700*).

G. (Gastrochaena). Shell smooth or nearly so, oval, tube short, formed of successive increments. *?U.Jur., U.Cret.-Rec.*, N.Am.-Eu.-circumtrop.—— FIG. E160,*5*. **G. (G.) cuneiformis* SPENGLER, Rec., IndoPac.; *5a,b*, LV ext., ventral, ×1 (Reeve).

G. (Spengleria) TRYON, 1862 [**G. mytiloides* LAMARCK, 1818; SD STOLICZKA, 1871]. Valves divided by oblique furrow, posterior area with vertical striae. *Rec.*, E.Indies-W.Indies.——FIG. E160,*4*. **G. (S.) mytiloides* LAMARCK, E.Indies; *4a,b*, LV ext., ventral, ×1 (Reeve).

Eufistulana EAMES, 1951 [**Gastrochaena mumia* SPENGLER, 1783; OD] [=*Fistulana* BRUGUIÈRE,

1789 (*non* MÜLLER, 1776); SD FLEMING, 1818]. Elongate valves enclosed in adventitious tubular structure; widely gaping. *Eoc.-Rec.*, Eu.-N.Afr.-IndoPac.——FIG. E160,*1*. **E. mumia* (SPENGLER), Rec., E.Indies; both valves, LV view, ×0.5 (Fischer).

Gastrochaenopsis CHAVAN, 1952 [**Gastrochaena unicostata* DESLONGCHAMPS, 1838; OD]. Posterior cardinal margin patulous, accentuated by 2 dorsal carinae. *U.Jur.*, Eu.——FIG. E160,*2*. **G. unicostata* (DESLONGCHAMPS), France; RV ext., ×1 (Chavan).

Kummelia STEPHENSON, 1937 [**Gastrochaena americana* GABB, 1860; OD]. Shell resembling *Gastrochaena* but ventral margin broadly rounded, not truncate; tube cylindrical, not tapering, annular, rough, somewhat sinuous. *Eoc.*, E.N.Am. ——FIG. E160,*3*. **K. americana* (GABB), USA (N.J.); *3a,b*, tube, RV ext., ×0.5 (Stephenson).

Superfamily HIATELLACEA Gray, 1824

[*nom. transl.* NEWELL, 1965 (*ex* Hiatellidae GRAY, 1824] [Materials for this superfamily prepared by MYRA KEEN except as otherwise recorded]

Quadrate to trapezoidal, valves slightly to widely gaping; habit nestling or burrowing; hinge with one or two weak teeth, ligament on nymph; pallial sinus mostly well developed *(516)*. *Perm.-Rec.*

Family HIATELLIDAE Gray, 1824

[*nom. correct.* WINCKWORTH, 1932 (*pro* Hyatelladae GRAY, 1824)] [=Saxicavidae SWAINSON, 1835; Glycimeridae DESHAYES, 1839 (*nom. correct.* PETIT DE LA SAUSSAYE, 1869, *pro* Glycimeridées)]

Characters of superfamily. *Perm.-Rec.*

Hiatella Bosc (*ex* DAUDIN, MS), 1801 [**H. monoperta* (=*Mya arctica* LINNÉ, 1767); SD WINCKWORTH, 1932] [=*Saxicava* FLEURIAU DE BELLEVUE, 1802 (obj.), *Laxicava* CONRAD, 1855 *(nom. null.)*; *Haicana* SACCO, 1901 *(nom. null.)*; *Clotho* FAUJAS DE SAINT FOND, 1808 *(nom. dub.)*; *Didonta* SCHUMACHER, 1817 (obj.) (type, *Solen minutus* LINNÉ, 1767, =*Mya arctica;* M); *Byssonia* DE BLAINVILLE, 1817 (*ex* CUVIER, *vernac.*) (type, *Mytilus pholadis* LINNÉ, 1771), *Bissomya, Bissomyia, Byssomia, Byssomya,* spelling errors; *Biapholius* LAMARCK (*ex* LEACH, MS), 1818 (in synonymy of *Mytilus rugosus* LINNÉ, 1767); *Biapholus, Biopholeus* LEACH, 1847 *(nom. null.)*; *Pholeobia* LEACH, 1819 (type, *Mytilus rugosus* LINNÉ, 1767; M); *Agina* TURTON, 1822 (obj.; M); *Rhomboides* DE BLAINVILLE, 1824 (*non* GOLDFUSS, 1820); *Coramya* BROWN, 1844 (obj., in synonymy); *Spongyophylla* BRUSINA (*ex* NARDO, MS), 1866 (obj.; M). Small, trapezoidal, with thin periostracum; hinge teeth best developed in juvenile stages. *U.Jur.-Rec.*, Asia-Eu.-N.Am.

H. (Hiatella). Outline rendered irregular by nestling habit, in general with posterior end wider than anterior, gape small. *Oligo.-Rec.*, E.Asia-N.Am.-Eu.——FIG. E161,*1*. **H. (H.) arctica* (LINNÉ), Rec., France, *1a-d*, LV ext., int., RV int., ext., ×1 *(89a)*.

H. (Pseudosaxicava) CHAVAN, 1952 [**P. bernardi;* OD]. Hinge teeth weak, muscle scars elliptical. *U.Jur.*, Eu.——FIG. E161,*2*. **H. (P.) bernardi* (CHAVAN), France; *2a-c*, RV ext., int., LV int., ×2 (Chavan).

Capistrocardia TATE, 1887 [**C. fragilis;* OD]. Rounded quadrate to elliptical, with internal radial ridge; not gaping; hinge with 2 teeth in LV, none in RV; pallial sinus small or wanting. *Tert.*, Australia.——FIG. E161,*3*. **C. fragilis; 3a,b*, LV ext., int., ×2 (Tate).

Cyrtodaria REUSS, 1801 (*ex* DAUDIN, vernac.) [**Mya siliqua* SPENGLER, 1793; SD VOKES & COX, 1961] [=*Cyrtodera* DE BLAINVILLE, 1825 *(nom. null.)*; *Glycimeris* LAMARCK, 1801 (*non* LAMARCK, 1799)]. Elongate, with thick, dark periostracum; hinge with 2 teeth, nearly central; pallial sinus small, irregular. *Paleoc.-Rec.*, Eu.-Arctic.——FIG. E161,*10*. **C. siliqua* (SPENGLER), Rec., N.Atl.; *10a,b*, RV int. with LV hinge, RV ext., ×1 (H. Adams & A. Adams).

Panopea MENARD, 1807 (ICZN, pend.) [**P. faujasi* (=*Mya glycimeris* BORN, 1778); SD FLEMING, 1818] [=*Glycimeris* LAMARCK, 1799 (*non* DA COSTA, 1778); *Panope* MENARD, 1807 *(nom. null.)*; *Panodea* OKEN, 1817 *(nom. null.)*; *Panopaea* LAMARCK, 1818 *(nom. null.)*; *Myopsis* AGASSIZ, 1840 (type, *Mya mandibula* J. SOWERBY, 1813; SD COX, 1964); *Heteromya* MAYER, 1884 (type, *P. (H.) lessepsi;* M)]. Medium-sized to large, elongate, gaping, beaks subcentral; ligamental nymph large, high; pallial sinus wide. *?Trias., L.Cret.-Rec.*, Eu.-N.Am.-S.Pac.

P. (Panopea). Hinge with 1 small cardinal tooth in either valve. *?Trias., L.Cret.-Rec.*, Eu.-S.Pac.-N.Am.——FIG. E161,*7*. **P. (P.) glycimeris* (BORN), Rec., Medit.; *7a,b*, LV ext., RV hinge, ×0.5 *(124b)*.

P. (Degrangia) COSSMANN & PEYROT, 1909 [**Panopaea fischerina* MAYER, 1861; OD]. Resembling *P. (Panopea)* in outline and shape of ligamental nymph and pallial sinus but hinge with 2 strong cardinal teeth in either valve. *?Eoc., Mio.*, Eu. ——FIG. E161,*8*. **P. (D.) fischerina* (MAYER), Mio., France; *8a,b*, LV and RV hinges, ×3; *8c*, RV ext., LV int., ×1 (Mayer; Cossmann & Peyrot).

P. (Panomya) GRAY, 1857 [**Mya norvegica* SPENGLER, 1793 (not preoccupied by *M. norwegica* GMELIN, 1791); M] [=*Chaenopaea* MAYER, 1885 (obj.; OD)]. Smaller than *P.*

(Panopea), with median depressed area bordered by broadly rounded ridges; pallial line interrupted, forming series of oval scars. *?L.Cret. (Neocom.), Tert.-Rec.,* Eu.-N.Am.-Arctic.—FIG. E161,*9*. **P. (P.) norvegica* (SPENGLER), Rec., N.Atl.; *9a,b,* LV int. with RV hinge, LV ext., ×1 (H. Adams & A. Adams).

Roxoa MENDES, 1952, p. 103 [**Anoplophora intrigans* MENDES, 1944; OD]. Elongate, subelliptical, equivalve, compressed, with or without weak posterior umbonal fold; beaks prosogyre, small, situated well forward; lunule and escutcheon lacking; surface smooth with well-defined lateral sulcus and ventral sinus; edentulous; pallial line with deep sinus. [In view of CHAVAN, this genus is allied to *Cowperesia* MENDES and at least doubtfully assignable to the Tellinidae.]. *Perm.(Corumbatae F.),* S.Am.(S.Brazil).—FIG. E161,*5*. **R. intrigans* (MENDES); *5a,b,* RV ext., RV int. mold, ×1 (Mendes, 1952), [NEWELL]

Saxicavella FISCHER, 1878 [*"*Mytilus plicatus* GMELIN" of MONTAGU, 1808 (*non* GMELIN, 1791)

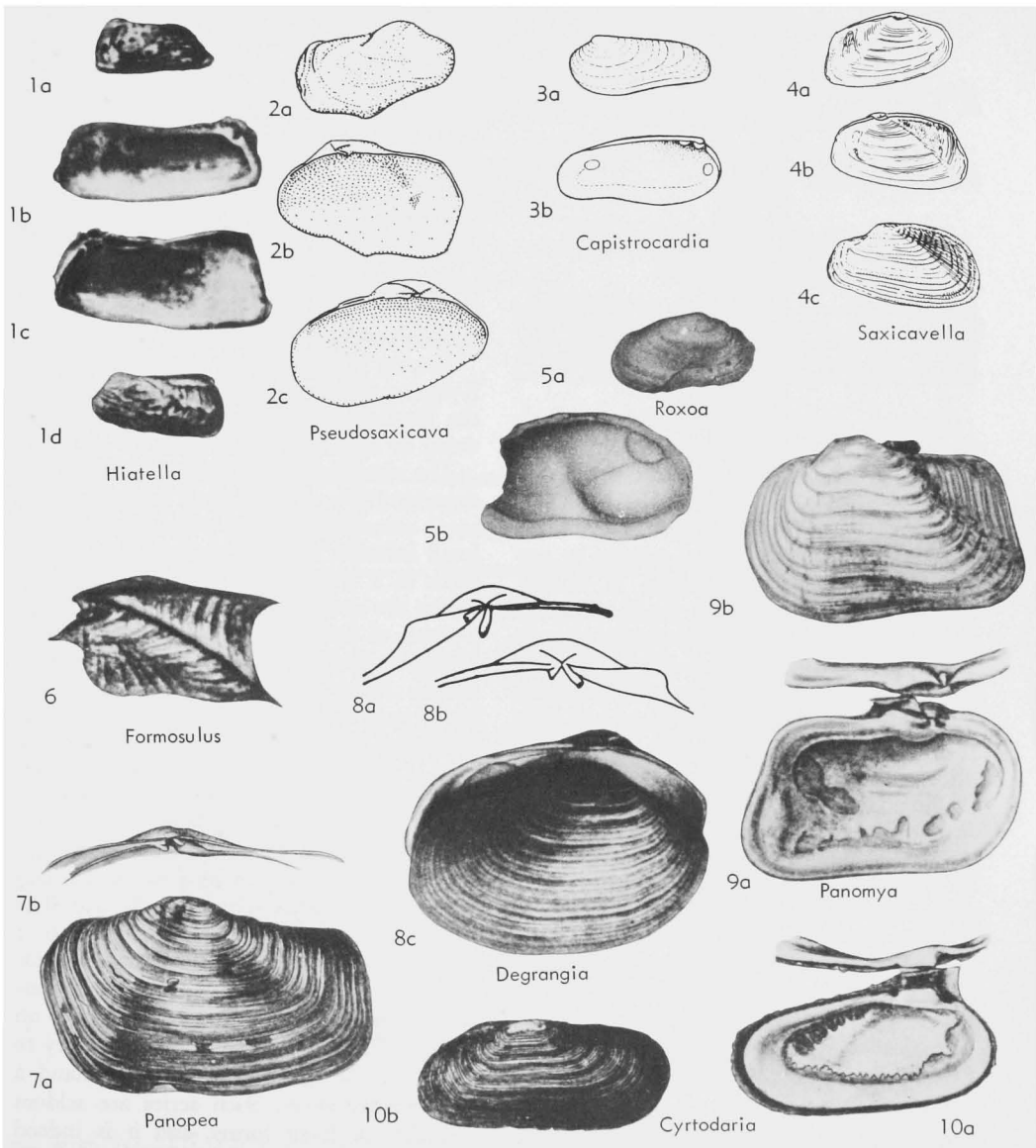


FIG. E161. Hiatellidae (p. *N*700-*N*702).

(=**S. jeffreysi* WINCKWORTH, 1930); M] [=*Arcinella* PHILIPPI, 1844 (*non* SCHUMACHER, 1817); *Arcinellina,* spelling error]. Thin, small, inequilateral, gaping, subtrapezoidal; hinge edentulous or with small conical cardinal in RV and socket in LV; ligament short, external; pallial line slightly sinuous, pallial sinus large but not deep. *U.Oligo.-Rec.,* Eu.-W.N.Am.——FIG. E161,*4*. **S. jeffreysi* WINCKWORTH, Rec., N.Atl.; *4a-c,* LV int., RV int., LV ext., ×3 (Jeffreys, 1865).

Suborder PHOLADINA H. Adams & A. Adams, 1858

[*nom. transl. et correct.* NEWELL, 1965 (*ex* order Pholadacea H. ADAMS & A. ADAMS, 1858)] [=Adesmacea AUCTT.] [Diagnosis by N. D. NEWELL]

Characters of superfamily Pholadacea. *?Carb., Jur.-Rec.*

Superfamily PHOLADACEA Lamarck, 1809

[*nom. transl. et correct.* VOKES, 1967, p. 326 (*ex* Pholadaires LAMARCK, 1809)] [=family Pholadaria RAFINESQUE, 1815; Adesmacea DE BLAINVILLE, 1825, p. 577; Cladopoda GRAY, 1847, p. 187] [Materials for this superfamily prepared by RUTH D. TURNER, Museum of Comparative Zoology, Harvard University]

Bivalves characterized by closed mantle and truncate, more or less circular foot developed as suction disc. Shells inequilateral, dorsal margin reflected anterior to beak, forming attachment area for anterior adductor muscle which works counter to posterior adductor when animal is boring. Hinge teeth lacking, but small chondrophore and internal ligament usually present. Ventral adductor muscle or at least thickening of muscles of ventral margin of mantle located at union of anterior slope and disc, forming pivotal point opposite umbones on which valves rock when boring. Gills usually elongate, with two demibranchs except in the Xylophagainae and Teredinidae. Apophyses found in all Pholadacea except in some Pholadidae (Jouannetiinae, Xylophagininae). [The Pholadidae are characterized by the presence of one or more accessory plates and the Teredinidae by the presence of pallets. In the Pholadidae the intestine traverses the heart, whereas in all Teredinidae, except Kuphinae, it does not.] *?Carb., Jur.-Rec.*

The Pholadacea is a highly specialized assemblage of bivalves adapted for boring into relatively hard substrata such as peat, wood, nuts, woody plant stems, stiff clays, soft or friable rocks, corals, and shells. Though most are marine, some species occur in brackish and even fresh water.

Semidiagrammatic sketches of the anatomy of the Pholadidae and Teredinidae given in Figure E162 show the relationship of the two families and will be referred to when defining some genera. As a result of close approximation of the anterior and posterior adductor muscles in the Teredinidae, it can be seen that the visceral mass has been extended posteriorly in a long loop, with the mouth and anus remaining in normal position, that the ventricle is anterior to the auricles, and that the kidney is dorsal to the heart. Recent work by TURNER on anatomy of the Teredinidae has shown some striking differences within the group which have necessitated the redefining of some genera and the reassignment of several species. It has also resulted in firm establishment of the subfamily Kuphinae.

Among living forms, the Teredinidae, Xylophagainae, and the genus *Martesia* of the Martesiinae are found normally only in wood or other plant materials.

The classification of living species in this superfamily is not difficult if complete specimens are available, but when dealing with fossil forms it is often impossible to assign them to a subfamily. The reason for this is that the shells may be deformed, either as a result of the material in which they were boring or as a result of processes of fossilization. Many fossil species and genera are based only on internal casts; in others the accessory plates are lacking, the siphonoplax is broken off, and the apophyses are usually imbedded so as not to be seen at all. Using only the outer surface of the valve, one finds it impossible definitely to distinguish some young *Jouannetia* from young *Xylophaga* or even some Teredinidae. The variation in size and shape of individuals of any one species of pholad or teredinid is extremely great, depending upon conditions under which the animal was living and on its age. Therefore, it is usually necessary to have large series in order to understand a species adequately. Such series are seldom available in fossil forms, and it is indeed seldom that a growth series, together with

complete adults showing characters of both the inner and outer surface of the valves, is found. It is little wonder, then, that the assignment of fossil genera to the well-defined subfamilies based on living species has been done either provisionally or not at all.

In assigning fossil genera to subfamilies, the substrata in which they were found and the depth of the burrows are of prime importance. In the fossilized state, valves of the young of some species of *Martesia, Xylophaga,* and the Teredinidae—all wood-borers—could be indistinguishable, but a

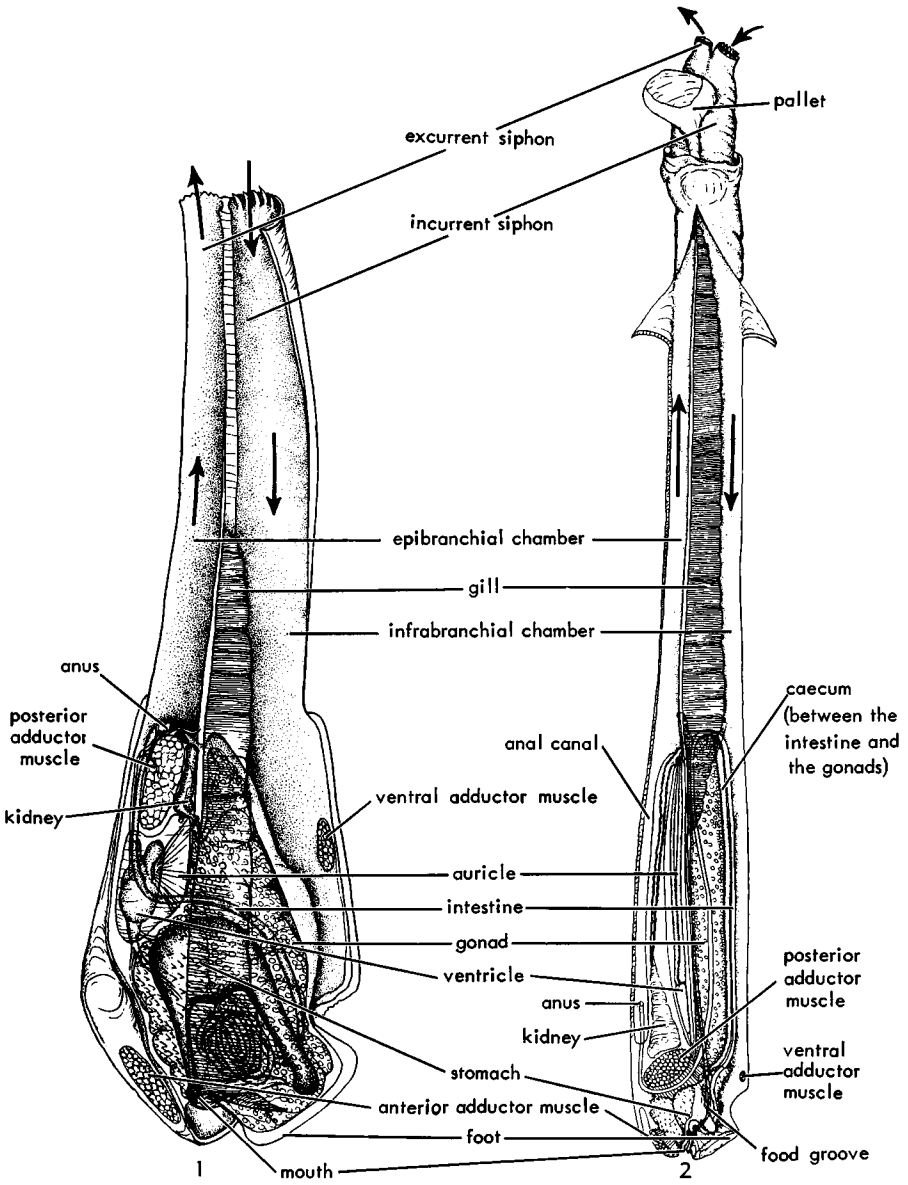


FIG. E162. Morphological features of Pholadidae *(1)* illustrated by semidiagrammatic drawing of soft parts of *Zirfaea crispata* LINNÉ with mantle partially cut away, *ca.* ×2. and of Teredinidae *(2)* by similar drawing of *Psiloteredo healdi* BARTSCH, *ca.* ×2.5 (Turner, 1965).

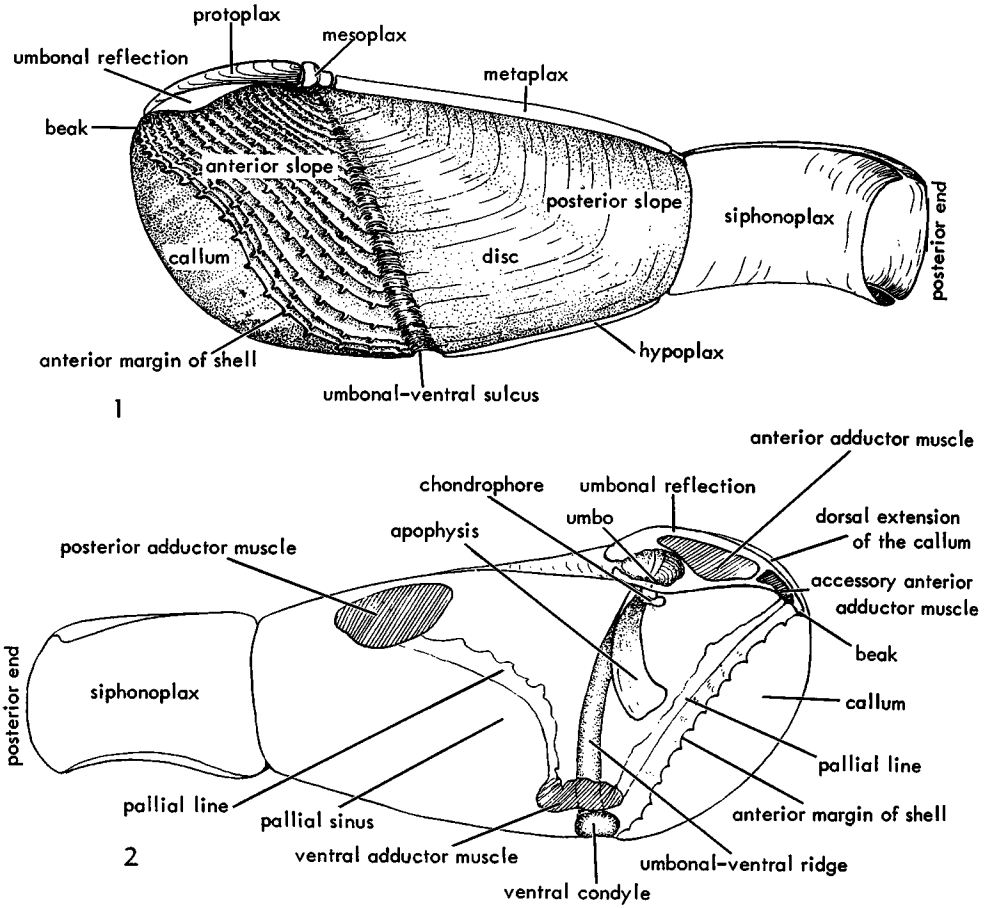


FIG. E163. Side views of LV (*1*, exterior, *2*, interior) of diagrammatic composite shell showing morphological features of Pholadidae *(921a)*.

Martesia burrow is only slightly longer than the shell, whereas *Xylophaga* may make burrows five to ten times the length of the shells, and the burrows of Teredinidae are long and wormlike (see footnote, p. *N*721).

The presence of an umbonal-ventral sulcus on the outer surface of the valve or the corresponding ridge on the inner surface immediately eliminates all Pholadinae except *Zirfaea,* which is a transition genus between this subfamily and the Martesiinae.

The presence of a callum immediately places a genus in the Martesiinae or Jouannetiinae. This is not always easy to determine, for after the animal dies the valves remain in place, though the accessory plates may move or disintegrate and the burrow is completely filled with silt. This filling protrudes beyond the valves and fills the anterior end of the burrow. When the entire mass is removed from the substratum, and particularly if it is an internal cast, the resulting specimen appears to have a callum. If a true callum is present, a central division should be evident, for the two halves of the callum do not fuse but are joined by a band of periostracum (in the case of the Martesiinae) or the line of overlap of the callum should be evident (e.g., *Jouannetia*). On the basis of such considerations the fossil genera have been placed in what seems to be the appropriate subfamily and the Recent genus to which they appear to be related is indicated.

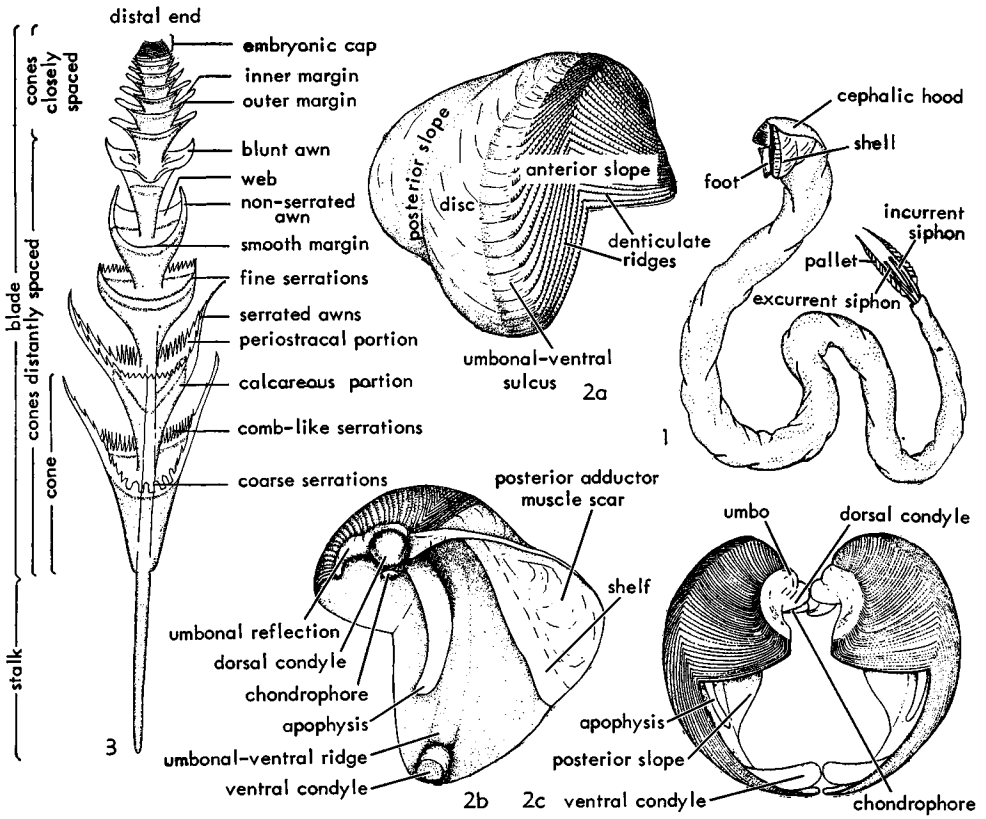


FIG. E164. Morphological features of Teredinidae.——*1, Bankia,* entire animal, *ca.* ×2.——*2,* Enlarged views of valves; *2a,* outer view of right valve; *2b,* inner view of right valve; *2c,* anterior view of opposed valves showing the condyles on which the valves rock and the pedal gape.——*3.* Composite diagrammatic sketch of a *Bankia* pallet showing all characters (923; Clench & Turner, 1946).

In view of the large number of specialized terms used in describing the Pholadacea, a glossary is included, along with diagrammatic sketches indicating the specialized characteristics (Fig. E163, E164).

Special Morphological Terms Used For Pholadacea

apophyses. Calcareous, styloid projections, one in each valve, extending from beneath umbo and serving for attachment of pedal muscles.

callum. Closure of pedal gape in the Martesiinae and Jouannetiinae. It may be partial or complete, entirely calcareous or composed partly of periostracum. Generally halves of callum do not quite meet and are joined by a periostracal fold with only a minute pore remaining open.

cephalic hood. Thickened fleshy fold of mantle covering umbonal area.

chimney. Tube of agglutinized particles produced as result of boring activities. It fits over posterior end of shell and in some species extends anteriorly nearly to umbos. [Occurs in *Parapholas* and *Xylophaga.*]

chondrophore. Projection of hinge area for support of internal ligament. Chondrophore of RV a small swelling with central depression, that of LV a small shelflike projection.

hypoplax. Long, narrow, ventral plate covering space between valves and joined to ventral margin of valves by periostracal fold.

mesoplax. Transverse plate, usually wider than long, which straddles valves at the umbos and protects posterior portion of anterior adductor muscle. It usually originates ventral to the muscle, is calcareous, and may be in one or two pieces.

metaplax. Long, narrow plate covering gap between valves on dorsal margin behind mesoplax and joined to valves by periostracal fold.

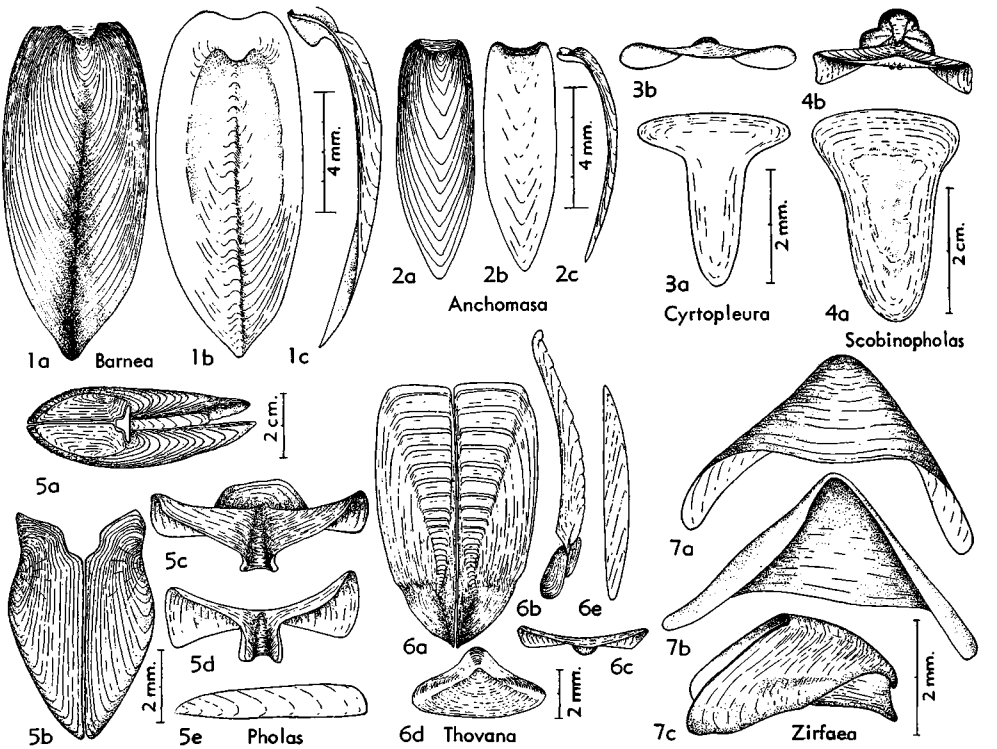


FIG. E165. Accessory plates of genera in Pholadinae (921a).

pallets. Pair of paddle-shaped, calcareous and periostracal organs located at base of siphons in Teredinidae and functioning to close entrance of burrow. They may be in one piece or composed of numerous elements.

protoplax. Simple, nearly flat, elongate dorsal plate which rests on top of anterior adductor muscle but does not enclose it. It may be calcareous or periostracal, in one piece, or divided longitudinally.

siphonal tube. Tube fused to siphonoplax and composed of secretions of mantle and agglutinized particles produced as result of boring. [Occurs in *Pholadidea.*]

siphonoplax. Accessory structure secreted by mantle and added to posterior end of valves in adult stage. It may be calcareous, periostracal, or combination of both, and may be variously formed.

Family PHOLADIDAE Lamarck, 1809

[*nom. correct.* VOKES, 1967, p. 326 (*pro* family *Pholadaires* LAMARCK, 1809, p. 319)] [=*Pholadaria* RAFINESQUE, 1815, p. 146; *Pholadariae* LATREILLE, 1825, p. 223; Pholadae FLEMING, 1828, p. 410, 456; *Pholadidae* GRAY, 1847, p. 20; *Pholadoidae* AGASSIZ, 1847, p. 286; *Pholidae* SWAINSON, 1835, p. 30; *Pholadeae* MENKE, 1828, p. 73]

Shells elongate to globular, with slitlike to nearly circular pedal gape which may or may not be closed by callum in adult; anterior portion of valves with imbricate or denticulate concentric ridges and commonly ribbed radially; umbonal-ventral sulcus may separate anterior slope from disc; posterior slope not generally demarked, but clearly defined in *Parapholas;* accessory plates present in all forms but varying in number. Dorsal and ventral condyles and internal umbonal-ventral rib (reflection of umbonal-ventral sulcus of outer surface of valve) present or absent; pallial sinus usually deep. Siphons variable, usually united, capable of considerable extension, smooth or papillose, and commonly enclosed in periostracal sheath, may or may not be completely retracted within valves when animal contracts; foot well developed, usually truncate and adapted for suction, atrophying in adults of callum-producing forms. [Members of this family bore into stiff clays or muds, shales, friable or soft rock, shells, poor grade cement, wood, nuts, or other plant products.] *?Carb., Jur.-Rec.*

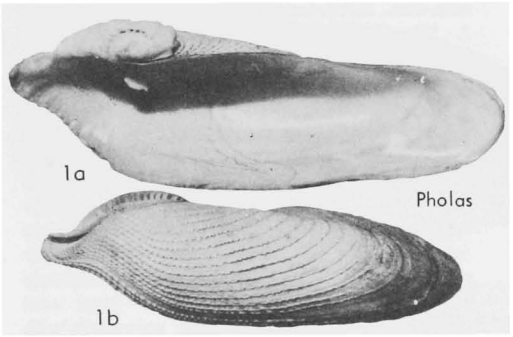


FIG. E166. Pholadidae (Pholadinae) (p. *N*707-*N*708).

Subfamily PHOLADINAE Lamarck, 1809

[*nom. transl. et correct.* VOKES, 1967, p. 326 (*ex* family *Pholadaires* LAMARCK, 1809, p. 319)] [=*Pholadina* GRAY, 1847, p. 187]

Shell elongate, rounded or beaked anteriorly and not closed by callum in adult; number of accessory plates variable, but hypoplax always lacking and siphonoplax lacking except in *Talona,* where a periostracal siphonoplax occurs, making this genus a transition form with the Martesiinae; apophyses present; condyles and umbonal-ventral rib and sulcus absent except in *Zirfaea,* which has weak rib, ventral condyles, and sulcus barely visible in adult, thus also seeming to be transitional with the Martesiinae. Foot well developed, not atrophying in adult. Animal not capable of retraction within shell. Gill with two demibranchs. Accessory plates in Pholadinae shown in Figure E165. *Cret.-Rec.*

Pholas LINNÉ, 1758, p. 669 [**P. dactylus;* SD CHILDREN, 1822, p. 82] [=*Pholadites* DAVILA, 1767, p. 169 (refers to D'ARGENVILLE, 1757, pl. 26, fig. H, =**P. dactylus* LINNÉ) (obj.); *Polas* GRONOVIUS, 1781, p. 259 *(nom. null.); Hypogaea* POLI, 1791, p. 29 (obj.); *Hypogaeoderma* POLI, 1795, p. 251, 257 (obj.); *Pholas* LAMARCK, 1799, p. 90 (*non* LAMARCK, 1801, p. 127) (obj.); *Phloas* TURTON, 1802, p. 172 *(nom. null.); Pholadites* VON SCHLOTHEIM, 1813, p. 105 *(nom. van.); Pholalites* SCHLAEPFER, 1821, p. 278 *(nom. null.); Xylotrya* MENKE, 1830, p. 121 (obj.); *Dactylina* GRAY, 1847, p. 187 (*non* ZBORZEWSKI, 1843) (obj.); *Pholadarius* HERRMANNSEN, 1852, Suppl., p. 105 *(nom. null.); Pholalithes* PAETEL, 1875, p. 160 *(nom. null.); Pragmopholas* FISCHER, 1887, p. 1133 (obj.)]. Rock borers occurring in temperate and tropical seas. Shell elliptical, rounded or beaked anteriorly with septate umbonal reflections and 3 dorsal accessory plates; protoplax thin, calcareous, and divided longitudinally; mesoplax transverse, calcareous, and solid; metaplax calcareous, long and narrow. *Cret.-Rec.,* E.Atl.-W. Atl.-E.Pac.-IndoPac.

P. (Pholas). Shell beaked anteriorly, nuclei of divided protoplax near posterior outer margin. *Mio.-Rec.,* Eu.-N.Afr.——FIG. E165,*5;* E166,*1.*

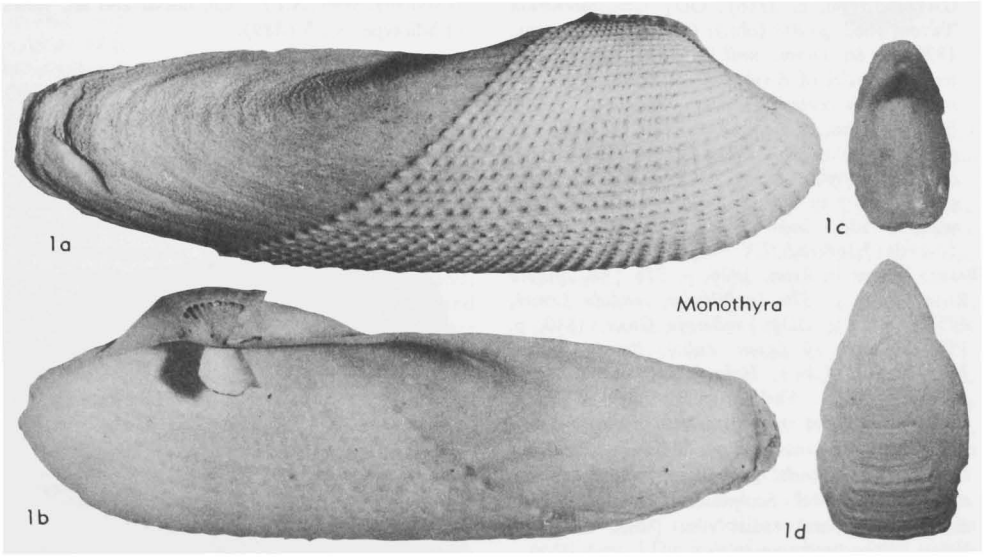


FIG. E167. Pholadidae (Pholadinae) (p. *N*708).

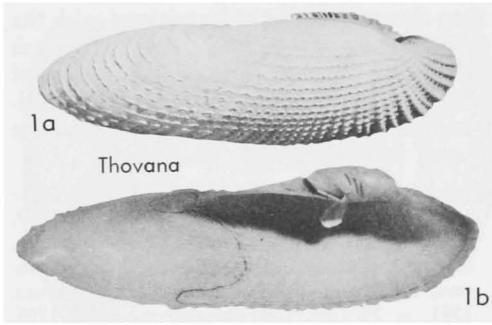


FIG. E168. Pholadidae (Pholadinae) (p. *N708*).

P. (Monothyra) TRYON, 1862, p. 205 [**Pholas orientalis* GMELIN, 1790, p. 3216; OD]. Shell beaked anteriorly; protoplax in one piece, with central nucleus. [The protoplax of this species has twice been described as a *Scutum*.] *Cret.-Rec.*, IndoPac.——FIG. E167,*1*. **P. (M.) orientalis* GMELIN, Rec., Singapore; *1a,b*, RV ext., int., ×1.2; *1c,d*, inner and outer sides of protoplax, ×1.3 (Turner, n).

P. (P.) dactylus LINNÉ, Rec., Malta; E165,*5a*, entire specimen (dorsal) showing protoplax, mesoplax, and metaplax in place; E165,*5b*, long, divided protoplax (dorsal); E165,*5c,d*, mesoplax (dorsal) showing variations; E165,*5e*, metaplax (dorsal); E166,*1a,b*, RV int. and LV ext. showing septate umbonal reflection, ×0.5 *(921a)*.

P. (Thovana) GRAY, 1847, p. 187 [**Pholas oblongatus* SAY, 1822, p. 320 (=**P. campechiensis* GMELIN, 1790, p. 3216); OD] [=*Gitocentrum* TRYON, 1862, p. 203 (obj.); *Gitoventrum* PAETEL, 1875, p. 86 *(nom. null.)*]. Shell rounded anteriorly, nuclei of divided protoplax anterior and more or less centrally located. *Mio.-Rec.*, W.Atl.-E.Pac.——FIG. E165,*6*; E168,*1*. **P. (T.) campechiensis* GMELIN, Rec., Trinidad; E165,*6a,b*, long, divided protoplax (dorsal, lat.); E165,*6c,d*, mesoplax (dorsal) in normal position and tipped forward to show basal flange; E165,*6e*, metaplax (dorsal); E168,*1a,b*, LV ext., int., ×0.75 *(921a)*.

Barnea LEACH in RISSO, 1826, p. 376 [**B. spinosa* RISSO, 1826, p. 376 (=**Pholas candida* LINNÉ, 1758, p. 669); OD] [=*Barnia* GRAY, 1840, p. 150; 1842, p. 76 *(nom. null.)*; *Barnia* LEACH, 1852, p. 254 (obj.); *Holopholas* FISCHER, 1887, p. 1133 (obj.)]. Shell broadly oval to elliptical, beaked or rounded anteriorly; accessory plate a simple, calcareous, lanceolate protoplax; umbonal reflection simple; pedal gape ranging from narrow slit to broad oval. Sculpture consisting of concentric ridges and radial ribs. [Rock and peat borers.] *Mio.-Rec.*, cosmop.

B. (Barnea). Shells elliptical, rounded at both ends with slitlike pedal gape and slight posterior gape. *Mio.-Rec.*, E.Atl.-IndoPac.——FIG. E165,*1*; E169, *1*. **B. (B.) candida* (LINNÉ), Rec., France; E165,*1a-c*, protoplax (dorsal, ventral, lat.); E169, *1a-c*, LV ext., RV int., opposed valves (dorsal) with protoplax in place, ×1 *(921a)*.

B. (Anchomasa) LEACH, 1852, p. 253 [**Anchomasa pennatiana* LEACH, p. 253 (=**Pholas parva* PENNANT, 1777, p. 77); OD] [=*Anchomosa* LAMY, 1925, p. 79 *(nom. null.)*; *Barnea (Umitakea)* HABE, 1952, p. 241 (type, *Pholadomya japonica* YOKOYAMA, 1920, p. 106, =*Barnea dilatata* SOULEYET; OD)]. Shell broadly to narrowly elliptical, beaked anteriorly with large oval pedal gape, rounded to truncate posteriorly with moderate to large posterior gape. *Plio.-Rec.*, cosmop.——FIG. E165,*2*; E170,*2*. *B. (A.) truncata* (SAY), Rec., USA(Mass.); E165,*2a-c*, protoplax (dorsal, ventral, lat.); E170,*2a,b*, LV ext., int., ×1; E170,*2c,d*, entire animal, dorsal view showing siphons and protoplax in place and ventral view showing foot, ×1 *(921a)*.——FIG. E170,*1*. **B. (A.) parva* (PENNANT), Rec., Eng.; *1a,b*, LV ext., RV int., ×1 *(921a)*.

Clavipholas CONRAD, 1868, p. 728 [**Pholas pectorosa* CONRAD, 1852, p. 200; OD]. Shell elongate, subtrigonal in outline, gaping slightly anteriorly, gape apparently closed by callum in adult; umbonal-ventral ridge and sulcus present, narrow and extending in sinuous curve from umbo to ventral margin. Sculpture on anterior slope consisting of strong radial ribs and rather weak concentric ridges. Accessory plates, apophyses, etc., unknown. *U.Cret.*, N.Am.——FIG. E171,*1*. **C. pectorosa* (CONRAD), USA(N.J.); *1a,b*, dorsal and lat. views of holotype, ×1.5 *(889)*.

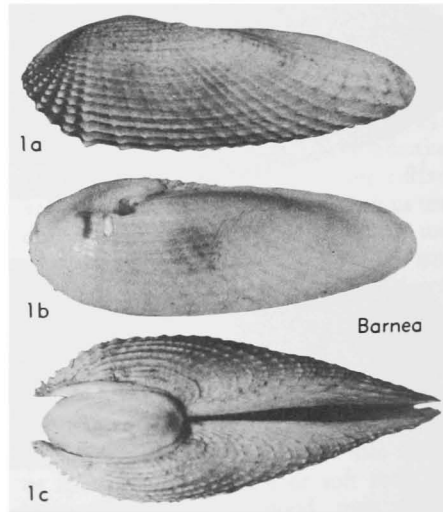


FIG. E169. Pholadidae (Pholadinae) (p. *N708*).

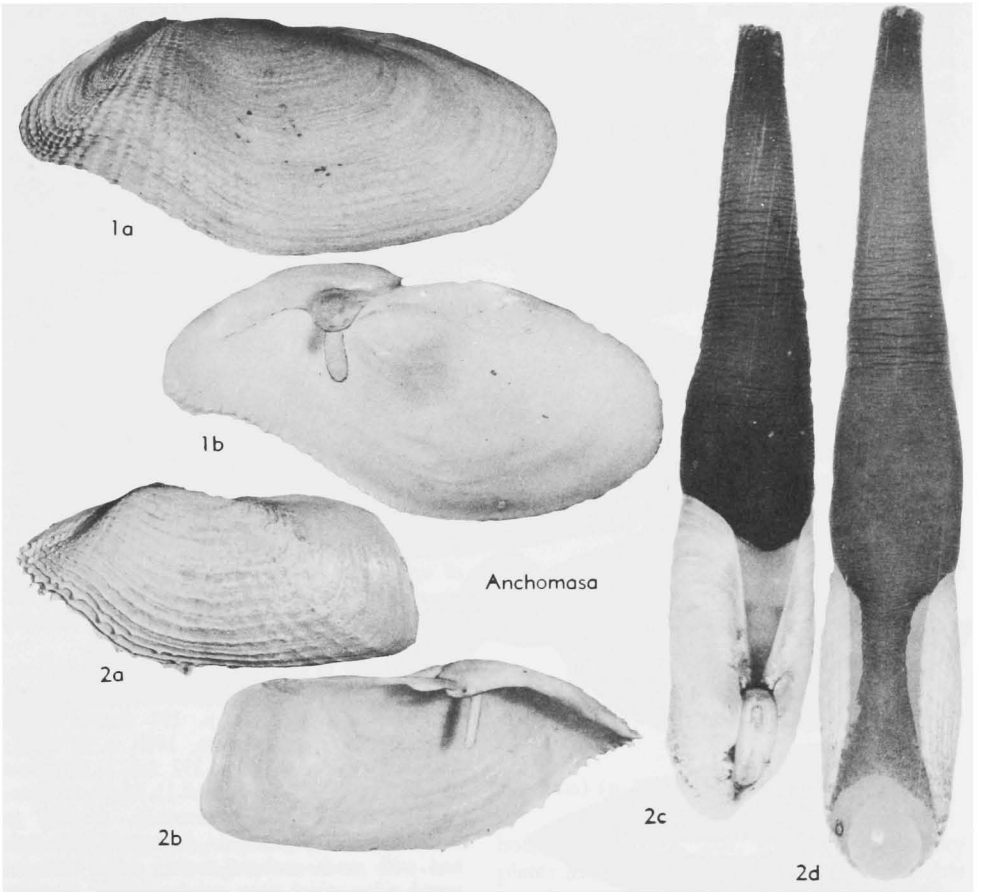


FIG. E170. Pholadidae (Pholadinae) (p. *N*708).

Cyrtopleura TRYON, 1862, p. 201 [**Pholas crucifera* SOWERBY, 1849, p. 489 (=**Pholas cruciger* SOWERBY, 1834, p. 69); SD STOLICZKA, 1871, p. 22]. Shell rounded or beaked anteriorly; accessory plates consisting of thin, largely chitinous, triangular to T-shaped protoplax and heavy transverse, calcareous mesoplax which may be in one or two pieces; umbonal reflection well separated from umbos and supported at posterior end where sockets are formed for reception of anterior projections of mesoplax; apophyses broad and flattened, or more or less spoon-shaped. [Clay, peat, and soft rock borers.] *Mio.-Rec.,* E.Pac.-E.N.Am.-C.Am.-E.S. Am.

C. (Cyrtopleura). Shell beaked anteriorly, with broad oval pedal gape. *Rec.,* E.Pac.——FIG. E165, *3*; E171,*2*. **C. (C.) cruciger* (SOWERBY), W. Panama; E165,*3a,* protoplax (dorsal); E165,*3b,* mesoplax (dorsal); E171,*2a,b,* LV ext., RV int., ×1; E171,*2c,d,* dorsal and ventral views of opposed valves showing large chondrophore and small apophysis, ×1 *(921a)*.

C. (Scobinopholas) GRANT & GALE, 1931, p. 431 [*nom. subst. pro Scobina* BAYLE, 1880 (*non* LEPELETIER, 1825; *nec* WADE, 1917) *(nom. van. pro Pholas* LAMARCK, 1801, p. 127)] [**Pholas costata* LINNÉ, 1758, p. 669; OD] [=*Pholas* LAMARCK, 1801, p. 127 (*non* LINNÉ, 1758; *nec* LAMARCK, 1799) (type, *Pholas costata* LINNÉ, 1758) (obj.); *Pholadigenus* RENIER, 1807, pl. vii (type, *P. costata* LINNÉ; OD, work rejected, ICZN Opinion 427); *Pholas* ADAMS & ADAMS, 1856, p. 325 (*non* LINNÉ, 1758) (type, *Pholas costata* LINNÉ, 1758; SD BAYLE, 1880) (obj.); *Leuconyx* ADAMS & ADAMS, 1863, p. 18; 1865, p. 755 (type, *L. tayleriana* ADAMS & ADAMS, =*P. costata* LINNÉ) (based on apophysis only) *(nom. oblit.); Leuconix* CROSSE, 1868, p. 298 *(nom. null.)*]. Shell rounded anteriorly with slitlike pedal gape. [The isolated apophysis of this species has been described as a *Capulus* and as noted above, the genus *Leuconyx* was created for them.] *Mio.-Rec.,* E.N.Am.-E.S.Am.——FIG. E165,*4;* E172,*1*. **C. (S.) costata* (LINNÉ), Rec., USA

(Fla.); 165,*4a,b,* protoplax and mesoplax (dorsal); E172,*1a,b,* LV ext., RV int., ×0.7; E172, *1c,d,* mesoplax (dorsal, ventral), ×1.7; E172, *1e-g,* RV apophysis showing cavity and curvature, ×1.7 *(921a).*

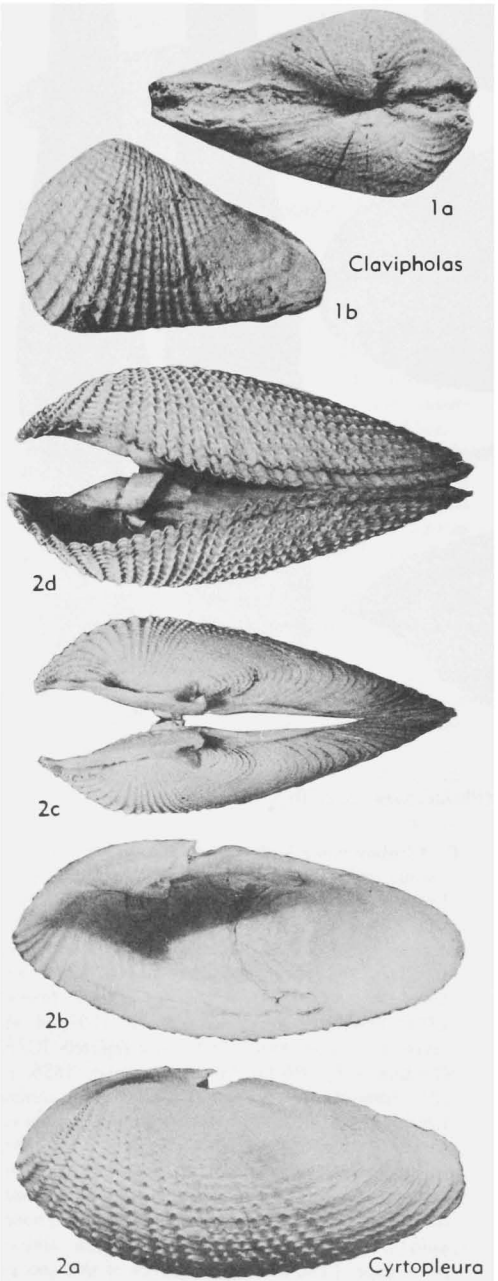


FIG. E171. Pholadidae (Pholadinae) (p. *N*708-*N*709).

Talona GRAY, 1842, p. 76, 91 [**Pholas clausa* HANLEY, 1842, p. 6, 336 (=*Pholas explanata* SPENGLER, 1792, p. 91); OD] [=*Talona* GRAY, 1840, p. 154 *(nom. nud.);* =*Talena* SOWERBY, 1849, p. 498 *(nom. null.)*]. Shells elongate, rounded and closed anteriorly, rounded and gaping posteriorly; reflection of dorsal margin anterior to umbos narrow and nearly erect; umbonal-ventral sulcus lacking. Sculpture consisting of concentric ridges over entire surface and radial ribs on anterior slope and disc, ribs imbricate where they cross ridges; apophyses small, short, and thin. Mesoplax small, transverse, and composed of 2 triangular pieces. Posterior end of valves with reflected lobes which are composed largely of periostracum (seldom present in dried specimens) and form incipient siphonoplax. [Probably a transition genus between *Cyrtopleura,* which has a similar mesoplax and very thin protoplax composed almost entirely of periostracum and the Martesiinae, which have a siphonoplax.] *Rec.,* W.Afr.——FIG. E173,*1.* **T. explanata* (SPENGLER), Senegal; *1a,b,* RV ext., LV int.; *1c,d,* ventral and dorsal views of opposed valves showing incurving of valves, remains of siphonoplax, and left half of divided mesoplax remaining in position; all ×1 (Turner, n).

Zirfaea LEACH in GRAY, 1842, p. 76 [**Pholas crispata* LINNÉ, 1776, p. 111; SD GRAY, 1847, p. 188] [=*Zirfaea* GRAY, 1840, p. 154 *(nom. nud.); Thurlosia* CATLOW & REEVE, 1845, p. 3 (obj.); *Zirphaea* LEACH, 1852, p. 252 (obj.); *Zyrphaea* CLESSIN, 1891, p. 7 *(nom. null.)*]. Shells elongate-oval in outline, beaked anteriorly, rounded to truncate posteriorly, widely gaping at both ends and with weak umbonal-ventral sulcus and internal ridge which may not be evident in older specimens; apophyses solid, commonly broad and spoon-shaped; single accessory plate (mesoplax), small and more or less triangular in outline. [Soft clay, mud and peat borers.] *Mio.-Rec.,* N.Atl.-N. Pac.——FIG. E165,*7;* E174,*1.* **Z. crispata* (LINNÉ), Rec.; E165,*7a-c,* mesoplax (dorsal, ventral, lat.) *(921a);* E174,*1,* USA(Mass.) *(1a-c),* USA(N.H.) *(1d-f);* E174,*1a,* RV int. showing umbonal-ventral ridge and apophysis, ×1.5; E174,*1b,* LV ext. showing umbonal-ventral sulcus, ×1.5; E174,*1c,* LV int. showing muscle scars, ×1; E174,*1d,* dorsal view of entire specimen showing anterior adductor muscle covered only by periostracum with small mesoplax at posterior end, ×1; E174,*1e,* side view of entire specimen showing foot and extent of periostracal covering on siphons, ×1; E174,*1f,* ventral view of entire specimen showing foot, anterior muscular collar of mantle, and extent to which siphons can be contracted, ×1 *(921a).*

Zirlona FINLAY, 1930, p. 257 [**Pholadidea increnata* MARWICK, 1929, p. 914; OD]. Shell rounded anteriorly and only slightly gaping. Umbonal-ventral ridge and sulcus present. Anterior slope

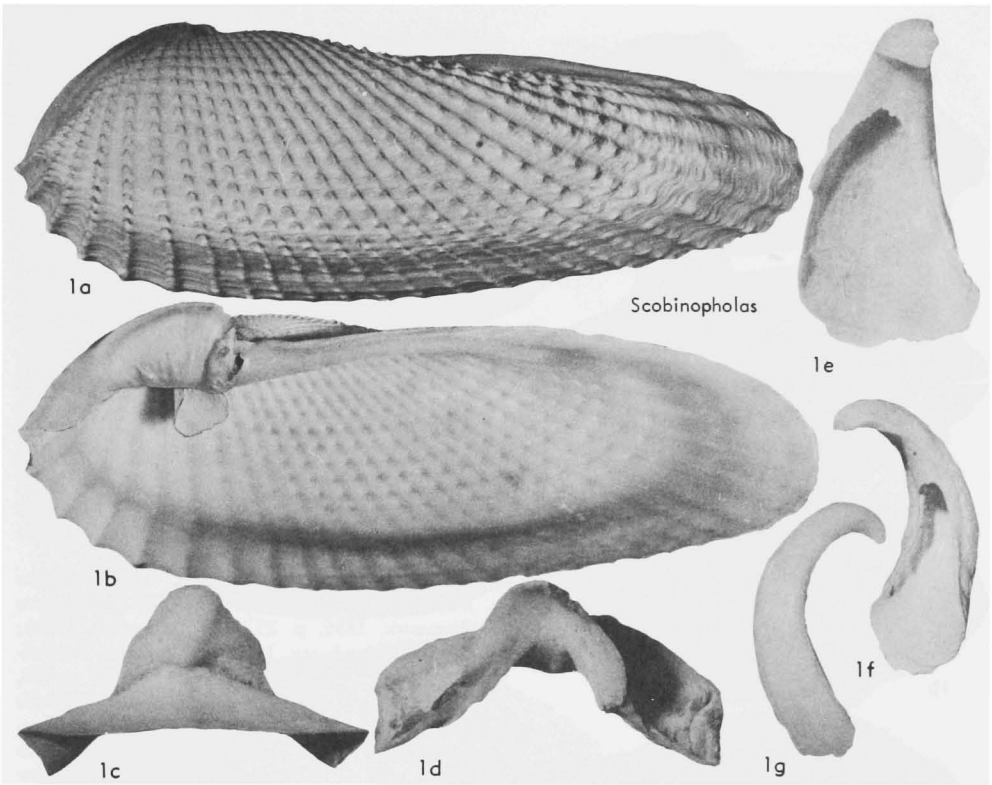


FIG. E172. Pholadidae (Pholadinae) (p. *N*709).

sculptured with strong regularly spaced concentric lamellae which are slightly crenulate; disc and posterior slope sculpture with concentric ridges; radial sculpture lacking. Accessory plates unknown. *Tert.(Chatton F.),* N.Z.——FIG. E175,*1*. **Z. increnata* (MARWICK); LV ext. (holotype), ×3 *(594)*.

Subfamily MARTESIINAE Grant & Gale, 1931

Shell elongate to globular, beaked and gaping anteriorly in young stage, completely closed by calcareous callum in adult in all genera except *Chaceia,* which produces only a partial callum; number of accessory plates variable but always lacking protoplax, apophyses, condyles, umbonal-ventral rib and sulcus present; siphonal tube, chimney, and periostracal laminae on posterior slope present in some forms. Foot well developed in young working stage but atrophied in adult. Siphons capable of complete retraction within shell except in *Chaceia,* which is transitional with Pholadinae. [Species of Martesiinae have been reported from Carboniferous strata, but, since the accessory plates are unknown, these are unassignable to subgenera. Plates typical of the subfamily are illustrated in Figure E176.] *?Carb., Jur.-Rec.*

Martesia SOWERBY, 1824, p. 2 [**Pholas clavata* LAMARCK, 1818, p. 446 (=**P. striata* LINNÉ, 1758, p. 669); OD] [=*Mactresia* GRAY, 1840, p. 154; *Mactesia* PAETEL, 1875, p. 119 *(nom. null.); Martesiella* VERRILL & BUSH, 1898, p. 777 (type, *M. (M.) fragilis;* OD); *Hiata* ZETEK & MCLEAN, 1936, p. 110 (type, *H. infelix,* =young *M. striata* (LINNÉ); OD) (obj.); *Mesopholas* TAKI & HABE, 1943, p. 109 (type, *M. intusgranosa,* =*M. striata* (LINNÉ); OD) (obj.); *Diploplax* BARTSCH & REHDER, 1945, p. 10 (type, *M. (D.) americana,* =young *M. striata* (LINNÉ); OD) (obj.)]. Shells beaked and widely gaping anteriorly in young; adult with callum; beaks sinuously to sharply truncated, giving young *Teredo*-like appearance. Protoplax lacking, mesoplax variable, circular to cuneiform in outline; metaplax and hypoplax long and narrow, pointed anteriorly, pointed truncate or divided posteriorly. [Small wood-borers.] *?Carb.* (subgenus unknown), *Jur.-Rec.,* world-wide, temp.-

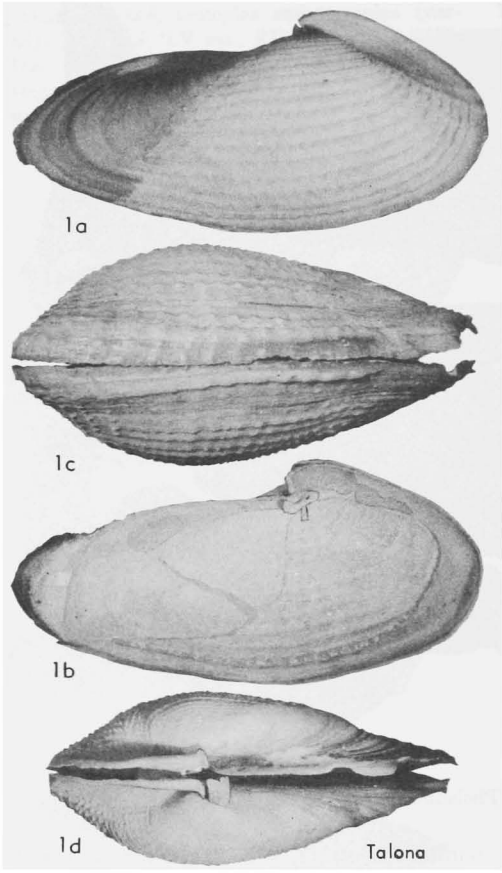


FIG. E173. Pholadidae (Pholadinae) (p. *N*710).

trop. [=*Martesia* DE BLAINVILLE, 1825, p. 578, 632 (obj.).]

M. (Martesia). Mesoplax of adult broadly oval to circular, cushion-like in adult; flat, semicircular, and located posteriorly beneath anterior adductor muscle in young; metaplax and hypoplax pointed or truncate posteriorly. *?Carb., Jur.-Rec.,* temp. and trop. seas of world.——FIG. E176,*2;* E177,*1.* **M. (M.) striata* (LINNÉ), Rec.; E176,*2,* diagram.; E177,*1,* Trinidad *(1a-c),* USA(Fla.) *(1d-g);* E176,*2a-c,* mesoplax of adult (dorsal, ventral, lat.); E176,*2d,e,* mesoplax of young (dorsal, ventral) *(921b);* E177,*1a,* dorsal view of adult with mesoplax and metaplax in place, ant. to right, ×1.2; E177,*1b,* ventral view of adult showing callum and hypoplax, ant. to left, ×1.2; E177,*1c,* side view of adult, ant. to left, ×1.2; E177,*1d,e,* LV ext., RV int. of young specimens; E177,*1f,* dorsal view of opposed valves with small, flat mesoplax of young in place; E177,*1g,* ventral view of opposed valves showing large pedal gape; all ×1.5 *(921b).*

M. (Particoma) BARTSCH & REHDER, 1945, p. 5 [**Pholas cuneiformis* SAY, 1822, p. 322; OD]. Mesoplax cuneiform, similar in shape in young and adult; metaplax and hypoplax long, narrow, forked posteriorly and extending over posterior end of valve where they meet and fuse. *?Carb., Jur.-Rec.,* W.Atl.-E.Pac.——FIG. E176,*3;* E178,*1.* **M. (P.) cuneiformis* (SAY), Rec., USA(N.Y.); E176,*3a-c,* mesoplax (dorsal, ventral, lat.) *(921b);* E178,*1a,* dorsal view of adult with mesoplax and forked metaplax in place; E178,*1b,* dorsal view of young specimen showing similarity of mesoplax to that of adult; E178,*1c,* ventral view of adult showing forked hypoplax; E178,*1d,* side view of adult showing fused metaplax and hypoplax; E178,*1e,* ventral view of opposed valves of young specimen showing pedal gape, apophyses, and chondrophore; E178,*1f,* RV ext. of young specimen; E178,*1g,* LV int. of young specimen; all ×2.5 *(921b).*

Aspidopholas FISCHER, 1887, p. 1137 [**Pholas scutata* DESHAYES, 1824, p. 252; OD] [=*Scutigera* COSSMANN, 1886, p. 25 (*non* LATREILLE, 1803); *Calyptopholas* LAMY, 1927, p. 180 (type, *Pholadidea (Calyptopholas) cheveyi* LAMY, 1927, p. 180, =*Pholas obtecta* SOWERBY, 1849; OD)]. Shells similar to *Pholadidea,* beaked and gaping anteriorly in young stage; partially closed by callum in adult; umbonal-ventral sulcus and ridge narrow and rather weak; anterior slope sculptured by closely set, finely imbricate concentric ridges and weak radial ribs. Apophyses short, solid, and broad at free end; mesoplax greatly produced, forming cap which may cover anterior end of adult; siphonoplax small, calcareous extension of valves which may be covered with periostracum. Siphons may be retracted completely. [Coral-borers.] *Eoc.,* Eu.; Rec., IndoPac.——FIG. E179,*1a.* **A. scutata* (DESHAYES), Eoc., France(Paris Basin); specimen showing large mesoplax and lining of tube covering posterior end of shell, ×3 *(259,* pl. 6, fig. 5).——FIG. E179,*1b,c. A. cheveyi* (LAMY), Rec., Annam; *1b,* adult with dorsal plate removed; *1c,* specimen with greatly enlarged mesoplax in place; both ×1.5 *(520).*

Chaceia TURNER, 1955, p. 66 [**Pholas ovoidea* GOULD, 1851, p. 87; OD]. Shell beaked anteriorly, gaping widely in young stage, with pronounced umbonal ventral sulcus and partial callum in adult. Mesoplax small, transverse in one piece and *Zirfaea*-like. No other accessory plates present. [Rock borers.] *Rec.,* E.Pac.——FIG. E176,*1;* E179,*2;* E180,*1.* **C. ovoidea* (GOULD), USA(Calif.); E176, *1a-c,* mesoplax (dorsal, ventral, lat. with ant. at left) *(921b);* E179,*2a,b,* LV ext., RV int. of young specimens, ×1; E179,*2c,* ventral view of opposed valves of young specimen, ×1 *(921b);* E180,*1a,*

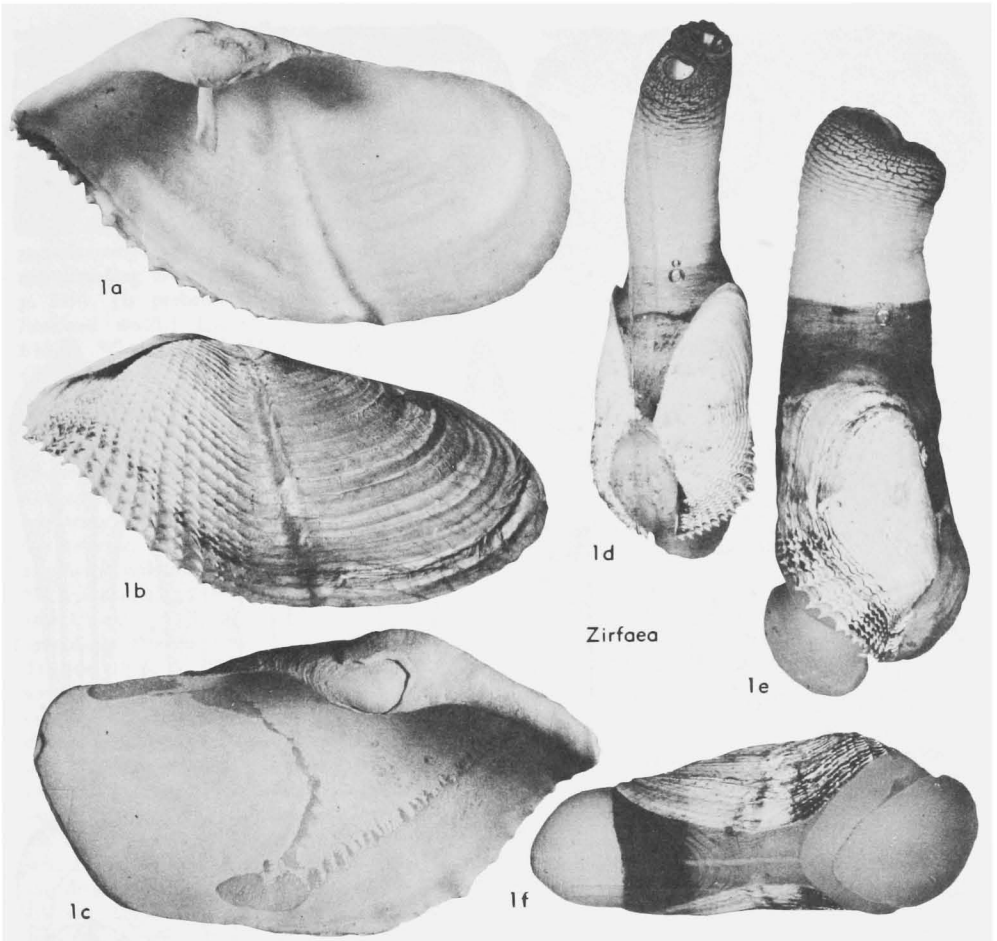


FIG. E174. Pholadidae (Pholadinae) (p. *N*710).

side view of entire adult showing partial callum and siphons, ×0.6; E180,*1b,* ventral view of young specimen showing foot, large anterior gape, and meeting of valves at ventral condyle, ×0.6; E180, *1c,d,* LV ext., RV int. of adult specimens, ×0.6 *(921b).*

Diplothyra TRYON, 1862, p. 449 [**D. smithii;* OD] [=*Schroteria* TRYON, 1862, p. 221 *(nom. oblit.)* (type, *Pholas cordata* TRYON, 1862, p. 221, =*Pholas cordata* GMELIN, 1790) (refers to SCHROTER, 1786, v. 3, p. 554, pl. 9, fig. 22-24)]. Shell *Martesia*-like but with beaks obliquely truncated; mesoplax subquadrate to subtriangular in adult, extending anteriorly between dorsal extension of callum; metaplax and hypoplax pointed anteriorly and forked posteriorly, forked portions extending over posterior margins of valves and fusing with one another. [Small shell- and rock-borers, usually found in oysters and *Haliotis*]. *Rec.,* W.Atl.-E.Pac.

——FIG. E176,*5;* E181,*1-4.* **D. smithii,* USA (N.Y.); E176,*5a-c,* mesoplax of adult (dorsal, ventral, lat.); E176,*5d,e,* mesoplax of young (lat., dorsal) *(921b);* E181,*1a,b,* split shell of *Crasso-*

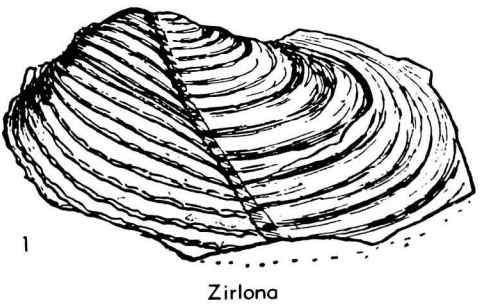


FIG. E175. Pholadidae (Pholadinae) (p. *N*710-*N*711).

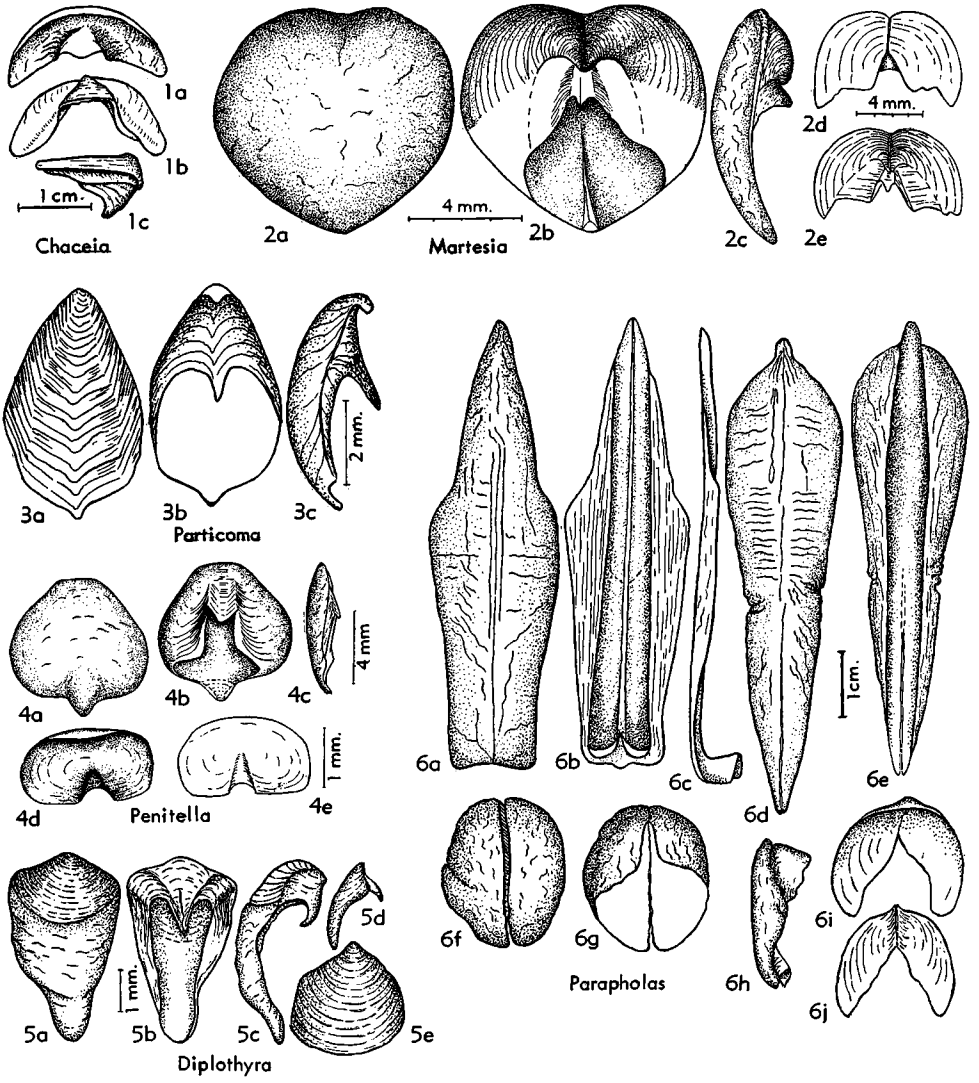


FIG. E176. Accessory plates of genera in Martesiinae *(921b)*.

straea virginica (LINNÉ) showing attack of *D. smithii*, ×1; E181,*2a-c*, ventral and 2 dorsal views showing extension of callum around mesoplax and differences in shape of mesoplax; ×3.5; E181, *3a,b*, RV ext., RV int. of adult, ×3.5; *4a,b*, RV ext., LV int. of young specimen, ×4.5 *(921b)*.

Eutylus VINCENT, 1891, p. 164, pl. 4, fig. 1-4 [**Pholadomya cuneata* SOWERBY, 1844, p. 40; OD] [=*Phenacomya* DALL, 1898, p. 823 (obj.)]. Probably close to *Pholadidea*. Anterior slope sculptured with rather weak concentric ridges and only a few rather widely spaced radial ribs; umbonal-ventral sulcus weak; anterior margin sinuous; pedal gape small; callum ribbed, showing extension of radial ribs of anterior slope. Dorsal plates unknown. Apophyses probably present. [Mud-dweller.] *Eoc.*, Eu.——FIG. E182,*1*. **E. cuneata* (SOWERBY), Belg.; *1a*, RV ext.; *1b*, ant. view of opposed valves; *1c*, int. cast showing pallial sinus; *1d*, dorsal view of opposed valves; all ×1 *(941)*.

Formosulus ZHIZHCHENKO, 1934, p. 44 [**F. lucidus*; OD] [= *Formesulus* ZHIZHCHENKO, 1939 *(errore* NEAVE, p. 736)]. Shell small, more or less rectangular in outline, beaked anteriorly and divided into 3 distinct areas by 2 furrows extending from umbos in ventral margin. [Description and figure poor. Described as a hiatellid bivalve (Hiatellacea) but now regarded by Russian paleon-

tologists as probably nonmolluscan, a cirriped plate, fide VOKES, 1967, p. 346.] *Mio.,* USSR(Ciscaucasia).——FIG. E161,*6*. **F. lucidus;* LV ext., ×10 (Zhizhchenko).

Goniochasma MEEK, 1864, p. 34 [**Xylophaga stimpsoni* MEEK & HAYDEN, 1857, p. 141; OD]. Shell *Martesia*-like, ovate-oblong with beak truncated at sharp angle; umbonal-ventral sulcus and ridge oblique, internal ridge faintly crenulate; posterior ridges very oblique, broad, rounded and not extending to margin. Mesoplax present *(889,* p. 249). [Is probably a young *Martesia.* From fossilized wood.] *U.Cret.,* N.Am.-India.——FIG. E182,*2*. **G. stimpsoni* (MEEK & HAYDEN), USA (Idaho); *2a,* LV ext., ×2; *2b,* cast of holotype, ×1 *(609,* pl. 30, fig. 9a-b).

Heteropholas FISCHER, 1887, p. 1136 [**Pholas xylophagina* DESHAYES, 1860, p. 142; OD]. Shell *Martesia*-like but with beaks obliquely to sinuously truncated; umbonal-ventral sulcus very oblique and with 2 additional grooves on outer surface, one anterior, other median. Accessory plates and apophyses unknown. *Eoc.,* Eu.——FIG. E183,*1*. **H. xylophagina* (DESHAYES), France(Paris Basin); *1a,b,* LV ext., int., ×2 *(259)*.

Lignopholas TURNER, 1955, p. 98 [**L. clappi;* SD TURNER, 1956, p. 188]. Shell *Martesia*-like, posterior slope elongated and having series of fringed, overlapping, thin, periostracal lamellae; mesoplax divided longitudinally; other accessory plates lacking; apophyses long and thin, chondrophore prominent. [Small wood borers, in brackish and fresh water.] *Rec.,* W.Atl.-IndoPac.——FIG. E184,*1-3*. **L. clappi,* Nicaragua; *1a,* adult, lat. view, ant. to left; *1b,* dorsal view of adult, ant. to right, showing divided mesoplax (holotype), ×4; *2a,* young LV ext., ant. to left; *2b,* young RV int., ant. to left (paratype), ×6; *3a-c,* dorsal, ventral, lat. views of mesoplax of adult, ×6; *3d,* dorsal view of mesoplax of young, anterior for all to left, ×6 *(921b)*.

Opertochasma STEPHENSON, 1952, p. 139 [**O. venustum;* OD]. Shell *Martesia*-like but with 2 radial grooves extending from beak to ventral margin in area of umbonal-ventral ridge; posterior slope sculptured. Mesoplax long and narrow, divided longitudinally and extending anteriorly in adult in 2 lobes over umbos; hypoplax lacking. [Probably close to *Parapholas.*] *U.Cret.,* N.Am.——FIG. E183,*2*. **O. venustum,* Woodbine F., USA(Tex.); *2a,* LV ext., *2b-d,* dorsal, ant., and ventral views of opposed valves; *2a-c,* ×3; *2d,* ×2 *(890)*.

Parapholas CONRAD, 1848, p. 121 [**Pholas californica* CONRAD, 1837, p. 226; OD] [=*Paraphola* PAETEL, 1875, p. 152 *(nom. null.)*]. Shell divided into 3 distinct areas, anterior slope, disc, and posterior slope being clearly marked; posterior slope having series of overlapping periostracal plates; accessory plates consisting of oval mesoplax, elongate metaplax, and hypoplax, which may or may not be forked posteriorly; siphonoplax lacking; chimney not attached to valves but fitting over end of valves and composed of fine particles which have been ejected from siphons and cemented together. [Moderate-sized to rather large rock-borers.] *Cret.-Rec.,* E. Pac.-Indo Pac.-W. Afr. ——FIG. E176,*6;* E185,*1*. **P. californica* (CONRAD), Rec., USA(Calif.); E176,*6a-c,* metaplax (dorsal, ventral, lat.); E176,*6d,e,* hypoplax (dorsal, ventral); E176,*6f-h,* mesoplax of adult (dorsal, ventral, lat.); E176,*6i,j,* mesoplax of young (dorsal, ventral); E185,*1a,* side view of adult, ×1; E185,*1b,* ventral view of young specimen showing foot, ×1; E185,*1c,* adult RV int., ×1; E185,*1d,* ventral view of adult showing hypoplax in place, ×0.7; E185,*1e,* dorsal view of adult showing mesoplax and metaplax in place, ×0.7; E185,*1f,* chimney of specimen in fig. *1d,* ×0.7. [Figures show variation in size of adults] *(921b)*.

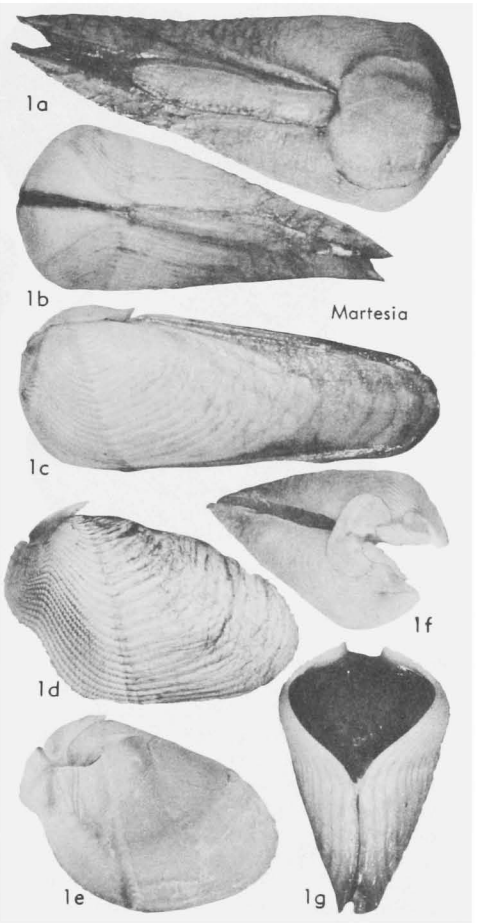


FIG. E177. Pholadidae (Martesiinae) (p. *N712*).

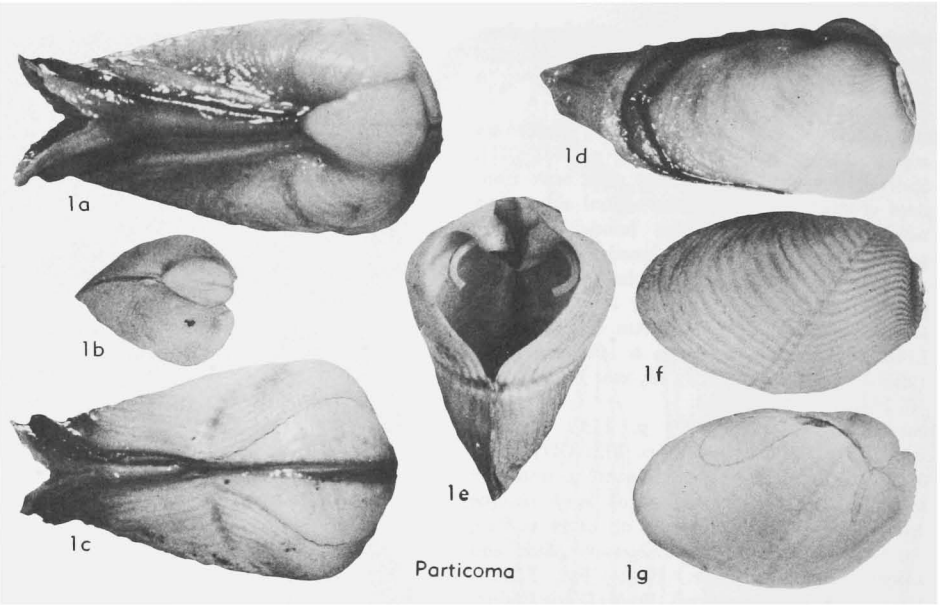


FIG. E178. Pholadidae (Martesiinae) (p. *N712*).

Penitella VALENCIENNES in ABEL DU PETIT-THOUARS, 1846, pl. 24 [**P. conradi;* SD HABE, 1952, p. 243] [=*Penicilla* CONRAD, 1854, p. 335 *(nom. null.); Navea* GRAY, 1851, p. 385 (type, *N. subglobosa* GRAY, 1851, p. 385; SD TURNER, herein)]. Shell oval in outline, beaked anteriorly in young stage with pronounced umbonal-ventral sulcus, callum partial or complete. Mesoplax *Zirfaea*-like in young but producing dorsal covering in adult; siphonoplax variable, present or absent; no other accessory plates present. [*Navea* GRAY was based upon a young form. Shale- and rock-borers.] *Mio.-Rec.,* E.Pac.-N.Pac.——FIG. E176,*4;* E186, *1-4.* **P. conradi* VALENCIENNES; Rec., USA(Calif.); E176,*4a-c,* mesoplax of adult (dorsal, ventral, lat.); E176,*4d,e,* mesoplax of young (dorsal, ventral); E186,*1,* adult specimens in substrata (type from VALENCIENNES), ×1; E186,*2a,b,* adult LV ext. taken from shale and RV int. of same specimen showing muscle scars and siphonoplax, ×3; E186,*3a,* dorsal view of adult showing mesoplax in position, ×3; E186,*3b,c,* dorsal and LV int. views of adult taken from *Haliotis,* ×2; E186,*4a,b,* LV ext. and RV int. of young specimen taken from shale, ×4.5 *(921b).*

Pholadidea TURTON, 1819, p. 147 [**P. loscombiana;* OD] [=*Pholadidoidea* DE BLAINVILLE, 1826, p. 535 (obj.); *Pholidea* SWAINSON, 1835, p. 30 (obj.); *Pholadideae* SOWERBY, 1839, p. 81 *(nom. null.); Pholidaea* SWAINSON, 1840, p. 364 *(nom. null.); Talonella* GRAY, 1851, p. 385 (type, *T. tridens* GRAY, 1843; OD); *Cadmusia* GRAY, 1852, p. 254 (obj.); *Pholameria* CONRAD, 1865, p. 2 (type, *Pholas triquetra* CONRAD, 1848, p. 127, pl. 13, fig. 3; OD); *Pholididae* PAETEL, 1875, p. 160 *(nom. null.)*]. Shell beaked anteriorly in young stage, closed by callum which extends dorsally over beaks in adult; rounded to truncate posteriorly, divided into 2 areas by prominent umbonal-ventral sulcus; posterior slope not clearly defined. Mesoplax variable, divided longitudinally in young but may be greatly produced in adult; incipient metaplax and hypoplax present or absent, not existing as separate plates but resulting from deposition of calcium in periostracum uniting valves posterior to umbos; siphonoplax commonly tubular, composed largely of periostracum and fused; siphonal tube present in most species. Apophyses short, fragile and not broadening at free end. [Shale, soft-rock and coral-borers.] *Eoc.-Rec.,* E.Pac.-IndoPac.-E.Atl.

P. (Pholadidea). Umbonal reflection raised well above umbos; mesoplax small, lacking basal portion; siphonoplax cuplike; siphonal tube lacking. *Eoc.-Rec.,* E.Atl.-IndoPac.——FIG. E187,*1-3.* **P. (P.) loscombiana* TURTON, Rec., Eng.; *1a,b,* adult RV ext., and LV int., showing small apophysis and large chondrophore, ×1.5; *2,* dorsal view of opposed valves with mesoplax and siphonoplax in place, ×1.5; *3,* lateral view of adult with siphonoplax, ×1.5 *(921b).*

P. (Hatasia) GRAY, 1851, p. 385 [**Pholas melanura* SOWERBY, 1834, p. 70; SD STOLICZKA, 1871, p. 21] [=*Hatoisia* SCHAUFUSS, 1869, p. 17 *(nom. null.); Hastasia* PAETEL, 1875, p. 91 *(nom. null.)*]. Umbonal reflection closely appressed, mesoplax in young stage flat, semicircular and in one piece, upper part, added in

adult stage, divided longitudinally, young basal part extending beyond it; siphonoplax composed largely of periostracum, variable in shape and size. Siphonal tube attached to siphonoplax. *Rec.* E.Pac.——Fig. E188,*1*. **P. (H.) melanura* (Sowerby), Panama *(1a,b)*, Mexico *(1c)*; *1a,* adult LV ext. with siphonoplax; *1b,* adult RV int.; *1c,* dorsal view of adult showing extension of callum over beaks and mesoplax, all ×1 *(921b)*.——Fig. E188,*2*. *P. (H.) tubifera* (Sowerby), Panama; lateral view of adult showing siphonal tube attached to the siphonoplax, ×2 *(921b)*.

Ramsetia Stephenson, 1941, p. 250 [**R. whitfieldi;* OD]. Shell *Martesia*-like, beaked and gaping anteriorly in young but closed by callum in adult; beaks diagonally truncated; umbonal-ventral ridge and sulcus present. Sculpture consisting of coarse concentric ridges which are crossed on anterior slope by weakened radial ribs. Accessory plates unknown. *U.Cret.,* N.Am.——Fig. E183,*3*. **R. whitfieldi,* Navarro Gr., USA(Tex.); *3a,* LV ext. (holotype); *3b,* RV ext. of another specimen; *3c,* dorsal view of opposed valves; all ×1 *(889)*.

Teredina Lamarck, 1818, p. 438 [**Fistulana personata* Lamarck, 1806, p. 429, 1808, pl. 43, fig. 6-7; SD Children, 1823, p. 81] [=*Fistulana* Lamarck, 1806 (*non* Lamarck, 1789) (obj.); *Teridina* Sowerby, 1839, p. 117 *(nom. null.)*]. Shell *Teredo*-like, particularly in young stage, but anterior gape closed by callum in adult; umbos covered by large, 4-lobed mesoplax which extends anteriorly; apophyses present; long, thick calcareous tube fused to valves anteriorly and in some shells divided by longitudinal partitions posteriorly; calcareous tube probably homologous with that found in some *Pholadidea,* to which seemingly it is most closely related. *U.Cret.-M.Mio.,* Eu.——Fig. E189,*1-6*. **T. personata* (Lamarck), France(Paris Basin); *1,* entire specimen; *2a,b,* dorsal and ventral views of opposed valves, mesoplax removed; *3a,b,* dorsal and ant. views of opposed valves showing lobed mesoplax; *4,* internal view of shells showing apophyses; *5,* abnormal post. end of tube with 2 openings; *6a,b,* posterior ends of tubes showing internal ribbing; all ×1 (*259,* pl. 3, fig. 10-15, 17-20).

Xylophomya Whitfield, 1902, p. 75, pl. 27-29 [**X. laramiensis;* OD]. Shell somewhat *Xylophaga*-like in general outline, anterior gape being closed by broad shieldlike plate (callum) in adult form; widely gaping posteriorly, with posterior margin of valves prolonged by thin, smooth tongue-shaped extensions, which probably fuse with lining of tube. Narrow umbonal-ventral sulcus present. Dorsal margin of RV with 4 minute toothlike denticles anterior to umbo. [Wood-boring.] *Cret.,* USA(Wyo.).——Fig. E190,*1*. **X. laramiensis,* Laramie Gr.; *1a,* outline showing form of RV; *1b,* composite sketch from several

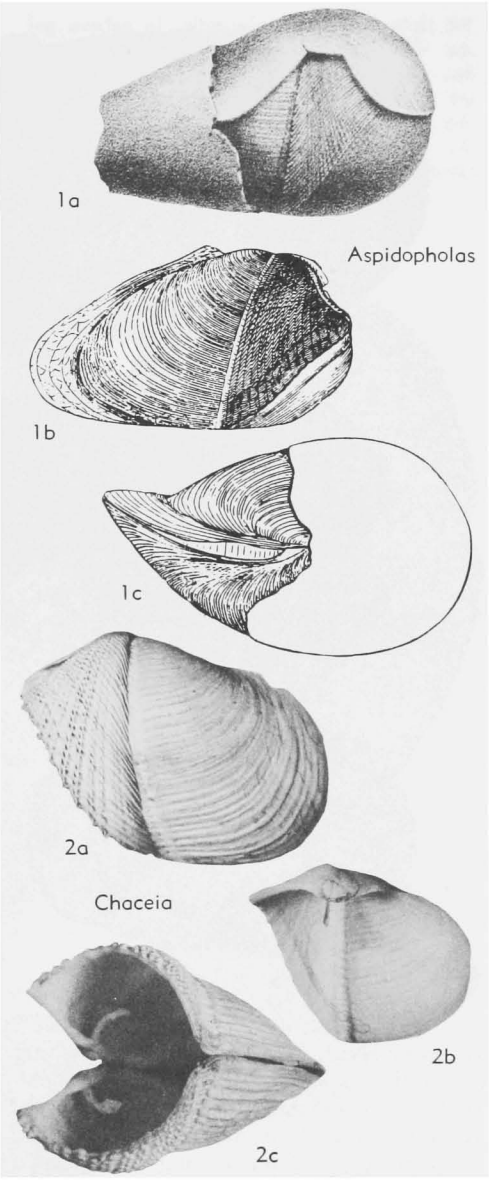


Fig. E179. Pholadidae (Martesiinae) (p. *N712*).

specimens to show sculpture and callum; *1c,* ant. end (reconstr.); *1d,* ant. teeth as seen on fragment chipped from between beaks; *1e,* outline of dorsal view of ant. end; *1a-c, 1e,* ×1; *1d,* ×3 *(982)*.

Subfamily JOUANNETIINAE Tryon, 1862

[*nom. correct.* Turner, 1955 (*pro* Jouannetinae Tryon, 1862)]

Shells in young stage more or less globu-

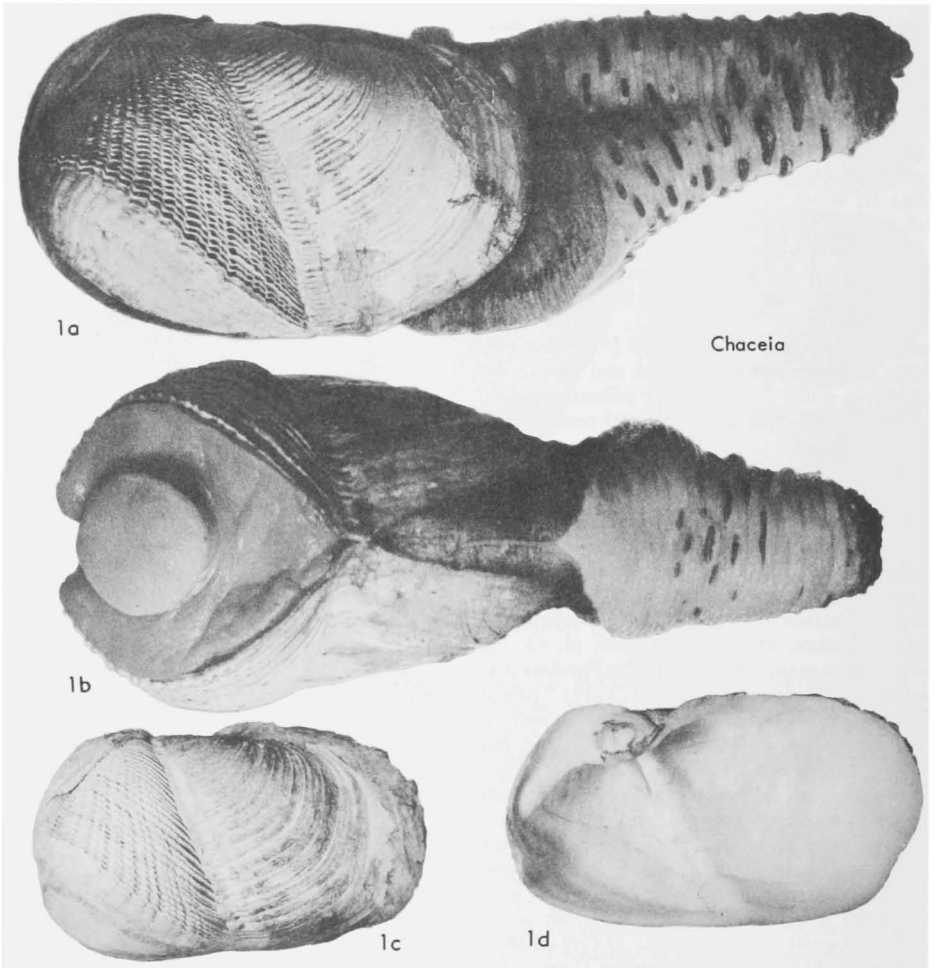


FIG. E180. Pholadidae (Martesiinae) (p. *N*712-*N*713).

lar, equivalved, beaked and widely gaping anteriorly; apophyses lacking; umbonal-ventral rib and sulcus present but weak; adult valves may or may not be equal; if inequivalved, callum closing pedal gape usually greatly produced anteriorly and entirely calcareous; if equivalved, callum flat and composed largely of periostracum. Rudimentary mesoplax present in some forms. Siphonoplax calcareous and variable in shape, unequal in *Jouannetia*. Foot well developed in young stage, atrophied in adult. Siphons capable of complete retraction within shell. Gills with two demibranchs. *U. Cret.-Rec.*

Jouannetia DESMOULINS, 1828, p. 244 [**J. semicaudata;* OD] [=*Iouannetia* GRAY, 1840, p. 154 *(nom. van.); Juanetia* D'ORBIGNY, 1846, p. 737 *(nom. null.); Juannetia* DESMAREST, in CHENU, 1859, p. 231 *(nom. null.)*]. Shells in young stage equivalved, beaked and widely gaping anteriorly, closed posteriorly; mesoplax, if present, in young shell more or less semicircular in outline and located in normal position transversing both valves, but displaced in adult by unequal growth of callum on LV; callum very large, that of LV being largest and overlapping callum of RV. Siphonoplax of LV, if present, always much smaller than that of RV, L siphonoplax always smooth, while R may be pectinate or smooth. Shell with or without an inwardly projecting lamina for the attachment of posterior adductor and pedal mus-

cles. [Shale- and soft-rock-borers.] *U.Cret.-Rec.*, cosmop., temp. and trop. seas.

J. (Jouannetia). Shell with special lamina for attachment of muscles; margin of siphonoplax smooth. *U.Cret.-Rec.*, cosmop. in temp. and trop. seas.——Fig. E191,*1*. **J. (J.) semicaudata* Des-Moulins, ?Eoc., France(Mérignac, Bordeaux); *1a,b*, right and left sides of complete adult showing overlap of callum from LV; *1c*, adult RV int. showing siphonoplax; *1d*, adult LV int. showing lack of siphonoplax; *1e-f*, RV int. and LV int. without callum, showing laminae for attachment of posterior adductor muscle; *1g*, ant. view of opposed valves without callum; *1h*, complete specimens as found in calcareous rock; all ×1 *(648)*.

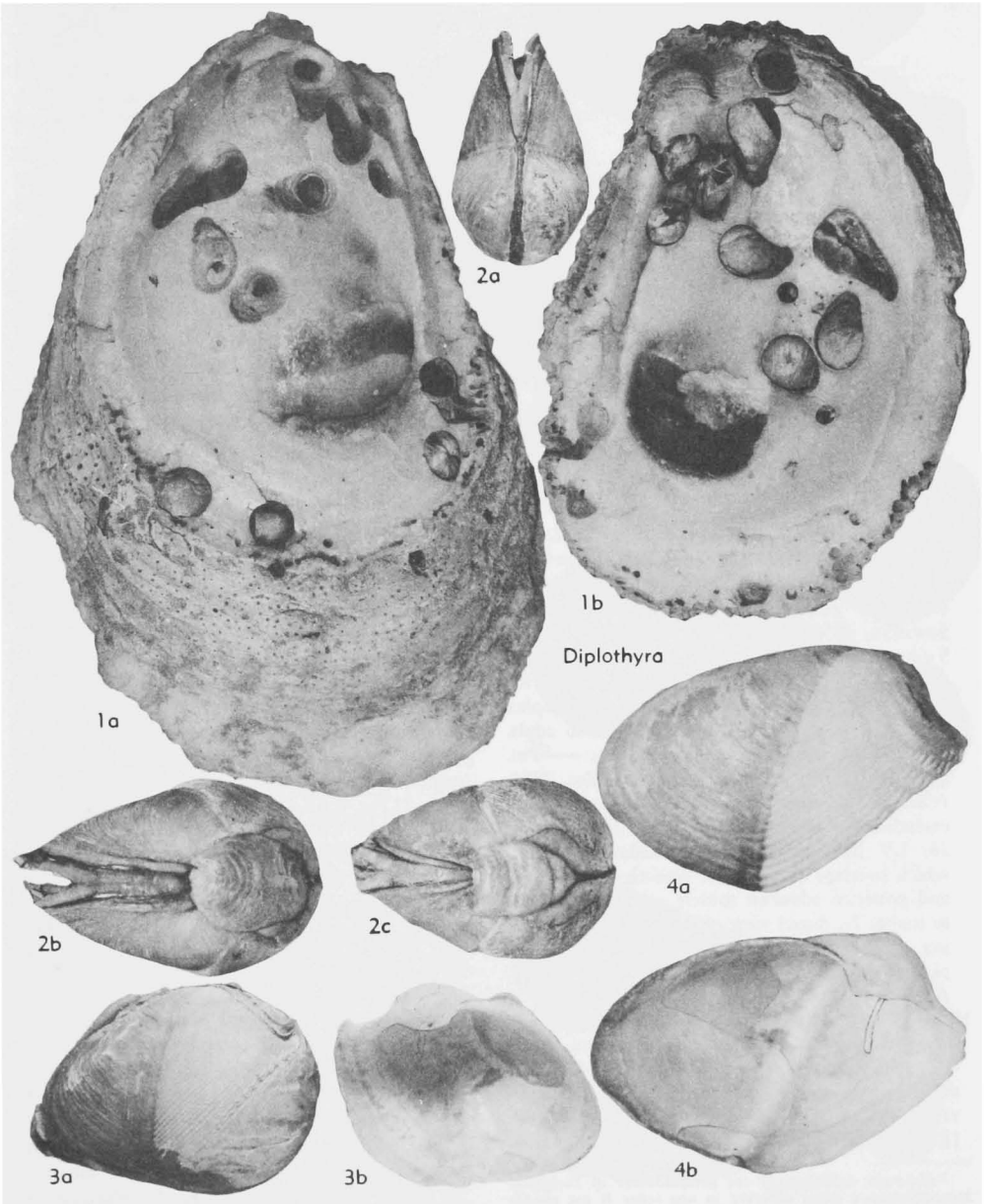


Fig. E181. Pholadidae (Martesiinae) (p. *N*713-*N*714).

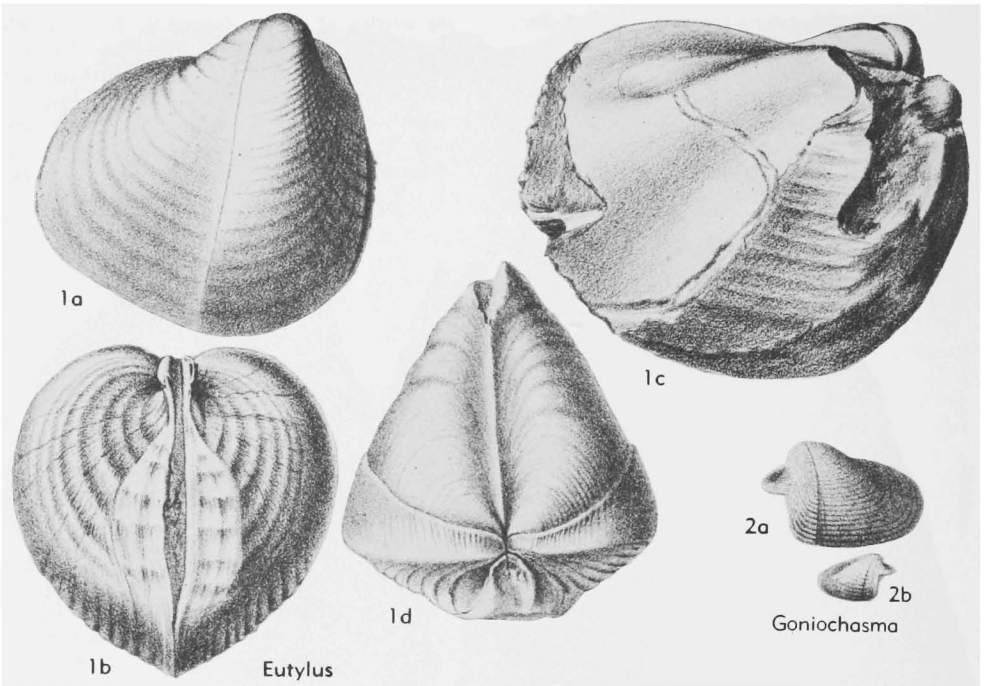


FIG. E182. Pholadidae (Martesiinae) (p. *N*714-*N*715).

J. (Pholadopsis) CONRAD, 1849, p. 156 [**Pholadopsis pectinata;* OD] [=*Triomphalia* SOWERBY, 1849, p. 500 (type, *Pholas globosa* QUOY) (=*Pholas globulosa* QUOY & GAIMARD; SD SOWERBY, 1850); *Triumphalia* PAETEL, 1890, p. 5 *(nom. null.); Triomphala* CLESSIN, 1892, p. 33 *(nom. null.)*]. Shells without special lamina for attachment of muscles; margin of siphonoplax pectinate; mesoplax small and displaced in adult. *Paleoc.-Rec.,* Eu.-W.Atl.-E.Pac.-IndoPac.——FIG. E192,*1*. **J. (P.) pectinata* (CONRAD), Rec., USA (Calif.); *1a,* adult RV ext. showing callum not extending to mid-line and pectinate siphonoplax; *1b,* LV int. showing greatly enlarged callum which overlaps RV, smaller smooth siphonoplax, and posterior adductor muscle scar just posterior to umbo; *1c,* dorsal view of opposed valves showing greatly enlarged LV callum which has displaced mesoplax; all ×1.5 *(1a,b,* holotype; *1c,* paratype) *(921b, 922)*.

Nettastomella CARPENTER, 1865, p. 202 [**Netastoma darwinii* SOWERBY in CARPENTER, 1865 (=*Pholas rostrata* VALENCIENNES, 1846, *non darwinii* SOWERBY); OD] [=*Netastoma* CARPENTER, 1864, p. 637 (*non Nettastoma* RAFINESQUE, 1810[1]); *Netastomella* PAETEL, 1875, p. 138 *(nom. null.); Nettastoma* LAMY, 1926 *(nom. null.)*]. Large pedal gape of young only partially closed by calcareous callum which forms band along anterior margin of shell in adult, equal on both valves or much wider on LV; periostracal callum with minute central pore filling most of pedal gape in adult. Siphonoplax, present on both valves or on RV only, may be short or long, straight, diverging or tapering and tubelike. Mesoplax, if present, small and fused with dorsal extension of callum on LV. [Shale- and soft-rock-borers.] *Plio.-Rec.,* N.Pac.-S.Atl.-S.Pac.——FIG. E193,*1;* E194,*1*. **N. rostrata* (VALENCIENNES), Rec., USA(Calif.); E193,*1a,* large LV ext. with wide callum and short siphonoplax; E193,*1b,* small LV ext. with long siphonoplax; E193,*1c,* dorsal view of opposed valves; E193,*1d,* RV int. with siphonoplax broken off; E193,*1e,* ventral view of specimen beginning to produce siphonoplax; all ×2.5; E194,*1,* specimen with LV removed to show muscles, siphons and periostracal callum with open central pore, ×4.5 *(921b, 922)*.

Scyphomya DALL, 1898, p. 822 [**Pholas semicostata* H. C. LEA, 1844, pl. 24, fig. 1; OD]. Shell similar to young *Jouannetia (Pholadopsis)*. [The location of the type of *P. semicostata* LEA is unknown and specimens labeled with this name by DALL proved to be young *J. (Pholadopsis)*, a genus not known to occur in the Atlantic at the time DALL was working. *Scyphoma* probably is a synonym of *Pholadopsis*.] *Tert.-Rec.,* W.Atl.

[1] Although according to the present rules of Zoological Nomenclature a name differing in one letter is not considered a homonym, this was not the case at the time CARPENTER himself instituted a new name for his *Netastoma*. Since *Nettastomella* has been in general use since CARPENTER introduced it in 1865 it is being retained in accordance with Article 23b.

Subfamily XYLOPHAGAINAE Purchon, 1941

[*nom. correct.* Turner, herein (*pro* Xylophaginae Turner, 1955, *non* Latreille, 1807) *nom. transl. ex* Xylophagidae Latreille, 1807 (*nom. correct.* Schiner, 1868, *pro* family Xylophagi Latreille, 1807, Insecta)] [=Xylophaginidae Purchon, 1941]

Shells small, globular, beaked and gaping anteriorly throughout life; beaks truncated at nearly right angles, giving shell a *Teredo*-like appearance. Apophyses absent. Anterior slope sculptured with numerous rows of finely denticulated ridges, as in Teredinidae; disc and posterior slope sculptured only by growth lines and low concentric ridges; umbonal-ventral ridge and sulcus well developed; ventral condyle usually present but weak; dorsal condyle lacking; chondrophore well developed. Accessory plates consisting only of small divided mesoplax, which varies greatly in shape. Posterior adductor muscle scar large, located high on posterior slope. Foot well developed, truncate and not atrophying in adult. Siphons commonly capable of retraction within shell, and quite variable. Excurrent siphon may be shorter than incurrent siphon and in some species exists only as series of lappets on dorsal side of incurrent siphon. Gills with single demibranch. Length of the tunnel ranging from slightly longer than the shell to about ten times the length of the valves, the posterior end often lined with agglutinized particles ejected from the excurrent siphon forming a chimney similar to that in *Parapholas*.[1] *U.Cret.-Rec.*

Attempts have been made to erect several genera on the basis of dorsal plate characters and type of siphons, but Knudsen (1961) has shown that these do not group naturally and that on the basis of our present knowledge there is no way to divide *Xylophaga*.

Xylophaga Turton, 1822, p. 258 [**Teredo dorsalis* Turton, 1819, p. 185; OD] [=*Xilophaga* Geinitz, 1845, p. 397 *(nom. null.); Xylotomea* Dall, 1898, p. 821 (new name *pro Xylophaga* Turton [*non Xylophagus* Meuschen, 1778; *nec* Meigen, 1803]—name not needed as *Xylophaga* and *Xylophagus* are not considered homonyms); *Xilotoma* Gigoux, 1934, p. 285 *(nom. null.); Protoxylophaga* Taki & Habe, 1945, p. 112 (type, *X. tomlini* Prashad; OD); *Neoxylophaga* Taki & Habe, 1950, p.

[1] A remarkable new genus of bathyal Xylophagainae was discovered while this work was in press. An account of it is being prepared now for publication. The two species (Western Atlantic and Eastern Pacific) are very *Teredo*-like in habit, making tunnels over 15 cm. long, the posterior two-thirds of which have a thin calcareous lining. If wood containing species of this genus were fossilized it probably would be impossible to distinguish them from teredinids.

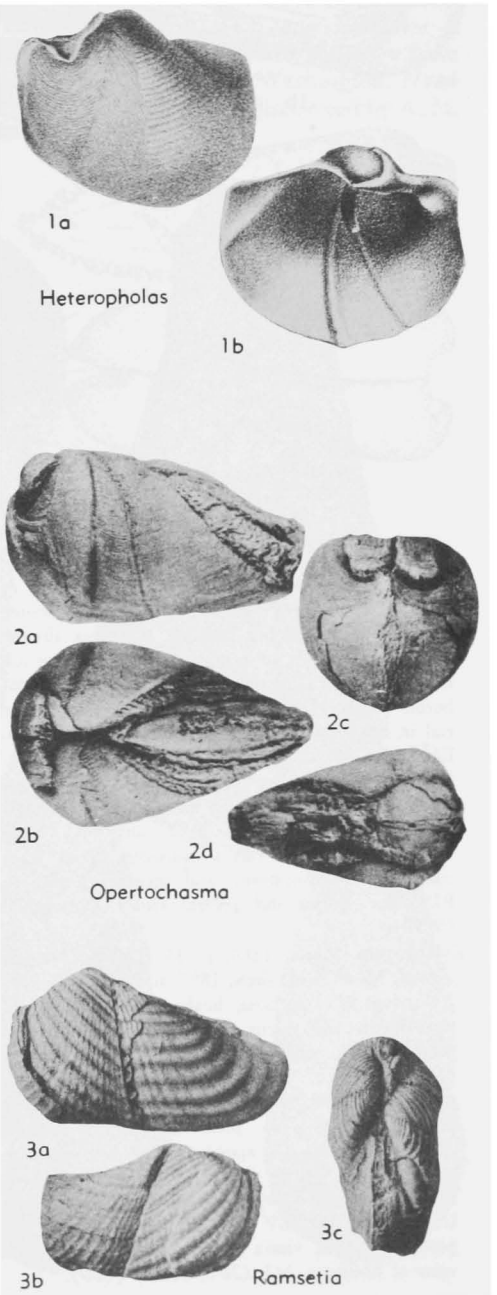


Fig. E183. Pholadidae (Martesiinae) (p. *N*715).

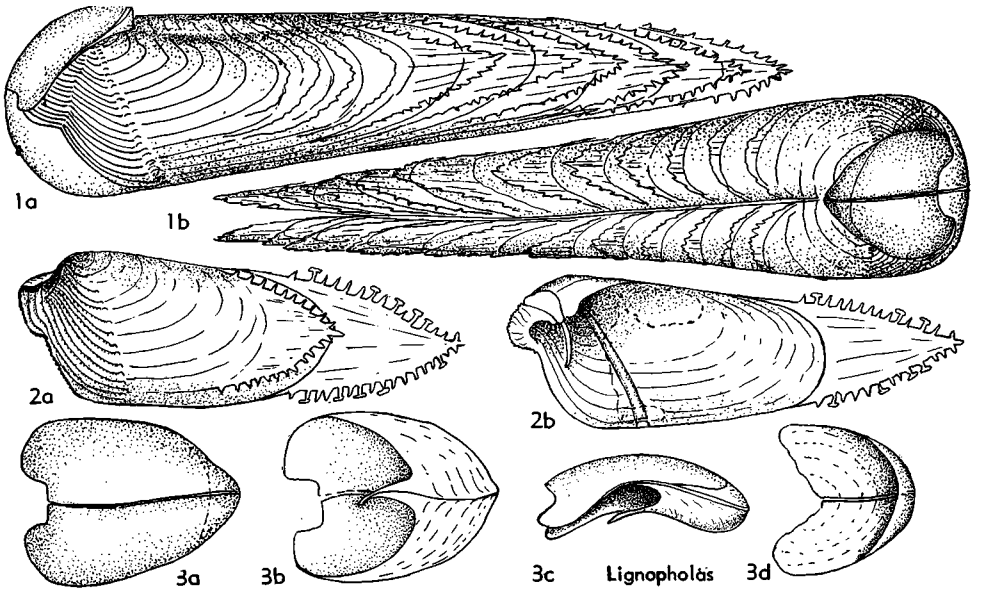


FIG. E184. Pholadidae (Martesiinae) (p. *N*715).

46 (type, *X. rikuzenica* TAKI & HABE; OD); *Metaxylophaga* TAKI & HABE, 1950, p. 47 (type, *M. supplicata* TAKI & HABE; OD). Shell globose, *Teredo*-like, apophyses lacking, mesoplax divided and variable in shape and size. Chondrophore and internal ligament present. Siphons variable. [Small borers usually found in water-logged plant material in deep water.] *U.Cret.-Rec.*, cosmop.——FIG. E195,*1,2*. **X. dorsalis* (TURTON), Rec., Scot.; E195,*1a,* LV ext. showing umbonal-ventral sulcus; E195,*1b,* LV int. showing muscle scars and umbonal-ventral ridge; E195,*1c,d,* ant. and dorsal views of opposed valves showing pedal gape, condyles, chondrophores, and mesoplax in place; E195,*2a,b,* dorsal and ventral views of mesoplax *(921b)*.

Xylophagella MEEK, 1864, p. 34 [**Xylophaga elegantula* MEEK & HAYDEN, 1857, p. 141; OD]. Shell *Xylophaga*-like, globose, beaks sharply truncated; umbonal-ventral sulcus and ridge present and extending from umbos in nearly straight line to ventral margin; internal ridge strongly crenate; second posterior internal ridge extending from umbos obliquely to posterior ventral margin. Accessory plates and apophyses not known. Burrows without shelly lining. *U.Cret.*, N.Am.——FIG. E190,*2*. **X. elegantula* (MEEK & HAYDEN), USA(Idaho); *2a,* LV ext.; *2b,* LV int. cast; *2c-e,* post., ant., post. views of opposed valves; *2f,* side view of holotype, ×1 *(2a-e,* ×3.5) *(609)*.

Family TEREDINIDAE Rafinesque, 1815

[*nom. correct.* DEKAY, 1843, p. 249 (*pro* Teredaria RAFINESQUE, 1815, p. 148)] [=Teredinites LATREILLE, 1825, p. 224; Teredinadae FLEMING, 1828, p. 409; Teredina GRAY, 1847, p. 188; Teredidae CARPENTER, 1861, p. 248; Teredinadae TRYON, 1862, p. 459 *(nom. null.)*]

Shells greatly reduced, covering only anterior tip of long wormlike animal (Fig. E164,*1a*). Burrow usually with calcareous lining which varies greatly in thickness and is in some species divided or has septa at distal end. Valves divided into three parts as shown in Figure E164,*1b,c*. Condyles (on which valves rock during boring process), umbonal-ventral ridge and apophyses prominent. Chondrophore and small internal ligament present in all species examined by author. Siphons separate or united, relatively short and with pair of pallets inserted at base which serve to close end of burrow when siphons are withdrawn. Gill with only single demibranch. Intestine not transversing heart, except in Kuphinae. Visceral mass extending in loop posterior to shell, as shown in Figure E162,*2*. Caecum present, except in the Kuphinae. *?Cret., Paleoc.-Rec.*

The classification of genera is based on the morphology of the soft parts and on the

pallets. The species are usually distinguished on the basis of pallets and siphons. The shells are almost useless in classification as they are extremely variable, depending upon the age of the specimen and the ecologic conditions affecting it. Similar shell forms may appear in widely separated genera.

Though many fossil species have been named, some as early as the Lower Cretaceous, most have been instituted on the basis of shells and tubes only, and consequently they cannot be placed definitely in any Recent genus. Pallets of *Bankia* have been recorded from the Paleocene of Iraq (Elliott, 1963, p. 315) and Durham & Zullo (1961, p. 1) described a *Bankia* from the Middle Oligocene of Washington. *Nototeredo* has recently been discovered by A. M.

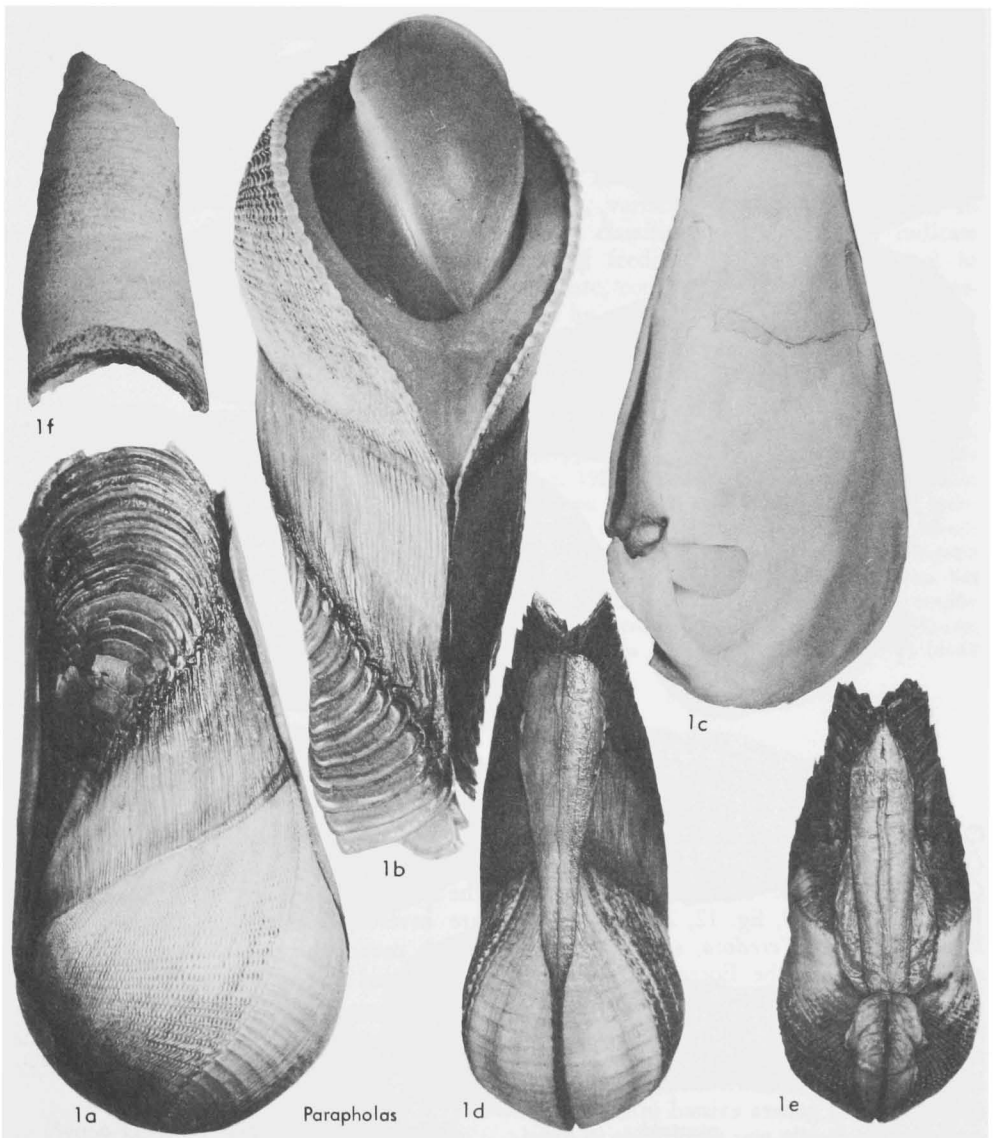


Fig. E185. Pholadidae (Martesiinae) (p. *N*715).

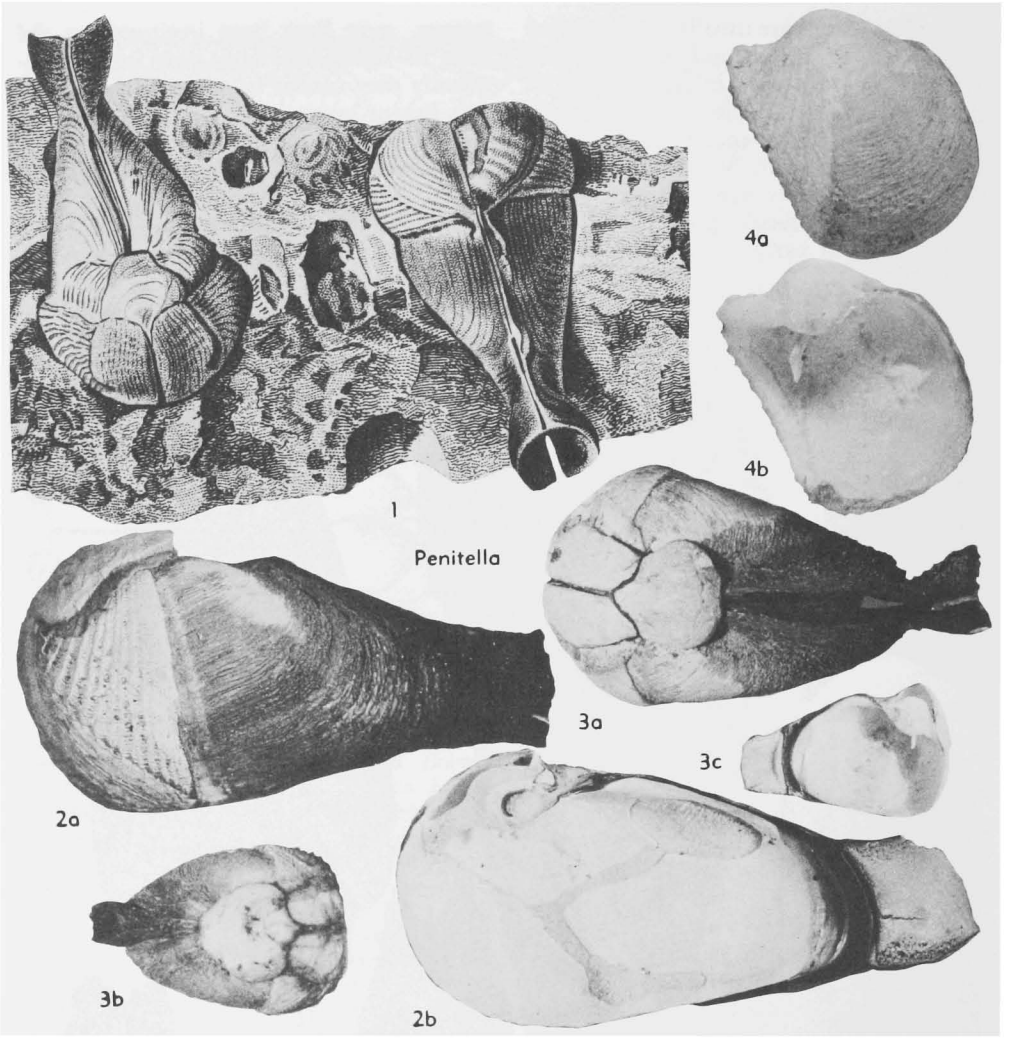


FIG. E186. Pholadidae (Martesiinae) (p. *N716*).

CVANCARA in the Cannonball Formation (Paleocene) of Morton Co., North Dakota (TURNER, 1966, p. 16, fig. 3; CVANCARA 1966, p. 350, pl. 9, fig. 12, 28). Pallets of *Bankia, Teredo, Teredora,* and *Nototeredo* are known from the Eocene of the Paris Basin, the Upper Eocene of Barton, Hampshire, England, and from Burgenland Formation, Austria. The fossil record is poor, but from what is known it may be assumed that all Recent genera existed in the Eocene and that the family was worldwide in distribution, for wherever sufficient fossilized wood is found in a marine horizon, evidence of borers is also eventually found. Unfortunately, the characters which distinguish the species, particularly in the genus *Bankia,* are invested mainly in the periostracum which covers the calcareous portion of the pallets, and this is not preserved in fossils. Pallets, devoid of periostracum, are similar in appearance, and so it is usually impossible to relate fossil forms definitely with any one living species.

Inferred relationships of Recent genera of the Teredinidae are shown diagrammatically in Figure E196.

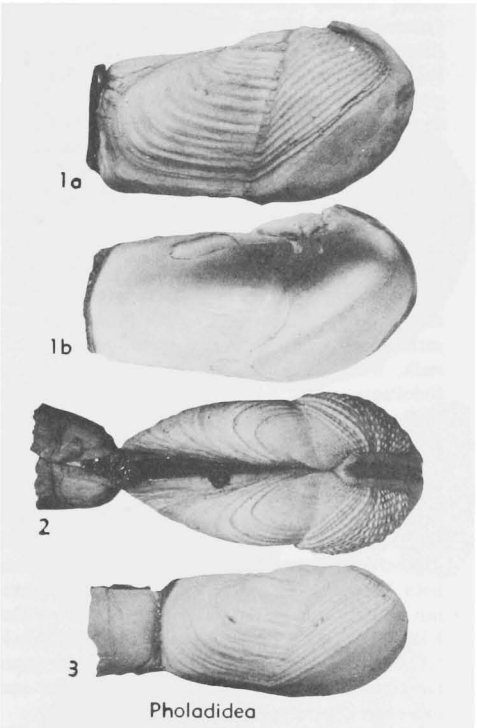


FIG. E187. Pholadidae (Martesiinae) (p. *N716*).

Subfamily TEREDININAE Rafinesque, 1815

[*nom. transl.* STOLICZKA, 1871, p. 11 (*ex* Teredaria RAFINESQUE, 1815)]

Wood-borers with posterior adductor muscle much larger than anterior one and without muscular collar surrounding body posterior to shell. Calcareous tube lining burrow, varying greatly in thickness but never as heavy as in Kuphinae. Digestive tract elongate, esophagus short, anterior portion of stomach and crystalline style in front of posterior adductor muscle; caecum and intestine extending posteriorly; intestine not transversing heart but passing beneath it, around posterior adductor muscle, and opening into anal canal. Length of gills, as well as size and type of stomach and posterior caecum, variable. These are important in generic classification and probably indicate type of feeding. Pallets nonsegmental in structure, composed of calcareous base covered by periostracum; blade increased in size by addition of material over entire surface. *Eoc.-Rec.*

Teredo LINNÉ, 1758, p. 651 [**T. navalis;* SD ICZN, 1926, opin. 94] [=*Teredigenus* RENIER, 1807, pl. vii (obj.) (ICZN, work rejected); *Toredo* MAY, 1929, p. 652 (*nom. null.*)]. Pallets variable in shape, but with blade always in one piece, periostracum usually thin and closely adhering to calcareous base (in some species may extend beyond calcareous portion distally as narrow border, but never forms cap, as in *Lyrodus*); blade usually sheathing stalk. Siphons usually separate. Young, in all species examined to date, carried in brood

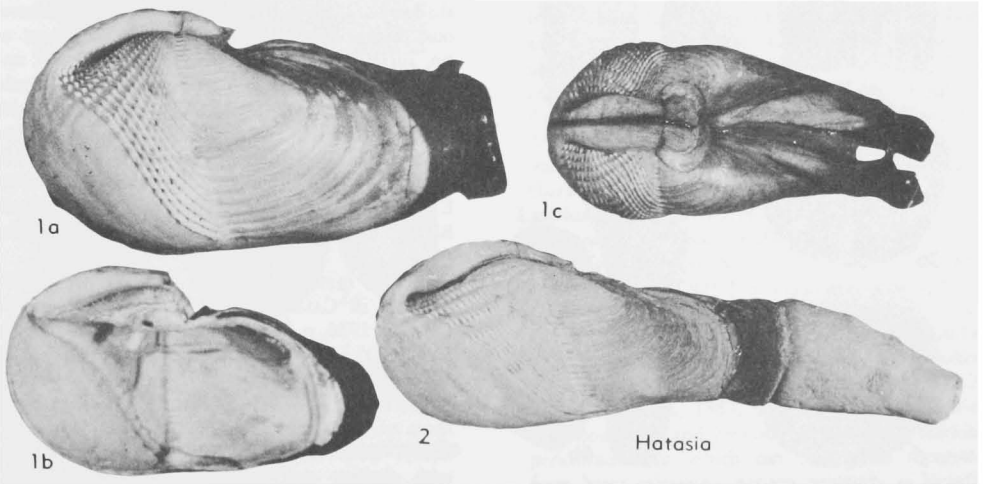


FIG. E188. Pholadidae (Martesiinae) (p. *N716-N717*).

pouch dorsal to gills. Anatomy generally similar to *Lyrodus*. [The genus has been divided into numerous subgenera which are probably of little value, as intergrades are constantly being found.

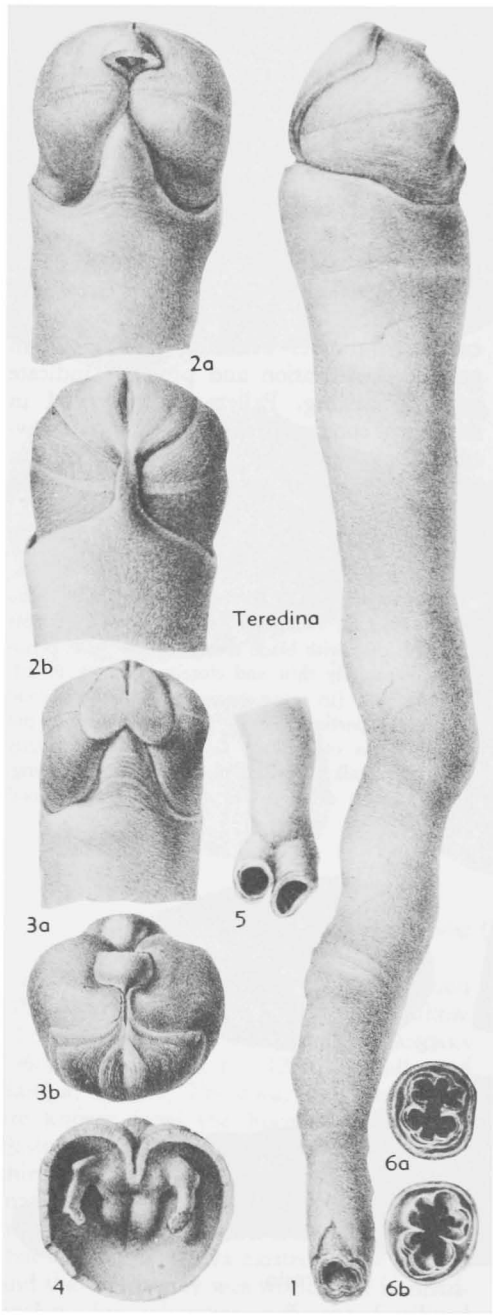


FIG. E189. Pholadidae (Martesiinae) (p. *N717*).

These, however, are listed and their type species figured.] *Eoc.*, Eu.(Eng.-Belg.-France)-*Rec.*, cosmop.

T. (Teredo) [=*Zopoteredo* BARTSCH, 1923, p. 96 (type, *Teredo (Zopoteredo) clappi;* OD); *T. (Austroteredo)* HABE, 1952, p. 249 (type, *Teredo (Teredo) parkşi* BARTSCH, 1921, p. 28; OD)]. Pallets white with thin pale yellow to dark brown periostracum covering distal portion of blade; distal margin of outer face U- or V-shaped, but varying from U-shaped to nearly straight on inner margin. *Eoc.-Rec.*, cosmop.——FIG. E197,*1*. **T. (T.) navalis* LINNÉ, USA(N.Y.); *1a,b,* LV ext. and int.; *1c,d,* pallet, outer and inner faces *(923)*.

T. (Coeloteredo) BARTSCH, 1923, p. 99 [**T. (C.) mindanensis;* OD]. Pallet blade wedge-shaped, convex on outer surface, concave to flat on inner surface and with deep cup extending nearly to stalk, which is short and swollen at base. *Rec.*, IndoPac.——FIG. E197,*2*. **T. (C.) mindanensis*, Philip.; *2a,b,* RV ext. and int.; *2c-e,* pallet, outer and inner faces and side (holotype) *(923)*.

T. (Pingoteredo) IREDALE, 1932, p. 30 [**Teredo shawi* IREDALE, 1932, p. 30; OD] [=*Pinguiteredo* HABE, 1952, p. 250 *(nom. null.)*]. Pallets similar in shape to *Teredo (Teredo)* but with thick periostracum extending beyond calcareous base, both laterally and distally (best seen with transmitted light). *Rec.*, temp. and trop. seas.——FIG. E197,*3*. **T. (P.) shawi* IREDALE, Australia; *3a,b,* LV ext. and int.; *3c-e,* pallet, outer and inner faces and side; *3f,g,* pallet of young, outer and inner faces (paratypes) *(923)*.

Bactronophorus TAPPARONE-CANEFRI, 1877, p. 290 [*nom. subst. pro Calobates* GOULD, 1862, p. 283 (*non* KAUP, 1829)] [**Teredo thoracites* GOULD, 1862, p. 283; OD]. Pallets asymmetrical, basal portion of blade more or less triangular, with shallow cup from which issues pustulose, calcareous, dagger-like blade. Siphons united except at tip, surrounded by wide mantle collar. Heart anterior, extending from posterior adductor muscle about 0.3 length of animal. Digestive system with globular stomach and large, thin-walled caecum. Gills broad and flattened ventrally with well-developed food groove. *Rec.*, IndoPac.——FIG. E198,*1*. **B. thoracites* (GOULD), *Australia; 1a,b,* RV ext. and int.; *1c,d,* pallet, outer and inner faces *(923)*.

Dicyathifer IREDALE, 1932, p. 28 [**Teredo manni* WRIGHT in CALMAN, 1920, p. 395 (=*D. caroli* IREDALE, 1936, p. 38, =*T. manni* WRIGHT, 1866, p. 565); OD] [=*Pseudodicyathifer* TCHANG, TSI & LI, 1958 (type, *Teredo manni* WRIGHT, 1866; OD)]. Pallets simple, solid, almost entirely calcareous, blade more or less triangular in outline, stalk long and heavy. Inner face of blade flat, outer face convex with shallow cup which is partially or almost completely divided by central, longitudinal ridge.

Shell with very broad anterior slope, disc narrow and posterior slope reduced in mature specimens, typical in young. Tube thick, solid and divided posteriorly. Siphons separate. Mantle collar around siphons narrow, rather muscular. Gills broad, truncated and extending from posterior tip of gonads to base of siphons. Branchial groove lateral and well developed. Labial palps attached. Stomach globular, caecum short and bulbous, intestine making simple loop around it; digestive gland large, extending posteriorly beyond caecum. Gonads mainly posterior to digestive glands. Heart anterior, about half length of animal; ventricle short and broad; auricles long, tapering and red-brown in color. Kidney large and dorsal to heart. *Rec.*, IndoPac.——Fig. E199,*1*. **D. manni* (Wright), Singapore; *1a,b,* LV ext., int. (apophysis broken); *1c,* RV ant.; *1d,* LV post.; *1e,f,* pallet, outer and inner faces; *1g,* entire animal, showing anatomical characters of genus with section cut out, ×2 *(923)*.

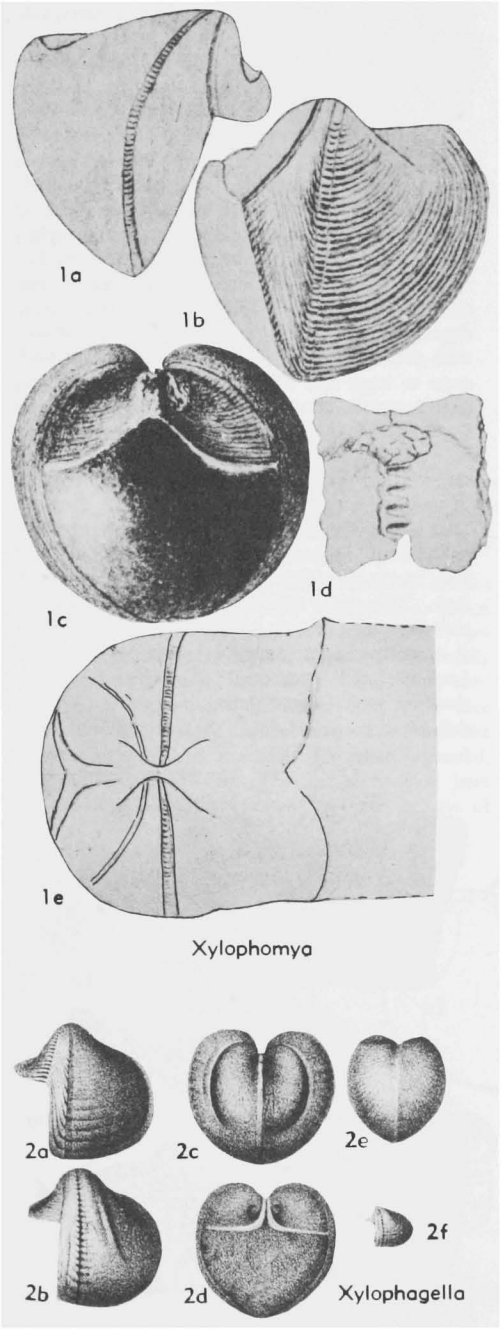


Fig. E190. Pholadidae (Martesiinae) *(1)*, (Xylophagainae) *(2)* (p. *N717*, *N722*).

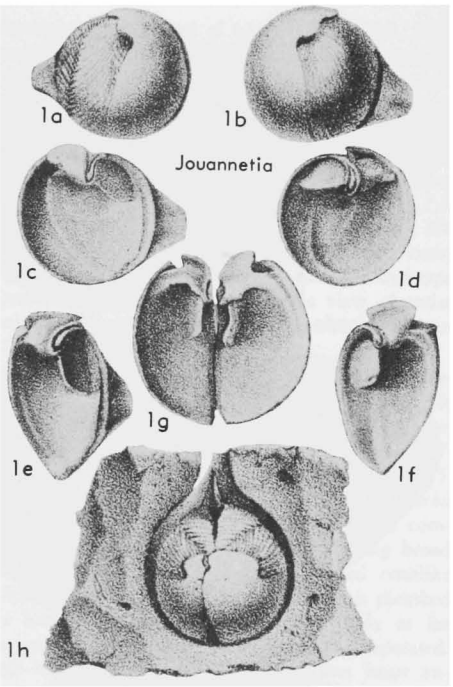


Fig. E191. Pholadidae (Jouanettiinae) (p. *N718-N719*).

Lyrodus Gould in Gould & Binney, 1870, p. 34 [**Teredo chlorotica* Gould, 1870, p. 33 (=*T. pedicellata* de Quatrefages, 1849, p. 26, *non* Döring, 1885); OD] [=*Teredops* Bartsch, 1921, p. 26 (type, *T. diegensis* Bartsch, 1916, p. 48; OD); *Cornuteredo* Dall, Bartsch & Rehder, 1938, p. 209 (type, *T. (Cornuteredo) milleri* Dall, Bartsch, & Rehder, 1938, p. 210, =*T. affinis* Deshayes, 1863, p. 6; OD)]. Pallets with calcareous base and pronounced brown to blackish periostracal cap which can readily be separated from base; calcareous portion narrowly to broadly rounded at distal end and commonly marked with growth lines. Distal margin of periostracal

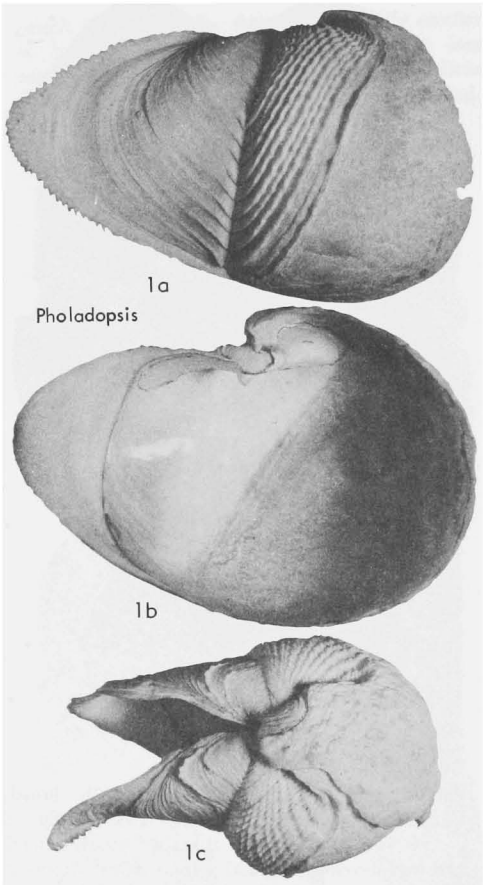


FIG. E192. Pholadidae (Jouannetiinae) (p. *N720*).

cap may be straight, broadly curved, or have lateral horns; cap may be solid or have bubble-like cavity which usually breaks open in old specimens, allowing cavity to become filled with debris which solidifies and produces a knoblike process. Siphons short and separate, gills long, bladelike, stomach elongate, caecum large, intestine making simple loop around caecum. Young carried in brood pouch dorsal to gills until veliger stage. *Rec.*, cosmop. in temp. and trop. seas.——FIG. E200, *1-3*. **L. pedicellatus* (DE QUATREFAGES), Br. Is. *(1)*, USA(Calif.) *(2)*, USA(Hawaii) *(3)*; *1a,b*, LV ext., int.; *1c-e*, pallet, outer and inner faces, lat.; *2a-e*, corresponding views of holotype of *L. diegensis* (type species of *Teredops*); *3a-d*, RV ext., int., outer and inner face of pallet, holotype of *L. milleri* (=lectotype of *L. affinis*, type species of *Cornuteredo*) *(923)*.

Neoteredo BARTSCH, 1920, p. 69 [**Teredo (Neoteredo) reynei* BARTSCH; OD]. Pallets simple, broadly oval, solid, slightly cupped at distal end and usually greatly eroded. Posterior end of animal with 2 long fleshy lappets on dorsal surface. *Rec.*, N.S. Am.-W.Afr.——FIG. E201,*1*; E202,*1*. **N. reynei* (BARTSCH), Surinam; E201,*1*, entire animal (61 cm. long); E202,*1a,b*, RV ext., int. (apophysis lost); E202,*1c-e*, pallet, outer and inner faces, side view (holotype) *(923)*.

Psiloteredo BARTSCH, 1922, p. 36 [**Teredo dilatata* STIMPSON, 1851, p. 113 (=*T. megotara* HANLEY, 1848, p. 77); OD] [=*Dactyloteredo* MOLL, 1941, p. 193 (type, *Teredo megotara* HANLEY, 1848, p. 77; SD MOLL, 1952, p. 83)]. Pallets broad to elongate oval in outline, solid, almost entirely calcareous, and with short stalk. Blade thick at base, becoming thin at distal margin, slightly concave on inner face, convex on outer; outer face variable, usually with moderate to deep thumbnail-like depression, paddle-like, or with slight depression and 2 finger-like projections. Valves with prominent condyles; the posterior slope moderate to large and usually flaring. Tubes probably concamerated at posterior end. Siphons united for most of their length. Gills extending from base of siphons to visceral mass; intestine making simple loop around the caecum. *Rec.*, cosmop. in temp. and trop. seas.——FIG. E162,*2*. *P. healdi* (BARTSCH), Surinam; entire animal showing major features of anatomy *(923)*.——FIG. E203,*2a-d*. **P. megotara* (HANLEY), Brit. Is. (lectotype); *2a,b*, LV ext., RV int., *2c,d*, outer and inner face of pallet *(923)*.——FIG. E203,*2e-h*. *P. megotara excisa* (JEFFREYS), Brit. Is. (lectotype) [=deformed *P. megotara*]; *2e,f*, LV ext., LV int. showing typical large dorsal condyle but reduced deformed posterior slope; *2g,h*, outer and inner face of pallet *(923)*.

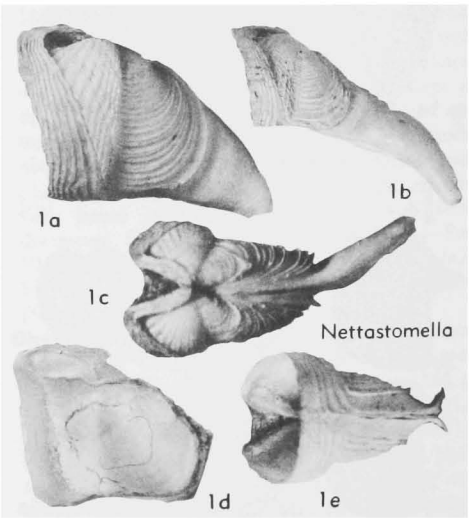


FIG. E193. Pholadidae (Jouannetiinae) (p. *N720*).

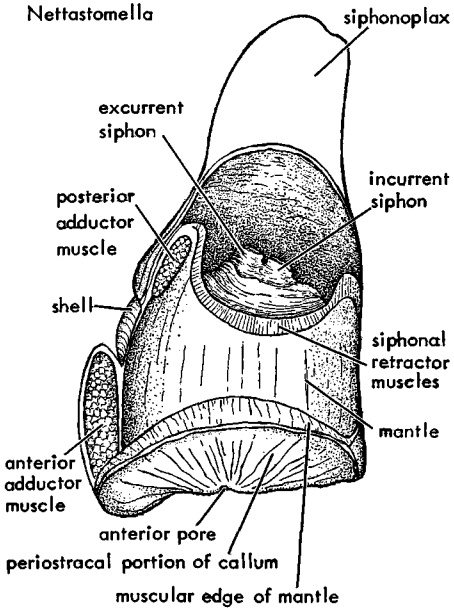


FIG. E194. Pholadidae (Jouannetiinae) (p. *N*720).

Teredora BARTSCH, 1921, p. 26 [**Teredo malleolus* TURTON, 1822, p. 255; OD] [=*Malleolus* GRAY, 1847, p. 188 (obj.) (*non* RAFINESQUE, 1815; *nec* EHRENBERG, 1838)]. Pallets narrowly to broadly oval in outline with short stalk; blade thin, convex on outer, concave on inner face, outer face with small to large, usually deep, thumbnail-like depression which is marked with broadly curved, concentric growth lines. Thickened area at base of pallet smooth. Stalk extending only to base of depression. Distal end of tube concamerated. Shell usually with small, high posterior slope. Siphons united. Gill lamellae bladelike, extending length of animal from base of siphons to mouth. Heart anterior, with short broad ventricle and small auricles. Stomach transitional, caecum doubling on itself. Intestine short, making only simple loop around caecum. *Rec.,* cosmop.——FIG. E204,*1,2.* **T. malleolus* (TURTON), Eng.; *1a,b,* LV ext., RV int.; *1c-e,* pallet, outer and inner face, side view; *1f,g,* pallet, outer and inner face of lectotype (malformed); *2,* semidiagrammatic view of entire animal showing anatomical characters of genus (from Sénégal) *(923).*

Teredothyra BARTSCH, 1921, p. 26 [**Teredo (Teredothyra) dominicensis* BARTSCH, 1921, p. 26, 30; OD] [=*Ungoteredo* BARTSCH, 1927, p. 544 (type, *Teredo (Ungoteredo) matacotana* BARTSCH, 1927, p. 544; OD); *T. (Idioteredo)* TAKI & HABE, 1945, p. 115 (type, *Teredo (Teredothyra) smithii* BARTSCH, 1927, p. 540)]. Blade of pallets composed of 2 elements, basal portion forming broad to elongate cup with secondary divided conelike element within it; stalk of pallet, which is sheathed by basal cone, extending into blade only as far as base of inner cone. Siphons long and separated. Gill long, lamellae thin and bladelike; heart anterior, extending beneath posterior adductor muscle. Digestive system with globular stomach, small caecum which folds on itself, and short intestine. *Rec.,* warm temp. and trop seas.——FIG. E205, *1,2.* **T. dominicensis* (BARTSCH), W.Indies; *1a,b,* LV ext., int.; *1c,* distal end of tube showing division and thickening; *1d,f,* outer faces of pallets; *1e,g,* inner faces of pallets; *1h,* side view of pallet (*1a-h,* holotype of *T. atwoodi* BARTSCH, =*T. dominicensis,* adult); *2a,b,* RV ext., int.; *2c,* distal end of tube; *2d-f,* pallet, outer and inner face, side

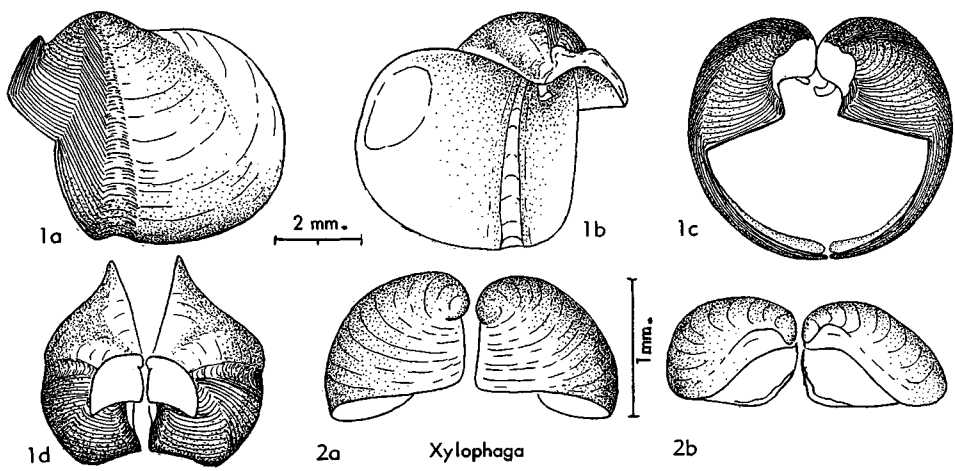


FIG. E195. Pholadidae (Xylophagainae) (p. *N*721-*N*722).

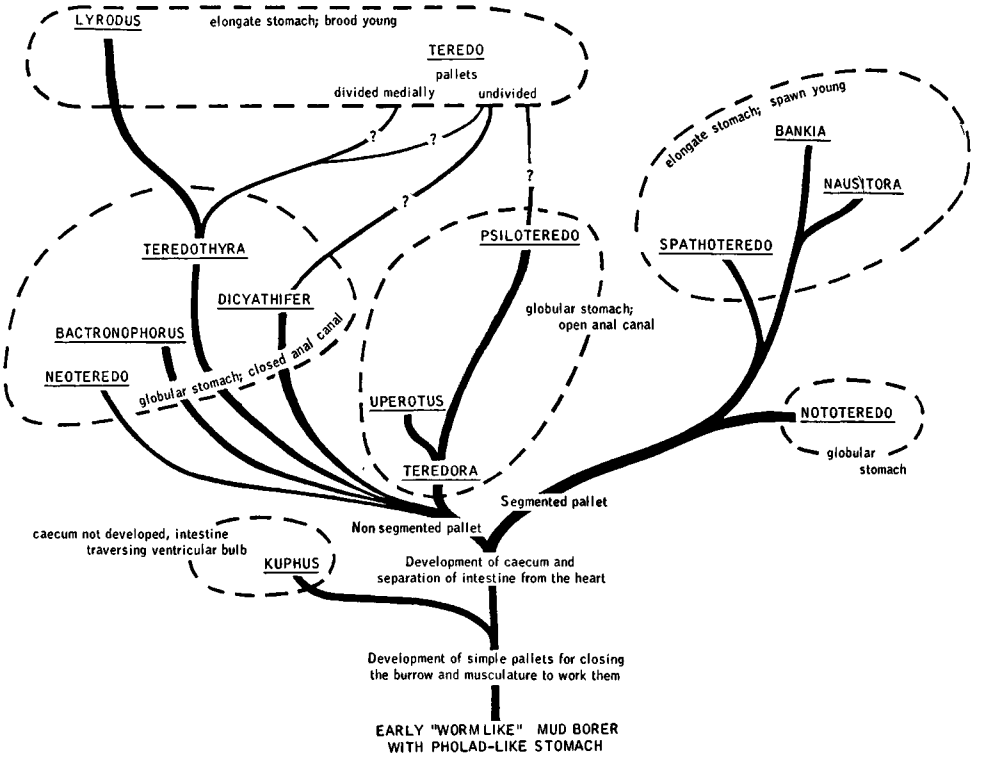


FIG. E196. Diagrammatic representation of relationships of living genera of Teredinidae *(923)*.

view *(2a-f, T. dominicensis,* holotype, young specimens) *(923)*.

Uperotus GUETTARD, 1770, p. 126 [**Teredo clava* GMELIN, 1791, p. 3748; SD LAMY, 1927, p. 275] [=*Fistulana* LAMARCK, 1799, p. 90 (obj.) (*non* MÜLLER, 1776, *nec* BRUGUIÈRE, 1789; *Fistulani-genus* RENIER, 1807, pl. 7 (obj.) (ICZN, work rejected); *Guetera* GRAY, 1840, p. 42 *(nom. nud.)*, 1847, p. 188 (type, *Fistulana corniformis* LAMARCK, 1799, =*T. clava* GMELIN, 1791; OD); *Hyperotus* HERRMANNSEN, 1847, p. 671 *(nom. van.); Hyperotis* PAETEL, 1875, p. 99 *(nom. null.); Guettera* H. ADAMS & A. ADAMS, 1856, p. 333 *(nom. null.); Glumebra* IREDALE, 1936, p. 42 (obj.) (type, *G. elegans,* =*T. clava* GMELIN; OD)]. Pallets oval to rectangular in outline with short heavy stalk, basal portion of blade nearly smooth, distal portion with pronounced radiating ribs. Shells with anterior and posterior slopes greatly reduced or typical in shape, with small, high posterior slope. [Species in this genus are usually obtained from dredged nuts or wood or from drift cast ashore. They are probably not an intertidal group. The anatomy of this species in this genus is very close to that of *Teredora,* gill extending from base of siphons to mouth (Fig. E204,2).] *Rec.,* IndoPac.-E.Pac.-E.Atl.——FIG. E206,*1*. **U. clavus* (GMELIN), Australia(Queensl.) (from a nut); *1a,b,* RV (holotype of *Glumebra elegans* IREDALE), ext., int., ×5; *1c,* cluster of tubes, ×0.9; *1d-f,* pallet, outer and inner face, side view, ×3 *(435)*.——FIG. E206, *2a-g. U. lieberkindi* ROCH (from dredged wood) off Rio de Oro, Afr.; *2a,b,* RV (holotype) ext., int.; *2c-g,* pallet, outer and inner face, side view *(923)*.

Zachia BULATOV & RZHAVSHCHIKOV [RJABTSCHIKOFF], 1933, p. 166 [**Z. zenkewitschi;* SD HABE, 1952, p. 255]. Shells greatly reduced; pallets similar to *Spathoteredo*. [Species living in roots of *Phylospadix,* apparently stenomorphic and malformed.] *Rec.,* N.Pac.——FIG. E207,*1*. **Z. zenkewitschi,* USSR(Vladivostok); *1a,* ant. view of opposed valves, ×20; *1b,* RV ext., ×20; *1c,d,* outer and inner face of pallet, ×40 (*1a-d,* holotype) *(90)*.

Subfamily BANKIINAE Turner, 1966

Wood-borers with pallets composed of numerous segments which may be very closely packed and indistinct (e.g., *Nototeredo, Spathoteredo*), distinct but fused

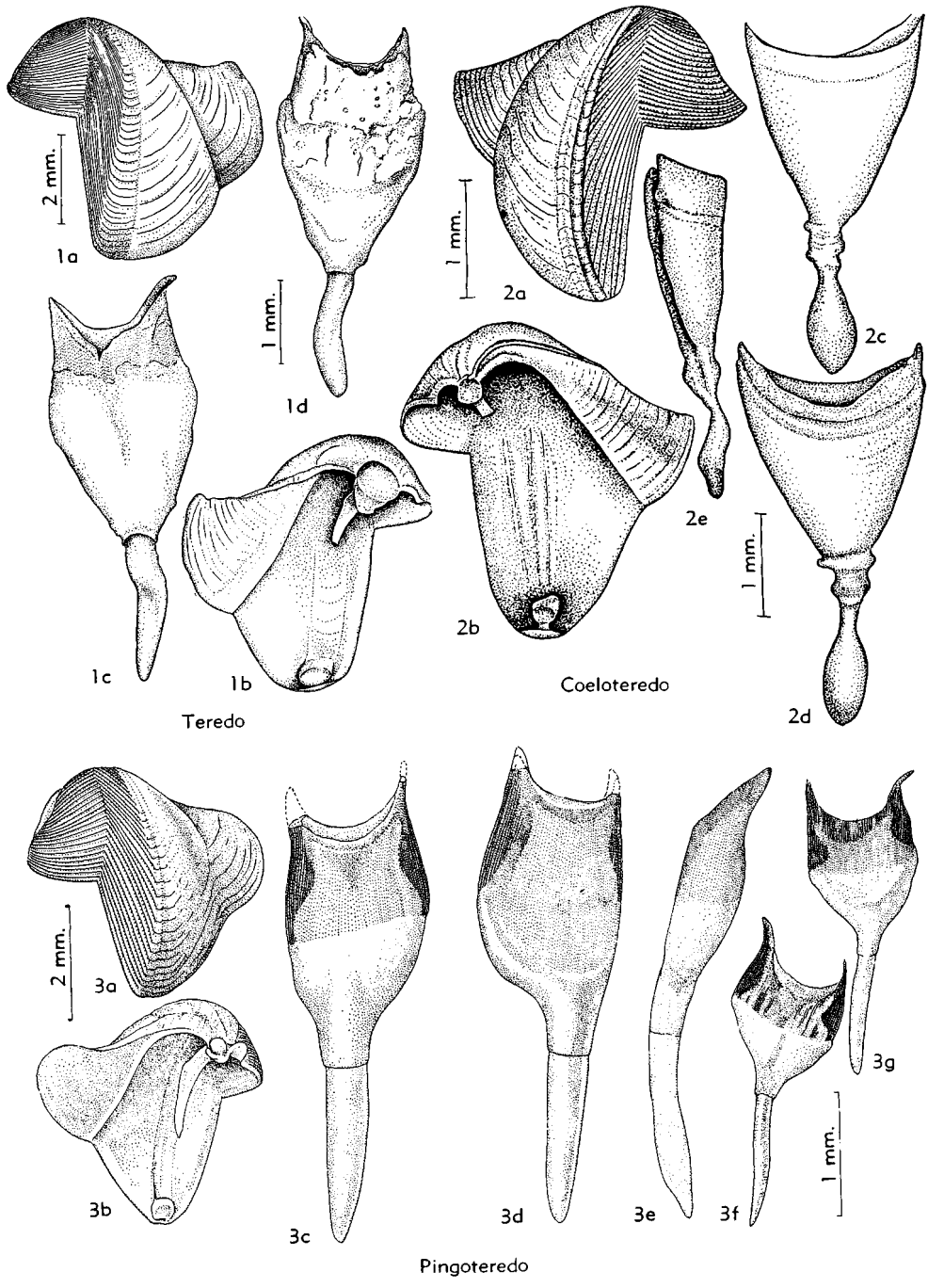


FIG. E197. Teredinidae (Teredininae) (p. *N725-N726*).

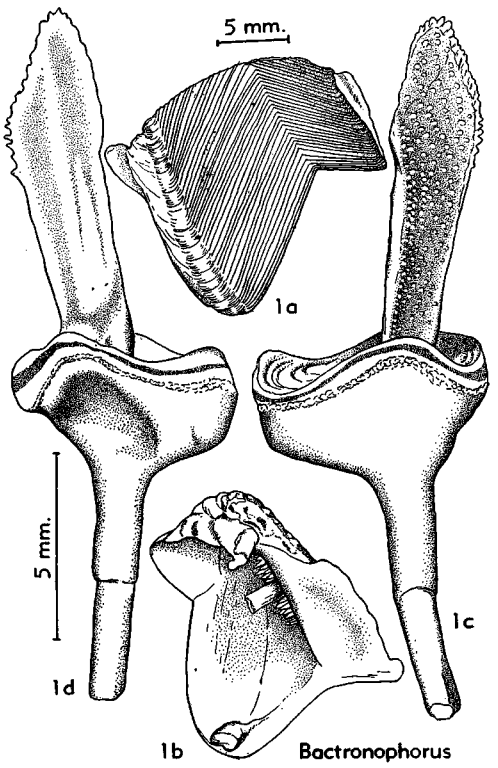


FIG. E198. Teredinidae (Teredininae) (p. *N726*).

(e.g., *Nausitora*), or widely spaced and conelike (e.g., *Bankia*). Blade of pallet increased in size by addition of new segments at distal end. Valves similar to those of Teredininae. *Paleoc.-Rec.*

Bankia GRAY, 1842, p. 76 [**Teredo bipalmulata* LAMARCK, 1801, p. 129; SD GRAY, 1847, p. 188] [=*Xylotrya* LEACH in GRAY, 1847, p. 188 (*non* MENKE, 1830; *nec* GRAY, 1842) (type, *Teredo bipalmulata* LAMARCK, 1801; OD); *Xylotyra* DE QUATREFAGES, 1849, p. 28 *(nom. null.); Xylotria* DESHAYES, 1860, p. 114 *(nom. null.); Xylotya* VON MARTENS, 1880, p. 331 *(nom. null.); Hylotrya* CLESSIN, 1893, p. 82 *(nom. null.)*]. Pallets elongate, composed of numerous conelike elements built upon central stalk which extends length of blade, cones separate and easily removed from stalk, base of cones calcareous, with periostracal covering extended as border which varies greatly in width, may be smooth or fringed, and may be produced laterally as awns. [The genus has been divided into numerous subgenera on the basis of ornamentation of the periostracal border and the presence or absence of awns, but these taxa prob-

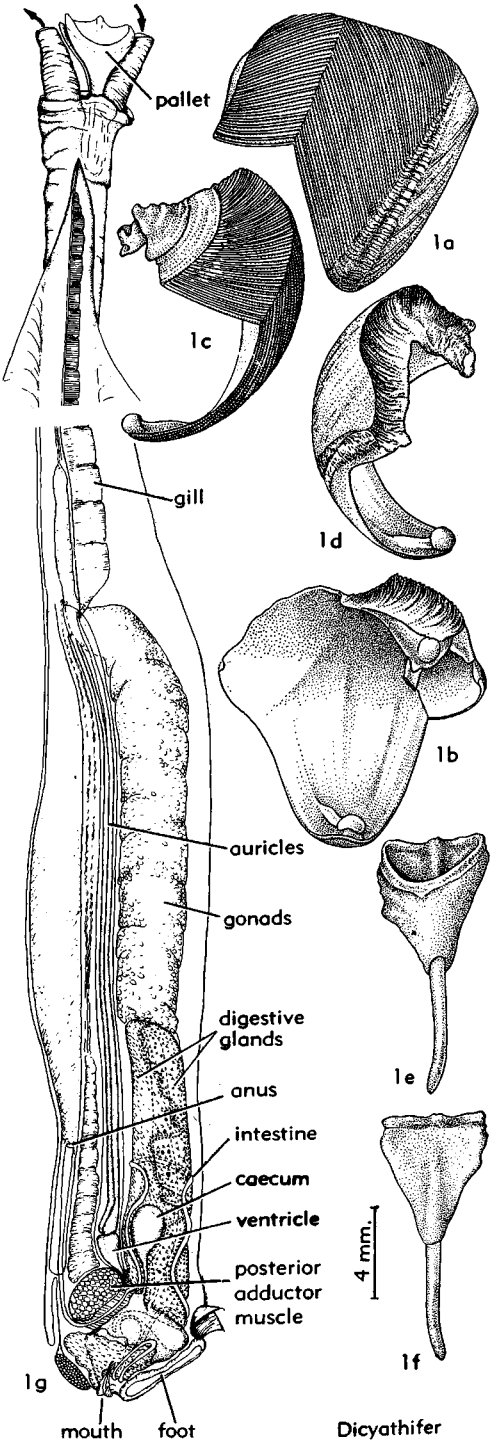


FIG. E199. Teredinidae (Teredininae) (p. *N726-N727*).

ably have small value owing to the presence of intergrades. However the subgenera are listed and a figure of the type species given.] The periostracum is not preserved in fossils, so usually the best one can do is refer to a fossil as *Bankia* sp. *Paleoc.-Rec.*, cosmop.

B. (Bankia) GRAY, 1842 [=*Bankiura* MOLL, 1952, p. 8, 42, 85 (obj.)]. Margin serrated on inner face, smooth on outer face and produced in unequal lateral awns, those on one side being 2 to 3 times length of other. *?Paleoc., Rec.,* IndoPac.

——FIG. E208,*1*. **B. (B.) bipalmulata* (LAMARCK), New Hebrides; *1a,b,* pallet, outer and inner faces *(920)*.

B. (Bankiella) BARTSCH, 1921, p. 25-26 [**Bankia (Bankiella) mexicana* (=*B. gouldi* BARTSCH, 1908); OD]. Margins of cones smooth, lateral awns long and thin. Margin on inner face wide, forming "web" between awns. *Rec.,* cosmop.—— FIG. E208,*2*. **B. (B.) gouldi* BARTSCH, USA(Va.); *2a,b,* pallet, outer and inner faces *(920)*.

B. (Clupibankia) MOLL, 1952, p. 42, 85 [**Bankia*

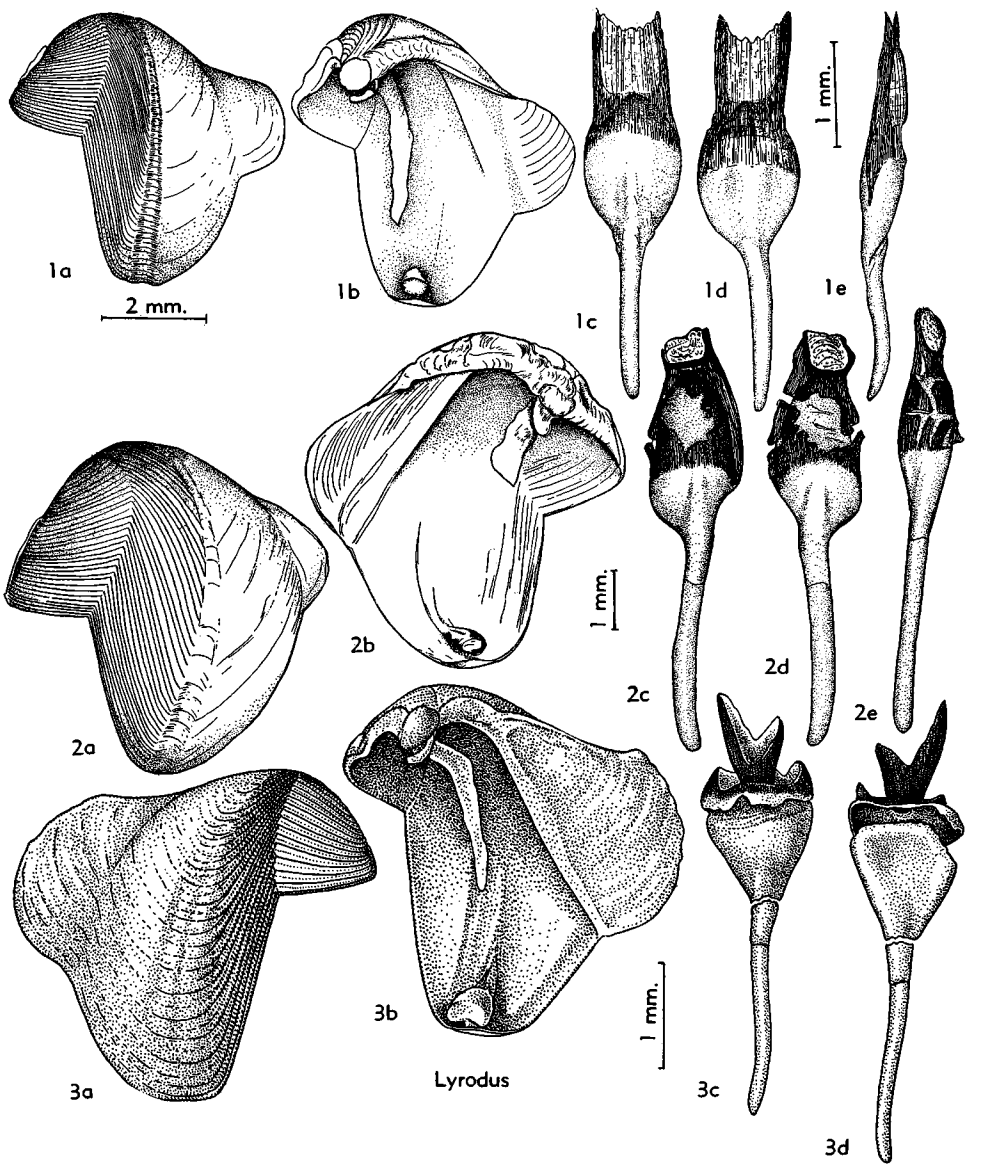


FIG. E200. Teredinidae (Teredininae) (p. *N727-N728*).

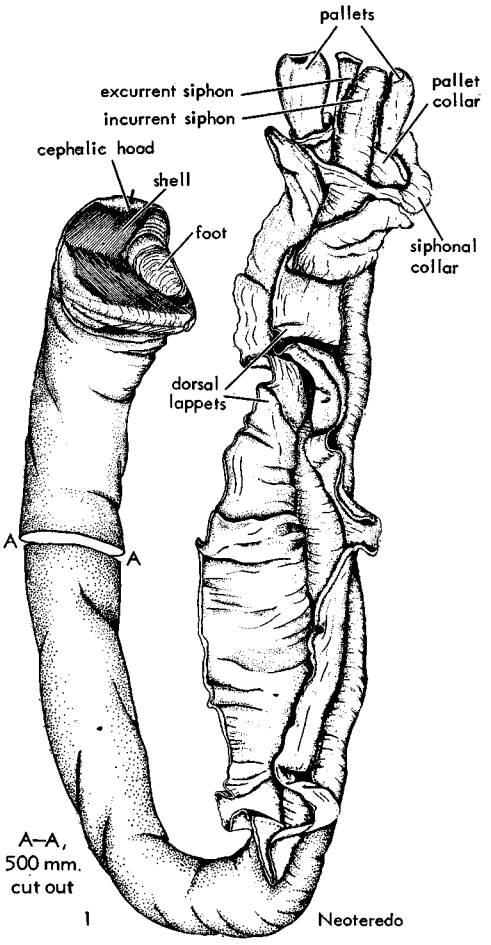


FIG. E201. Teredinidae (Teredininae) (p. *N728*).

barthelowi BARTSCH, 1927, p. 537; OD]. Calcareous portion of cones wide on inner face so that cones overlap one another; margin serrate on outer face, smooth on inner face. *Rec.*, IndoPac.——FIG. E208,*4*. **B. (C.) barthelowi* BARTSCH, Philip. Is.; outer face of pallet *(923)*.

B. (Liliobankia) CLENCH & TURNER, 1946, p. 17 [**B. (L.) katherinae* (=*B. campanellata* MOLL & ROCH, 1931); OD]. Margin of cones wide, smooth and produced laterally to form broad triangular awns. Embryonic cones separated. *Rec.*, subtrop. and trop. seas.——FIG. E208,*5*. **B. (L.) campanellata* MOLL & ROCH; *5a,b*, pallet, outer and inner faces *(920)*.

B. (Lyrodobankia) MOLL, 1941, p. 200 [**Nausitora kamiyai* ROCH, 1929, p. 17 (=young *B. carinata* GRAY, 1827); SD TURNER, 1966] [=*Bankiopsis* CLENCH & TURNER, 1946 (type, *B. (B.) caribbea* (=*B. carinata* GRAY) (obj.); OD)]. Margin smooth, equal width on both inner and outer faces, and produced laterally into short, blunt points. Embryonic cones closely packed and covered by periostracal cap. *Rec.*, temp. and trop. seas.——FIG. E208,*3*. **B. (L.) carinata* (GRAY), USA(Fla.) *(3a,b)*, Japan *(3c,d)*; *3a,b*, pallet, outer and inner face (holotype of *B. (Bankiopsis) caribbea* CLENCH & TURNER) *(920)*; *3c,d*, pallet, outer and inner face (holotype of *Nausitora kamiyai* ROCH, =young *B. carinata* GRAY) *(923)*.

B. (Neobankia) BARTSCH, 1921, p. 26 [**B. (N.) zeteki*; OD] [=*Deviobankia* IREDALE, 1932, p. 33 (type, *Bankia debenhami* IREDALE, 1932; OD)]. Margin of cones wide, even, serrated on both inner and outer faces and not produced laterally to form awns. *Rec.*, warm temp. and trop. seas.——FIG. E208,*6*. **B. (N.) zeteki*, Panama; *6a,b*, pallet, outer and inner faces *(920)*.

B. (Plumulella) CLENCH & TURNER, 1946, p. 22 [**B. fimbriatula* MOLL & ROCH, 1931; OD]. Margin of cones serrated on both inner and outer faces and produced laterally into long serrated awns. *Rec.*, temp. and trop. seas.——FIG. E208, *7*. **B. (P.) fimbriatula* MOLL & ROCH, Haiti; *7a,b*, pallet, outer and inner faces *(920)*.

Nausitora WRIGHT, 1864, p. 452 [**N. dunlopei*; OD] [=*Nausitoria* TRYON, 1868, p. 20 *(nom. null.)*; *Naucitora* SOWERBY, 1887, pl. 469, fig. 3 *(nom. null.)*; *Nausitoria* ROCH & MOLL, 1929,

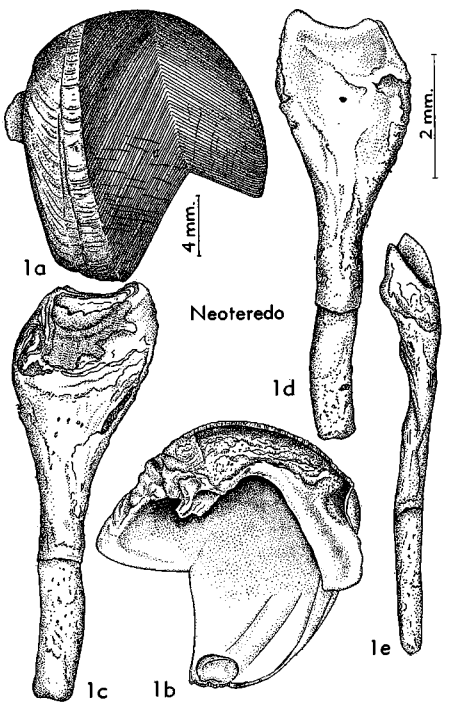


FIG. E202. Teredinidae (Teredininae) (p. *N728*).

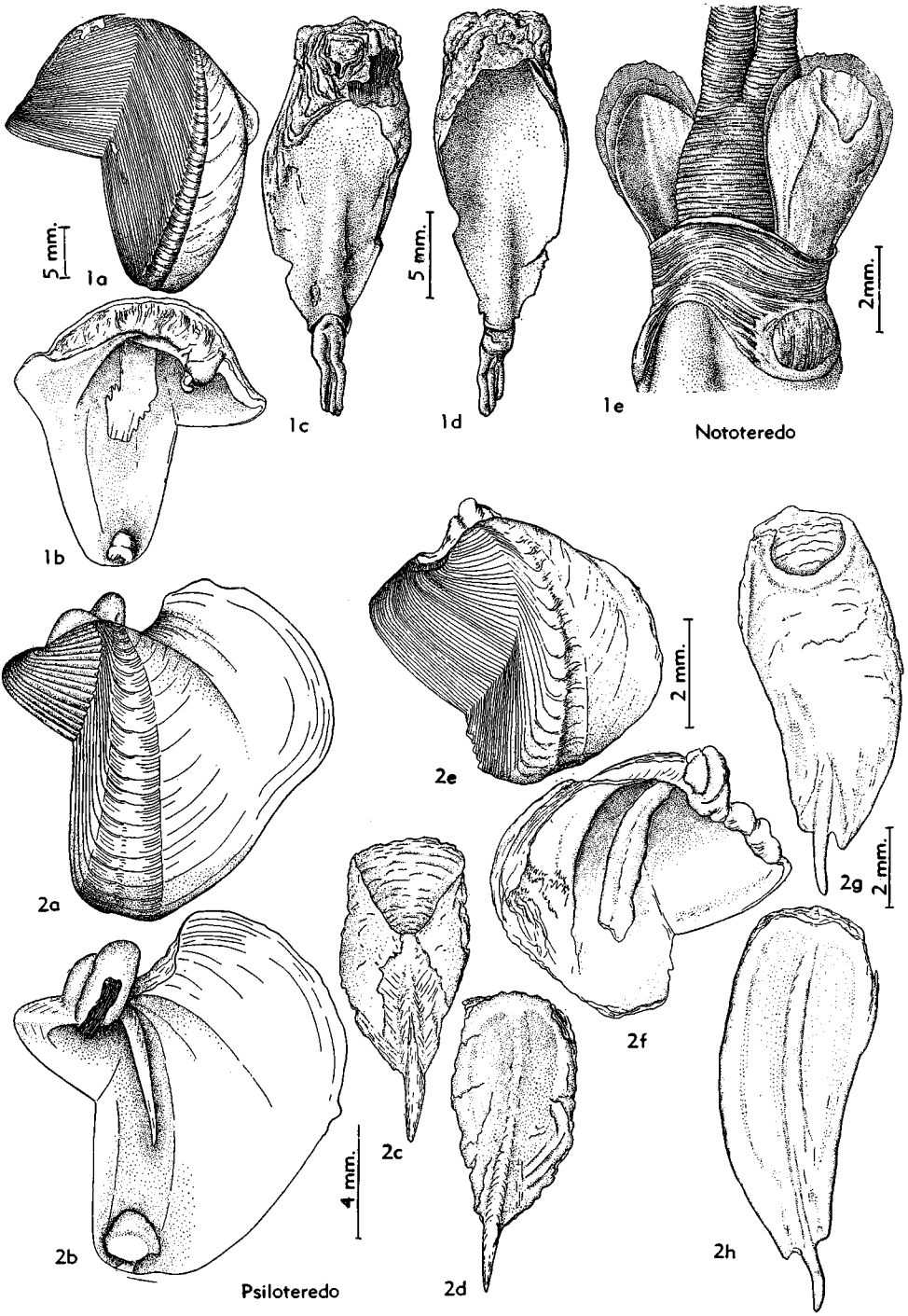


FIG. E203. Teredinidae (Teredininae) (p. *N728*, *N737*).

p. 17 *(nom. null.); Inequarista* IREDALE, 1932, p. 37 (type, *Nausitora messeli* IREDALE, =*N. dunlopei* WRIGHT; OD); *Nausitorella* MOLL, 1952, p. 84 (type, *T. fusticula* JEFFREYS, 1860, p. 125; OD)].

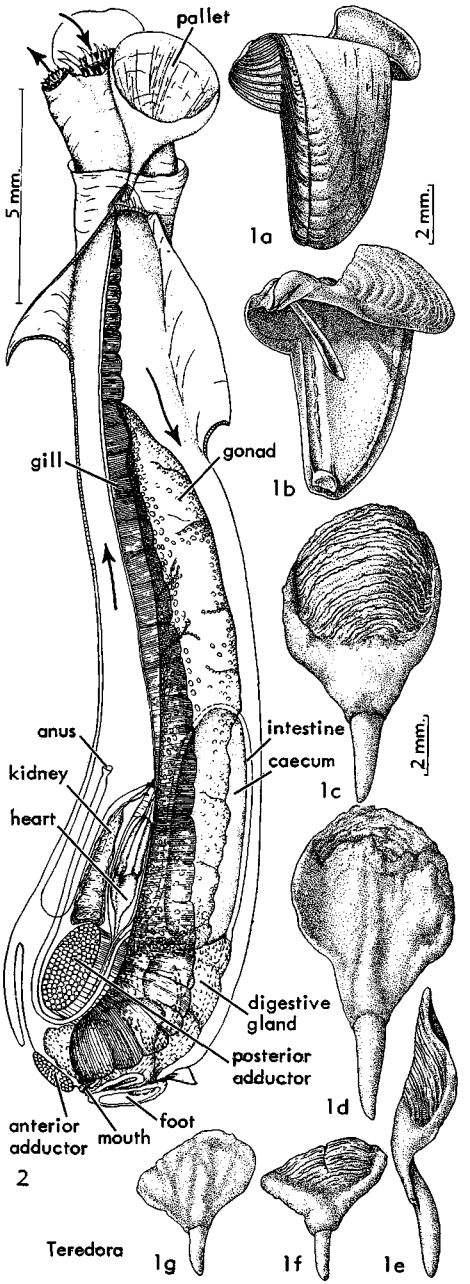


FIG. E204. Teredinidae (Teredininae) (p. *N729*).

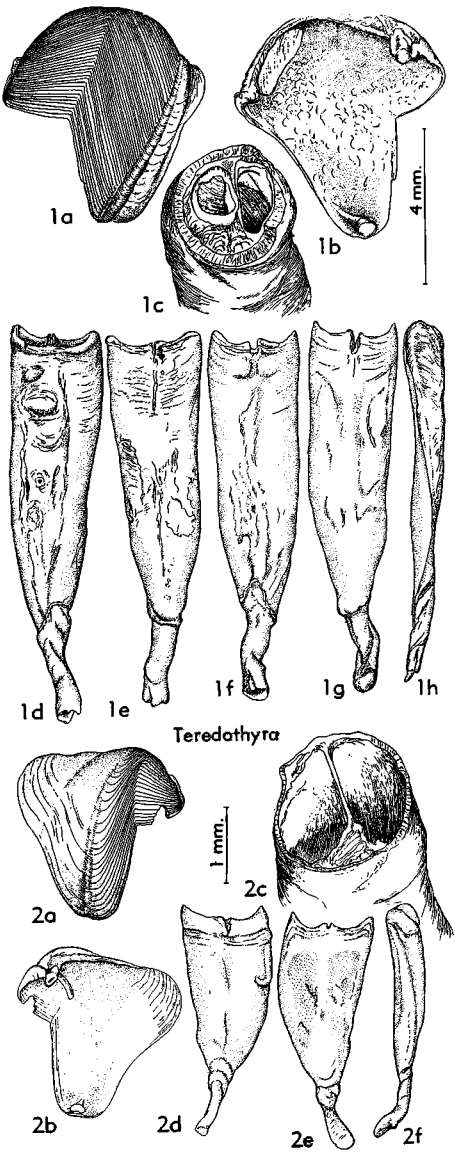


FIG. E205. Teredinidae (Teredininae) (p. *N729-N730*).

Pallets elongate, composed of closely packed, fused, conelike elements built on central stalk; periostracal covering commonly extended as awns, particularly on proximal portion of blade, distal portion of blade with asymmetrical, papillose, calcareous covering which is usually worn off in old specimens. Siphons united for about three-fourths of their length. Gills short, broad and flat; heart small and posterior, located at anterior end of

gills posterior to visceral mass. Stomach elongate; caecum very large, intestine making simple loop around it. *Rec.*, trop. and subtrop. seas, usually in brackish water.——Fig. E209,*1*. **N. dunlopei*, Australia; *1a,b*, LV ext., int.; *1c,d*, pallet, outer and inner faces *(923)*.

Nototeredo Bartsch, 1923, p. 100 [**Teredo (Nototeredo) edax* Hedley, 1895, p. 501; OD] [=*Phylloteredo* Roch, 1937, p. 169 (type, *Teredo norvagica* Spengler, 1792, p. 102; OD)]. Pallets elongate oval to broadly oval in outline with short stalk; blade thin, convex on outer and concave on inner face; composed of soft, friable calcareous material laid down in closely packed segments separated by thin layers of periostracum which may extend laterally as small awns, entire surface of blade with thin layer of periostracum. Stalk extending length of blade. Siphons united for about half their length. Gills about 0.4 length of animal, lamellae broadly U-shaped. Labial palps free at tips. Stomach globular, caecum large, and intestine extremely long and convoluted. Heart short, located at anterior end of gills, posterior to visceral mass; ventricle short and broad, auricles short; posterior aorta long, extending from ventricle to posterior adductor muscle. *Paleoc.-Rec.*, worldwide.——Fig. E203,*1*. **N. edax* (Hedley), Rec. S.Australia; *1a,b*, LV ext., int. (paratype); *1c,d*, pallet, outer and inner face; *1e*, post. end of young specimen *(923)*.

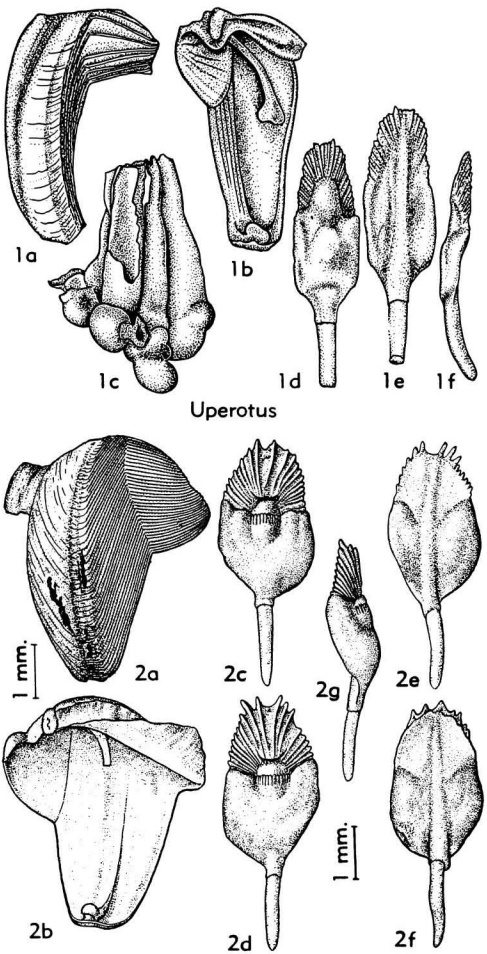


Fig. E206. Teredinidae (Teredininae) (p. *N730*).

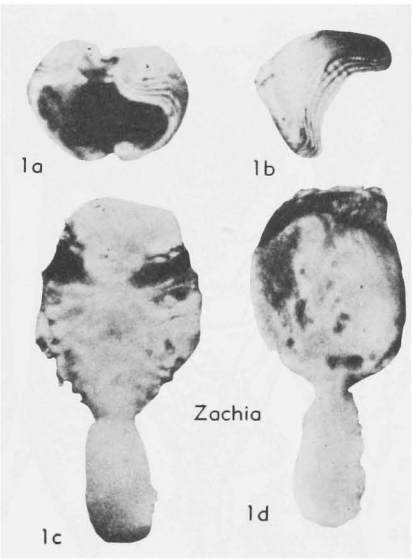


Fig. E207. Teredinidae (Teredininae) (p. *N730*).

Spathoteredo Moll, 1928, p. 282 [**Teredo bataviana* Moll & Roch, 1931, p. 207; (=*T. obtusa* Sivickis, 1928, p. 290); SD Turner, 1966, p. 122] [=*Spathoteredo* Roch, 1937, p. 173 (obj.)]. Blade of pallets more or less rectangular in outline, truncated at anterior end and sheathing stalk for about 0.3 of its length. Stalk extending well up into blade which is thick at anterior end and tapers posteriorly. Periostracum dark brown, usually appearing as band across middle of blade on outer face, distal portion of outer face covered with pustulose, calcareous incrustation. Siphons with muscular collar at their base, united for most of their length, incurrent siphon with rather elaborate branched papillae. Gills long, narrowly U-shaped. Heart median, ventricle broad, auricles long and tapering. Stomach elongate, caecum large, gonads dorsal and posterior to it, intestine making loop around it. *Rec.*, IndoPac.-S.Atl.——Fig. E210,*1*. **S. obtusa* (Sivickis), Java; *1a,b*, LV ext., int.; *1c-e*, pallet, outer and inner face, side view *(923)*.

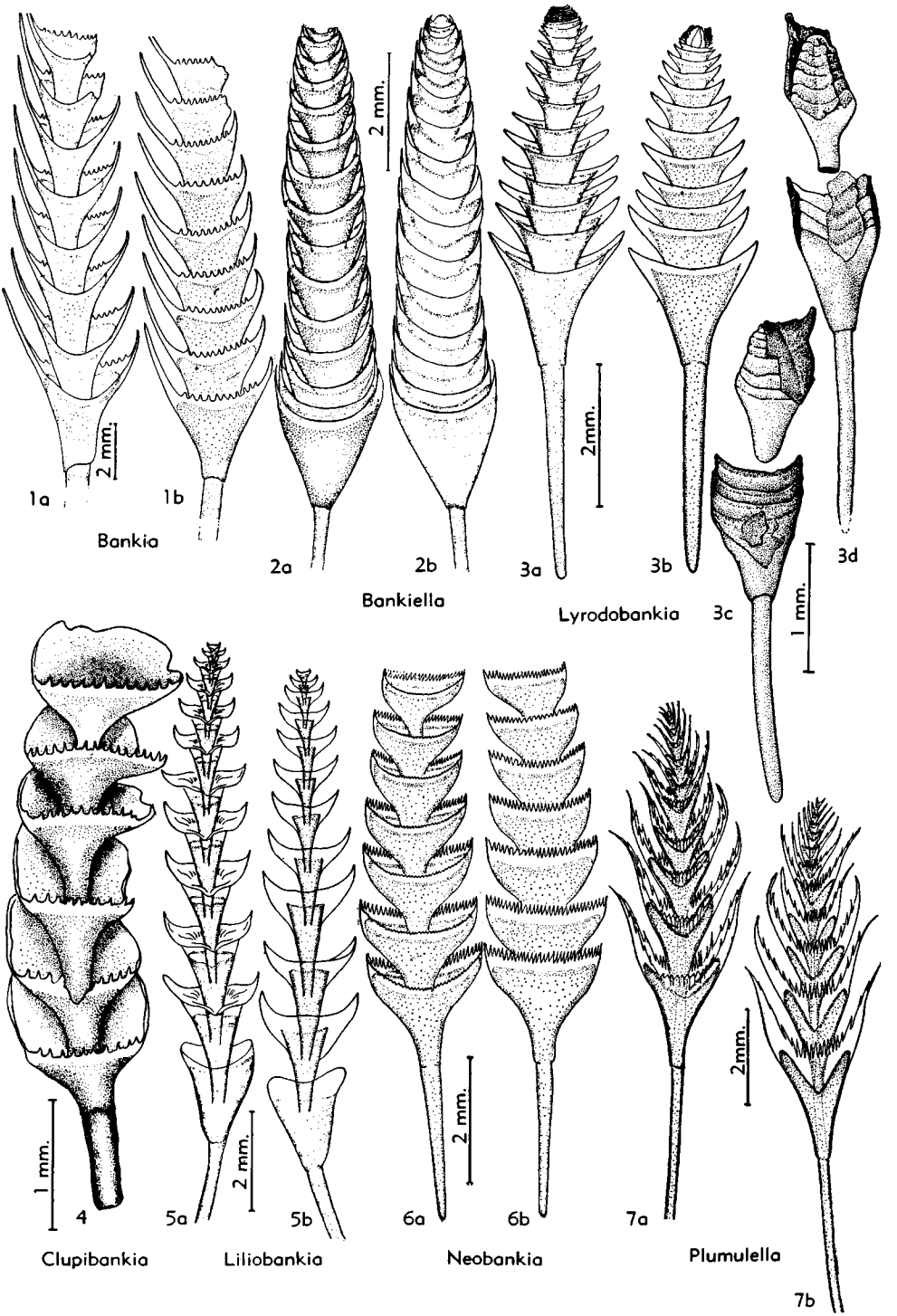


FIG. E208. Teredinidae (Bankiinae) (p. *N732-N734*).

Subfamily KUPHINAE Tryon, 1862

[Kuphinae Tryon, 1862, p. 455]

Large mud- and possibly wood-borers having greatly reduced shells and strong muscular collar surrounding body at posterior end of shell; anterior and posterior adductor muscles nearly equal in size; condyles, chondrophore and ligament reduced, and posterior end of shell covered by muscular collar. Digestive tract greatly reduced, esophagus extending posterior to muscular collar, crystalline style and stomach located at posterior end of visceral mass; caecum lacking. [Unlike all other Teredinidae, the heart has a large ventricular bulb. The intestine passes through this bulb and around the posterior adductor muscle; it becomes imbedded in the thickened mantle for the length of the pericardial cavity and then opens into the epibranchial chamber behind the heart. The Kuphinae apparently are all filter-feeders.] *?Eoc., Rec.*

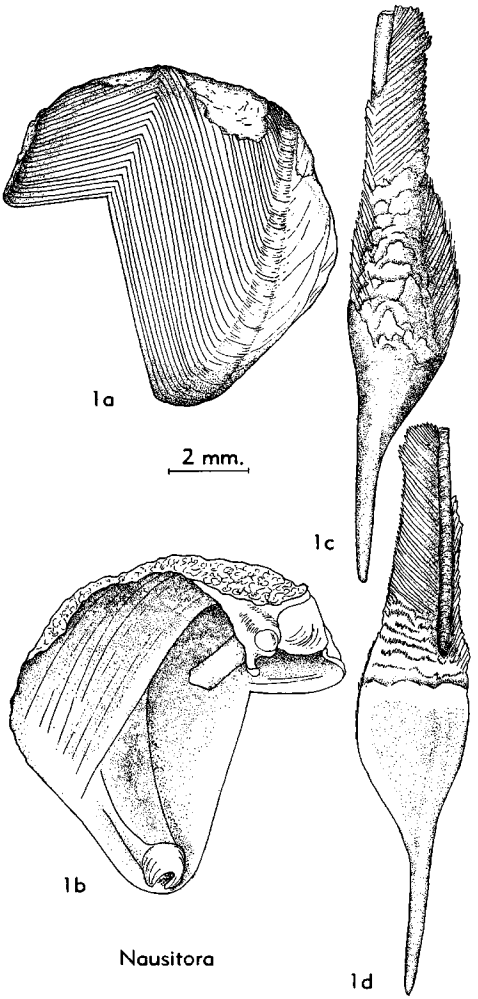


Fig. E209. Teredinidae (Bankiinae) (p. *N*734, *N*736).

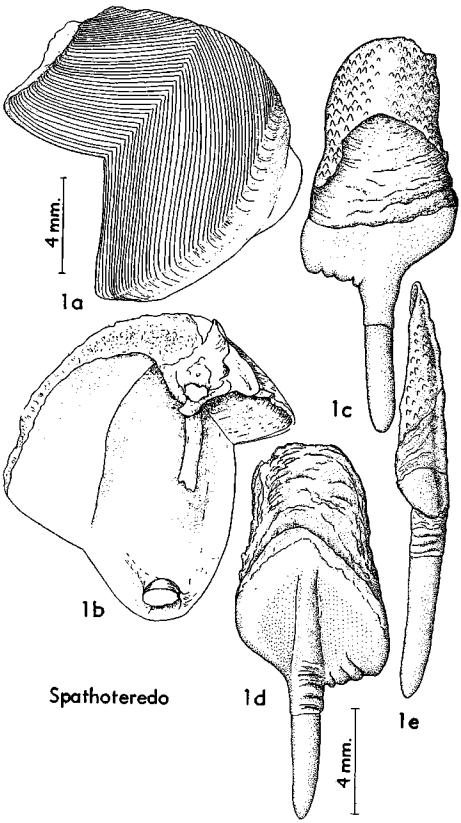


Fig. E210. Teredinidae (Bankiinae) (p. *N*737).

Kuphus Guettard, 1770, p. 139 [**Serpula polythalamia* Linné, 1758; SD Gray, 1847, p. 188] [=*Furcella* Lamarck, 1801, p. 104 (obj.); *Septaria* Lamarck, 1818, p. 436 (*non* Férussac, 1807) (obj.); *Clossonnaria* Férussac, 1822, p. xiv (referring to cloissonnaire and *Septaria* Lamarck); *Clausaria* Menke, 1828, p. 73; *Cloisonnaria* Adams, 1858, p. 648 *(nom. van.); Clossonaria* Paetel, 1875, p. 46 *(nom. null.); Cloissonaria* Paetel, 1890, p. 6 *(nom. van.); Cuphus* Agassiz, 1846, p. 108 *(nom. van.); Cyphus* Fischer, 1887,

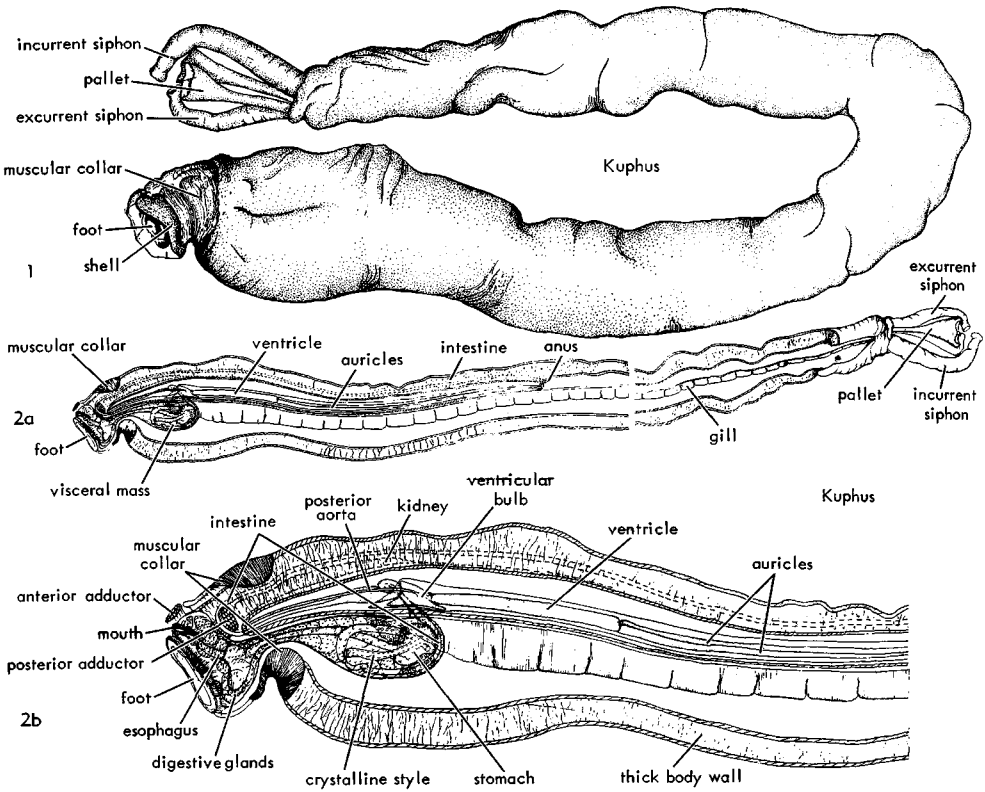


FIG. E211. Teredinidae (Kuphinae); *1, Kuphus,* entire animal, ×0.5; *2,* same, morphology of soft parts *(923).*

p. 1158 *(nom. van.); Kyphus* HERRMANNSEN, 1847, p. 569 *(nom. van.)*]. Pallets simple, solid, almost entirely calcareous; blade triangular in outline with long heavy stalk, flat on inner face and with shallow cup. Shells relatively small, denticulated ridges of anterior slope greatly reduced; posterior slope reduced; tube very thick, solid, divided posteriorly. [The morphology of the soft parts is shown in Figure E211,*2*. Though the genus has been reported from the middle Eocene, this is on the basis of the tubes only. The pallets and shells of *Kuphus* have never been found as fossils.] *?Eoc., Rec.,* IndoPac.——FIG. E211,*1,2*. **K. polythalamia* (LINNÉ), Rec., Solomon Is.; *1a,* sketch of entire animal 50.5 cm. long, ×0.5; *2a,* semidiagrammatic long. sec. showing relationship of organs; *2b,* ant. portion enl. *(923).*

Subfamily UNCERTAIN

Genera based on shells and tubes only cannot be classified as to subfamily within the Teredinidae.

Eoteredo BARTSCH, 1923, p. 98 [**E. philippinensis;* OD]. Name based on shells only, distinguished by projection of apophyses from beneath shelf rather than umbos. [This is an age factor which may be found in the shells of several genera.] *Rec.,* Philip. Is.——FIG. E212,*1*. **E. philippinensis,* Mindanao; *1a,b,* LV ext., RV int. (apophysis broken) (holotype), ×6 *(923).*

Terebrimya STEPHENSON, 1952, p. 141 [**T. lamarana;* OD]. Shells typical of family; pallets unknown. *U.Cret.(Cenoman.),* USA(Tex.).——FIG. E213,*1*. **T. lamarana,* Woodbine F.(Templeton Mbr.), Lamar Co.; *1a,b,* LV ext., RV ext., in matrix (holotype), ×4; *1c,* tube, ×1 *(890).*

Teredinopsis FUCH, 1878, p. 39 [**T. problematica;* OD]. Based on shells and cluster of tubes similar to *Uperotus clavus;* pallets unknown. *Quat.,* Suez. ——FIG. E214,*1*. **T. problematica; 1a,b,* LV ext., int., ×3; *1c,* anterior view of opposed valves; *1d,* cluster of tubes; all ×3 (*1a-c,* holotype) *(332).*

Teredolites LEYMERIE, 1842, p. 2 [**T. clavatus;* OD] [=*Teredolites* LEYMERIE, 1841, p. 341 *(nom. nud.); Teredolithes* HERRMANNSEN, 1852, p. 131 *(nom. null.)*]. Name based on tubes only. [Close to *Uperotus clavus* GMELIN.] *Cret.,* Eu.—— FIG. E214,*2*. **T. clavatus,* France(Spatangues, Dept. l'Aube); *2a,b,* basal and lat. views of cluster of tubes (holotype), ×1 *(540).*

Teredolithus BARTSCH, 1930, p. 460. [Collective

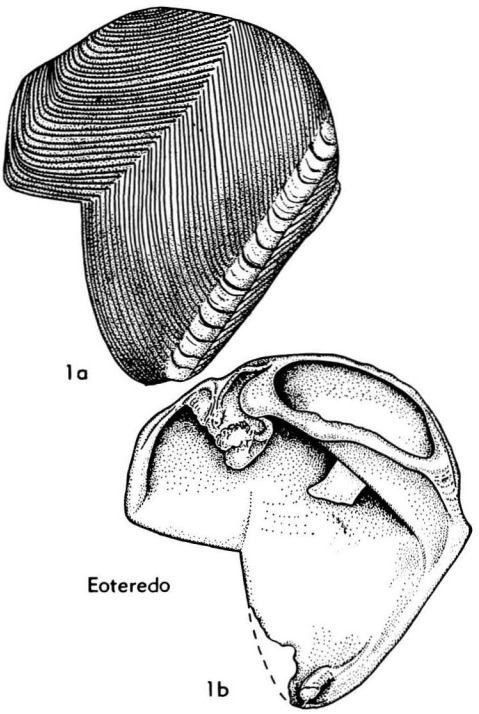


FIG. E212. Teredinidae (Subfamily Uncertain) (p. *N*740).

group name for species of Teredinidae that cannot be placed generically.]

Turnus GABB, 1864, p. 145 [**T. plenus;* OD]. Shell thin, pholadiform; internally bearing rib which rises in apex, and passes downward and backward to basal margin in same manner as umbonal groove and posterior to it. Accessory plates unknown. Tube simple, thin. [This genus was placed in the Teredininae by GABB and considered to be a link with the Pholadidae. Until more material is available the genus cannot be positioned.] *Cret.*, N.Am.——FIG. E213,*2*. **T. plenus,* USA(Calif.); (holotype), ×2 *(333)*.

INVALID GENERA

The following names for hypothetical genera are invalid (ICZN Code, 1961, Art. 1).

Bicornia MAY, 1929, p. 642, 665.
Microvexillum MAY, 1929, p. 642, 665.
Proteredo MAY, 1929, p. 664, 665.

GENERA ERRONEOUSLY ASSIGNED TO TEREDINIDAE

Polorthus GABB, 1861, p. 366 [**P. americana;* OD] [=*Polarthus* STOLICZKA, 1871, p. 14 *(nom. null.); Kummelia* STEPHENSON, 1936, p. 60 (obj.)]. Belongs to Gastrochaenidae.

Order HIPPURITOIDA Newell, 1965

[Diagnosis by N. D. NEWELL]

Rudists and pachydonts; thick-shelled, aberrant heterodonts, primitively equivalved, with few thick and amorphous hinge teeth; mainly attached and strongly inequi-

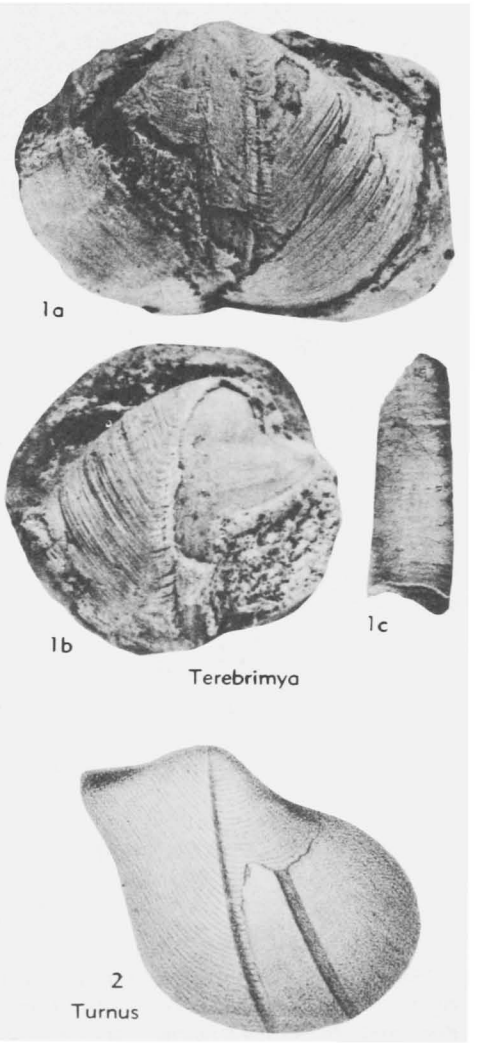


FIG. E213. Teredinidae (Subfamily Uncertain) (p. *N*740-*N*741).

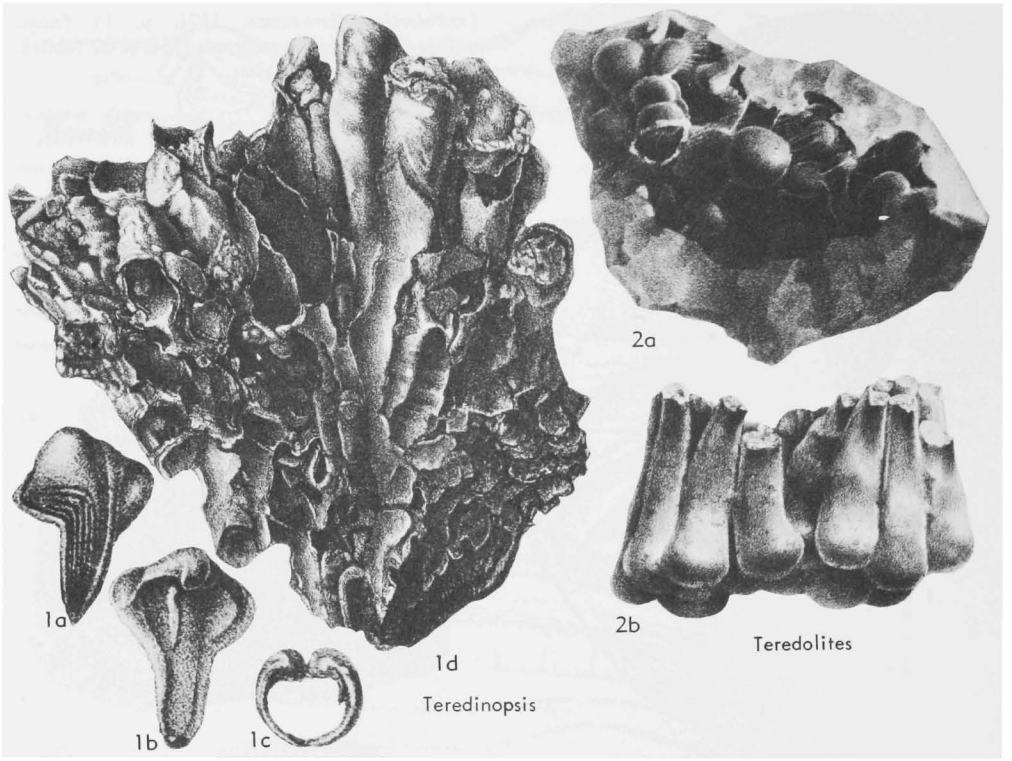


FIG. E214. Teredinidae (Subfamily Uncertain) (p. *N740*).

valved, tending to gyrate or conical, operculate and edentulous forms resembling solitary corals. *M.Sil.-U.Cret.(Maastricht.)*.

The Hippuritoida are cosmopolitan bivalves especially characteristic of low latitudes where they dominate extensive reefs.

Superfamily MEGALODONTACEA Morris & Lycett, 1853

[Diagnosis by N. D. NEWELL]

Characters of family Megalodontidae. *M. Sil.-L.Cret.*

Family MEGALODONTIDAE Morris & Lycett, 1853

[*nom. correct.* ZITTEL, 1881 (*pro* Megalonidae MORRIS & LYCETT)] [Materials for this family prepared by L. R. COX (Mesozoic) and AURÈLE LAROCQUE (Paleozoic)]

Shell mostly medium-sized to large, thick, equivalve except in some species of *Megalodon* and in *Pomarangina,* gibbose, subtrigonal or ovate, usually with prosogyrous beaks; hinge plate massive, bearing in each valve one to several cardinal teeth which are commonly rather amorphous and not all of which diverge from beak; lateral teeth present in some genera; ligament external, opisthodetic, nymphs heavy; pallial line entire; anterior adductor scar deep, situated in relatively dorsal and marginal position, just below anterior end of hinge plate; surface usually smooth or at most with weak concentric folds, but with radial ribs in a few forms. *M.Sil.-L.Cret.*

Megalodon J. DE C. SOWERBY, 1827, p. 131 [**M. cucullatus;* M] [=*Megaladon* LINK, 1830 *(nom. null.); Megalodonta* GOLDFUSS, 1832 *(nom. van.); Megalodus* GOLDFUSS, 1837 *(nom. van.)* (*non* RAFINESQUE, 1815); *Eumegalodon* GUEMBEL, 1862 (obj.)]. Shell medium-sized to large, subtrigonal or ovate, gibbose; beaks anterior, strongly prosogyrous; hinge plate very massive; cardinal teeth varying in number, from 1 or 2 in LV and 1 to 3 in RV, owing to suppression or duplication of elements of dentition; posterior adductor scar on slightly raised platform; surface smooth or con-

centrically rugose (Dechaseaux in Piveteau, 1952, p. 293, 333). *Dev.-U.Trias.(Rhaet.).*

M. (Megalodon). Equivalve, valves more or less carinate posteriorly; LV with strong, elongate, acutely triangular, commonly grooved posterior cardinal tooth close to posterodorsal margin and tuberculiform anterior cardinal tooth (represented by 2 unequal teeth in some specimens) near anterior end of hinge plate; RV with strong, subtriangular, commonly pustulose or transversely grooved, mesially placed cardinal tooth received in deep, broad recess between 2 main teeth of LV, and in some specimens with very thin, elongate posterior cardinal; traces of elongate lateral tooth adjacent to posterior margin beyond hinge plate seen in some RV's. *Dev.-Trias.*, cosmop.——Fig. E215,*4*. **M. (M.) cucullatus* Sowerby, Dev., Paffrath, Ger.; LV int., showing dentition, ×1 *(379)*.

M. (Neomegalodon) Guembel, 1862, p. 362 [**Cardium triquetrum* Wulfen, 1793, p. 48; SD Stoliczka, 1871, p. 275] [=*Tauroceras* Schafhaeutl, 1854 (*non* Hope, 1840); *Neomegalodus* Frech, 1904 *(nom. van.)*]. Equivalve or slightly inequivalve, presence of posterior carina variable; hinge plate narrowing posteriorly; LV without distinct posterior cardinal tooth but with 1 or 2 anterior teeth representing tuberculiform tooth of *M. (Megalodon);* when 2 such teeth are present these are commonly subequal and radially elongated; RV with variable, acutely triangular posterior cardinal tooth received in recess behind tooth or teeth of LV and with 2 anterior teeth which are commonly subequal and radially elongated. *U.Trias.*, cosmop.——Fig. E216,*1*. **M. (Neomegalodon) triqueter* (Wulfen), U.Trias. (Rhaet.), Aus.; *1a,b,* RV int., LV int., showing dentition, ×1 (Guembel, 1862).

Conchodon Stoppani, 1865, p. 246 [**C. infraliasicus* (=*Lycodus cor* Schafhaeutl, 1863, p. 375); M] [=*Lycodus* Schafhaeutl, 1863 (*non* Quenstedt, 1856); *Conchodus* Tausch, 1891 *(nom. van.)* (*non* M'Coy, 1848); *Lycodes* Dall, 1900 *(nom. null.)*]. Very large, thick-shelled, about as high as long, with strongly prosogyrous and incoiled beaks and projecting anterior extremity; valves sharply carinate posteriorly; hinge plate massive; RV with massive arcuate or irregularly tripartite main tooth which is situated near anterodorsal margin and is received in broad socket in LV between arms of horseshoe-shaped tooth; in some specimens second and weaker tooth lies between this main tooth and margin in RV; posterior part of hinge plate without distinct teeth; no lateral teeth; anterior adductor scar almost marginal, just below main tooth; posterior scar not observed; surface of shell with weak concentric folds. *U.Trias.(Rhaet.),* Eu.(N.Alps-S. Alps-Hung.-Carpathians).—— Fig. E216,*3*. **C. cor* (Schafhaeutl), S.Alps; *3a,* int. mold, ×0.3 (Stoppani, 1865); *3b,* ant. part of RV hinge showing tripartite main tooth, ×0.3 (Frech, 1904).

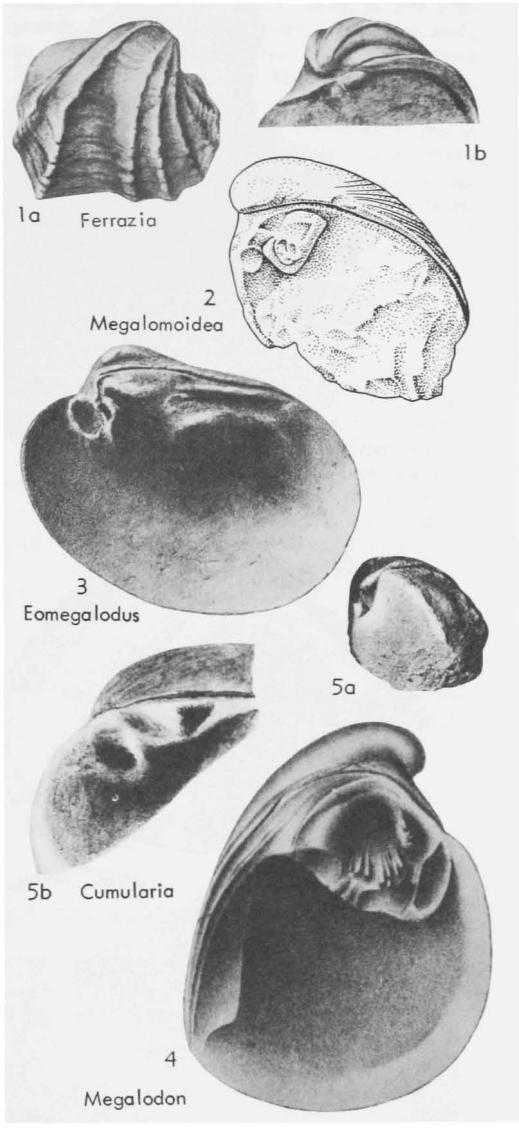


Fig. E215. Megalodontidae (p. *N*742-*N*743, *N*745).

Cumularia Spriestersbach, 1919, p. 467 [**C. circularis;* M]. Small, round-oval, not carinate; umbones depressed, well anterior; 1 stoutly triangular cardinal tooth in each valve, that in RV stronger and fitting behind tooth of LV; no laterals; anterior adductor scar small and deep, posterior scar larger, rounded. *M.Dev.*, Eu.(Ger.).—— Fig. E215,*5*. **C. circularis,* ?Honseler beds, Schaf-

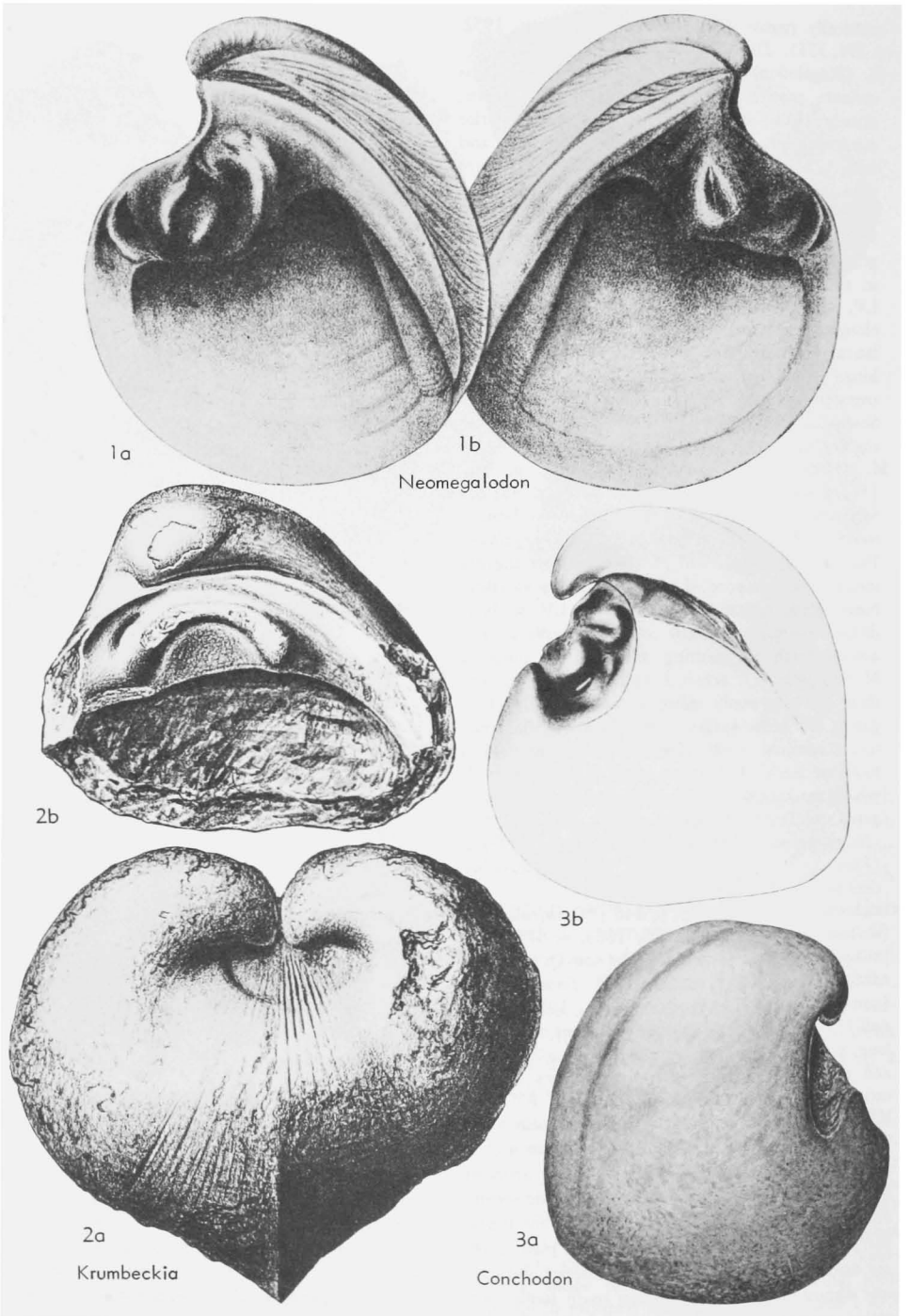


FIG. E216. Megalodontidae (p. *N*743, *N*745).

feld; *5a,* LV int. mold, ×1; *5b,* RV dentition, enl. *(872).*

Eomegalodus Spriestersbach, 1915, p. 53 [**E. fuchsi;* M] [=*Eomegalodon* Cossmann, 1922 *(nom. van.)*]. Medium-sized, thick, elliptical, not carinate; umbones anterior, not prominent; lunule small; hinge very thick; LV with 2 cardinal teeth, posterior one heavy, and broad, cuneiform posterior lateral; RV with 1 strong and 1 weak cardinal and lamellar posterior lateral; lower margin of hinge plate of RV thickened into large toothlike pad which projects into LV; anterior adductor scar small, elliptical, deep, striated; posterior scar large, deep; sculpture of fine concentric lines. *M.Dev.,* Eu.(Ger.).——Fig. E215,*3.* **E. fuchsi,* U.Honseler beds, Lenneschiefer, Verneis, near Haspe; RV int., showing dentition and toothlike pad below hinge, ×1 *(871).*

?**Ferrazia** Reed, 1932, p. 480 [**F. cardinalis;* M]. Equivalve; beaks subanterior, strongly prosogyre, incurved; lunule and escutcheon well defined; surface angulated and ornamented with strong radial carinae; each valve with large rounded, longitudinally oval cardinal tooth on narrow thickened hinge plate; ligament opisthodetic, parivincular. *Perm.,* S.Am.(S.Brazil).——Fig. E216,*1.* **F. cardinalis,* Corumbatai F., Rio Claro; *1a,b,* RV ext. and hinge views, ×1 (Reed, 1932). [Newell]

Krumbeckia Diener, 1915, p. 131 [**K. tambangensis* (=*Pomarangina* aff. *haydeni* Diener, Krumbeck, 1914, p. 256); M]. Medium-sized, oval, gibbose, not carinate; beaks prosogyrous, at anterior 5th of length; hinge plate heavy; RV with single heavy, broadly arched tooth, almost median in position; teeth of LV and muscle scars unknown; ornament of concentric ribs. *U.Trias.,* Indon.(Sumatra).——Fig. E216,*2.* **K. tambangensis; 2a,b,* ant. view of shell and RV int. showing dentition, ×1 (Krumbeck, 1914).

Megalomoidea Cox, 1964, p. 43 [**Megalomus canadensis* Hall, 1852, p. 343; OD] [=*Megalomus* Hall, 1852 (*non* Rambur, 1842); *Megalomys* Fischer, 1886 (*nom. van.; non* Trouessart, 1881); *Mewalomus* Kirk, 1927 *(nom. null.)*]. Large, reniform-ovate, thick-shelled, especially in hinge region and along V-shaped area extending posteriorly from it across middle of each valve; valves not carinate; beaks anterior, prosogyrous; hinge plate massive, not undercut, broad and projecting in middle, where in each valve it bears group of transversely elongated teeth variable in number (2-6) and strength; anterior adductor scar as in typical Megalodontidae, 2 small accessory scars on its posterodorsal side; posterior adductor scar obscure; surface smooth except for growth lines (Kirk, 1927, p. 4). *M.Sil.(Guelph),* E.N.Am.-Alaska.——Fig. E215,*2.* **M. canadensis* (Hall), Ont.(Elora); RV int., ×0.7 (Kirk, 1927).

Pachyrisma Morris & Lycett, 1850, p. 399 [**P. grande;* M] [=*Cardilla* Lycett, 1848 (*nom. nud.,* or error for *Cardilia* Deshayes, 1835); *Pachyerisma* Bayan, 1874 *(nom. van.)*]. Medium-sized to large, equivalve, thick-shelled, ovate to subtrigonal, with strongly prosogyrous, more or less anteriorly placed beaks; valves carinate posteriorly; hinge plate, ligamental nymph and teeth heavy; single strong, mesially placed cardinal in LV received in recess between strong posterior cardinal and weak (in some specimens ill-defined) anterior cardinal in RV; well-developed, tuberculiform lateral tooth present near each end of hinge plate in LV and received in sockets above corresponding laterals in RV; anterior adductor scar deep, situated just below anterior lateral tooth. *L.Jur.-U.Jur.,* Eu.

P. (Pachyrisma). Large, higher than long, beaks terminal in some but not all species; posterior adductor scar on lamina emerging from beneath hinge plate; surface smooth or with traces of radial ribbing. *M.Jur.-U.Jur.,* Eu.——Fig. E217, *2a-c.* **P. (P.) grande* Morris & Lycett, M.Jur. (Bathon.), Eng.; *2a,* RV ext.; *2b,* LV hinge, post. lat. tooth broken away; *2c,* RV hinge, post. lat. tooth broken away; all ×0.7 *(645).*——Fig. E217,*2d. P.* sp. cf. *P. (P.) beaumonti* Zeuschner, U.Jur.(Tithon.), Czech.; RV hinge showing lat. teeth, ×0.5 (Böhm, 1870).

P. (Durga) G. Böhm, 1884, p. 191 [**D. nicolisi*; OD]. Medium-sized, trigonally ovate, longer than high, tapering posteriorly; posterior carina sharp; posterior adductor scar not observed; surface smooth, except for growth rugae. *L.Jur.(L. Lias.),* Eu.(N.Italy-France).——Fig. E217,*3.* **P. (D.) nicolisi,* N.Italy; *3a,* RV ext., ×0.7; *3b,* RV hinge, defective posteriorly, ×1 (Böhm, 1884).

P. (Pachymegalodon) Guembel, 1862, p. 375 [**Bucardites chamaeformis* von Schlotheim, 1820, p. 208; M] [=*Pachymegalodus* Tausch, 1890 *(nom. van.)*]. Medium-sized, higher than long, acutely subtrigonal; posterior carina sharp, with broad radial sulcus in front of it; posterior adductor scar on lamina, as in *P. (Pachyrisma);* surface smooth, except for growth rugae. *L.Jur. (L.Lias.),* Eu.(S.Alps).——Fig. E217,*1.* **P. (P.) chamaeforme* von Schlotheim, Yugosl.; *1a,b,* RV ext., RV int., ×1 (Tausch, 1890).

Pachyrismella Cox, 1964, p. 43 [**Cardium septiferum* Buvignier, 1843, p. 230; OD]. Medium-sized, subequilateral, slightly longer than high, *Cardium*-like; beaks not strongly prosogyrous; hinge plate and teeth less heavy and irregular than in *Pachyrisma;* strong acutely angular posterior cardinal and weak or scarcely developed anterior cardinal present in both valves, main tooth of RV fitting in front of that of LV; lateral teeth and adductor scars as in *Pachyrisma,* posterior adductor on lamina emerging from be-

low hinge plate; radial ornament absent or obscure. *U.Jur.(U.Oxford.)*, Eu.-SW.Asia(Lebanon). ——Fig. E218,*2*. **P. septifera* (Buvignier), U. Oxford., France; *2a,b*, LV hinge, RV ext.; *2c*, RV int., all ×0.7 (Buvignier, 1852).

Paramegalodus Cox, **new genus** [*ex* Kutassy, 1934,

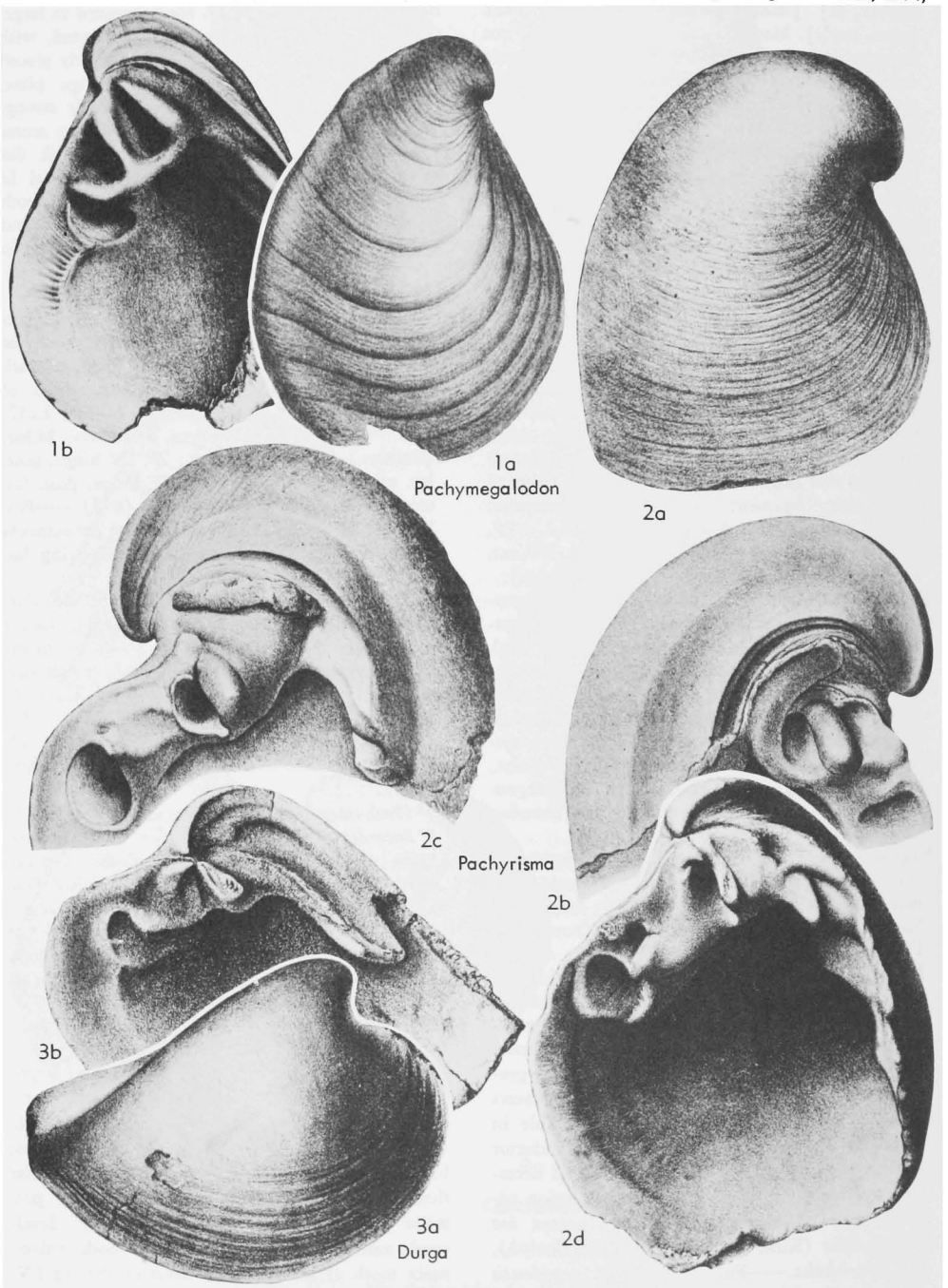


Fig. E217. Megalodontidae (p. *N745*).

p. 52 (*nom. nud.*, type species cited but no generic diagnosis)] [**Dicerocardium eupalliatum* FRECH, 1904, p. 51; OD]. Large, tall, trigonal, hornlike, with very prominent, terminal, pointed, prosogyrous umbones; internal mold with rounded rib running from near anterior margin almost to umbo, then curving around and descending to posterior end of ventral margin; dentition un-

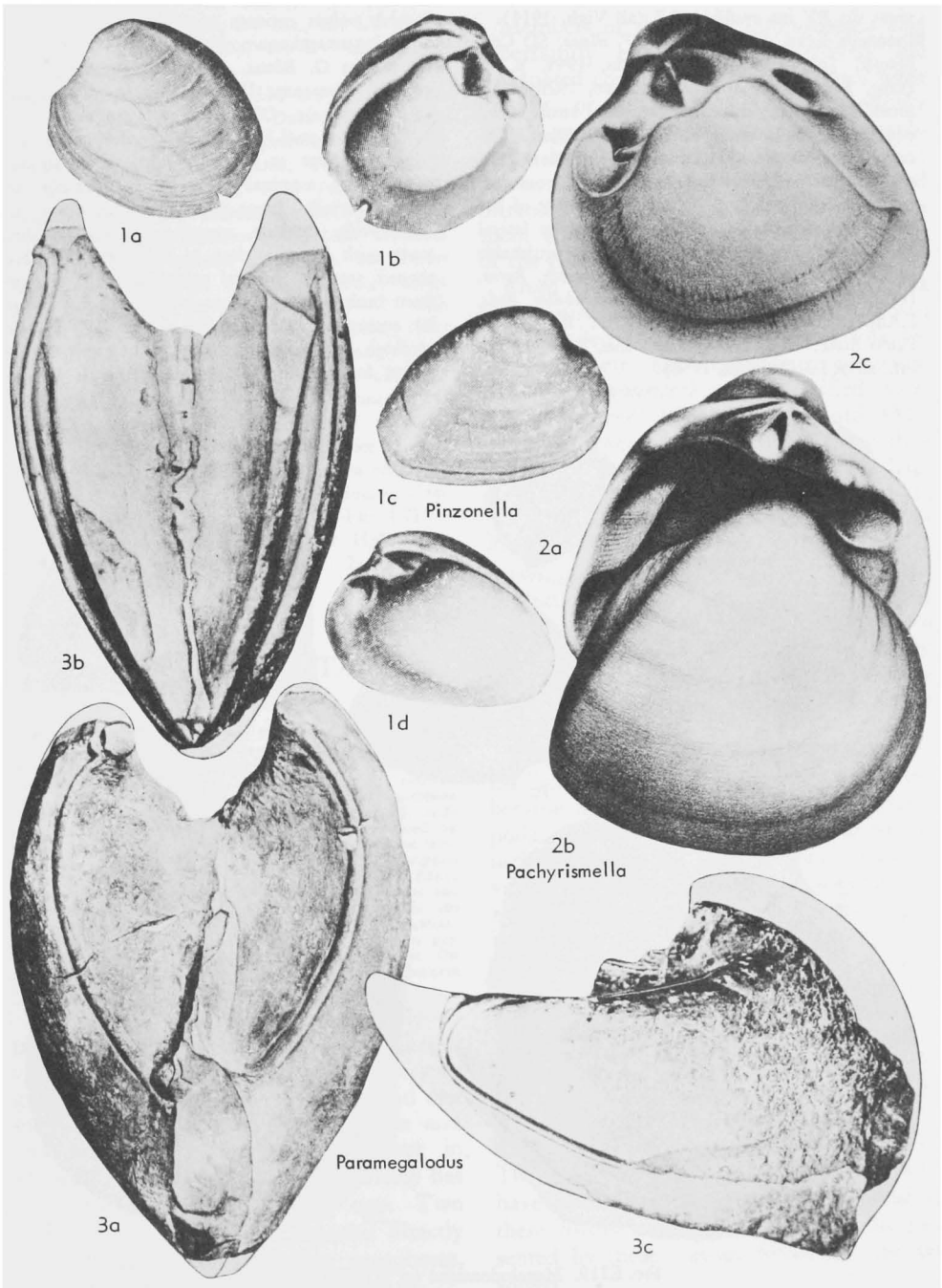


FIG. E218. Megalodontidae (p. *N*745-*N*748).

known. *U.Trias.(Rhaet.)*, Eu.(Hung.)-Asia(Himaayas).——Fig. E218,*3a*. **P. eupalliatus* (Frech), Hung.; ant. view of int. mold, ×0.3.——Fig. E218,*3b,c*. *P incisus* (Frech), Hung.; *3b*, post. view, *3c*, RV int. mold, ×0.7 (all Vigh, 1914).

Pinzonella Reed, 1932, p. 482 [**P. illusa;* SD Cox, herein] [=*Pinzonellopsis* Mendes, 1944, p. 58 (type, *Pachycardia occidentalis* Reed, 1929; M)]. Small for family, orbicular or ovate, strongly inequilateral, beaks fairly anterior, not strongly incurved; valves weakly carinate; hinge plate relatively broad and massive, with large, rounded-triangular cardinal tooth in each valve, that of RV fitting in front of LV tooth; weak lamellar lateral tooth close to posterodorsal margin distinguishable in LV of some specimens; surface smooth. *Perm.* (originally considered Trias.), *Corumbatai beds*, S.Am.(Brazil).——Fig. E218,*1*. **P. illusa*, São Paulo State; *1a-d*, LV ext. and int., RV ext. and int., all ×1.3 (Mendes, 1952).

?**Pomarangina** Diener, 1908, p. 64 [**P. haydeni;* M]. Ovate, inequilateral, moderately gibbose, thick-shelled, some specimens slightly inequivalve, with RV larger; beaks prosogyrous and incurved; valves carinate posteriorly; dentition and musculature unknown. *U.Trias.*, Asia(Himalayas).

Protodiceras G. Böhm, 1891, p. 19 [**Megalodon pumilus* Guembel, 1862, p. 367 (as *M. triqueter* var. *pumilus*); OD] [=*Prodiceras* Beringer, 1949 *(nom. null.)*]. Of small-medium size, subtrigonal, about as long as high, with strongly prosogyrous, terminal beaks; valves sharply carinate posteriorly; hinge plate and teeth heavy; LV with weak, elongate, marginal posterior cardinal tooth with its apex close to beak and horseshoe-shaped anterior cardinal which is well separated from beak; between them is large, deep, triangular socket for reception of strong RV posterior cardinal, and within 2 arms of anterior tooth is socket for simple RV anterior cardinal; RV an-

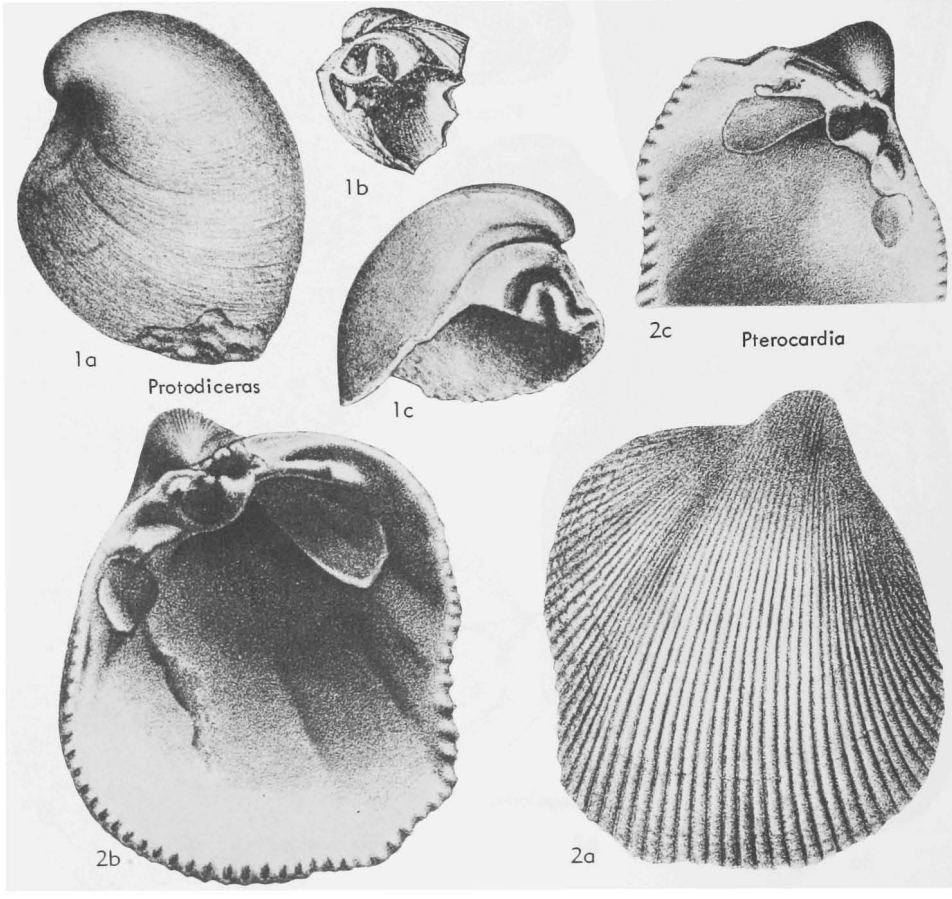


Fig. E219. Megalodontidae (p. *N748-N749*).

terior lateral is feebly developed but posterior laterals are absent; anterior adductor scar deep, located as in *Pachyrisma;* posterior adductor scar not observed; surface smooth. *L.Jur.(L.Lias.),* Eu.(N.Italy-France).——FIG. E219,*1*. **P. pumilum* (GUEMBEL), N.Italy; *1a,* LV ext., *1b,* LV hinge, both ×1 (Tausch, 1890); *1c,* RV hinge, ×1 (Böhm, 1891).

Pterocardia BAYAN, 1874, p. 338 (*ex* FAVRE, *nom. nud.*) [**Cardium buvignieri* DESHAYES, 1857, p. 49 (syn., *C. corallinum* LEYMERIE, 1847, *non* LINNÉ, 1758); SD COSSMANN, 1906, p. 292] [=*Pterocardium* ROLLIER, 1912 *(nom. van.)*]. Large, thick-shelled, subrectangular, higher than long, inequilateral, posteriorly sublobate; umbones prominent, beaks anterior to median, but almost orthogyrous; ornament of radial ribbing; hinge plate massive and moderately broad; LV with stoutly triangular, anteriorly placed cardinal, short anterior lateral close to it, and more elongate and distant posterior lateral; RV with 2 obliquely aligned cardinals, posterior and lower one stoutly triangular, anterior and marginal one relatively small, together with anterior and posterior laterals; posterior adductor scar on raised lamina emerging from below hinge plate. *M.Jur.(Bathon.)-L.Cret. (Apt.),* Eu.-SW.Asia(Syria)-Mex.——FIG. E219,*2*. **P. buvignieri* (DESHAYES), U.Jur.(U.Oxford.), Swiss Jura; *2a,b,* RV ext. and int.; *2c,* LV int., ×0.7 (de Loriol, 1891).

Superfamily HIPPURITACEA Gray, 1848

[*nom. transl.* NEWELL, 1965 (*ex* Hippuritidae GRAY, 1848)] [Materials for this superfamily prepared initially by COLETTE DECHASEAUX, typescript in French translated by R. C. MOORE reviewed and improved by L. R. COX with advice received from L. J. CHUBB (mainly on occurrence of Caribbean rudists); subsequently (1965-67) extensively revised, with additions of new typescript and illustrations produced by A. H. COOGAN and B. F. PERKINS, as noted in different families. The final version has been referred to the original author to allow expression of any disagreements. The Editor is responsible for integrating the text and illustrations and for accepting the taxonomic framework adopted in the *Treatise,* but with advice received from N. D. NEWELL. Illustrations with reference number *252* are taken by permission from *Traité de paléontologie,* MASSON et CIE (DECHASEAUX, 1952).] [Diagnosis of superfamily by COLETTE DECHASEAUX]

Inequivalve bivalves, most commonly attached to substrate by either right or left valve, but in rare instances free; solitary or gregarious. Hinge with two teeth and one socket in free valve and two sockets and one tooth in attached valve, except in *Diceras,* in which right valve invariably has two teeth and left valve only one. Two adductor muscles present, inserted directly on shell wall or on projecting myophores. *U.Jur.(U.Oxford.)-U.Cret.(Maastricht.).*

INTRODUCTION

By COLETTE DECHASEAUX

[Centre National de la Recherche Scientifique, Laboratoire de Paléontologie à la Sorbonne, Paris, France]

Members of the order Hippuritoida and superfamily Hippuritacea collectively are designated commonly as rudists. They were solitary or gregarous bivalve mollusks which generally were attached to the substrate by the extremity of one of their valves. Their highly varied external and internal morphological features separate them widely from all other representatives of the class, whether fossil or Recent.

From the time (1775) when PICOT DE LAPEIROUSE collected and figured fossil shells "called horns by the country folk because of their close resemblance to actual horns" *(Hippurites)* and "petrified vase-shaped oysters" *(Sphaerulites)* until 1825, naturalists were uncertain as to how they should be classified (Fig. E220). The diagnosis given in 1819 by LAMARCK (*505,* v. 6, p. 230), who introduced the term "les Rudistes," well illustrates the ignorance of contemporary scholars concerning the organization of these "shelly objects appearing to have some affinities with the oysters, but clearly distinguished from this group in that there is no trace of hinge, ligament, or muscle scars, and no indication as to where these were situated."

LAMARCK included certain brachiopods in his "rudists," but he omitted the hippurites because he considered them to be Cephalopoda. PICOT DE LAPEIROUSE was the first to include these "petrified oysters" with bivalves. CUVIER (1817) also suggested a relationship with this group, without giving convincing reasons. It was not until 1825 that DESHAYES and DE BLAINVILLE established that *Sphaerulites* and *Hippurites* should be classified as Bivalvia. This conclusion was opposed, however, by various naturalists, who continued to class the rudists as brachiopods, corals, or cirripeds. The study of rudists has been continued by S. P. WOODWARD, SAEMANN, BAYLE, PARONA, TOUCAS, DOUVILLÉ, and many others, who have made great advances in understanding these fossils; even so, many problems presented by these curious forms are not yet solved.

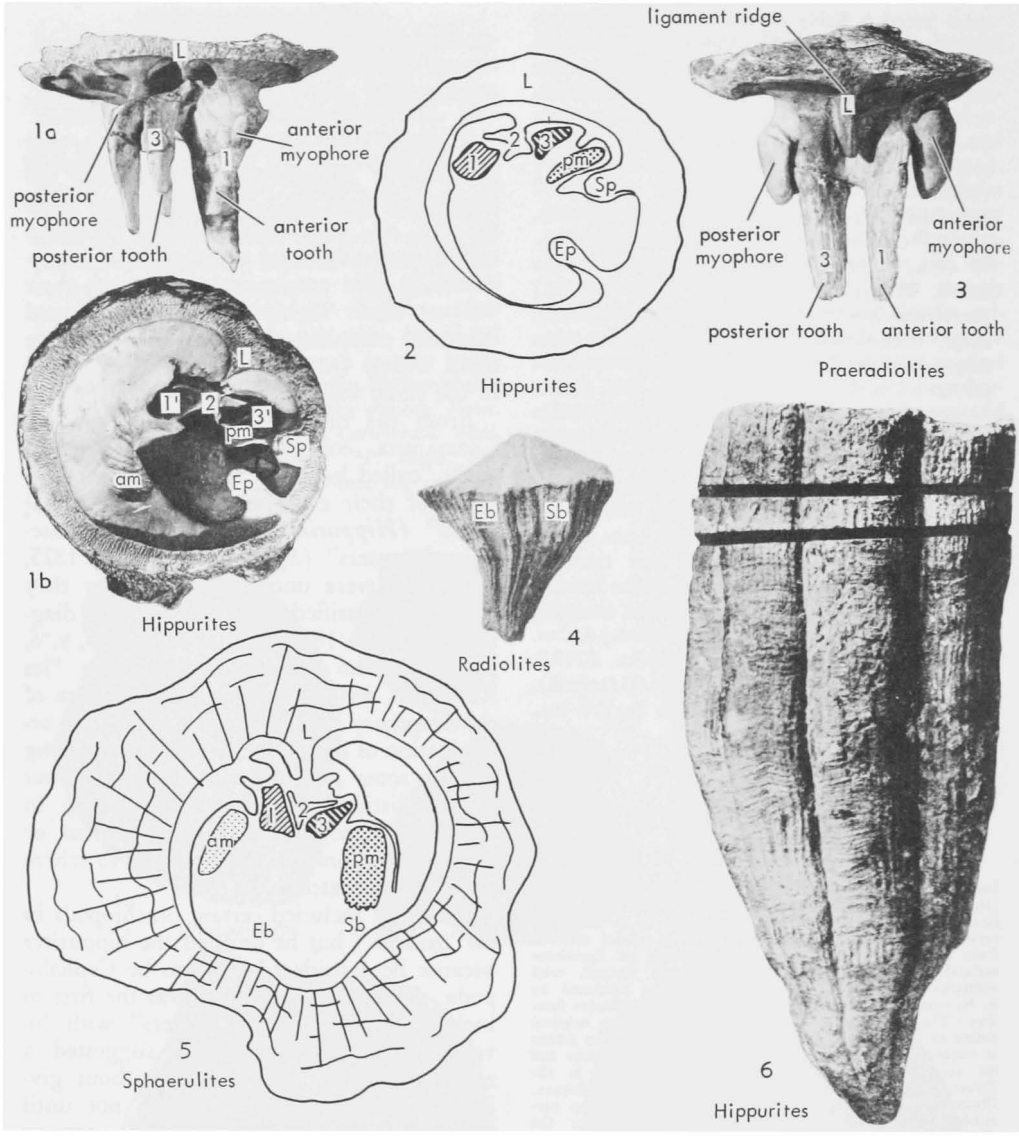


FIG. E220. Morphological features of rudists (hippuritids and radiolitids).

1. *Hippurites radiosus* DES MOULINS, U.Cret. (Maastricht.), France; *1a*, view of operculiform FV showing posterior myophore (left), posterior tooth (middle), anterior tooth (right), and anterior myophore, ×0.45; *1b*, interior of AV from above, ×0.45 *(252)*.
2. *Hippurites bioculatus* LAMARCK, U.Cret.(L. Campan.), France (Pyrenees) (Montagne des Cornes); transv. sec. at level of AV with projecting teeth and myophore of FV, ×0.9 *(910)*.
3. *Praeradiolites cylindraceus* DES MOULINS, U. Cret.(Maastricht.), France; lat view of FV showing myophores and elongate teeth, ×0.5 *(911)*.
4. *Radiolites angeoides* PICOT DE LAPEIROUSE, U. Cret.(low.Campan.), France, Pyrenees (Montagne des Cornes); side view of both valves showing on exterior of AV positions of *Eb* and *Sb* siphonal bands, ×0.7 *(911)*.
5. *Sphaerulites foliaceus* LAMARCK, U.Cret.(Cenoman.), France (Bouche-du-Rhone); transv. sec. at level of AV with projecting teeth and myophores of FV, ×0.3 *(911)*.
6. *Hippurites striatus* DEFRANCE, U.Cret., France (Rennes-les-Bains), side view of AV with cuts for transv. secs. (not figured) near top, ×1.5 *(269)*.

[Explanation: *am*, *pm*, anterior and posterior myophores; *Eb* and *Sb*, siphonal bands; *Ep*, *Sp*, internal pillars farthest and nearest *L*; *L*, ligamental ridge; *1*, *3*, anterior and posterior teeth of FV; *2*, tooth of AV; *1'*, *3'*, sockets in AV for reception of correspondingly numbered FV teeth.]

The earliest known rudists are found in Upper Jurassic (Rauracian) strata in France and elsewhere, and the latest ones lived during Maastrichtian times,[1] near the close of the Cretaceous Period. In intervening ages they spread widely, becoming highly diversified, and, according to present knowledge, were distributed along a belt extending between the latitudes of southern Sweden, which contains the most northerly rudist-bearing deposits, and Madagascar, which is the most southerly region where such fossils have been collected. Among the most prolific occurrences of rudists are those in Texas, Mexico, the Antilles, Portugal, France, the Alps, Italy, Yugoslavia, Turkey, Syria and Iran.

RUDIST MORPHOLOGY

By B. F. PERKINS[2]

[Louisiana State University, Baton Rouge, Louisiana]

SHELL SIZE AND SHAPE

Although the first rudists were only slightly inequivalve, their descendants very early became strongly so, with the two valves of individuals usually differing greatly from each other in size, shape, and shell wall structure. The inequivalve form in rudists was developed according to three basic plans (Fig. E221): 1) the attached valve coiled and larger of the two, the smaller, free valve flat or slightly convex and lidlike; 2) the attached valve conical and larger of the two, the smaller, free valve flat, lidlike, conical or coiled; and 3) the free valve coiled and larger of the two, the smaller, attached valve conical or only slightly coiled.

Conical or gently curved rudist shells range in length from 2 cm. *(Monopleura)* to more than 2 m. *(Titanosarcolites)*. They range in diameter from about 8 mm. *(Monopleura)* to more than 0.6 m. *(Bournonia)*. Coiled rudist valves range in coil diameter from about 2 cm. *(Toucasia)* to at least 30 cm. *(Caprinuloidea)*. Shell wall thickness of rudists varies from less than 2 mm. *(Monopleura, Toucasia)* to 10 cm. or more *(Durania)*.

Terminology of the principal sections which show the internal features and shell-wall structure through different shapes of rudist shells is summarized in Figure E222.

ORIENTATION

In descriptive morphology of rudists the terms right valve (RV), left valve (LV), dorsal, ventral, anterior and posterior have been used commonly, but the application of these to many rudists is not so obvious as with normal bivalves. Use of the terms in rudist descriptions depends upon a comparison between the shells of rudists and living Chamidae.

Among living cemented Chamidae certain species are almost invariably attached by the RV or oppositely by the LV, although some species are fixed to the substrate indiscriminately by either valve *(1024a)*. Comparison of attached LV's of some specimens with attached RV's of other specimens shows that they are mirror images with similar dentition. Comparison of free left with free RV's reveals that they, also, are mirror images. The similarity of dentition in attached valves of Chamidae was first noted by MUNIER-CHALMAS *(652a)*, who designated the commoner condition of attachment by the LV as "normal" and the contrasting condition of attachment as "inverse." He recognized that the designation of a valve as left or right does not identify its dentition. Consequently, he proposed that in attached Chamidae the free valves be designated a and the attached valves β.

MUNIER-CHALMAS considered the inversion in *Chama* and conditions in the rudists as comparable. Accepting this, DOUVILLÉ *(267a)* recognized two series of rudists: a "normal" series in which the LV is at-

[1] It is now known that beds in Catalonia (Spain), once thought to be Danian in age and the latest known deposits containing rudists, belong in fact to the Maastrichtian, and are no younger than rudist-bearing beds of that stage found in other areas (L. P. MANGIN, 1963, *21 Sess. Internatl. Geol. Congr.*, Norden, 960, pt. 27, p. 59).

[2] The contributions by PERKINS are adapted in part from Shell Development Company reports and are published with permission of the Company. He acknowledges with gratitude the opportunity provided by Shell Development Company to carry out the work on which his contribution is based. He also acknowledges the invaluable assistance of T. D. ALTMAN, J. F. LAVERDE, and J. W. MOORE in preparation of illustrations and of APHRODITE MAMOULIDES and BERNICE MELDE for library work.

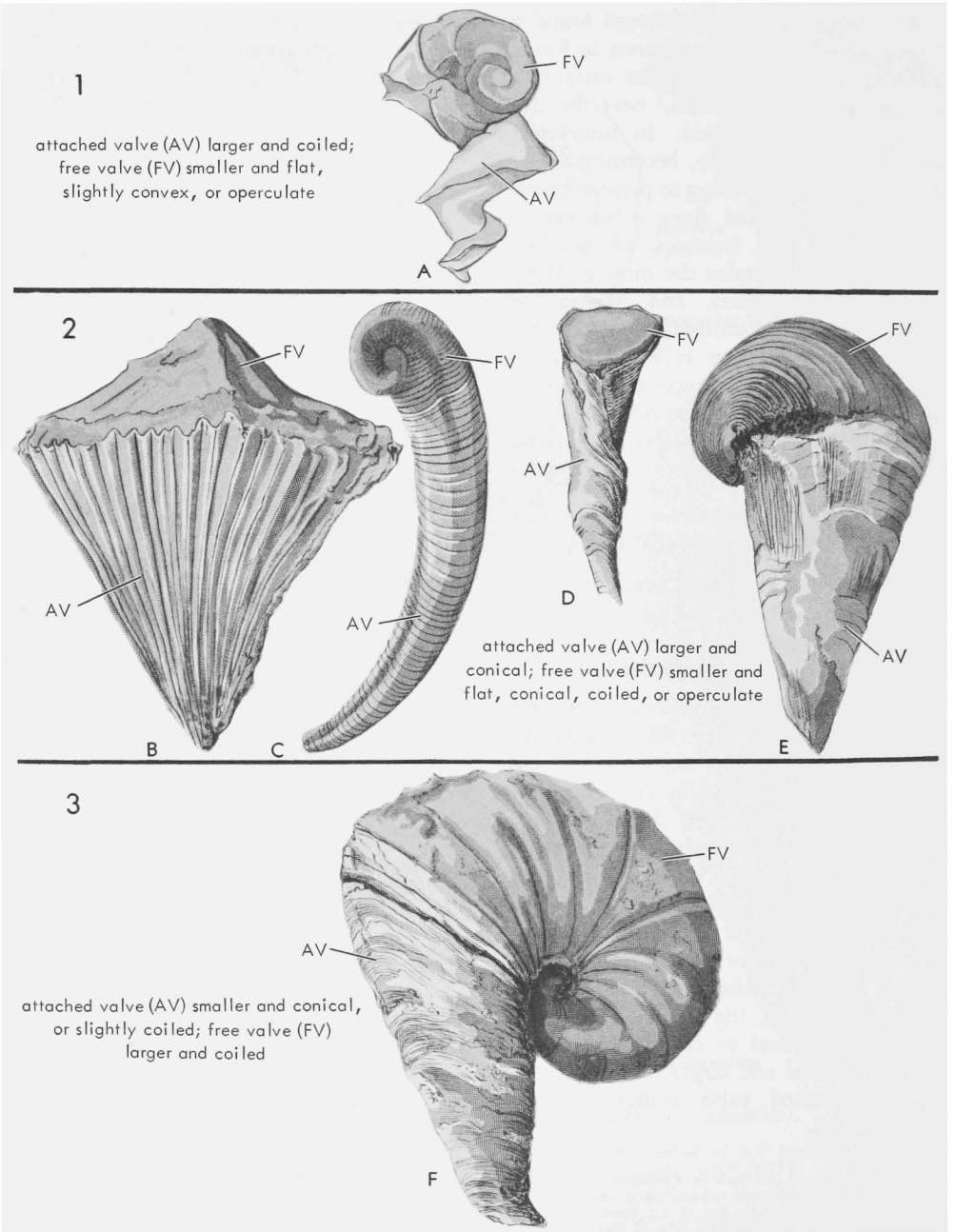


FIG. E221. Principal rudist shell forms (FV, free valve; AV, attached valve) (Perkins, n).

A. Toucasia patagiata WHITE, L.Cret.(Alb.), USA (Texas), ×1.
B. Radiolites angeiodes (PICOT DE LAPEIROUSE), U. Cret.(Campan.), France, ×1.
C. Caprinuloidea sp., L.Cret.(Alb.), USA(Texas), ×0.4.
D. Monopleura marcida WHITE, L.Cret.(Alb.), USA Texas), ×0.4.
E. Coralliochama orcutti WHITE, U.Cret.(Senon.), Mexico, ×0.3.
F. Sellaea sp., L.Cret.(Alb.), USA(Texas), ×0.6.

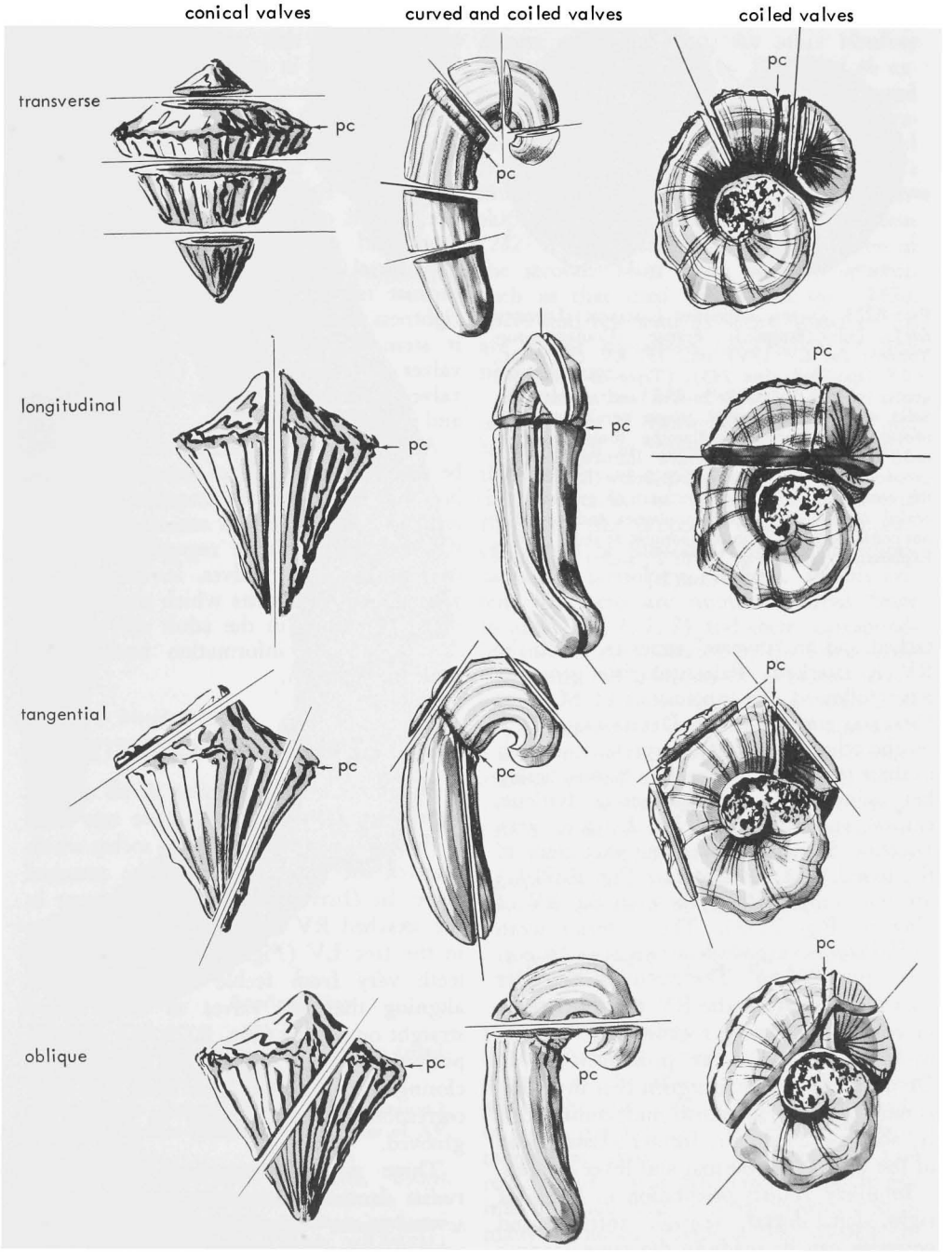


FIG. E222. Principal sections (polished or thin) through different shapes of rudist shells (*pc*, commissural plane) (Perkins, n).

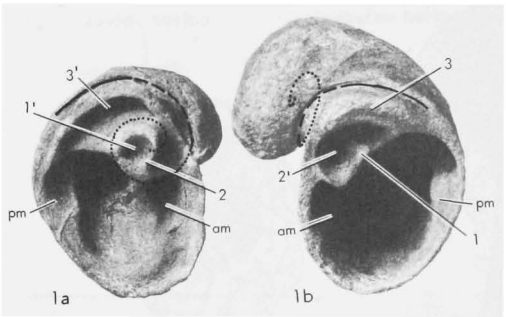


FIG. E223. *Diceras arietinum* LAMARCK (Diceratidae), U.Jur.(Raurac.), France (Coulanges-sur-Yonne); *1a,* LV (FV) int., *1b,* RV (AV) int., ×0.5 (modified after *246*). [Trace of ligamental groove shown in solid, broken and dotted line. Solid segment=ligamental groove parallel to commissure and probably containing functional ligament at stage shown; broken line=segment of groove visible in this view but below the level of the commissure; dotted line=part of groove concealed in this view below umbones and probably not containing a functional ligament at stage shown. Explanation as for Fig. E220; *2'*, socket for reception of tooth *2*.]

tached and an "inverse" series in which the RV is attached. Paleontologists generally have followed the conclusions of MUNIER-CHALMAS and DOUVILLÉ. DECHASEAUX*(252),* on the other hand, has interpreted the teeth in these two series as not homologous, basing her opinion on a comparison of *Valletia,* earliest rudist attached by the RV, with *Diceras*. She has pointed out that teeth of the free LV of *Valletia* (*see* Fig. E250,*4a*) are not comparable to those in the RV of *Diceras* (Fig. E223). The posterior tooth in *Valletia* is very weak, whereas in *Diceras* it is quite strong. The posterior tooth of rudists attached by the RV becomes larger in successively younger genera and at least by Albian time is as prominent as in *Diceras*. DECHASEAUX argued that inversion is only apparent in rudists and, consequently, she abandoned the former classification of the group into normal and inverse series.

In many rudists orientation in terms of right, left, dorsal, ventral, anterior and posterior can be made in the same manner (i.e., with the hinge line up and the beaks directed away from the observer) as for a normal bivalve. In conical forms such as the Radiolitidae and Hippuritidae, however, which show no evidence of coiling, orientation by this method is impossible. Without proof in some groups paleontologists have assumed that attachment was by the RV in Monopleuridae, Caprotinidae, Caprinidae, Hippuritidae and Radiolitidae, and by the LV in Heterodiceratinae, Plesiodiceratinae, Epidiceratinae, and Requieniidae. Based on this assumption, parts distinguished as anterior, posterior, ventral and dorsal can be determined. However, because of the uncertain identification of rightness or leftness in many rudist shells, it seems desirable to designate the two valves as attached valve (AV) and free valve (FV) in descriptions of rudist genera and species.

Anterior, posterior, dorsal, and ventral can be retained as convenient orientation terms, but it is important to recognize that these terms are applicable to conical shells only if assumption is made regarding rightness or leftness of the valves. Investigation of young shells of rudists which show no evidence of coiling in the adult may provide the ontogenetic information necessary to settle the question.

TEETH AND SOCKETS

Hinge structure is similar in all rudists. Except for *Diceras,* rudists have two teeth in the free valve separated by a socket which receives the single tooth of the attached valve. In *Diceras* two teeth are present in the attached RV and a single tooth occurs in the free LV (Fig. E223). Rudist hinge teeth vary from feeble tubercles weakly aligning the two valves to long, heavy straight or curved (Fig. E220,*1a,3;* E224,*3*) projections firmly guiding the opening and closing of the valves. The teeth and their corresponding sockets may be smooth or grooved.

Three principal notation systems for rudist dentition have been proposed, and several minor variations of these have been used (Table E1). The first system introduced by DOUVILLÉ *(267a)* has been used most commonly by rudist workers and has not been replaced completely by any later proposed notation system. This terminology

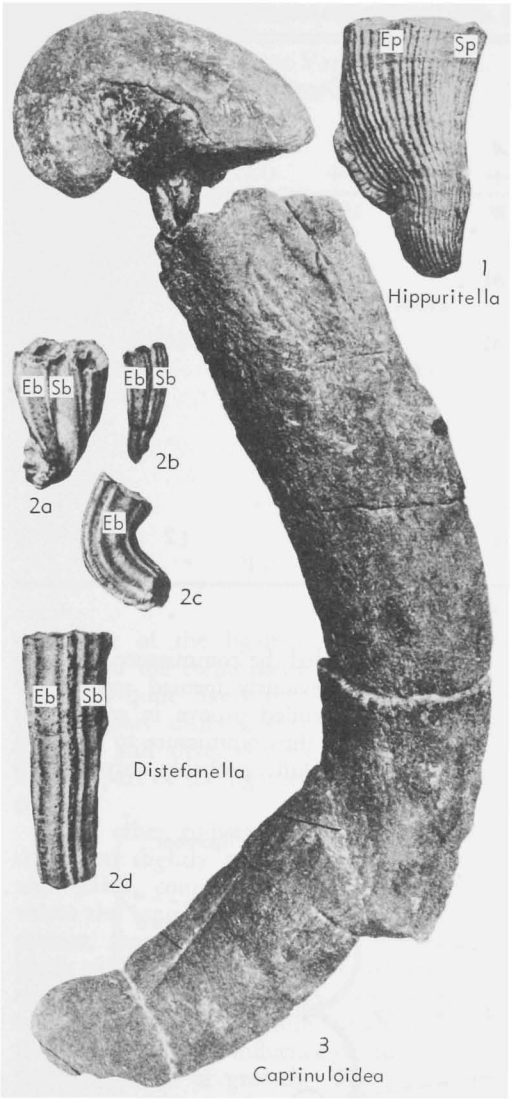


FIG. E224. Morphological features of rudists (coral-like shells with operculiform upper valve).

1. *Hippuritella maestri* VIDAL, U.Cret.(Santon.), France, Pyrenees (Montsech); side view of AV, ×1.7 *(269)*.
2. *Distefanella lombricalis* D'ORBIGNY, U.Cret. (Turon.), France (Charente); *2a-d*, side views of 4 AV's showing shape variations and position of *Eb* and *Sb* siphonal bands, ×0.7 *(911)*.
3. *Caprinuloidea perfecta* PALMER, U.Cret.(Cenoman.), Mexico; side view of both valves (cap-like FV above), ×0.35 *(714)*.

[Explanation: *Eb, Sb,* siphonal bands farthest and nearest ligament; *Ep, Sp,* internal pillars.]

apparently was not derived from nomenclature used previously for other bivalves and was not intended by DOUVILLÉ to express homology. The second system used by DOUVILLÉ *(278a)* was derived from terminology of MUNIER-CHALMAS *(652b)* and BERNARD *(37, 40)*. It expressed DOUVILLÉ's interpretation of the homologous relationships of rudist dentition. His last system *(282)* is only a slightly modified version of the second. Most other notation systems, such as that used by DI STEFANO *(882a, 882b)* and one used by KLINGHARDT *(475)*, are minor variations of DOUVILLÉ's first nomenclature.

DECHASEAUX *(245, 246, 252)* noted the impossibility of distinguishing cardinal and lateral teeth in rudists, and consequently, the difficulty of applying with certainty the dental notation of MUNIER-CHALMAS and BERNARD. She proposed using the numerical system of BERNARD, without the implications of homology, however. In this system the teeth are numbered from front to back (i.e., *1, 2, 3*) and their corresponding sockets are indicated by the same numbers with the addition of a prime accent (i.e., *1', 2', 3'*). By this system tooth *2* of the Diceratinae is in the free LV and teeth *1* and *3* are in the attached RV. In all other rudists teeth *1* and *3* are in the free valve (FV) and tooth *2* is in the attached valve (AV), whether the LV or RV is attached.

This simplified notation without homologous implications first used by DECHASEAUX is followed in the *Treatise*.

LIGAMENTAL STRUCTURES

The ligament is not preserved in fossil rudists, but its original location is marked by a ligamental groove or furrow on the exterior of the shell, a ligamental cavity within the shell wall, or a ligamental ridge or pit on the interior of the shell. The ligament was external in the most archaic rudists, but it was progressively submerged into the shell wall of other groups, and in many advanced groups it was entirely internal or lost completely.

The ligament in the Diceratidae, Requieniidae, and some Monopleuridae (e.g., *Valletia, Gyropleura*) lay in a groove parallel to the commissure. As the valves grew,

TABLE E1. *Notation Systems for Rudist Teeth and Sockets Employed by Various Authors.*

		DICERAS					
		RV			LV		
		A	*M*	*P*	*A*	*M*	*P*
		+	O	+	O	+	O
DOUVILLÉ, 1886 *(267a)*	Teeth	B′		B		N	
	Sockets		n		b′		b
DOUVILLÉ, 1918 *(278a)*	Teeth	AI		3b		AII	
	Sockets		AII′		AI′		3b′
DOUVILLÉ, 1935 *(282)*	Teeth	AI		3		AII-2	
	Sockets		AII′-2′		AI′		3′
DI STEFANO, 1889, 1899 *(882a, 882b)*	Teeth						
	Sockets						
KLINGHARDT, 1928 *(475)*	Teeth						
	Sockets						
DECHASEAUX, 1952 *(252)*	Teeth	1		3		2	
	Sockets		2′		1′		3′

EXPLANATION: +=tooth, O=socket; *A*, anterior; *M*, median; *P*, posterior.

the strong tangential growth component caused separation and coiling away from the commissure of the umbones and consequently the ligament was split so that only the most recently formed portion was entire and paralleled the commissure, the location of the previously formed sections remaining as a coiled groove in each valve extended from the commissure to the beak (Fig. E223). Quite probably only the un-

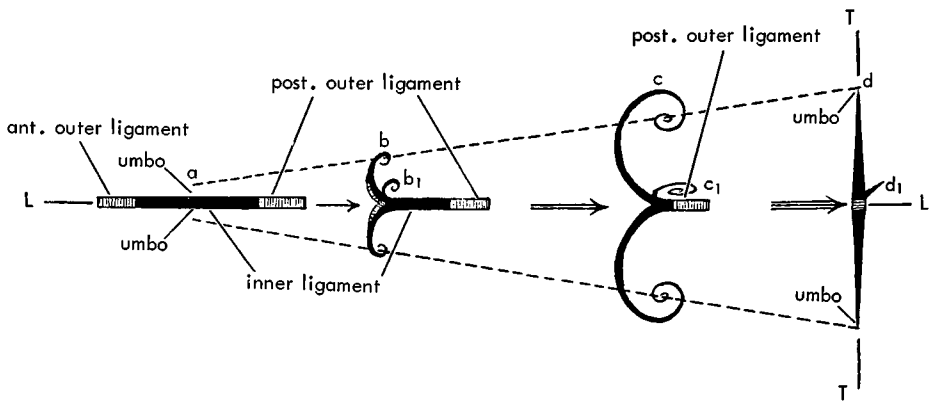


FIG. E225. Diagram showing effect of tangential growth component on ligament, arrows denoting increased effect *(1024a)*.

[Explanation: *L-L*, longitudinal axis; *T-T*, transverse axis; broken lines indicate divergence of umbones induced by interumbonal growth consequent on increasing effect of tangential growth component. ——*a*. Primitive amphidetic ligament, longitudinally disposed and anteroposteriorly symmetrical.——*b*. Anteriorly separated and coiled ligament of *Glossus*, bilaterally but not anteroposteriorly symmetrical. ——b_1. Ligament of Chamidae, bilaterally asymmetrical.——*c*. Coiled ligament of Diceratidae, almost bilaterally symmetrical.——c_1. Ligament of *Requienia* bilaterally symmetrical.——*d*. Secondarily straightened ligament of *Caprina*, functionless and now disposed transversely.——d_1. Bilaterally asymmetrical ligament of Hippuritidae and Radiolitidae.]

TABLE E1. *(continued)*

Rudists with Left Valve Attached						Rudists with Right Valve Attached					
	RV			LV			RV			LV	
A	*M*	*P*	*A*	*M*	*P*	*A*	*M*	*P*	*A*	*M*	*P*
+	O	+	O	+	O	O	+	O	+	O	+
B′		B		N			N		B′		B
	n		b′		b	b′		b		n	
AI		3b		AII			3B		AII		PII
	AII′		AI′		3b′	AII′		PII′		3b′	
AI		3		AII			3		AII		PIV
	AII′		AI′		3′	AII′		PVI′		3′	
							N		D′		D
						d′		d		n	
							N		B_1		B
						al_1		a1		N	
1		3		2			2		1		3
	2′		1′		3′	1′		3′		2′	

split part of the ligament approximately parallel to the commissure was functional, and it is quite likely that the older functionless part disintegrated while the animal was still alive, as does the older functionless part of the ligament in some living oysters.

In all other rudists with conical, openly coiled or slightly twisted attached valves and coiled, conical, or operculiform free valves the long axis of the ligament, when present, was approximately normal to the plane of commissure. The reorientation of the ligament from a parallel-to-commissure to a normal-to-commissure structure is a result chiefly of the influence of the tangential component of growth. The effects of the tangential growth component on the ligament have been summarized diagrammatically by YONGE (Fig. E225).

In rudists with the ligament oriented normal to the commissure the ligament may have been functionless. This type of ligament, if functional, was certainly subject more to tensional stresses than to bending stresses of a parallel-to-commissure ligament. This normal-to-commissure ligament may have served only as a stringlike guide holding the dorsal margins of the valves together but not strongly counteracting contraction of the adductor muscles.

In the Monopleuridae (excluding *Valletia* and *Gyropleura*) the ligament of the AV lay in a groove normal to the commissure. The ligamental groove is shallow and does not penetrate the shell wall (*Petalodontia,* Fig. E252,*4a,b*) or it is deep and penetrates the shell wall so that an internal groove or cavity is developed (*Himeraelites,* E252,*5b*).

In monopleurids with operculiform FV's (*Monopleura,* E250,*3b; Araeopleura,* E250, *2b; Petalodontia,* E250,*1a,b*) the FV ligamental position may be marked externally by a slight infolding or notching of the shell wall, but in some no external feature can be related to the ligament. Internally a shallow rounded or elongate ligamental pit is found between the dorsal margin and the tooth socket *(2′)*. The FV ligament in species of *Monopleura* with the FV coiled in a low spiral (E251,*3a;* E252,*1a*) is represented externally by a groove which extends from the beak to the commissure and leads internally to a shallow ligamental cavity. In the elevated FV of *Himeraelites* (E252,*5c*) an external ligamental groove extends from the beak to the commissure and opens internally into a deep ligamental pit.

In the AV of caprotinids the ligament location is marked externally by a deep groove which may open internally into a

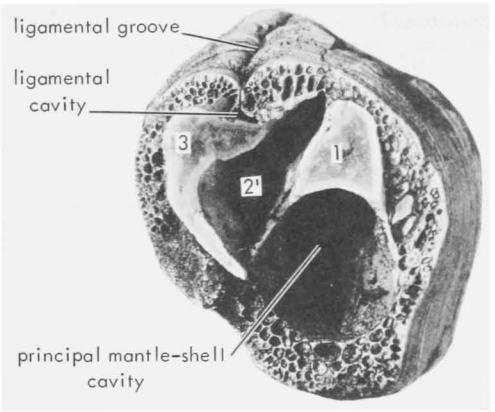


FIG. E226. *Caprinuloidea* sp. (Caprinidae), L.Cret. (Alb.), USA(Texas); FV int. showing ligamental cavity, ×1.3 (Perkins, n).

ligamental cavity (*Sellaea,* Fig. E255,*2b; Polyconites,* E254,*1b*). A similar external groove and internal ligamental cavity are found in conical or coiled caprotinid FV's (*Sellaea,* Fig. 255,*2a*). The ligament location in caprotinids with operculate FV's may be marked externally by a short, shallow groove which corresponds internally to a ligamental pit (*Polyconites,* E254,*1a; Chaperia,* E253,*1a*).

The ligament position is defined in most caprinids by a shallow to deep external groove in both valves (*Caprinula,* E257,*4d; Caprinuloidea,* E258,*3; Planocaprina,* E259, *3a; Plagioptychus,* E260,*2a; Coralliochama,* E258,*2a*). The ligamental groove may open internally into a narrow or wide ligamental cavity (*Sabinia,* E262,*3a,b; Caprinula,* E257, *4c; Caprina,* E257,*2a; Caprinuloidea* sp., E226). In some caprinids, however, there is no external groove or internal structure which can be related to the ligament (*Dictyoptychus,* E256,*2a-c*).

In most hippuritids the ligamental position in the AV is marked by an external furrow and an internal ligamental ridge, but in some species (e.g., *Hippurites bioculata,* Fig. E220,*2* and Fig. E263,*1b*) no internal ridge occurs and an external furrow is not developed. In other species a well-developed ligamental ridge is not matched by a distinct external furrow. The external furrow, when present, extends from the apex to the commissure and may be broadly (E220,*1b*) or narrowly rounded (E220,*6*). In transverse section the ligamental ridge may be a low, rounded swelling (*Batolites,* E237,*11*), a sharp triangle (*Hippurites,* E220, *1b*) or rounded triangle (*Tetracionites,* E264,*5*), a long, parallel-sided projection with a truncated, rounded or swollen tip (*Torreites,* E238,*5;* E265), or a beaded (moniliform) ray (*Barrettia,* E227,*2*). An internal ligamental ridge and external furrow are present in the FV of some hippuritids (*Hippurites,* E220,*1a*) which correspond to the ridge and furrow of the AV. Hippuritids have been studied most commonly from transverse sections because separate, free valves are rare. As a result, little is known about the ligamental structures of the FV and only those features of the AV which are exposed in transverse sections are well known. It seems likely that the ligament in hippuritids was not functional.

An internal ligamental ridge is present in the AV of all Radiolitinae and in *Sauvagesia* (Sauvagesiinae), *Praelapeirousia* (Lapeirousiinae) and *Joufia* (subfamily uncertain). An external groove (*Paronella,* E269, *4*) corresponding to the ligamental ridge is not found commonly in radiolitids. In transverse section the ridge may be long, slender and parallel-sided (*Pseudopolyconites,* E266,*3*), bilobed (*Kuehnia,* E267, *5*), or truncate (*Neoradiolites,* E269,*6*). An internal ligamental ridge is known in the FV of *Praeradiolites* (E220,*3;* E269,*2e*) *Eoradiolites, Sauvagesia* and *Joufia.* The FV ligamental ridge is straight and narrow and may terminate in a ligamental pit. A ligamental ridge may be developed in the FV of other genera which have ridges in the AV. The ligament of most radiolitids probably was functionless, but in some (*Praeradiolites, Eoradiolites,* and others) it may have served as a stringlike guide.

SIPHONAL STRUCTURES

Structures presumably related to siphons are present in many rudists. Siphonal structures include bands, fossettes, pillars, pseudopillars and oscules. These occur in pairs when present and have been designated by DOUVILLÉ as *"E"* and *"S"* according to their positions. The posterodorsal structures

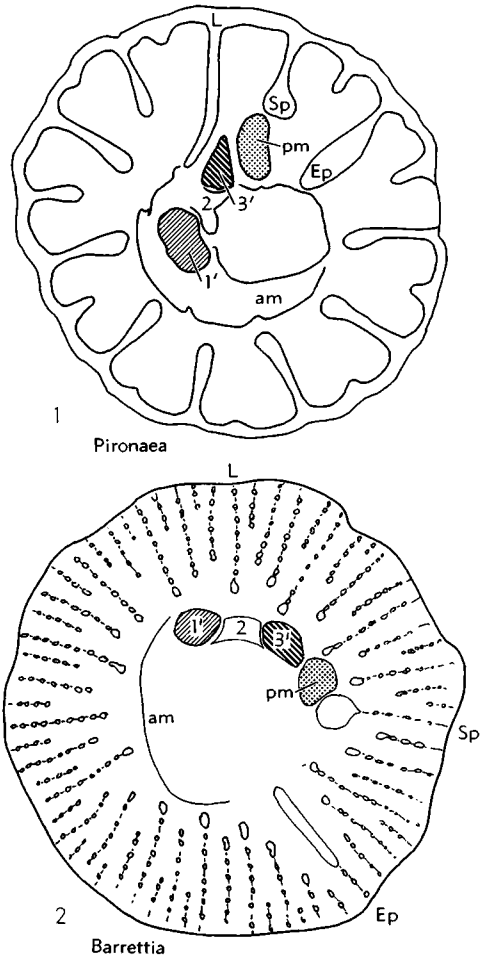


FIG. E227. Morphological features of rudists (shell structure) (hippuritids).

1. *Pironaea polystylus* (PIRONA), U.Cret. (Maastricht.), Italy; transv. sec. of type (AV) showing radial inward projecting partitions formed of bundled calcite prisms, ×0.5 *(269)*.
2. *Barrettia monilifera* WOODWARD, U.Cret. (Maastricht.), Jamaica; transv. sec. of type (AV) showing radial beaded structure in thick shell wall, ×0.5 *(269)*.

[Explanation as for Fig. E220.]

nearer the ligamental position were presumed by DOUVILLÉ to mark the location of the excurrent siphon and hence were designated *"S"* for *sortie* (French, excurrent). The ventral structures farther from the ligamental position were presumed to represent the incurrent siphon location and were named *"E"* for *entré* (French, incurrent). DOUVILLÉ's interpretation of these structures has been questioned by YONGE *(1027a)* who presented a biologically convincing alternative explanation (discussed elsewhere in this introduction by COOGAN). However, DOUVILLÉ's symbols *"E"* and *"S"* have been used generally and are retained in the *Treatise* but modified by a lower case letter to denote the particular structure. For example, *Eb* and *Sb* mark bands, *Ep* and *Sp* denote pillars, *Es* and *Ss* indicate pseudopillars, and *Ef* and *Sf* indicate fossettes. Oscules are designated *Eo* and *So*.

Siphonal bands (Fig. E224,*1,2;* E254,*2b*) are external features of the AV (and, in some genera, the FV) of Radiolitidae, a few Requieniidae *(Requienia, Toucasia)* and one Caprotinidae *(Horiopleura)*. Siphonal bands are broad to narrow, salient or superficial to deeply impressed areas with the long dimension normal to the commissure and extending from the apex of the valve to the commissure. In Requieniidae the bands are broad areas marked by slight deflections of the growth lines *(Requienia)* and slight depression of the area *(Toucasia)*. The siphonal bands of *Horiopleura* (Caprotinidae) (Fig. E254,*2b*) are smooth depressed areas on an otherwise radially ribbed shell.

The siphonal bands of the AV of most Radiolitidae are smooth, shallow, depressed areas as in *Radiolites* (Fig. E267,*2*). However, in some radiolitids the bands may be finely and longitudinally costulate *(Sauvagesia)* (Fig. E266,*4*), broadly costulate *(Medeella (Medeella))*, marked by strongly convex-upward folds *(Praeradiolites)* (Fig. E269,*2*) or occur in deeply sunken grooves *(Thyrastylon)* (Fig. E243,*2*). The siphonal bands of *Medeella (Fossulites)* (Fig. E243, *1*) are salient areas which mark cylindrical siphonal fossettes within the shell wall. In *Tampsia* (Fig. E272,*2*) sharp inflections define the bands and *Eb* is marked by a deep slit cutting the shell wall almost to the inner layer of the shell. In many radiolitids no external feature of the FV corresponds to bands of the AV, although in some genera *(Hardaghia)* bands are present in the FV. In *Medeella* (Fig. E243,*1a;* E267,*1c*) inflected crescentic slits or arches in the FV correspond to bands and fossettes

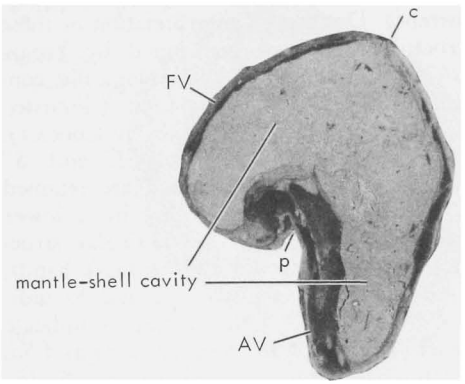


FIG. E228. *Sellaea* sp. (Caprotinidae), L.Cret.(Alb.), USA(Texas); long. sec. both valves showing mantle-shell cavity open without tabulae (*p-c;* commissural plane), ×0.7 (Perkins, n).

of the AV and in *Thyrastylon* openings or oscules through the FV correspond to the deeply sunken bands of the AV.

In hippuritids infoldings of the AV shell wall produced ridges normal to the commissure (Fig. E220,*1b,2*). These ridges or **pillars** are usually three in number, one marking the ligamental position and the other two presumably siphonal in location. The pillars are matched in the FV by openings, **oscules,** through the valve (Fig. E263, *1a,2b*).

In *Parasauvagesia* (Radiolitinae) and in most Lapeirousiinae development of cellular structure (Fig. E273,*6*) in the outer shell wall produces pillar-like ridges (termed **pseudopillars**) on the inner shall wall. Oscules in the FV correspond to pseudopillars in the AV. The function of pillars, pseudopillars, and oscules is discussed by COOGAN in "Evolutionary Trends in Rudist Hard Parts," and in the systematic sections on Hippuritidae and Radiolitidae.

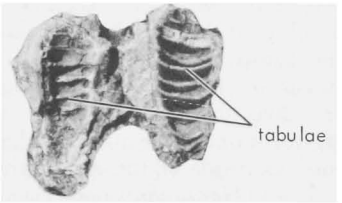


FIG. E229. *Eoradiolites* sp. (Radiolitidae), L.Cret. (Alb.), USA(Texas); natural long. sec. of two AV's showing closely spaced tabulae in mantle-shell cavity, ×0.7 (Perkins, n).

MANTLE-SHELL CAVITY

The mantle-shell cavity of rudists is a single or subdivided cavity within each of the two valves. The cavities of the valves are nearly equal in size in the Diceratidae and in many Caprotinidae and Caprinidae. In the Requieniidae, Monopleuridae, Radiolitidae, and Hippuritidae the shell cavity of the AV is much more elongate normal to the commissure and is larger than that of the FV. In the shells of species which have operculiform FV's the cavity of that valve is reduced to a shallow depression. In the Caprotinidae, Caprinidae, some Requieniidae and Monopleuridae the shell cavity consists of a principal cavity which contained the visceropedal mass and gills along with accessory cavities which probably were lined only by the mantle. In rudists having relatively thin or compact shell walls (e.g., Diceratidae, Requieniidae, Monopleuridae, and Caprotinidae) the shell cavity is large in proportion to the cross-sectional area of the valve. In rudists with thick shell walls (Hippuritidae) or spongy shell wall structure (Radiolitidae, Caprinidae) the principal shell cavity may be very small in proportion to the valve's cross-sectional area.

The shell cavity may be open throughout its length from the commissure to the um-

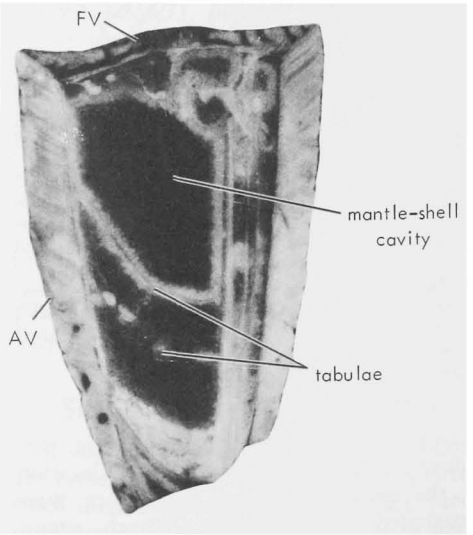


FIG. E230. *Hippurites bioculatus* LAMARCK, U.Cret. (L.Campan.), France (Corbières); long. sec. both valves showing tabulae in mantle-shell cavity of AV, ×1.3 (Perkins, n).

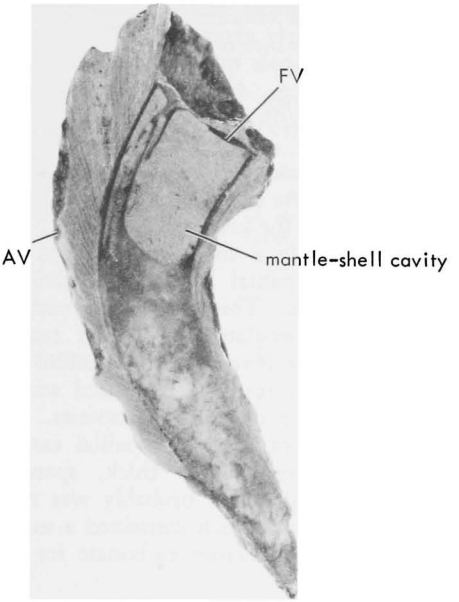


FIG. E231. *Eoradiolites davidsoni* HILL (Radiolitidae), L.Cret.(Alb.), USA(Texas); long. sec. both valves showing mantle-shell cavity size in relation to shell size, ×0.7 (Perkins, n).

bonal area (Fig. E228), but in Caprinidae, Radiolitidae, and Hippuritidae the shell cavity commonly is divided by transverse tabulae concave toward the commissure (Fig. E229-E231). In caprinids in which the shell cavity is divided into a principal cavity and accessory cavities all cavities may be tabulate but the tabulae in these various spaces do not occur at common levels. The tabulae close off earlier-formed portions of the shell cavity and spaces remain as vacant chambers. In some Hippuritidae the earlier-formed part of the shell cavity is filled from the umbo toward the commissure by dense shell material. The tabulae and dense shell material reduce the available space in the cavity for the animal which was small in relation to size of the shell in many caprinids, radiolitids, and hippuritids (Fig. E231).

ACCESSORY CAVITIES

Accessory cavities were first defined by DOUVILLÉ *(267a)* from studies of *Caprotina* (Caprotinidae). These cavities separate anterior and posterior myophore plates and teeth from the shell wall in caprotinids and caprinids. They are developed chiefly in the FV but also occur in the AV of some genera.

Accessory cavities are large in most caprotinids but may be reduced greatly *(Chaperia, Retha)*. They are usually oval or lunate in section parallel to the commissure and in some shells are divided by thin, radial plates normal to the commissure. Accessory cavities occur in all caprotinid genera but are not limited to this family, for accessory cavities are found in *Bayleia* and *Bayleoidea* (Requieniidae), *Himeraelites* (Monopleuridae), and in most Caprinidae.

The posterior accessory cavity is connected with the posterior socket in the AV of Western Hemisphere caprinid genera (e.g., *Amphitriscoelus, Coalcomana, Caprinuloidea*) and has a characteristic shape in transverse section. MACGILLAVRY *(561)* first noted this distinction of Western Hemisphere caprinids and described the cavity as "more or less shaped like an ant's larva, or better, like the ornament one often encounters on oriental tapestry" (Fig. E241; E257,*1a;* E232). The AV posterior accessory cavity in some caprotinids (e.g., *Sellaea*) is connected also with the posterior socket, which, in turn, is connected to the ligamental cavity (Fig. E239,*3a;* E255,*2b*).

A myophorous accessory cavity is present in the FV of some caprotinids (e.g., *Pachytraga,* Fig. E253,*4*) and caprinids (e.g., *Caprina,* Fig. E256,*1; Caprinula,* Fig. E257, *4b; Caprinuloidea, Plagioptychus,* Fig. E259, *5b*). These accessory cavities are usually connected to the tooth socket *(2')* and may be only partially separated from the principal shell cavity. The cavity is formed by a vertical plate connecting the anteroventral margin of the anterior tooth *(1)* with the anteroventral shell wall. The plate does not reach the commissure in most species, so that at this level the principal cavity is not separated from the myophorous accessory cavity. The anterior muscle insertion of the FV is on the anterior or anteroventral cavity and the cavity received the anterior myophore plate of the AV when the valves were closed.

Accessory cavities occur in the AV of some hippuritids, radiolitids, and caprinids

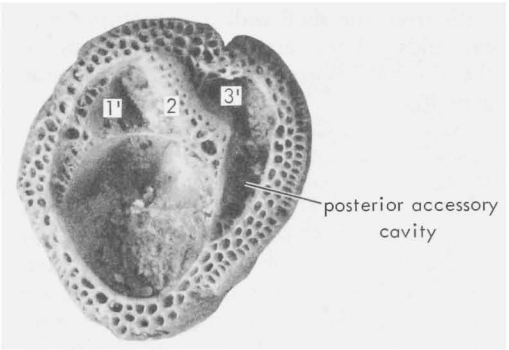


FIG. E232. *Caprinuloidea* sp. (Caprinidae), L.Cret. (Alb.), USA(Texas); AV int. showing characteristic shape of posterior accessory cavity and connecting posterior socket *(3')* in western hemisphere caprinids, ×0.7 (Perkins, n).

between the cardinal structures and the dorsal shell wall.

DOUVILLÉ postulated that accessory cavities developed as the valve increased in height and the teeth and myophore plates became erect to the point that these structures no longer increased in size at the same rate as the shell diameter. As a result, a cavity developed between the muscle insertion surfaces and teeth on one side and the shell wall on the other. Consequently, a much larger but much less dense shell was formed.

Accessory cavities converge toward the apex of the shell. Steinkerns of the cavities appear as clusters of cones attached to each other by their bases and are the "birostres" of 18th and early 19th century French paleontologists.

PALLIAL CANALS

Longitudinal, thin-walled canals, called **pallial canals,** in the shell wall characterize the Caprinidae. These canals may be present in either or both valves of a shell, and although they occur only in the shell wall of most caprinids they may be in the dental apparatus of some genera (e.g., *Caprinuloidea* and *Titanosarcolites,* Fig. E232). The canals are bounded by radial, transverse and tangential plates lying normal to the commissure. The radial plates may be simple, bifurcate or many-branched, and the transverse and tangential plates may be regularly or irregularly arranged. In transverse section pallial canals may be approximately quadrangular (e.g., *Amphitriscoelus*), regularly oval to pyriform (e.g., *Coalcomana, Caprinuloidea*), or irregularly polygonal (e.g., *Coralliochama*). The pallial canals of some caprinids are traversed by thin tabulae concave toward the commissure.

In some shells a distinction cannot be made between pallial canals and divided accessory cavities. This observation caused DOUVILLÉ to speculate that pallial canals originated by the invasion of the pallial region by canals formed in advanced stages of the subdivision of accessory cavities.

Development of abundant pallial canals in caprinids produced a thick, spongy, porous shell wall which probably was rapidly deposited and which contained a minimum amount of calcium carbonate for its size and strength.

Pallial canals are discussed further in the section on shell-wall structures (Caprinidae).

MUSCLE INSERTIONS

The two adductor muscles in rudists were inserted on the shell wall, joined to projecting plates or myophores or within myophorous sockets. Within an individual rudist the type of muscle insertion may be different for the two valves or for the two muscles and are not necessarily symmetrical. For example, in Diceratidae the anterior muscle insertions in both valves may be on the shell wall, but the posterior insertions are on myophore plates. In Radiolitidae the FV muscle insertions are on projecting myophores but the AV insertions are on the shell wall (Table E2).

Shell-wall insertions may be superficial, on weakly to strongly depressed areas or on thickened areas.

Platelike prolongations of the cardinal platform are muscle insertion sites in some Diceratidae (e.g., *Heterodiceras,* Fig. E244, *1; Mesodiceras,* Fig. E244,*2a,b*), Requieniidae (e.g., *Kugleria,* Fig. E246,*6a*) and Monopleuridae (e.g., *Monopleura,* Fig. E252,*1*). The insertion surfaces on plates of this type are parallel or nearly parallel

TABLE E2. *Summary of Muscle Insertions in Rudists.*

FAMILY	ATTACHED VALVE		FREE VALVE	
	ANTERIOR INSERTION	POSTERIOR INSERTION	ANTERIOR INSERTION	POSTERIOR INSERTION
DICERATIDAE	1) Shell wall or 2) prolongation of cardinal platform	1) Plate projecting above shell wall or 2) prolongation of cardinal platform	1) Shell wall or 2) on prolongation of cardinal platform	1) Plate projecting above shell wall, 2) prolongation of cardinal platform, or 3) plate extending beneath cardinal platform
REQUIENIIDAE	Shell wall	1) Shell wall or 2) on plate extending beneath cardinal platform	1) Shell wall or 2) on prolongation of cardinal platform	1) Plate extending beneath or above cardinal platform, 2) prolongation of cardinal platform, 3) plate separated from shell wall by accessory cavity, or 4) plate parallel to shell wall and attached to it by plate normal to shell wall
MONOPLEURIDAE	Extension of cardinal platform as thickened area or buttress	Extension of cardinal platform as thickened area or buttress	Extension of cardinal platform as thickened area, buttress or myophore plate	1) Extension of cardinal platform as thickened area, buttress or myophore plate or 2) on erect separate myophore plate or lamina
CAPROTINIDAE	1) Shell wall or 2) on plate separated from shell wall by accessory cavity	1) Shell wall or 2) on plate separated from shell wall by accessory cavity	1) Shell wall or 2) on plate separated from shell wall by accessory cavity	Shell wall or on plate separated from shell wall by accessory cavity
CAPRINIDAE	1) Shell wall or 2) on plate separated from shell wall by accessory cavity	1) Shell wall or 2) on plate separated from shell wall by accessory cavity	1) Shell wall or 2) on plate separated from shell wall by accessory cavity	1) Shell wall, 2) on plate separated from shell wall by accessory cavity, or 3) on projecting myophore which fits into socket of AV
HIPPURITIDAE	Shell wall	In socket which receives FV myophore	Projecting myophore or buttress	Myophore which fits into AV socket
RADIOLITIDAE	Shell wall	Shell wall	Projecting myophore or buttress	Projecting myophore or buttress

to the commissure. These plates are attached to the shell wall along their front (for the anterior plate) and back (for the posterior plate) edges and curve around the shell cavity. Similar plates which are not connected directly to the cardinal platform are developed in the Requieniidae. These plates either pass above (e.g., RV posterior of *Requienia,* Fig. E246,*1b*) or below (e.g., LV posterior of *Bayleia,* Fig. E246,*2a;* LV posterior of *Apricardia,* Fig. E246,*3*) the cardinal platform.

Erect **myophore plates** are present in many Caprotinidae (e.g., *Sellaea,* Fig. E255, *2b*) and most Caprinidae (e.g., *Amphitriscoelus,* Fig. E257,*1, Schiosia,* Fig. E262, *5*). Plates of this type are normal to the commissure and extend from the hinge to the posteroventral and anteroventral shell wall. The plates are separated from the anterior and posterior shell wall by simple or subdivided accessory cavities (described above).

Strongly projecting myophorous apophyses or **myophores** are characteristic of the FV of most Radiolitidae and Hippuritidae. Myophores of this sort may be elongate and toothlike (e.g., *Hippurites,* Fig. 220,*1a*) or thick-based with the tip swollen into a knob or boss (e.g., *Praeradiolites,* Fig. 220, *3*). The two myophores in a shell may be similar in form and subequal in size (e.g., *Praeradiolites,* Fig. 220,*3*), or they may be quite unsymmetrical in size and shape as in *Hippurites* (Fig. 220,*1a*).

A **muscle buttress** is intermediate between an insertion on a thickened shell wall area and a well-developed projecting myophore. A buttress is an elevated or pendent structure in which the insertion surface usually is only slightly inclined to the shell wall as in the FV of *Agriopleura* (Fig. E237, *1*). Buttresses are usually developed as extensions of the cardinal platform to which they remain attached. They are found in the FV of some Radiolitidae and in the AV of some species of Monopleuridae (Fig. E233).

In hippuritids the posterior muscle insertion area in the AV is on the inner wall of a socket dorsal to *Sp* (e.g., *Hippurites,* Fig. 220,*1b*). When the valves are closed the toothlike posterior myophore of the FV fits into the myophorous socket of the AV.

MECHANISM FOR OPENING AND CLOSING VALVES

By Colette Dechaseaux

The almost constant occurrence of attachment scars for anterior and posterior adductor muscles indicates that the rudists could open and close their valves. In all except the Hippuritidae and Radiolitidae the apparatus for this purpose, consisting of a ligament, well-developed teeth (not, however, forming long projections), and muscle scars, situated either directly on the shell wall or on more or less projecting apophyses (myophores), shows that the two valves could be opened by a hinging movement as in an ordinary lamellibranch. The form of the teeth in some shells (e.g., *Plagioptychus*) may have required a slight rotational movement of the free valve with respect to the fixed valve in order to disengage the expanded extremity of a tooth from its socket.

The problem of opening the shell is more involved when we consider the Hippuritidae and Radiolitidae, in which the teeth and myophores form elongate projections (Fig. E220,*1,3*). The free valve in this group forms a lid to the attached valve, its long teeth and myophores being received in elongate sockets, so that only vertical movements are possible. The free valve, when raised above the fixed one, is guided by grooves along the teeth and also (in some forms) along the myophores and by corresponding ridges along the sides of their sockets (Fig. E220,*1,3*). It may be suggested that the free valve could be raised by increased pressure inside the shell, brought about by expansion of the soft parts such as the foot. When the valves were separated the muscles were stretched, but when internal pressure was relaxed they would resume their normal length, thus closing the shell.

MODE OF LIFE

By Colette Dechaseaux

Some rudists lived as solitary individuals (Fig. E224), whereas other were gregarious, their accumulated shells now forming dense masses called "rudist reefs." Except for certain radiolitids the form of which suggests that they lay resting on a flattened side on the sea bottom, and also some others with an equivalve shell lacking an attachment scar, and thus possibly capable of some free movement, all rudists grew attached, either intermingled with other organisms, particularly corals, or, when in an erect position, in clusters of varying magnitude. The earliest known species occur in coral reefs, forming an ele-

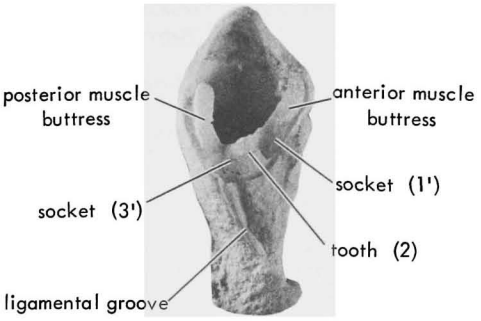


FIG. E233. *Monopleura* sp. (Monopleuridae), L. Cret.(Alb.), USA(Texas); dorsal oblique view of AV showing muscle buttresses and external ligamental groove, ×1.3 (Perkins, n).

ment of about the same importance as less specialized bivalves, gastropods, echinoderms, etc.

Hippuritidae and Radiolitidae are also associated locally with corals (as in eastern Serbia), but then other elements of the usual coral reef fauna are absent. Generally they occur in colonies of a single species or in assemblages containing only a small number of species. Near Angoulême, in France, certain Turonian beds which can be traced for several dozen meters contain only *Distefanella lombricalis* (D'ORBIGNY) (Fig. E224,*2*), apart from a very impoverished microfauna.

ORIGIN AND EXTINCTION

By COLETTE DECHASEAUX

According to present knowledge, the appearance of *Diceras* in Late Jurassic (Rauracian) time marks the beginning of the history of the rudists, a history extending almost to the close of the Cretaceous and including the development of a host of highly varied forms. Two hypotheses have been advanced as to the origin of *Diceras*. According to DOUVILLÉ, its ancestor was a bivalve living where its earliest representatives are found and having some of its distinctive characters. These requisites, it seemed to him, were possessed by *Pterocardium,* a genus in which the ornament consists of radial costae and in which the posterior muscle was attached to a projecting lamella. He supposed that the newly hatched young of *Pterocardium* became cemented to the substrate with the aid of the foot to avoid being carried away by currents during early life, and that as the shell developed it became twisted about the point of fixation so as to acquire a spiral form, the number of hinge teeth being reduced to three. Such modifications led ultimately to the genus *Diceras*.

The other hypothesis (by DECHASEAUX) is based on the tendency of the posterior elements of the hinge of *Megalodon* and *Protodiceras* to become reduced. In *Megalodon* (Devonian-Upper Triassic) one (or in some shells two) of these teeth are absent. In *Protodiceras* (Lower Jurassic) which normally has fewer hinge elements than *Megalodon,* a tendency toward reduction of the teeth on the posterior side occurs also, the final stage corresponding to the hinge of *Diceras*. Thus, beginning in the Devonian, a tendency toward development of the *Diceras* type of hinge is shown by *Megalodon* and *Protodiceras*. In support of this hypothesis we may note that in early growth stages of *Diceras* the posterior muscle was attached in the same way as in *Megalodon*.

Among the last surviving rudists were three radiolitids and a hippuritid which lived in Catalonia during the Maastrichtian Stage. They were not solitary bivalves, but on the contrary formed large "rudist reefs." Their abrupt extinction is the more difficult to explain since in this region deposition of calcareous sediment had continued uninterruptedly from the Coniacian onward, some species nevertheless disappearing while others persisted and new ones appeared; then, at the same moment, apparently all became extinct.

In Somalia, where the succession has been studied by TAVANI, Upper Cretaceous limestones pass without a break into lower Eocene limestone, yet no rudists occur in beds higher than Upper Cretaceous. The nature of the sediments gives no indication of a possible change in ecological conditions, so that we are entirely ignorant of factors responsible for extinction of the rudists and other groups that disappeared; more particularly, we are unable to ascertain what changes accounted for the fact that new species of these groups ceased to appear to replace those that died out. All we can say is that extinction of the group took place at this time.

CLASSIFICATION

By COLETTE DECHASEAUX

The hypothesis is here accepted that the rudists were derived from the Megalodontidae, and they are considered to form a major taxon of the Bivalvia to which STEINMANN assigned the name Pachyodonta, and for which the name Hippuritoida is adopted in the *Treatise*. The rudists constitute the superfamily Hippuritacea. It is thought probable that the Chamacea are not descended from them but are sessile heterodonts. In early ontogeny the shell of chamids is unattached and regular both in outline and in the nature of its concentric ornament. Much has yet to be learned of the early ontogeny of the rudists, but we have no knowledge of the existence of a comparable stage in this group.

To a large extent, the classification of the rudists in families has been based on the various characters (fixation, hinge structure, etc.) which have been discussed in preceding paragraphs. Certain special internal features (accessory cavities, canals, pillars, pseudopillars) allow other families to be defined, as stated in the systematic descriptions which follow.

A tabular summary of the classification adopted in the *Treatise,* showing the number of genera and subgenera (for example, "2; 4" denoting 2 genera and 4 subgenera) in each division, and recording known stratigraphic distribution, follows.

Divisions of Hippuritacea

Hippuritacea *(superfamily)* (115;3). *U.Jur.(U. Oxford.)-U.Cret.(U.Maastricht.)*
- Diceratidae (8). *U.Jur.(U.Oxford.)-L.Cret. (Valangin.)*
  - Diceratinae (1). *U.Jur.(U.Oxford.)-L. Kimmeridg.)*
  - Heterodiceratinae (3). *U.Jur.(Tithon.)-L.Cret. (Valangin.)*
  - Plesiodiceratinae (2). *U.Jur.(Oxford.-Kimmeridg.)*
  - Epidiceratinae (2). *U.Jur.(Oxford.)-L.Cret. (Valangin.)*
- Requieniidae (8;2). *U.Jur.(Tithon.)-U.Cret. (Maastricht.)*
- Monopleuridae (8). *L.Cret.(Valang.)-U.Cret. (Maastricht.)*
- Caprotinidae (8). *L.Cret.(Neocom.)-U.Cret. (Turon.)*
- Caprinidae (23). *L.Cret.(Barrem.)-U.Cret. (Maastricht.)*
- Hippuritidae (12). *U.Cret.(Turon.-Maastricht.)*
- Radiolitidae (39: 1)[a]. *L.Cret.(Barrem.)-U.Cret. (Maastricht.)*
  - Radiolitinae (14; 1). *L.Cret.(Barrem.)-U.Cret. (Maastricht.)*
  - Biradiolitinae (7). *U.Cret.(Turon.-Maastricht.)*
  - Sauvagesiinae (7). *L.Cret.(Alb.)-U.Cret. (Maastricht.)*
  - Lapeirousiinae (8). *U.Cret.(Santon.-Maastricht.)*
  - Subfamily Uncertain (3).
- Family Uncertain (9).

EVOLUTIONARY TRENDS IN RUDIST HARD PARTS

By A. H. COOGAN

[COOGAN's present affiliation is with Kent State University, Kent, Ohio. His *Treatise* contributions are based mainly on studies made while he was employed by the Humble Oil & Refining Company and Esso Production Research Company, Houston, Texas, to the staffs and management of which he acknowledges assistance and encouragement. Special appreciation is expressed to R. M. JEFFORDS, R. D. WOODS, and the late H. N. FISK.]

The morphological diversity of rudists is a stony monument to the plasticity of the bivalve mantle as it operated in adapting to a variety of reef, bank, and shallow-shelf environmental niches available on extensive sea-covered continental platforms of the Late Jurassic and Cretaceous. Broadly speaking, two groups of rudists can be recognized with respect to their rapidity of morphological change. The conservative, little-changing, and for the most part older families are the Diceratidae, Requieniidae, Monopleuridae, and Caprotinidae. The more plastic, rapidly changing, adaptive families are the Caprinidae, Radiolitidae, and Hippuritidae (Fig. E234). In the conservative group distinctions between families involve slight differences in dentition and musculature, different modes of attachment, variations in shape and size, and the development of internal structures. In the more plastic families these same differences occur at the subfamily or generic level and in addition dramatic changes are observed in wall structure, mechanism of opening the valves, and development of structures for lightening and strengthening the shell and for support of the siphons.

Evolutionary trends with morphological significance can be discussed selectively in terms of dentition, ligamental and muscular supports, wall structure, siphonal structures and pillars. Several instances of parallel evolutionary trends in one or more of

[a] Includes 3 radiolitids of unknown affinity.

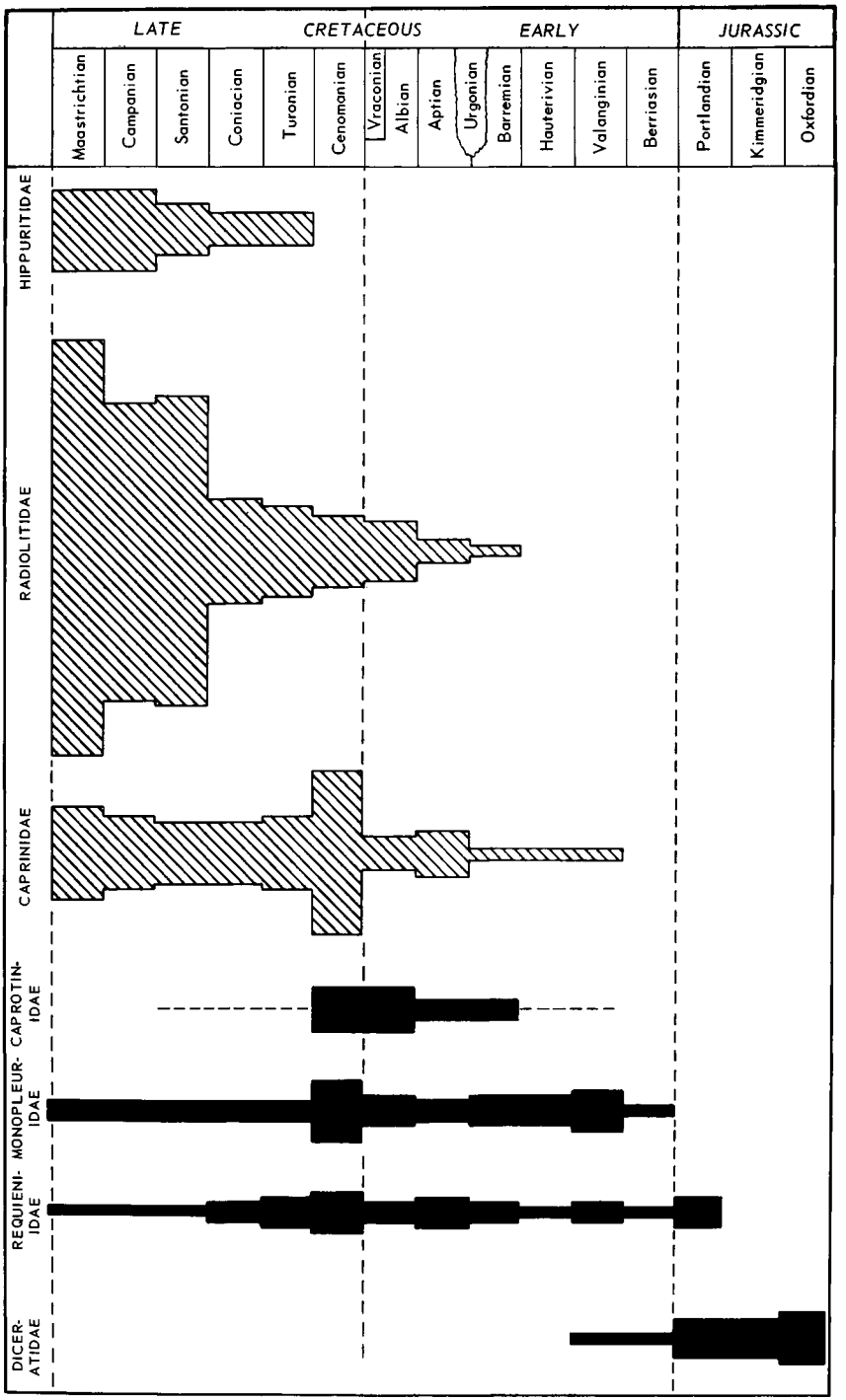
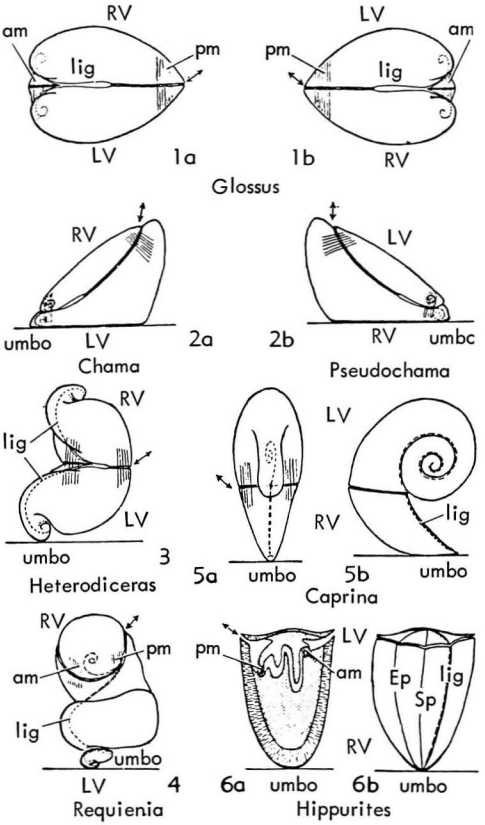
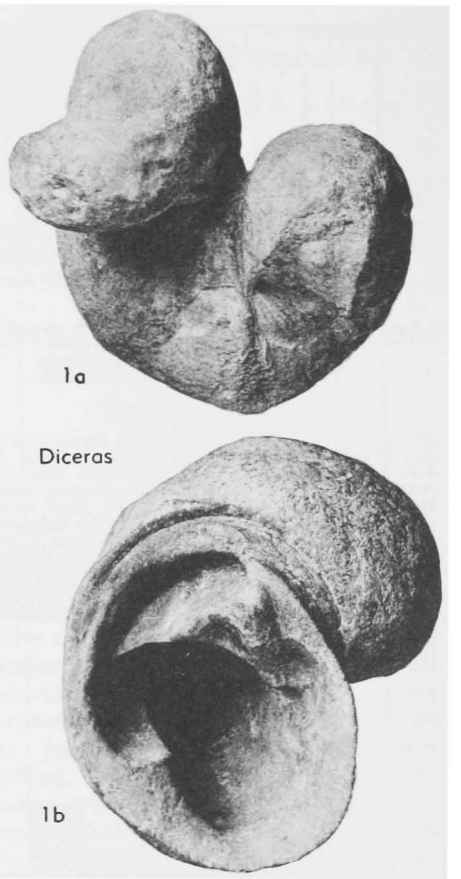


FIG. E234. Late Jurassic and Cretaceous stratigraphic distribution of rudist families, more plastic and rapidly evolving ones distinguished by oblique-ruled pattern (Coogan, n).





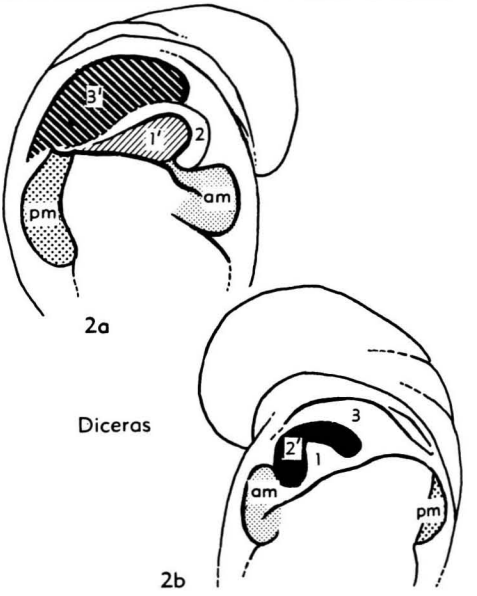


FIG. E235. Diagram indicating effects of tangential components in growth of various bivalve shells—Glossidae *(1)*, Chamidae *(2)*, Hippuritacea *(3-6)* *(1024a)*.

1. *Glossus; 1a,* lying on LV; *1b,* lying on RV.
2. Chamids; *2a,* normal *Chama* viewed from dorsal side, lying on LV; *2b,* inverse *Pseudochama,* lying on RV.
3. *Heterodiceras* (Diceratidae), with "normal" dentition, viewed from dorsal side, attached by LV.
4. *Requienia* (Requieniidae), with "normal" dentition, viewed from dorsal side, attached by LV.
5. *Caprina* (Caprinidae), attached by RV; *5a, C. adversa,* with almost planospirally coiled LV, viewed from dorsal side; *5b,* same, viewed from left side.
6. *Hippurites* sp. (Hippuritidae), attached by RV; *6a,* long. sec.; *6b,* posterodorsal side view showing position of *Ep* and *Sp* pillars inside shell.

[Ligament shown plain where exposed, indicated by broken line where enclosed by shell. Arrows mark locations of inhalant and exhalant apertures. Explanation: *am, pm,* anterior and posterior myophores; *Ep, Sp,* internal pillars; *lig,* ligament.]

these features are known from different families and subfamilies. YONGE *(1024a)* has recently emphasized a highly developed tangential component of shell growth in rudists and an associated lateral extension and coiling of the umbonal regions of the shell with attachment as the cause of great bilateral asymmetry in rudists (Fig. E235).

DENTITION

Across the whole spectrum of rudist families runs a trend toward modification of dentition from the "primitive" diceratid type (Fig. E236,*2*), which itself is a modification of heterodont dentition by reduction in tooth number, to extremes of the caprinid, radiolitid, and hippuritid dentitions.

From the simple, slightly unequally sized teeth of *Diceras* a trend in the radiolitids is directed toward enlargement and elongation of the FV teeth accompanied by reduction in size or loss of the AV tooth, or both. For example, in the oldest radiolitid genus, *Agriopleura* (Fig. E237,*1*), the FV teeth are already elongate. *Eoradiolites,* a younger genus, has similar FV teeth, as does *Praeradiolites* (Fig. E220,*3*), but has a narrow finger-like AV tooth (Fig. E237,*2*). A reduction in the AV tooth occurs in the bioradiolitine line (e.g., *Distefanella,* Fig. E237, *8*) and complete loss of the tooth in other bioradiolitines (e.g., *Biradiolites,* Fig. E237, *4*). A parallel evolutionary trend of reduction and loss of the AV tooth occurs in the Lapeirousiinae (e.g., *Dubertretia,* Fig. E237, *7*). In the hippuritids the FV teeth are elongate (e.g., *Hippurites,* Fig. E220,*1a*), as in the radiolitids, and the AV tooth is reduced in size but not lost (e.g., *Hippurites,* E220,*2; Barrettia,* Fig. E237,*10*).

In the Caprinidae distinct trends are less clearly discernible among the considerable diversity of tooth types. In some genera the teeth are large and porous (e.g., *Caprinuloidea,* Fig. E237,*3*), and located nearly in the center of the shell. In others they are reduced, apparently solid, and placed marginally (e.g., *Caprinula,* Fig. E237,*5*).

LIGAMENT SUPPORTS

Ligament supports of calcite and in some fossils calcite molds or casts of the flexible ligament are preserved in many rudists. In the primitive diceratid condition the ligament was coiled. In fact, it was already greatly modified from the primitive amphidetic ligament (Fig. E225). A general trend toward reduction in size of ligamental supports partly results from the strong tangential growth component and consequent interumbonal growth of the ligament which may become functionless. The ligament moves to the outside of the shell as rudists evolved from slightly unequally coiled diceratid-requieniid shape to extremely unequal vaselike forms of the radiolitids and hippuritids. Among radiolitids an internal ligament support occurs (e.g., *Eoradiolites,* Fig. E237,*2*), which becomes reduced in size and eventually is lost in branches of three separate radiolitid subfamilies. The bioradiolitines, which probably evolved from one of the radiolitine genera, have no internal ligament ridge (e.g., *Biradiolites,* Fig. E237,*4; Chiapasella,* Fig. E238,*1*). In the Sauvagesiinae the ligamental ridge is present in the older genus *Sauvagesia* (Fig. E238,*4*) but is lost in other genera (e.g., *Durania,* Fig. E237,*9; Tampsia,* Fig. E238, *2*). In the Lapeirousiinae a similar loss occurs. *Praelapeirousia* has a weak ligament ridge and other genera lack it entirely (e.g., *Lapeirousia, Dubertretia,* Fig. E237,*7*). In the caprinids the ligament has a strong external expression in the form of a groove and commonly is curved internally. The hippuritids, starting from a Turonian shell with a relatively small ligament ridge formed by infolding of the shell wall (e.g., *Hippurites,* Fig. E220,*1*b), developed enormously elongate and thick ligament pillars (e.g., *Vaccinites,* Fig. E237,*6; Torreites,* Fig. E238,*5*). In another hippuritid line the

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FIG. E236. Morphological features of rudists (diceratids).

1. *Diceras rotundatum* BAYLE, U.Jur.(Raurac.), France (Coulanges-sur-Yonne); *1a,* exterior, front view (AV at left) of type specimen showing strongly coiled beaks, ×0.7; *1b,* interior of FV showing single tooth *(2),* ×0.7 *(246).*
2. Diagrammatic sketches of interiors of FV *(2a)* and AV *(2b)* showing teeth and sockets and muscle insertions *(246).*

[Explanation as for Fig. E220; *2'*, socket corresponding to tooth 2.]

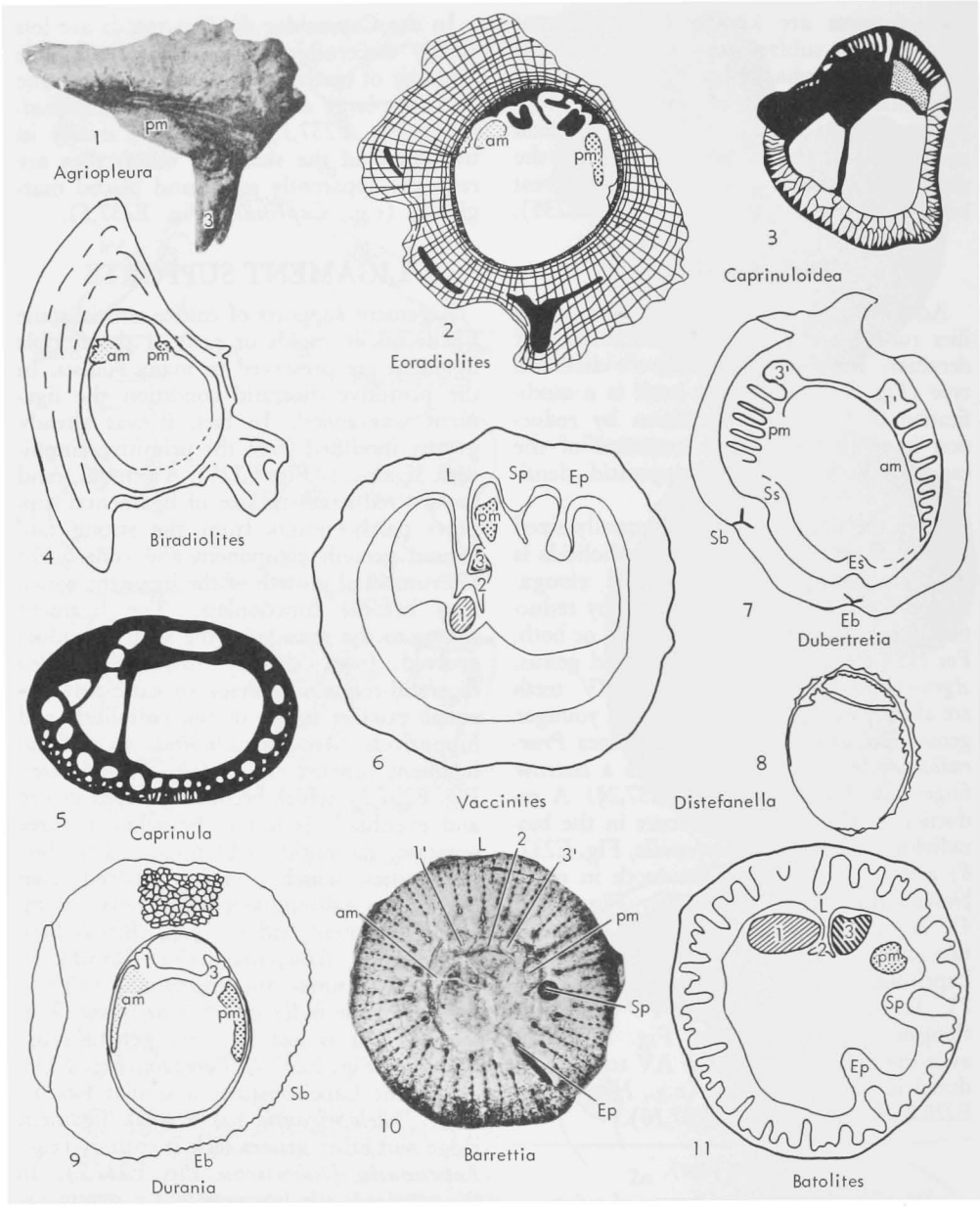

FIG. E237. Morphological features of rudists (dentition).

1. *Agriopleura blumenbachi* (STUDER) (Hippuritidae), L.Cret.(Barrem.), France (Brouzet); side view of FV showing projecting teeth, ×0.6 *(911)*.
2. *Eoradiolites davidsoni* (HILL) (Radiolitidae), L.Cret.(mid.Alb.), USA(Texas); transv. sec. AV, ×1.9 (Coogan, n).
3. *Caprinuloidea* sp. (Caprinidae), U.Cret.(Cenoman.), Mexico; schematic transv. sec. FV *(714)*.
4. *Biradiolites canaliculatus* D'ORBIGNY (Radiolitidae), U.Cret.(Coniac.), France; transv. sec. AV, ×0·6 *(277)*.

(Continued on facing page).

ligament ridge was modified to a thin bulbous pillar (compare *Batolites,* Fig. E237,*11,* and *Pironaea,* Fig. E238,*6*). In a parallel line of evolution *(Praebarrettia,* Fig. E238,*3* to *Barrettia,* Fig. E237,*10*) the ligament support was drawn out gradually until it became narrowed into a moniliform ray.

MUSCLE SUPPORTS

Adductor muscle supports of calcite, the **myophores,** are relatively stable morphological characters in the rudists. In the conservative diceratids the muscles are attached to part of the cardinal area or connect with it (e.g., *Diceras,* Fig. E236,*2*). Modifications of this scheme occur in the requieniids. As the shape of the AV valve changed markedly to vaselike, the myophores shifted laterally (e.g., *Eoradiolites,* Fig. E237,*2; Hippurites,* Fig. E220,*2*), while the apophyses became massive, grooved, elongate downward projections of the FV (Fig. E220, *1a,3*).

In the radiolitids the elongation of the FV myophores occurs early in the Cretaceous. *Agriopleura* (Fig. E237,*1*), a Barremian and younger genus slightly evolved from the monopleurids, has short massive apophyses. In younger radiolitids (e.g., *Praeradiolites,* Fig. E220,*3,* Albian) the apophyses are elongate smooth and displaced 90 degrees from the ligament crest (Fig. 238,*4*). Still younger genera evolved highly serrated lateral apophyses margins as can be seen in *Dubertretia* (Fig. E237,*7*) and *Dechaseauxia* (Fig. E239,*1b*). The earlier evolutionary imprint of twisting still may be manifest internally in highly specialized genera and where it is marked by a greater extension of the anterior apophysis in the radiolitids (e.g., *Chiapasella,* Fig. E238,*1*) and hippuritids (e.g., *Praebarrettia,* Fig. E238,*3; Torreites,* E238,*5*).

Adductor muscle supports in the caprotinids and caprinids took an entirely different turn. In these families the development of marginal accessory cavities and canals between the body cavity and anterior wall provided a thin, long interior plate or wall for muscle attachment which can be seen in *Sellaea* (Fig. E239,*3*) and *Schiosia* (Fig. E239,*2*). In the caprotinids this wall became a projecting plate in *Polyconites* (Fig. E239,*4*), whereas in *Titanosarcolites* (Fig. E262,*4b*) the posterior myophore was a raised apophysis in the FV that fits into an alveole in the AV.

WALL STRUCTURE

Wall structure is a useful basis for classification in rudist families and accordingly several trends are discussed here briefly.

The radiolitids, which characteristically have a celluloprismatic wall with a thick outer layer of hollow prisms, display a major trend toward less dense, more open network outer shell walls in younger taxa. Early genera (e.g., *Agriopleura,* Fig. E240, *5; Sphaerulites,* Fig. E240,*2*) have a compact reticulate outer wall. Younger genera (e.g., *Eoradiolites,* Fig. E240,*1*) have a compact to loosely open rectangular network. *Sauvagesia* (Fig. E238,*4*), *Chiapasella* (Fig. E238,*1*) and others have an open polygonal network. More complicated mixed wall structure of compact and open occurs in some later Cretaceous genera (e.g., *Joufia,* Fig. E240,*6,* and *Colveraia,* Fig. E240,*4*). Wall structure appears to be a relatively

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(FIG. E237).

5. *Caprinula* sp. (Caprinidae), U.Cret.(Cenoman.), Eu.; schematic transv. sec. FV *(252).*
6. *Vaccinites marticensis* DOUVILLÉ (Hippuritidae), U.Cret.(Coniac.), France; transv. sec. at level of AV with projecting teeth and posterior myophore of FV, ×1 *(910).*
7. *Dubertretia kelleri* Cox (Radiolitidae), U.Cret. (Maastricht.), Syria; transv. sec. at level of AV viewed toward commissure, ×0.9 *(468).*
8. *Distefanella salmojraghii* PARONA (Radiolitidae), U.Cret., Italy; transv. sec. AV, ×0.6 *(719).*
9. *Durania cornupastoris* DES MOULINS (Radiolitidae), U.Cret.(Turon.), France; transv. sec. at level of AV with projecting teeth and myophores of FV, ×0.6 *(268).*
10. *Barrettia monilifera* WOODWARD (Hippuritidae), U.Cret.(Campan.), W.Indies; transv. sec. AV, ×0.3 *(269).*
11. *Batolites organisans* DE MONTFORT (Hippuritidae), U.Cret.(Santon.), S.France (Pyrénées, Rennes-les-Bains); transv. sec. at level of AV with projecting teeth and posterior myophore of FV, ×2 *(269).*

[Explanation as for Fig. E220; also *Es, Ss,* pseudopillars.]

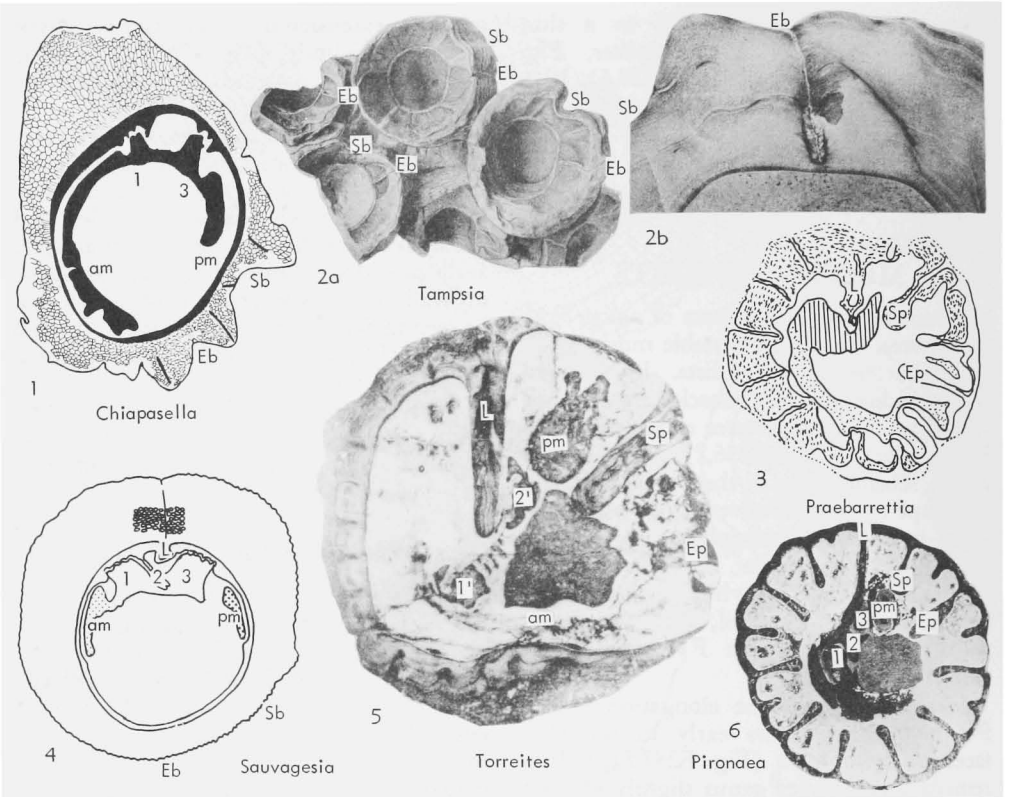

FIG. E238. Morphological features of rudists (ligament supports).

1. *Chiapasella cubensis* RUTTEN (Radiolitidae), U.Cret.(Maastricht.), Cuba; transv. sec. at level of AV with projecting teeth and myophores of FV, ×1.5 *(810)*.
2. *Tampsia bishopi* STEPHENSON (Radiolitidae), U. Cret.(?Maastricht.), Mexico, *2a,* colony viewed from above, ×0.17; *2b,* transv. sec. ant. part of AV, ×1 *(886)*.
3. *Praebarrettia sparcilirata* (WHITFIELD) (Hippuritidae), U.Cret.(Maastricht.), Cuba; transv. sec. AV, ×0.3 *(67)*.
4. *Sauvagesia sharpei* (BAYLE) (Radiolitidae), U. Cret.(Turon.), Port.; transv. sec. at level of AV with projecting teeth and myophores of FV, ×0.6 *(268)*.
5. *Torreites sanchezi* (DOUVILLÉ) (Hippuritidae), U.Cret., Cuba; transv. sec. AV, ×0.6 *(281)*.
6. *Pironaea polystylus* (PIRONA) (Hippuritidae), U.Cret.(Maastricht.), Italy; transv. sec. at level of AV with projecting teeth and posterior myophore of FV, ×0.3 *(269)*.

[Explanation as for Fig. E220.]

conservative character which nevertheless has a certain adaptive potential.

Among the caprinids the pattern of marginal canal development in the shell wall shows a remarkable tendency to repeat a sequence of increasing complexity in several lines of caprinid evolution (MACGILLAVRY, *561*). Early caprinid genera in different lines commonly have simple undivided or bifurcating radial plates that make a pattern of marginal pyriform canals. As the plates became increasingly polyfurcated, rows of marginal polygonal canals appeared on the periphery of the shell. In the Early Cretaceous of the Western Hemisphere, marginal canal development can be traced in the sequence of genera *Amphitriscoelus, Planocaprina, Coalcomana,* and *Caprinuloidea* (Fig. E241), spanning the Aptian to late Albian. In the Eastern Hemisphere an analogous sequence of canal development occurs in mainly the Cenomanian genera *Caprina, Schiosia, Orthoptychus,* and *Sphaerucaprina* (Fig. E241). Similar de-

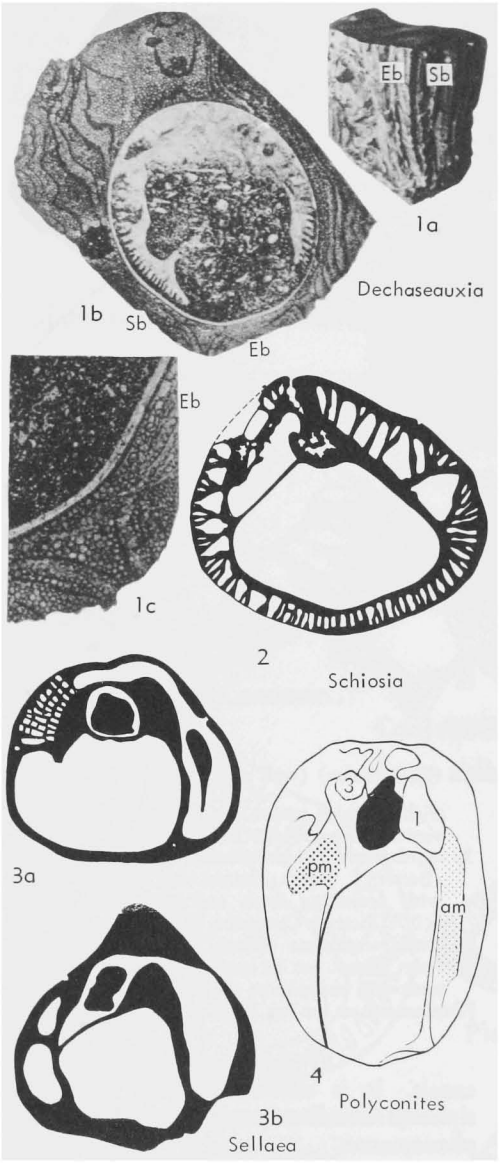

FIG. E239. Morphological features of rudists (muscle insertions).

1. *Dechaseauxia costata* TAVANI (Radiolitidae), U.Cret.(Maastricht.), Somalia; *1a,* side view of AV, ×0.2; *1b,c,* transv. sec. AV, ×3.3, ×4.6 *(904)*.
2. *Schiosia schiosensis* BÖHM (Caprinidae), U.Cret., Alps; schematic transv. sec. FV (Dechaseaux, after Parona).
3. *Sellaea orbignyi* DI STEFANO (Caprotinidae), U. Cret.(Cenoman.), Italy; *3a,b,* schematic transv. secs. AV and FV (Dechaseaux, after di Stefano).

velopment of canal patterns in the line *Offneria* (Fig. E260,*4*)-*Caprinula* (Fig. E257,*4b*) and the line *Plagioptychus* (E260,*2b*)-*Mitrocaprina* (E260,*3*) confirm the highly adaptive nature of the development of multiple marginal canals by polyfurcation of radial plates. The superficial homeomorphy between genera such as *Sphaerucaprina* and *Caprinuloidea* or *Caprina* and *Planocaprina* was a source of taxonomic confusion among workers who first tried to identify Western Hemisphere rudists.

SIPHONAL STRUCTURES

External opening to the shallow sea of predators, contaminants, and fluctuating salinities and oxygen content is served by the siphons. Expected adaptations induced by environmental pressure are well displayed in siphonal structures of the radiolitids and hippuritids. In the radiolitids the siphonal positions are marked by bands or grooves in both valves; this is the usual morphological expression of the siphons. In a few genera of different subfamilies additional intramural siphonal structures are developed. YONGE's *(1027a)* stimulating comparison of chamid and rudist soft parts calls for a different interpretation of the position of siphonal openings than commonly accepted (KLINGHARDT, *475*). YONGE recognized water currents and cleaning currents (Fig. E242) but did not place them necessarily as coincident with the position of the siphonal bands or the pillars *E* and *S*.

In the radiolitine genus *Medeella* (Fig. 243,*7*) the siphonal supports take the form of cylindrical structures within the AV outer wall. As continuation of this feature, cylindrical fossettes are developed in the AV and operculiform arches in the FV of *Medeella (Fossulites)* (Fig. E243,*1*). Similar protective structures for the FV siphons develop in the bioradiolitine genus *Thyrastylon* (Fig. E243,*2*). The AV bands in

(Continued.)

4. *Polyconites operculatus* ROULLAND (Caprotinidae), L.Cret., Eu.; interior FV (Dechaseaux, after *267b*).

[Explanation as for Fig. E220.]

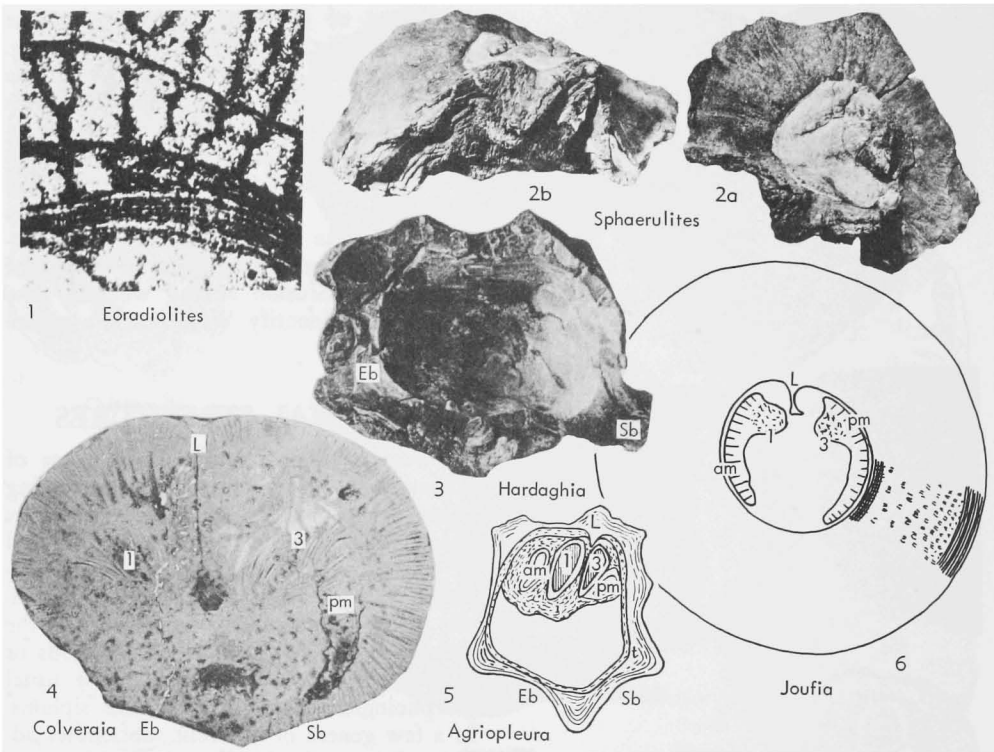

FIG. E240. Morphological features of rudists (Radiolitidae) (wall structure).

1. *Eoradiolites davidsoni* (HILL), L.Cret.(mid. Alb.), USA(Texas); part of transv. sec. showing AV inner and outer wall structure, ×2 (Coogan, n).
2. *Sphaerulites patera* ARNAUD, U.Cret. (low. Turon.), France; *2a*, AV from above, ×0.3; *2b*, side view of AV siphonal bands, ×0.3 *(23)*.
3. *Hardaghia quadrata* TAVANI, U.Cret.(Maastricht.), Somalia; AV from above, ×0.7 *(904)*.
4. *Colveraia variabilis* KLINGHARDT, U.Cret.(Maastricht.), Italy; transv. sec. FV near commissure viewed from above, ×0.5 *(475)*.
5. *Agriopleura blumenbachi* (STUDER), L.Cret. (Barrem.), Switz.; transv. sec. at level of AV with projecting teeth and myophores of FV, ×0.7 (Pictet & Campiche, in *911*).
6. *Joufia reticulata* BÖHM, U.Cret.(Maastricht.), Italy; transv. sec. at level of AV with projecting teeth and myophores of FV, ×0.2 *(853)*.

[Explanation as for Fig. E220.]

this genus are deeply sunken and in the FV the brim of the valve forms oval oscules above the AV siphonal bands. The subfamily Lapeirousiinae is characterized by intramural siphonal structures. In the AV these structures generally consist of tubular bands of polygonal cells (e.g., *Vautrinia*, Fig. E243,*5-6*) called pseudopillars. In the FV there are oscules or openings for the siphons.

Finally, an analogous development of oscules occurs in the hippuritid genus *Yvaniella* (Fig. E243,*3-4*) where a tubercle on the FV surface is traversed by two large canals. It is noteworthy that intramural siphonal structures are a Late Cretaceous phenomenon.

HIPPURITID PILLARS

The basic hippuritid stock, exemplified by *Hippurites*, has three extensions of the AV wall internally which are called pillars (Fig. E220,*1b*). The arrangement of the three pillars (usually lettered *L*, *S* (sortie) and *E* (entrée) following DOUVILLÉ carries through from Turonian to Maastrichtian in widespread and morphologically conserva-

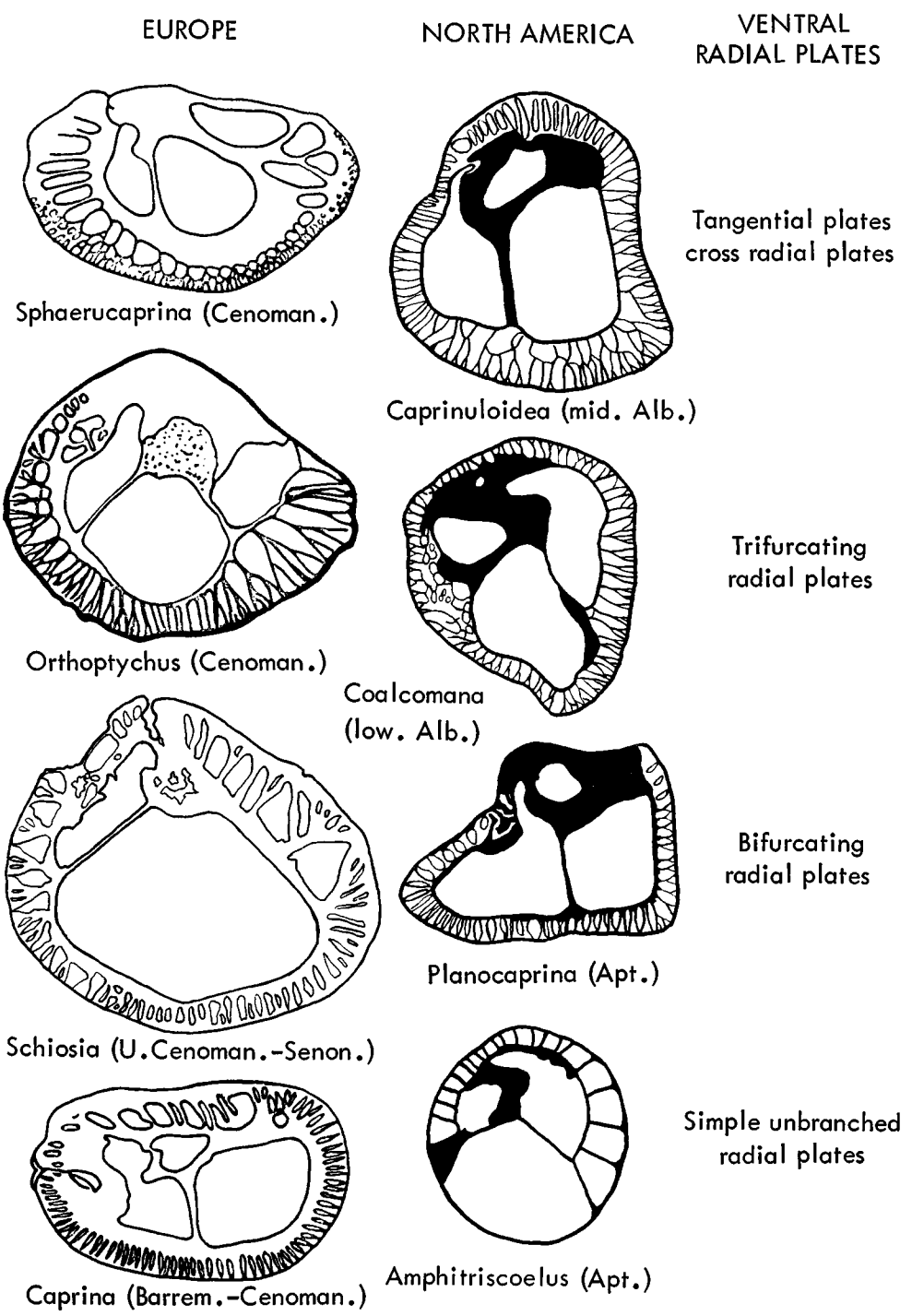

FIG. E241. Morphological features of rudists (wall structure). Marginal canals and ventral radial plates in four European and four North American caprinid genera; AV transverse sections, ×0.9 (Coogan, n).

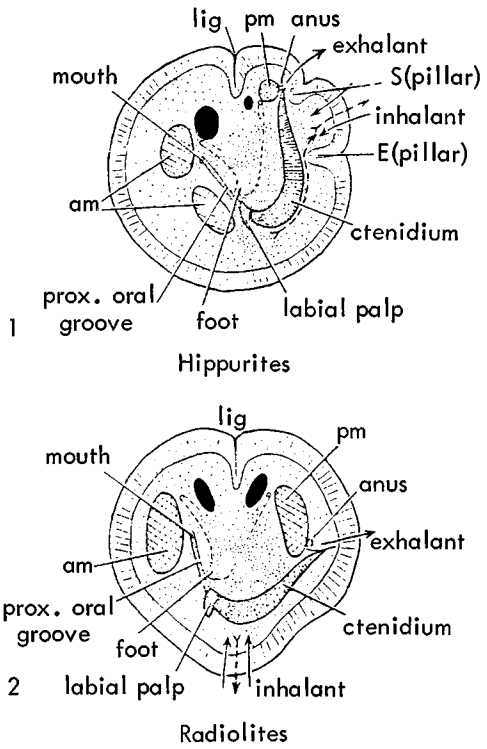

FIG. E242. Morphological features of rudists, AV interiors of *Hippurites (1)* and *Radiolites (2)* with indications of inhalant and exhalant water currents (full-line arrows) and cleaning currents (broken-line arrows), possible disposition of visceral mass and foot marked by light broken lines, teeth sockets solid black *(1024a)*. [Explanation: *am, pm,* anterior and posterior myophores; *lig,* ligament.]

tive genera such as *Hippurites, Hippuritella* (Turon.-Maastricht., Fig. E263,*4*), and *Vaccinites* (Turon.-Maastricht., Fig. E237, *6*). A trend toward increasing the number and length of pillars in both European and American lines of hippuritids is recognized. In the European line the increase in pillar number begins in *Batolites* (Fig. E237,*11*) which has numerous folds that do not project as far inward as the three pillars *L, S,* and *E.* In *Pironaea* (Campan.-Maastricht., Fig. E227,*1*), there are more than 12 pillars of lengths equal to those of *L, E,* and *S.* Many of these accessory pillars are elongate and reach 0.7 the distance to the center point of the AV. In the American line the marked increase in pillar number (15 to 20) occurs in *Praebarrettia* (Santon.-Maastricht., Fig. E238,*3*). The pillars extend toward the center and become narrow and beadlike (moniliform) in late growth stages. The final stage of this development occurs in *Barrettia* (Campan.-Maastricht.) where the AV is filled with 60 or more elongate beaded pillars or rays (Fig. E237,*10*). Lengthening of the pillars may occur independently of increase in pillar number as is evident in *Vaccinites* and *Torreites* (Fig. E238,*5*).

SYSTEMATIC DESCRIPTIONS

Family DICERATIDAE Dall, 1895

[Materials for this family prepared by COLETTE DECHASEAUX and A. H. COOGAN (subfamily divisions not recognized by DECHASEAUX, introduced by COOGAN)]

One valve or both hornlike, coiled, with umbo directed anteriorly and outward. Valves generally subequal, attached by RV or unequal, attached by LV with free valve more or less operculiform. Surface ornamented by striae or finely radiating ribs. AV with two unequal teeth, small one anterior and large one posterior, separated by horseshoe-shaped socket; FV with strong conical tooth bearing small socket on its anterior face, bordered behind by large socket. Anterior muscle inserted in each valve to shell wall, posterior muscle insertion on plate that projects above shell (except in Heterodiceratinae in which AV muscles were attached to elongations of cardinal platforms). Long ligamentary groove between beak and most posterior element of hinge. *U.Jur.(Oxford.)-L.Cret. (Valangin.).*

This most ancient family of the rudists comprises genera or subgenera which are defined partly by mode of attachment of the shell. Fixation by the right valve is observable only in *Diceras,* whereas fixation is by the left valve in *Epidiceras* and *Heterodiceras.*

Subfamily DICERATINAE Dall, 1895

[*nom. transl.* COOGAN, herein (*ex* Diceratidae DALL, 1895)]

Shell attached by RV (AV), which has large conical posterior tooth; LV (FV) tooth hook-shaped. *U.Jur.(U.Oxford.-L. Kimmeridg.).*

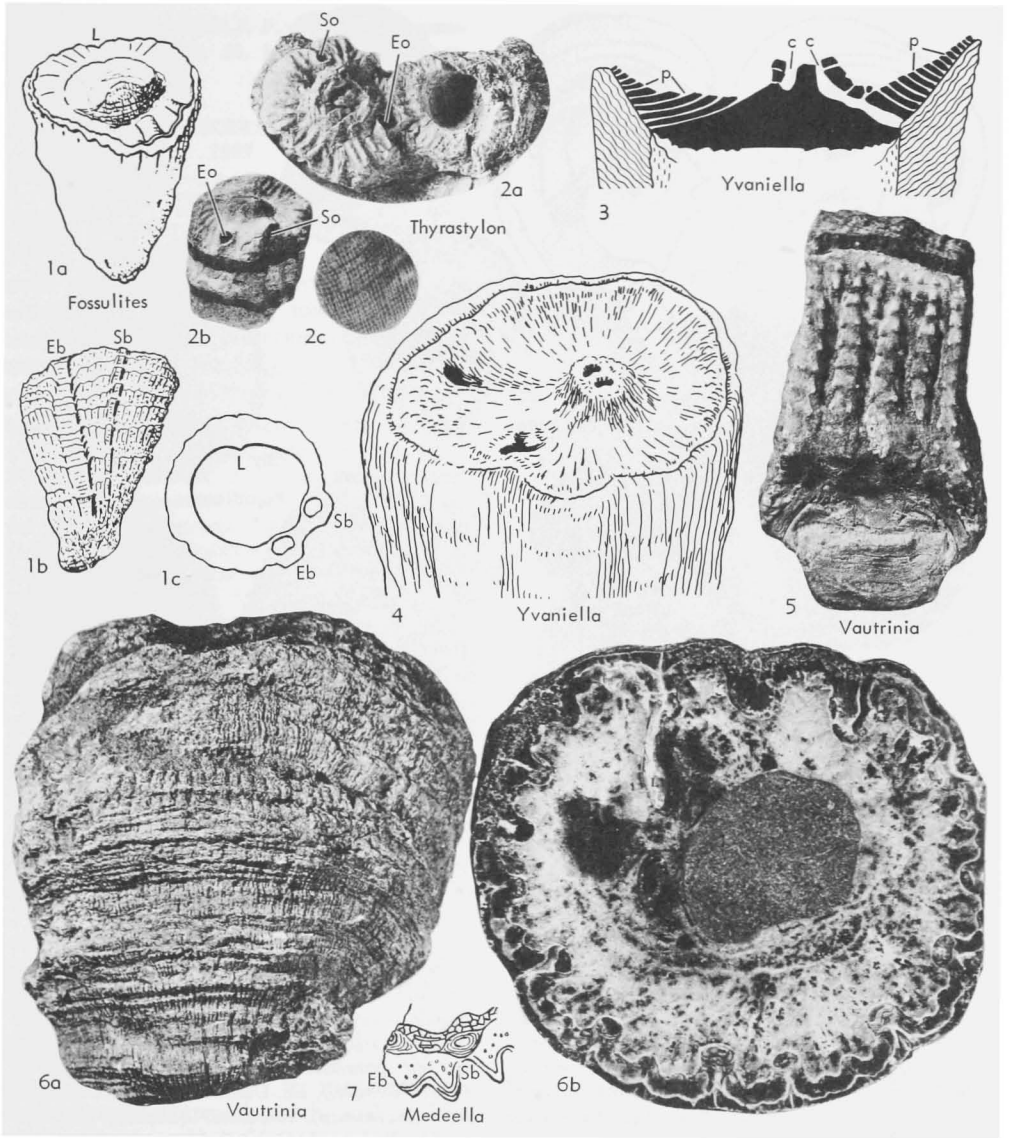

FIG. E243. Morphological features of rudists (siphonal structures).

1. *Medeella (Fossulites) undaesaltus* ASTRE (Radiolitidae), U.Cret.(Coniac.), France (Aude); *1a,* oblique side view of both valves, ×0.7; *1b,* side view of AV, ×0.7; *1c,* transv. sec. AV, ×0.7 *(24)*.
2. *Thyrastylon adhaerens* (WHITFIELD) (Radiolitidae), U.Cret.(Maastricht.), Jamaica; *2a,* adjoined shells, one at left showing oscules *(So* and *Eo)* in FV, ×0.7; *2b,* both valves, FV with *Eo* and *So* oscules, ×0.7; *2c,* transv. sec. AV, ×4 *(131)*.
3. *Yvaniella maestrichtiensis* (MILOVANOVIĆ) (Hippuritidae), U.Cret.(Maastricht.), Yugosl.; vertical sec. FV and upper part of AV, ×0.7 [*c,* canal of central excrescence; *p,* pore] *(624)*.
4. Same, E.Serbia; oblique view of both valves, ×0.6 *(628)*.
5-6. *Vautrinia syriaca* (VAUTRIN) (Radiolitidae), U.Cret.(Maastricht.), Syria; *5,* transv. sec. part of AV at level of pseudopillar, weathered, showing small columns in relief above prismatic tissue, ×0.7 *(933); 6a,* lat. view AV, ×0.3 *(933); 6b,* transv. sec. AV, ×0.5 *(933)*.
7. *Medeella* sp. (Radiolitidae), U.Cret., France; transv. sec. AV showing part of cylindrical siphonal structure, ×0.6 *(24)*.

[Explanation: *c,* canal; *Eb, Sb,* siphonal bands; *Eo, So,* oscules; *Ep, Sp,* internal pillars farthest and nearest *L; L,* ligament ridge; *p,* pore.]

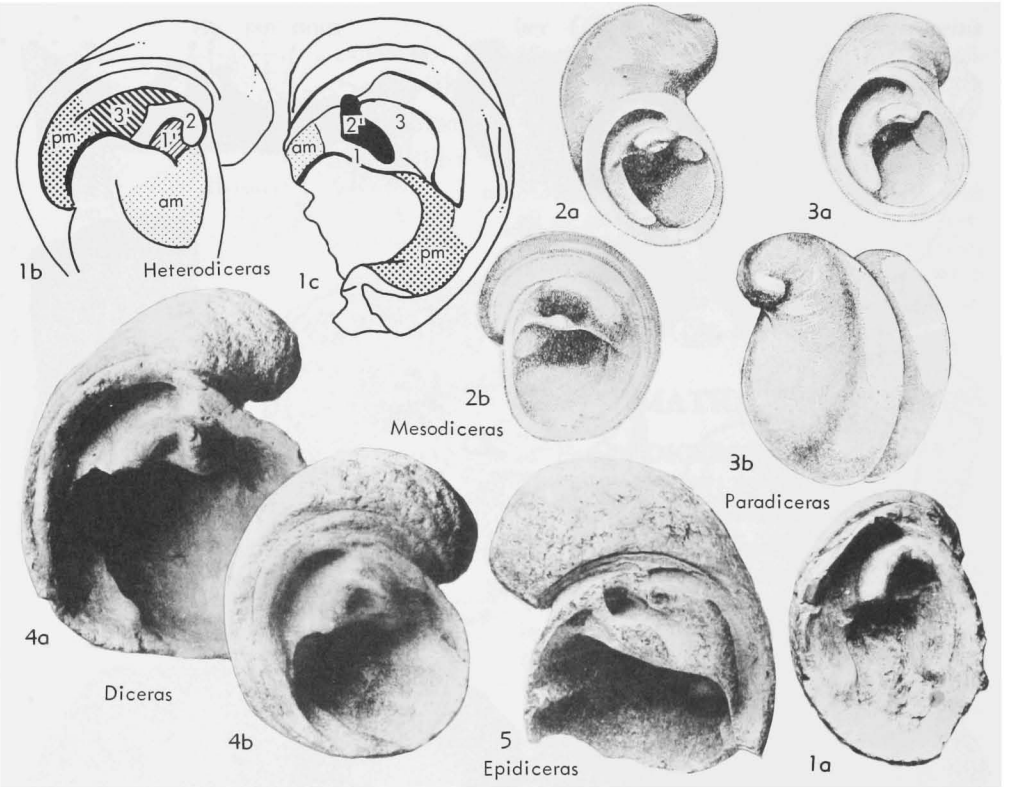

FIG. E244. Diceratidae (Diceratinae) *(4);* (Heterodiceratinae) *(1-3),* (Epidiceratinae) *(5)* (p. *N778-N779*). [Explanation: *am, pm,* anterior and posterior myophores; *1, 3,* anterior and posterior teeth of FV; tooth of AV; *1', 3',* sockets in AV for reception of correspondingly numbered FV teeth; *2',* socket for reception of tooth *2*.]

Diceras LAMARCK, 1805, p. 299 [**D. arietinum;* M] [=*Diceratia* OKEN, 1815 *(nom. van.)* (ICZN rejected publ.); *Dicerata* RAFINESQUE, 1815 *(nom. van.)*]. Shell robust, valves subequal, both with partially coiled beaks. *U.Jur.(U.Oxford.-L.Kimmeridg.),* Eu.-N.Afr.——FIG. E244,*4*. **D. arietinum,* Raurac., France (Saint-Mihiel); *4a,b* (LV=FV), ×1 *(246)*. [Also Fig. E236,*1-2;* E223,*1a,b*.]

Subfamily HETERODICERATINAE Pchelintsev, 1959

[*nom. transl.* COOGAN, herein (*ex* Heterodiceratidae PCHELINTSEV, 1959)]

Valves large, inequivalve, attached by LV (AV); RV (FV) smaller, may be operculiform, posterior tooth in RV large, trapezoidal to triangular, projecting upward; LV (AV) tooth arcuate, muscles attached to elongation of cardinal platform. *U.Jur.(Tithon.)-L.Cret.(Valangin.).*

Heterodiceras MUNIER-CHALMAS in HEBERT, 1870, p. 116 [**Diceras luci* DEFRANCE, 1819, p. 177; M] [=*Pseudodiceras* GEMMELLARO, 1876, p. 50 (type, *Diceras carinatum* GEMMELLARO; SD Cox herein)]. FV small, may be operculiform, both muscle insertions of FV on elongations of cardinal platform and curved outer edge of body cavity, not on prominent myophore. *U.Jur.(Tithon)-L.Cret.(Valangin.),* Eu.-USSR.——FIG. E244,*1a*. **H. luci* (DEFRANCE) *communis* (BÖHM), Jur.(Portland.), France; LV, ×0.5 *(246)*.——FIG. E244, *1b,c*. *H.* sp.; diagram showing features of hinge; *1b,c,* AV, FV *(252)*.

Mesodiceras PCHELINTSEV, 1959, p. 82 [**M. enissalense;* OD]. Differs from *Heterodiceras* in having operculiform FV and posterior muscle insertions of FV attached to cardinal platform by narrow subdental bridge. *U.Jur.(Oxford.-Kimmeridg.),* USSR(Crimea).——FIG. E244,*2*. **M. enissalense;* int. view, *2a,b,* AV, FV, ×0.7 *(722)*.

Paradiceras PCHELINTSEV, 1959, p. 96 [**Chama speciosa* MÜNSTER in GOLDFUSS, 1837, p. 205; OD]. FV not operculiform, posterior cardinal tooth trapezoidal to triangular, posterior muscle insertions of AV on elongation of cardinal platform, anterior separate. *U.Jur.(Tithon.),* Eu.-USSR

(Crimea).——Fig. E244,*3*. *P. alsuense* Pchelintsev; *3a*, AV, ×0.7; *3b*, both valves diagram. *(722)*.

Subfamily PLESIODICERATINAE Pchelintsev, 1959

[*nom. transl.* Coogan, herein (*ex* Plesiodiceratidae Pchelintsev, 1959)]

Shell irregular, attached by larger LV (AV). RV (FV) usually operculiform, beaks moderately curved, posterior muscle sertion of FV extending toward and behind posterior tooth, posterior cardinal tooth strongly curved, reaching laterally nearly across valve. *U.Jur.(Oxford.-Kimmeridg.)*.

Plesiodiceras Munier-Chalmas, 1882, p. 478 [**Diceras valfinense* Böhm, 1881, p. 160; OD]. FV with large cardinal and smaller but prominent anterior tooth; posterior muscle insertion on cardinal platform, extending behind posterior tooth. *U. Jur. (Up. Oxford. - Kimmeridg.)*, Eu.——Fig. E245,*2a*. *P.* sp., diagram showing features of FV hinge *(246)*.——Fig. E245,*2b,c*. *P. muensteri* (Goldfuss), Kimmeridg., France; 2b,c, AV, FV, ×1 *(246)*.

Eodiceras Pchelintsev, 1959, p. 37 [**Diceras ursicinum* Thurmann, 1852, p. 278; OD]. Shell small, moderately inequivalve; FV hinge primitive, posterior tooth large, transversely elongate subtriangular, anterior muscle insertion extending partly onto hinge area. *U.Jur.(Oxford.)*, Switz.-USSR.——Fig. E245,*1b,c*. **E. ursicinum* (Thurmann), Lusit., Crimea; *1b*, ant., *1c*, post., ×1 *(722)*.——Fig. E245,*1a*. *E. eximium* (Bayle), Jur. (Kimmeridg.), Switz.; FV, ×1 (de Loriol in *722*).

Subfamily EPIDICERATINAE Rengarten, 1950

[*nom. transl.* Coogan, herein (*ex* Epidiceratidae Rengarten, 1950)]

Shell with triangular to oval outline, weakly inequivalve, attached by LV (AV), dentition massive, close to megalodontid, cardinal area flattened, teeth and sockets set obliquely. *U. Jur.(Oxford.) - L. Cret. (Valangin.)*.

Epidiceras Douvillé, 1936, p. 332 [**Diceras sinistrum* Deshayes, 1824, p. 466; SD Dechaseaux, 1952, p. 326]. Shell large, posterior part of valves flattened, furrowed; FV operculiform or elevated, smaller than AV. *U.Jur.(Oxford.-Kimmeridg.)*, Eu.-USSR.——Fig. E244,*5*. **E. sinistrum* (Deshayes), Raurac., France; FV, ×1 *(246)*.

Megadiceras Pchelintsev, 1959, p. 72 [**Diceras beyrichi porrecta* Böhm, 1883; OD]. Much larger than *Epidiceras*, beaks drawn out, posterior muscle insertion in FV extended under cardinal area. *U.Jur.(Tithon.)-L.Cret.(Valangin.)*, Eu.-USSR.

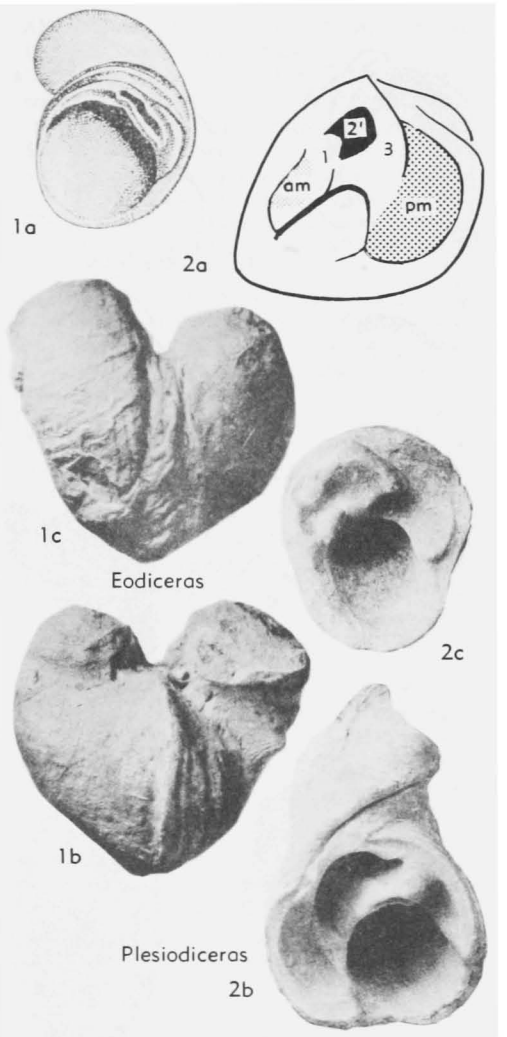

Fig. E245. Diceratidae (Plesiodiceratinae) (p. *N779*). [Explanation: *am*, *pm*, anterior and posterior myophores; *1, 3*, anterior and posterior teeth of FV; *2'*, socket in FV for reception of tooth *2* of AV.]

Family REQUIENIIDAE Douvillé, 1914

[=Bayleidae Munier-Chalmas, 1873 (rejected under *Code* Art. 23,b)] [Materials for this family prepared by Colette Dechaseaux and B. F. Perkins]

Inequivalve, attached by coiled LV (AV) which invariably is larger than operculiform RV (FV); hinge of *Diceras* type, with single tooth in LV (AV) and two teeth in RV (FV), although toothlike thickening behind posterior socket of LV (AV) may be present in some shells *(Requienia, Matheronia)*,

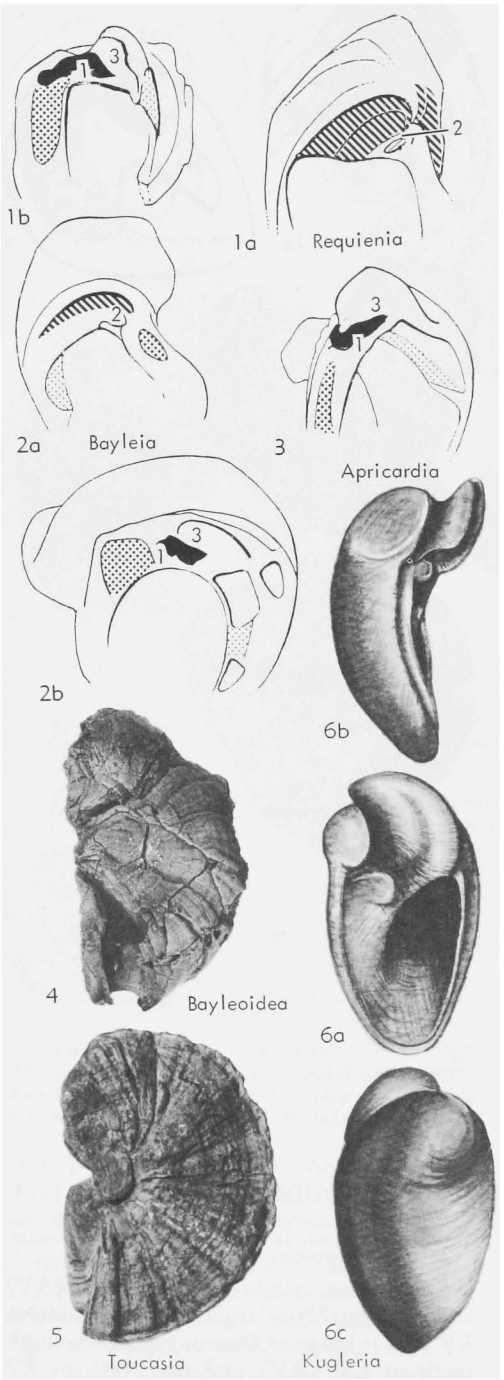

FIG. E246. Requieniidae (p. *N*781, *N*783). [Explanation: *1, 3,* anterior and posterior teeth of FV; *2,* tooth of AV.]

posterior tooth of RV (FV) generally more developed than anterior; siphonal bands more or less clearly present on posterior side of LV (AV); anterior muscle insertion on shell wall in LV (AV) and either on shell wall or prolongation of cardinal platform in RV (FV); posterior muscle inserted to shell wall in LV (AV) or on myophore plate beneath cardinal platform and on variously developed plate in RV (FV). *U.Jur.(Tithon.)-U.Cret.(Maastricht.).*

Genera comprised by the family Requieniidae are distinguished from one another by relative size of the teeth and by form and position of the posterior muscle insertions. They retain some features of the Diceratidae, but new characters make their appearance in them, for example, so-called siphonal bands *(Requienia, Toucasia)* and accessory cavities *(Bayleia).* These occur also in other rudist families, siphonal bands being a constant feature of the Radiolitidae and accessory cavities constituting an essential attribute of the Caprotinidae.

Requienia MATHERON, 1843, p. 102 [**Chama ammonia* GOLDFUSS, 1837, p. 205; OD] [=*Requienites* MATHERON, 1843 (obj.)]. Highly inequivalve; AV coiled in spiral of several whorls; FV forming flat spiral; ornament of growth wrinkles and fine radial ribs; sinuosities of growth lines on posterior side of AV define 2 siphonal bands; slight thickening behind posterior socket in AV of some species suggests tooth; AV muscle attachments on shell wall; FV anterior muscle insertion on shell wall, posterior muscle insertion on plate projecting above cardinal platform; pallial line entire. *L.Cret.(Valangin.)-U.Cret.(Senon.),* Eu.-N.Afr.-S.Am.-N.Am.-E.Afr.——FIG. E247,*3.* **R. ammonia* (GOLDFUSS), L.Cret.(U.Barrem.), France (Brouzet); both valves, ×0.5 *(278a).*——FIG. E246,*1. R.* sp., diagrams showing features of hinge, *1a,b,* AV and FV int., ×0.7 *(252).*

Apricardia GUÉRANGER, 1853, p. 36 [**A. carinata;* M]. External shell form as in *Toucasia;* AV hinge unknown; posterior tooth of FV large; posterior muscle insertion in both valves on plate passing below cardinal platform, plate of FV small and oblique to valve surface. *U.Cret.(Cenoman.-Senon.),* Eu.-N.Afr.-E.Afr.-Syria-Mexico.——FIG. E246,*3. A.* sp., diagram showing features of FV hinge, ×0.7 *(252).*

Bayleia MUNIER-CHALMAS, 1873, p. 74 [**B. pouechi;* OD]. External shell form, AV hinge and AV arched ligament ridge as in *Toucasia;* FV large coil; anterior muscle insertion on shell wall in both valves; AV posterior muscle insertion on plate

passing beneath cardinal platform; FV posterior muscle insertion on projecting plate thickened distally and attenuated proximally; FV with 3 small posterior accessory cavities, 1 below ligament and 2 others separated by muscle attachment plate. *U.Cret.(Campan.-Maastricht.)*, S. France-Alg.——FIG. E246,*2*. *Bayleia* sp., diagram showing features of hinge; *2a*, AV; *2b*, FV, ×0.7 *(252)*.

Bayleoidea PALMER, 1928, p. 35 [**B. clivi;* OD]. External shell form similar to that of *Toucasia;* AV loosely coiled, keeled; FV nonspiral semioperculiform; hinge greatly reduced; AV posterior muscle insertion on projecting plate, FV posterior muscle insertion on thin(?) plate separated from shell wall by accessory cavity; anterior muscle insertions unknown. *U.Cret.(Turon.)*, Mexico.——FIG. E246,*4*. **B. clivi;* both valves, ×0.7 (Perkins, n; courtesy L. G. Hertlein).

Kugleria BOUWMAN, 1938, p. 41 [**Toucasia steinmanni* SCHNARRENBERGER, 1901, p. 20; SD PERKINS herein]. External shell form similar to that of *Toucasia;* AV usually carinate, spirally coiled; FV flattened with several spiral whorls; posterior tooth of FV large and strongly projecting, anterior tooth reduced; FV posterior muscle insertion on plate forming extension of cardinal platform, anterior muscle insertion larger than posterior. *U.Cret.(Cenoman.)*, Eu.(Italy)-W.Indies(Trinidad.——FIG. E246,*6*. *K. macgillavryi* BOUWMAN, Trinidad; *6a*, FV int.; *6b*, FV post. profile; *6c*, FV ext., ×1 (after *78*).——FIG. E247,*4*. **K. steinmanni* (SCHNARRENBERGER), Italy(Appennines); ant. view of both valves, ×0.5 *(834a)*.

Matheronia MUNIER-CHALMAS, 1873, p. 74 [**Caprotina virginiae* GRAS, 1852, p. 32; OD]. Inequivalve, AV low spiral coil, FV operculiform or convex; AV with small posterior tooth; FV anterior tooth weak or absent, FV posterior tooth large and projecting; FV muscle insertions on prolongation of cardinal platform; shell wall thick and lamellose. *U.Jur.(Tithon.)-U.Cret.(Cenoman.)*, Eu.

M. (Matheronia). AV muscle insertions on shell wall except in earliest known species, *M. (M.) salevensis* JOUKOWSKY & FAVRE, Tithon., Alps, in which posterior AV muscle insertion on myophore plate of *Diceras* type. *L.Cret.(Valangin.)-U.Cret.(Cenoman.)* (but unknown *Hauteriv.-Alb.)*, Eu.——FIG. E247,*5a*. *M. (M.) munieri* PAQUIER, L.Cret.(Barrem.), France; ext. of both valves, ×0.5 *(278a)*.——FIG. E247,*5b,c*. **M. (M.) virginiae* (GRAS), L.Cret.(Urgon.), France; *5b-c*, AV and FV int., ×0.5 (after *716b*).

M. (Monnieria) PAQUIER, 1898, p. 343 [**Monnieria romani* PAQUIER; M]. AV commonly keeled, ornamented with concentric wrinkles in some species; AV muscle insertions on shell wall. *U.Jur.(Tithon.)*, S.France.——FIG. E247,*2*. **M. (M.) romani* (PAQUIER), France(Gard); *2a,b*, AV int., ext., ×0.75; *2c,d*, AV and FV int. (diagram.), ×0.4 (after *716a*).

M. (Hypelasma) PAQUIER, 1898, p. 846 [**Hypelasma colloti* PAQUIER, 1898; M]. Very inequivalve; AV anterior muscle insertion on shell wall, posterior muscle insertion on weakly developed plate passing under cardinal platform (*Diceras* type). *U.Jur.(Tithon.)*, Eu.(S.France).——FIG. E247,*1*. **M. (H.) colloti* (PAQUIER), France (Gard); *1a,b*, both valves and AV int., ×0.75 (after *716a*).

Pseudotoucasia DOUVILLÉ, 1911, p. 82 [**Toucasia santanderensis* DOUVILLÉ, 1889, p. 632; M]. Posterior muscle insertion of FV on plate lying parallel to shell wall surface and attached to shell wall by plate normal to the surface; teeth as in *Toucasia. L.Cret.(Apt.)*, Eu.(Spain).——FIG. E249,*1*. **P. santanderensis* (DOUVILLÉ); oblique section RV showing elevated myophore plate, ×0.5 (after *267c*).

Toucasia MUNIER-CHALMAS, 1873, p. 74 [**Requienia carinata* MATHERON, 1843, p. 104; OD] [=*Caprotina* D'ORBIGNY, 1842 (suppression proposed) ICZN pend.]. Valves keeled, carinate, or frilled with shallow siphonal bands on posterior side of AV; *Diceras*-type hinge but AV tooth less projecting and AV anterior socket shallower than in *Diceras;* anterior muscle insertions on shell wall in both valves, slightly depressed in AV; FV posterior muscle insertion on plate projecting obliquely from shell wall, with upper edge free or attached to lower surface of cardinal platform; posterior part of AV posterior muscle insertion on shell wall, anterior part raised and forming plate which passes under cardinal platform, as in *Diceras. L.Cret.(Barrem.)-U.Cret.(Cenoman.)*, Eu.-N.Afr.-N.Am.——FIG. E246,*5*; E249,*2*. **T. carinata* (MATHERON); E246,*5*, both valves, ×0.7 (Dechaseaux, n); E249,*2a,b*, AV and FV int., ×1.5; E249,*2c*, FV transv. sec. showing post. myophore, ×0.5 (E249,*2a,b*, after *716b*; E249,*2c*, after *267c*).——FIG. E248,*1*. *Toucasia* sp.; *1a,b*, AV and FV int. (diagram) showing hinge features *(252)*.

Family MONOPLEURIDAE Munier-Chalmas, 1873

[=Gyropleuridae MACGILLAVRY, 1935] [Materials for this family prepared by COLETTE DECHASEAUX and B. F. PERKINS]

Inequivalve (except *Valletia*); RV (AV) attached, larger; LV (FV) with two equal or unequal teeth; RV (AV) with single tooth; muscle insertions generally on extensions of cardinal platform. *L.Cret.(Valangin.)-U.Cret.(Maastricht.), U.Eoc.*

Monopleura MATHERON, 1843, p. 105 [**M. varians;* SD KUTASSY, 1934, p. 113][?=*Dipilidia* MATHERON, 1843, p. 111 (type, *D. unisulcata*)]. AV

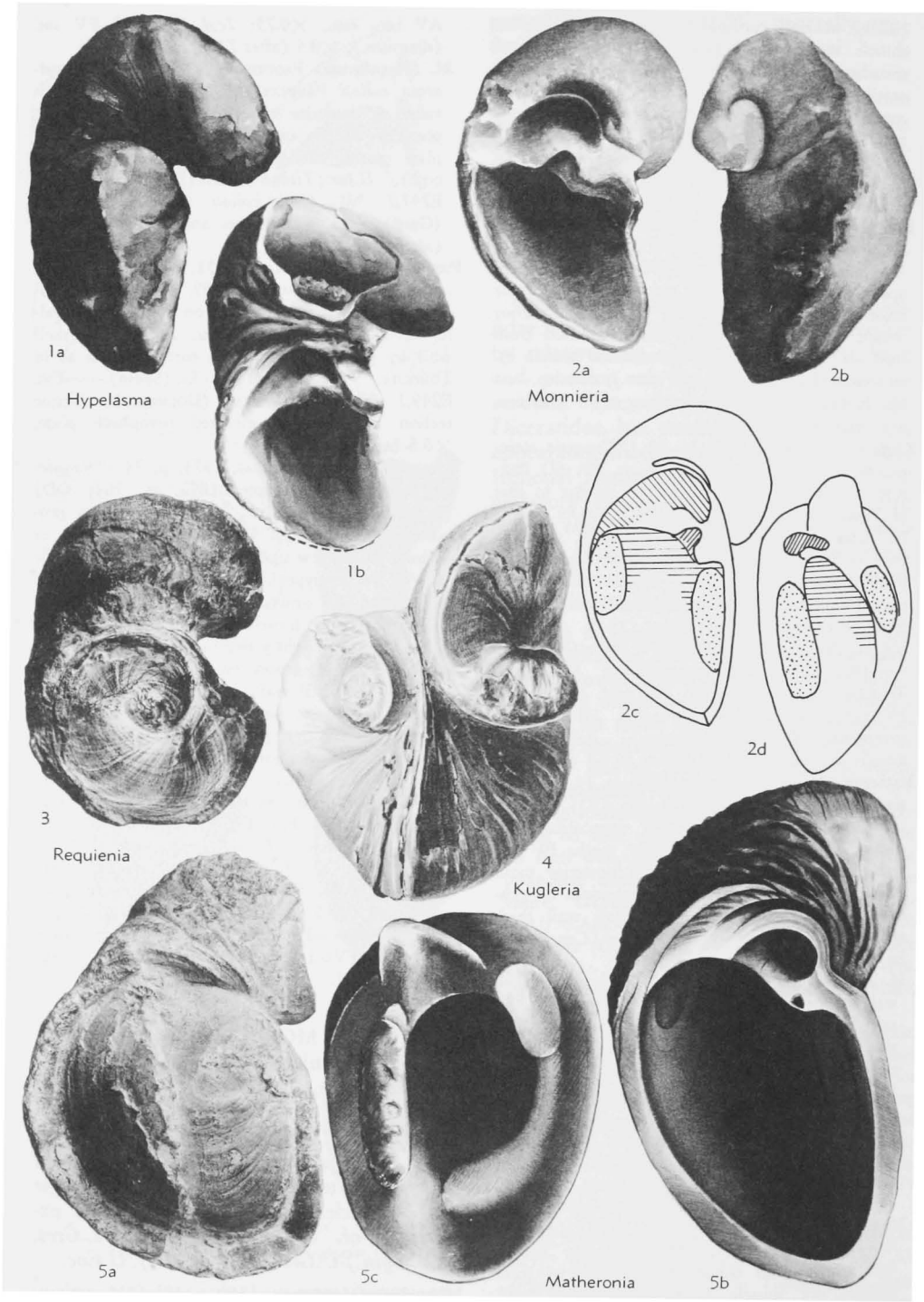

FIG. E247. Requieniidae (p. *N*781, *N*783).

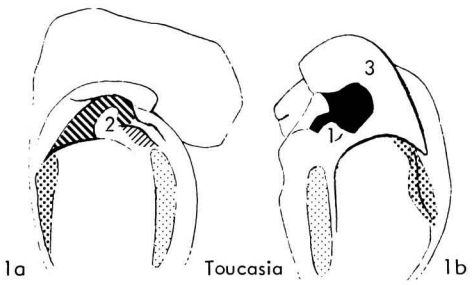

FIG. E248. Requieniidae (p. *N*783). [Explanation: *1,3,* anterior and posterior teeth of FV; *2,* tooth of AV.]

conical, spirally twisted; FV operculiform or coiled in low spiral; exterior ornamented with unequal ribs extending from apex to commissure; 2 teeth of FV conical, subequal; single tooth of AV oval in section, usually transverse to cardinal platform; ligamental groove arched according to degree of spiral twisting or coiling; muscle insertions in both valves on prolongations of cardinal platform. *L. Cret. (low. Valangin.) - U. Cret. (Maastricht.),* Eu.-N.Am.-Jamaica.——FIG. E250, *3a;* E252,*1.* **M. varians,* Barrem., France (Brouzet); E250,*3a,* both valves, ×1; 252,*1a,b,* AV and FV int., ×1 (both after *278a*).——FIG. 250, *3b. M. marcida* WHITE, Alb., USA(Texas); dorsal view of both valves, ×1 (Perkins, n).——FIG. E251,*3. Monopleura* sp.; *3a,b,* FV and AV int. (diagram.) showing hinge features *(252).*

Araeopleura Cox, 1965, p. 731 [*pro Stenopleura* POČTA, 1889, p. 35 (*non* STEBBING, 1888)] [**Plagioptychus angustissimus* POČTA, 1887, p. 204; SD KUTASSY, 1934, p. 127]. AV compressed coil, flattened along anterior-posterior axis; FV claviform; FV teeth weak, separated by deep socket, muscle insertions on thickened areas of shell wall extending from cardinal platform along margins of body cavity; AV teeth and muscle insertions unknown. *U.Cret.(Cenoman.),* Eu. (Czech.).——FIG. E250,*2.* **A. angustissimus* (POČTA); *2a,b,* AV ant., FV int., ×1 *(741c).*

Gyropleura DOUVILLÉ, 1887, p. 768 [**Requienia cenomanensis* D'ORBIGNY, 1850, p. 261; OD]. AV exogyriform; FV operculiform or coiled in low spiral; teeth anterior, FV teeth subequal, small; AV posterior muscle insertion on plate posterior to posterior socket and forming extension of cardinal platform. *L. Cret. (Valangin) - U. Cret. (Maastricht.),* Eu.-Jamaica-N.Am.(Texas).——FIG. E250,*5. Gyropleura* sp.; *5a,b,* FV and AV int. (diagram.) showing hinge features *(252).*

Himeraelites DI STEFANO, 1889, p. 1 [**Monopleura (Himeraelites) vultur;* SD KUTASSY, 1934, p. 123]. AV conical, straight; FV curved, elevated, beak overhanging AV; FV teeth subequal, AV tooth round to oval in section; cardinal platform extended toward valve interior in both valves; FV posterior muscle insertion on exterior surface of elevated plate or lamina. *U.Cret.(Cenoman.),* Eu.(Italy)-Mexico.——FIG. 252,*5a.* **H. vultur* (DI STEFANO), Sicily; both valves, ×0.5 *(882a).*——FIG. 252,*5b,c. H. douvillei* (DI STEFANO), Sicily; *5b,c,* AV and FV int., ×0.75 (after *882a*).

?**Paramonopleura** KOROBKOV in KOROBKOV & MAKARENKO, 1967, p. 135 [**P. ukrainica* KOROBKOV & MAKARENKO; OD]. Shell small; AV exogyroid, with cuneiform tooth, 1′ circular, 3′ divided by low ridge; FV operculiform, tooth 1 high, curved, tooth 3 marginal, biapical, socket deep. *U.Paleoc.,* Cherkasskaya Oblast, USSR.——FIG. E251,*1.* **P. ukrainica; 1a,b,* FV and AV ext., ×2.7; *1c,d,* FV and AV int., ×5.3 (Korobkov & Makarenko, 1967). [B. F. PERKINS. See additions, p. *N*868]

Petalodontia POČTA, 1889, p. 61 [**Hippurites gemari* GEINITZ, 1840, p. 60; SD KÜHN, 1932, p. 121]. Differs from *Monopleura* in having FV anterior tooth much larger than posterior; FV muscle insertions on myophore plates which are joined to teeth and project around sides of body cavity. *U.Cret.(Cenoman.),* Eu.(Czech.)-Mexico.——FIG. E250,*1. P. planoperculata* (POČTA),

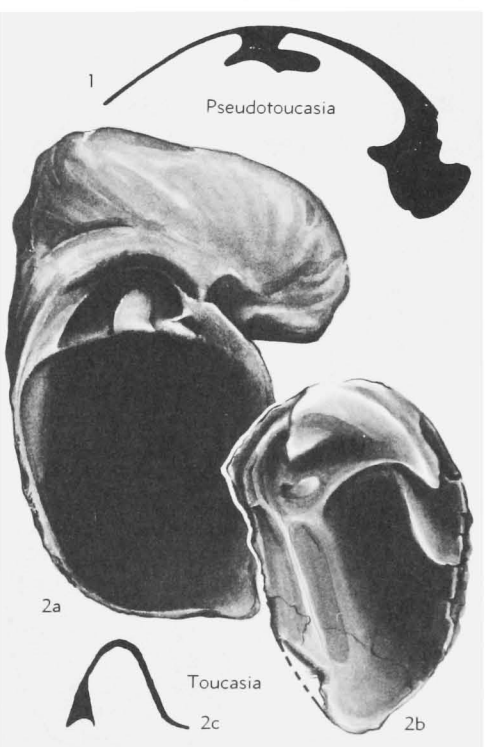

FIG. E249. Requieniidae (p. *N*783).

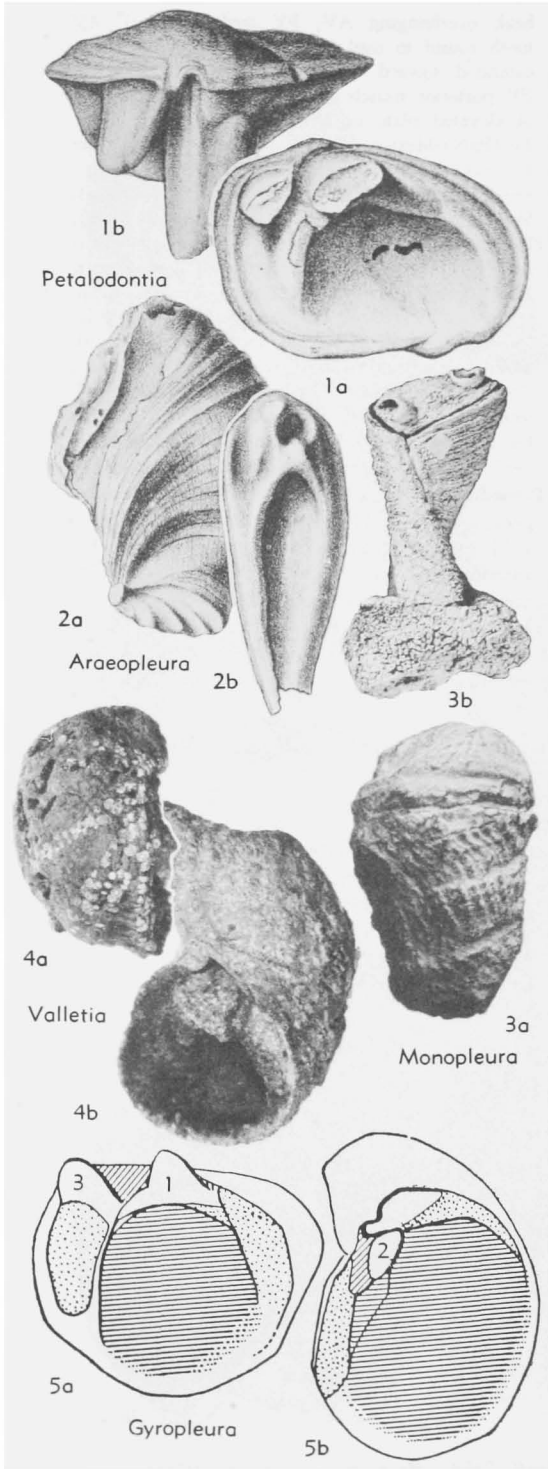

FIG. E250. Monopleuridae (p. *N*783-*N*785). [Explanation: *1, 3,* anterior and posterior teeth of FV; *2,* tooth of AV.]

Czech.; *1a,b,* LV int. and dorsal view, ×1 *(741c)*.——FIG. E252,*4*. *P. felixi* DOUVILLÉ, Mexico (Coalcoman); *4a,b,* transv. secs. parallel to commissure at level of AV with projecting teeth of FV myophore well below and close to it, ×0.5 (after *270a*).

Simacia POČTA, 1889, p. 39 [**S. minima;* M]. AV conical, curved or coiled, small; AV tooth broad, swollen; anterior socket rounded and deep, posterior socket lacking; FV unknown. *U.Cret. (Cenoman.),* Eu.(Czech.).——FIG. E252,*2*. **S. minima; 2a,b,* AV lat. and int. views, ×1.5 (after *741c*).

Valletia MUNIER-CHALMAS, 1873, p. 74 [**V. tombecki;* OD]. Externally similar to *Diceras;* FV anterior tooth much larger than posterior; muscle insertions in both valves on extensions of cardinal platform. *L.Cret.(Valangin.),* Eu.——FIG. E250,*4;* E252,*3*. **V. tombecki,* Alps; E250,*4a,b,* FV and AV int., ×1 (Dechaseaux, n); E252,*3a,b,* AV and FV int., ×0.75 (after *652a*).——FIG. E251,*2*. *Valletia* sp.; FV and AV int. (diagram.) showing hinge features *(252)*.

Family CAPROTINIDAE Gray, 1848

[*nom. correct.* GILL, 1871 (*pro* Caprotinadae GRAY, 1848)] [=Heterocaprinidae MUNIER-CHALMAS, 1873] [Materials for this family prepared by COLETTE DECHASEAUX and B. F. PERKINS]

Inequivalve; RV (AV) attached; LV (FV) with two subequal or unequal teeth; RV (AV) with single tooth; LV (FV) with cavities (accessory cavities) between shell wall and posterior muscle insertion and in some species between anterior muscle insertion and shell wall; similar but smaller cavities may be present in the AV. *L.Cret. (Neocom.)-U.Cret.(Turon.).*

Caprotina D'ORBIGNY, 1850, p. 236 [**Caprina striata* D'ORBIGNY, p. 170; ICZN pend.[1]] AV conical, spirally twisted, anterior muscle insertion on extension of cardinal platform along shell wall, posterior muscle insertion on posterior surface of plate extending from cardinal platform to posterior shell wall, posterior accessory cavity shallow and undivided; FV conical, strongly coiled, teeth not well developed, anterior muscle insertion on extension of cardinal platform and posterior on plate, separated from shell wall by two accessory cavities. *L.Cret.(Neocom.)-U.Cret.(Turon.),* Eu.-

[1] The genus *Caprotina,* as erected by D'ORBIGNY in 1842, contained 10 nominal species none of which is included in the genus by modern authors, and it would be a senior synonym of *Toucasia* MUNIER-CHALMAS, 1873, by strict application of the International *Code*. It would only be retained in the sense in which it has come to be used by attributing it to D'ORBIGNY, 1850, and by declaring *C. striata* to be its type species, setting aside any prior designations. An application to this effect is being submitted to the International Commission. [Note by L. R. COX.]

N.Afr.——Fig. E253,2. *Caprotina* sp.; *2a,b,* FV and AV int. (diagram.) showing hinge features *(252)*.

Chaperia Munier-Chalmas (1873, *nom. nud.*), 1882, p. 493 [**Caprina costata* d'Orbigny, 1839, p. 107; OD]. Differs from *Caprotina* in having slightly convex, operculiform FV; posterior accessory cavities of FV small and inconspicuous. *U.Cret.(Cenoman.),* Eu. (S. France)-Mexico.——Fig. E253,*1*. **C. costata* (d'Orbigny), France; *1a,b,* FV and AV int., ×2; *1c,* cluster of individual shells, ×1 *(695)*.

Horiopleura Munier-Chalmas in Douvillé, 1889, p. 639 [**Monopleura lamberti* Munier-Chalmas in Douvillé; SD Paquier, 1905, p. 56] [=*Oriopleura* de Lacvivier, 1884 *(nom. nud.)*]. AV exogyriform, ornamented with radial ribs except on siphonal bands which are smooth; AV posterior muscle insertion on a thickened platform somewhat projecting over body cavity, normal to straight line formed by tooth, sockets, and anterior muscle insertion platform; FV operculiform with a narrow, shallow posterior accessory cavity. *?L.Cret.(Barrem.), L.Cret.(Apt.)-U.Cret.(Cenoman.),* Eu.-N.Afr.-India-Mexico.——Fig. E254,*2a,c*. **H. lamberti* (Munier-Chalmas), Alb., Spain (Pyrenees); *2a,b,* AV int. and ventral ext., ×0.75; *2c,* AV vert. sec., ×0.4 (*2a,b,* after *267d; 2c,* after *561)*.——Fig. E254,*2d*. *H. baylei* (Coquand), Apt., Spain(Pyrenees); FV int., ×0.75 (after *267d*).

Pachytraga Paquier, 1900, p. 337 [**Sphaerulites paradoxa* Pictet & Campiche, 1869, p. 48; SD Paquier, 1905, p. 61]. AV conical, spirally twisted, tooth strongly projecting, posterior muscle insertion on posterior face of vertical plate connecting posteroventral side of tooth with posteroventral shell wall, posterior accessory cavity present, anterior muscle insertion on thickened area of shell wall, anterior accessory cavity may be present and divided into large canals by radial plates; FV conical, openly coiled, anterior tooth much larger than posterior, anterior muscle insertion on anterior face of plate connecting large anterior tooth with anteroventral shell wall, anterior accessory cavity simple and shallow or subdivided into large shallow canals by radial plates, posterior muscle insertion on shell wall, vertical plate connects ventral edge of anterior tooth with shell wall at ventral margin of posterior muscle insertion forming a large cavity connected to tooth socket but separated from shell cavity. *L.Cret.(Urgonian facies),* Eu.(S. France-Switz.-Bulg.)-Jamaica.——Fig. E253,*4;* E254,*3*. **P. paradoxa* (Pictet & Campiche); E253,*4,* FV int. (diagram.), ×0.7 (Dechaseaux, n); E254,*3a,b,* AV sec. and ant. accessory cavities (canals), ×0.5 *(716c)*.

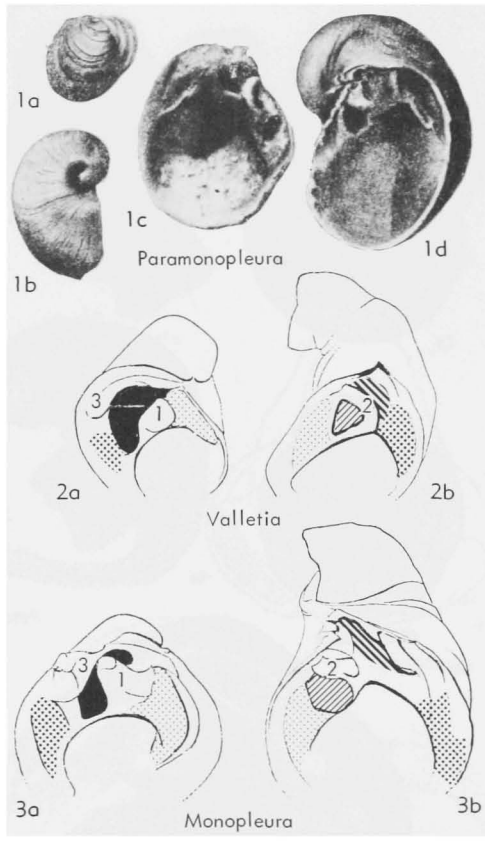

Fig. E251. Monopleuridae (p. *N*783-*N*785). [Explanation: *1, 3,* anterior and posterior teeth of FV; *2,* tooth of AV.]

Polyconites Roulland, 1830, p. 166 (genus without nominal species) [**P. operculatus* Douvillé, 1887, p. 778 (=*Radiolites polyconilites* d'Orbigny, 1842, p. 181); SM] [=*Polyconilites* d'Orbigny, 1842 *(nom. van.); Heterocaprina* Munier-Chalmas, 1873 (obj.)]. AV conical, resembling *Monopleura,* tooth transverse, muscle insertions on thickened areas of shell wall, no accessory cavities; FV operculiform, anterior muscle insertion extends from cardinal platform along the shell wall, posterior muscle insertion on a recumbent plate projecting posteriorly from cardinal platform, several accessory cavities as in *Caprotina. L.Cret.(Apt.)-U.Cret.(Cenoman.),* Eu.-Syria.——Fig. E254,*1*. **P. operculatus* (Douvillé), Cenoman., France; *1a,b,* FV and AV int., ×0.75 (after *267b*). [Also, Fig. E229,*4*.]

Praecaprotina Yabe & Nagao, 1926, p. 126 [**Horiopleura yaegashii* Yehara, 1920, p. 39; OD]. AV

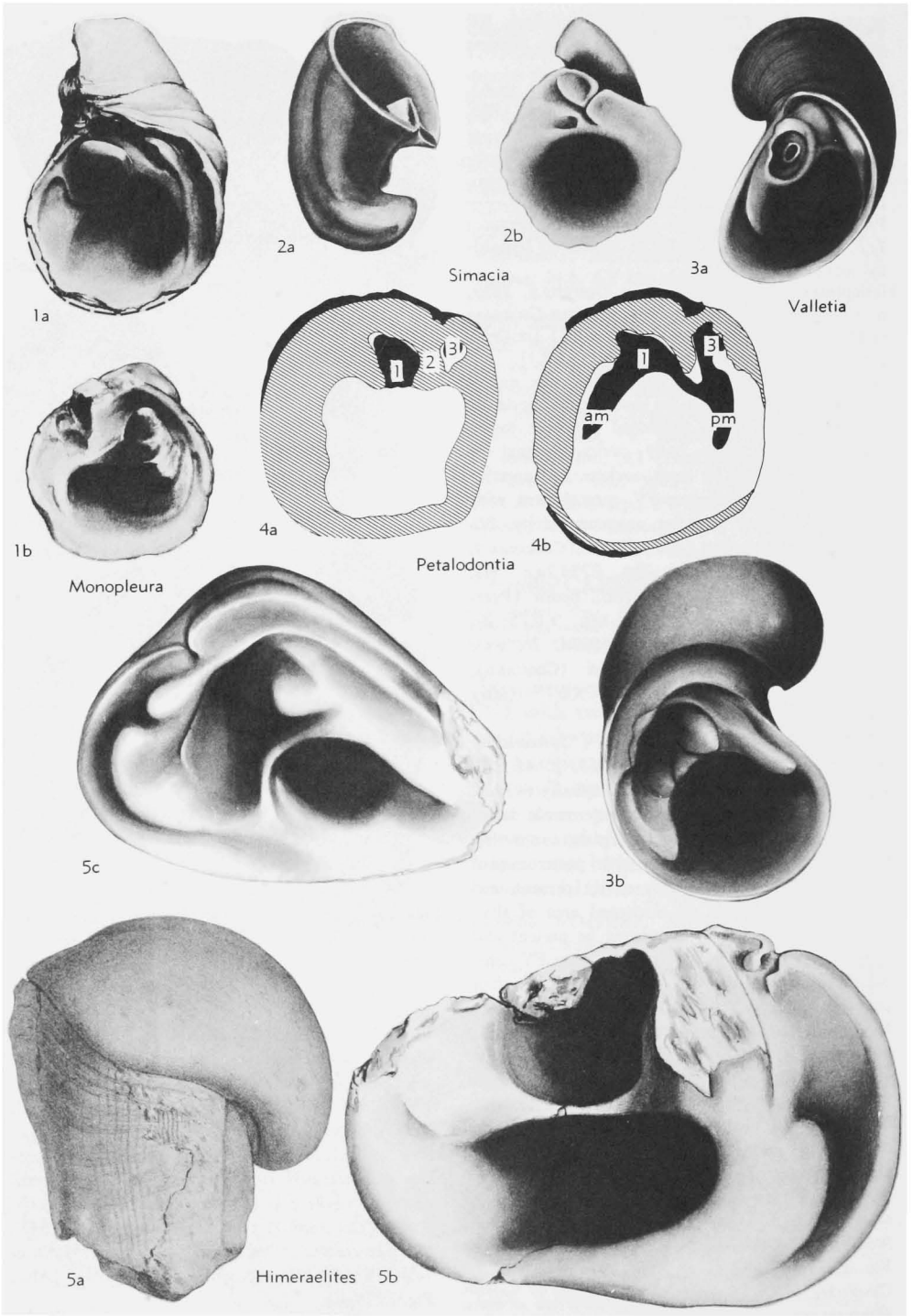

FIG. E252. Monopleuridae (p. *N*783-*N*785). [Explanation: *am*, *pm*, anterior and posterior myophores; *1*, *3*, anterior and posterior teeth of FV; *2*, AV tooth.]

irregularly conical, tooth strongly projecting, anterior muscle insertion on extension of cardinal platform on thickened area of shell wall, posterior muscle insertion extends as erect plate from tooth to posteroventral shell wall, large posterior accessory cavity may be divided in early stages by radial plates; FV convex, teeth subequal, elongate anterior muscle insertion extends from cardinal platform along shell wall and is separated from it by shallow groove, posterior muscle insertion on thin nearly vertical plate, large posterior accessory cavity extends from dorsal to ventral border, vertical plate connects ventral edge of anterior tooth with shell wall at ventral margin of posterior muscle insertion forming large cavity connected to socket but separated from shell cavity as in *Pachytraga*. *L.Cret.*, Japan.——Fig. E255,*3*. **P. yaegashii* (Yehara); *3a,b*, AV and FV int., ×0.75 (after *1009a*).

Retha Cox, 1965, p. 731 [*pro Ethra* Matheron, 1878 (*non* Laporte, 1833)] [**Ethra munieri* Matheron; SD Paquier, 1905, p. 59]. Valves in elongate loose spiral, FV larger, AV with deep ligamental furrow; AV tooth slightly projecting, anterior muscle insertion on thickened area of shell wall, posterior muscle insertion on posterior face of plate extending from cardinal platform to posteroventral shell wall, posterior accessory cavity wide and shallow; FV muscle insertions on thickened areas of shell wall extending from cardinal platform, no accessory cavities, vertical plate connects posteroventral edge of anterior tooth with shell wall at ventral margin of posterior muscle attachment forming large cavity connected to socket but separated from shell cavity as in *Pachytraga*. *L.Cret.(Urgonian facies)*, Eu.(S.France).——Fig. E253,*3*; E255,*1*. **R. munieri* (Matheron);E253,*3a,b*, FV and AV int., ×1 (253,*3a*, Dechaseaux after Paquier; E253,*3b, 716c*); E255, *1*, both valves, ×0.5 *(600b)*.

Sellaea di Stefano, 1889, p. 20 [**Caprotina zitteli* di Stefano, 1889, p. 28; SD Kutassy, 1934, p. 142]. Both valves conical, AV straight, FV coiled; AV anterior muscle insertion on extension of cardinal platform and separated from shell wall by large accessory cavity divided by vertical radial plates into small cavities which in turn may be subdivided into small canals by 2 sets of vertical plates lying parallel to the shell wall, posterior myophore plate extending from tooth to posterior shell wall; FV with 1 elongate deep anterior accessory cavity and 2 smaller but deep posterior accessory cavities. *L.Cret.(Albian)-U.Cret.(Cenoman.)*, Sicily-Apennines-USA(Texas)-Mexico.——Fig. E255,*2a,b*. **S. zitteli* (di Stefano), Cenoman., Sicily; *2a,b*, FV int., AV sec., ×0.75 (after *882a*).——Fig. E255,*2c*. *Sellaea* sp., Alb., USA(Texas), both valves, post. ext., ×0.5 (Perkins, n).

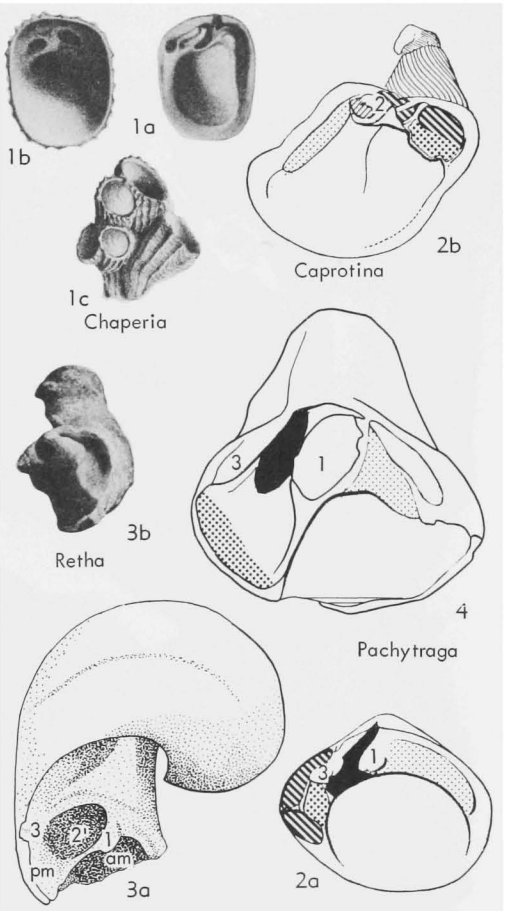

Fig. E253. Caprotinidae (p. *N785*, *N787*). [Explanation: *1,3*, anterior and posterior teeth of FV; tooth *2* of AV; *2'*, socket of FV corresponding to tooth *2* of AV; *am*, *pm*, anterior and posterior myophores.]

Family CAPRINIDAE d'Orbigny, 1850

[=Caprinellidae Gill, 1871; Trechmannellidae Cox, 1933; incl. Anomoptychidae Vokes, 1967] [Materials for this family prepared by Colette Dechaseaux and B. F. Perkins with acknowledgment of assistance by L. R. Cox]

Inequivalve, RV (AV) attached, some species attaining large size; teeth and myophores well developed, massive in some species; accessory cavities present in most

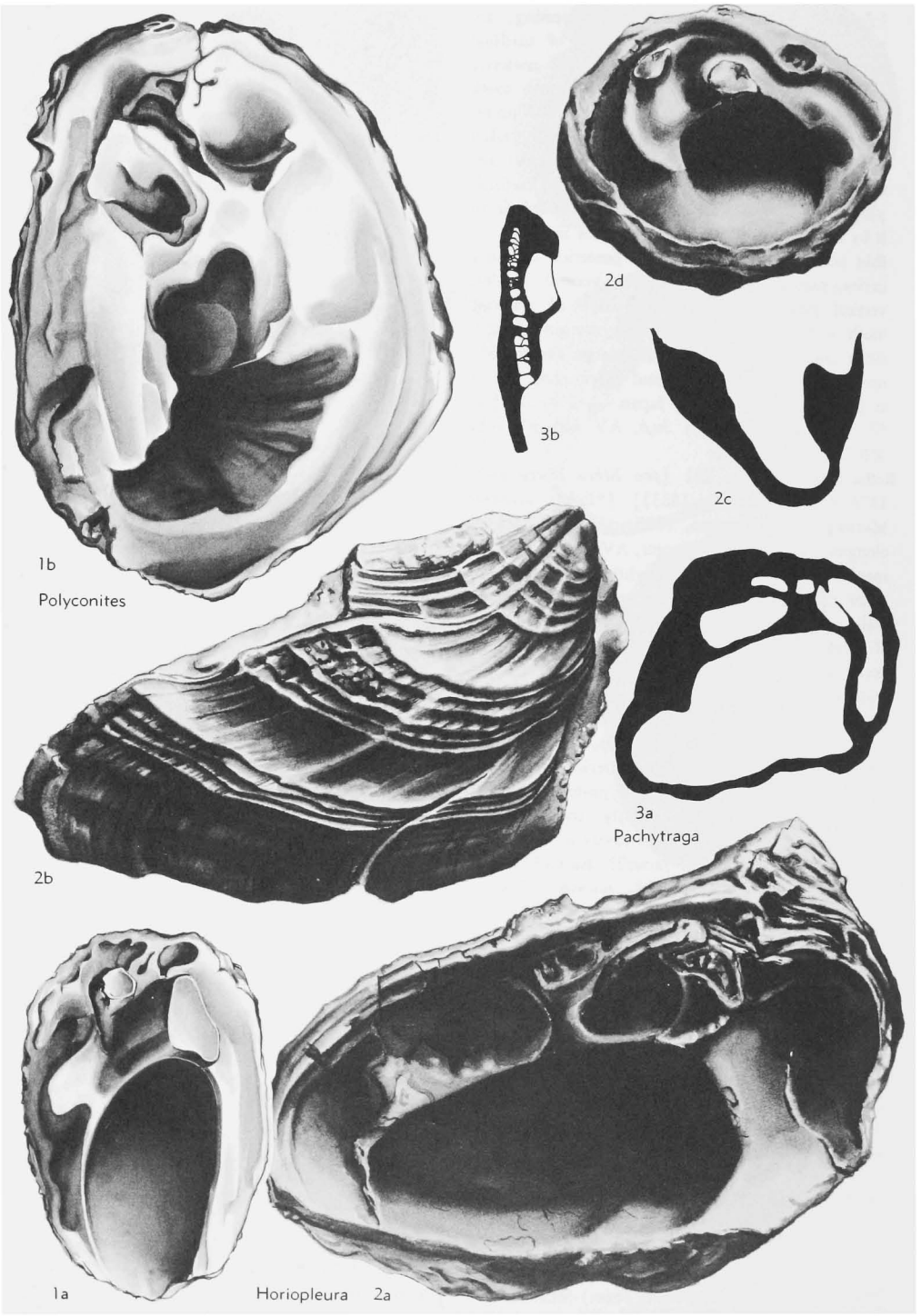

FIG. E254. Caprotinidae (p. *N*785, *N*787).

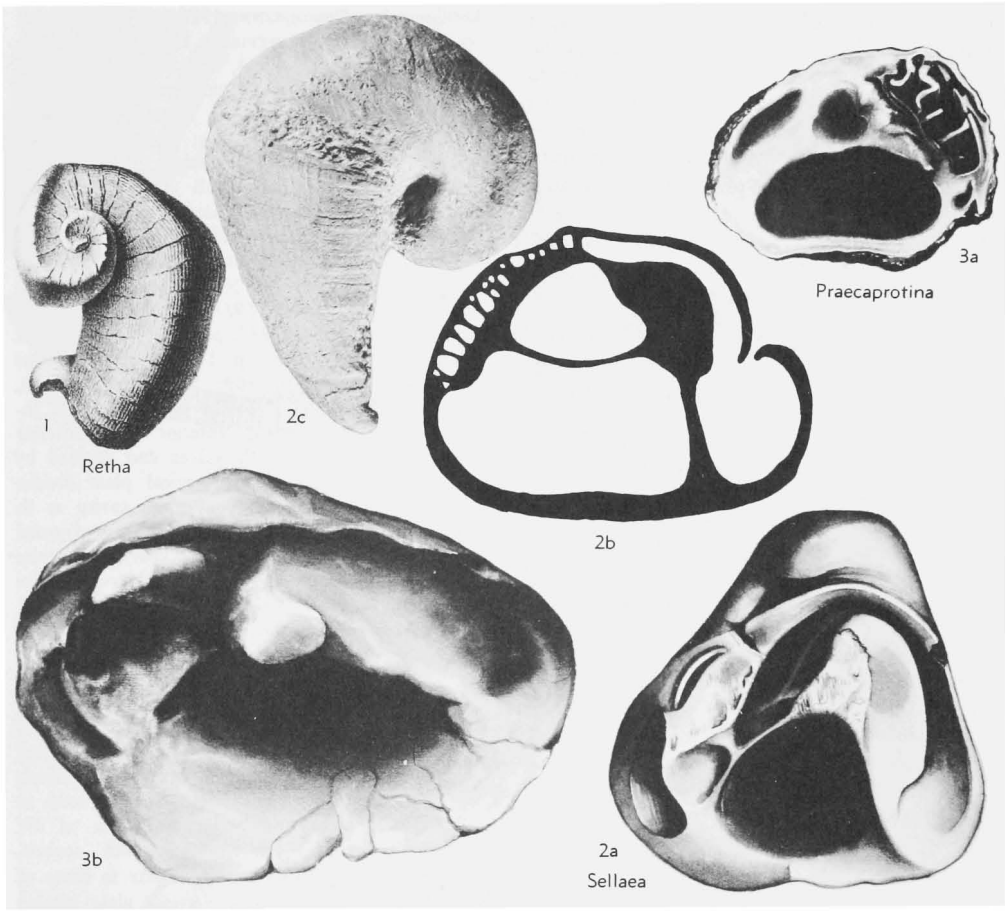

FIG. E255. Caprotinidae (p. *N*787, *N*789).

genera; pallial canals in pallial region of one or both valves. *L.Cret.(Urgonian facies)-U.Cret.(Maastricht.).*

In the Caprinidae generic distinctions have been based mainly upon the form and disposition of the pallial canals and accessory cavities. Both the canals and accessory cavities may vary in shape and arrangement, depending upon the distance from the apex that a section is made, and such variations rarely have been taken into account in the definition of caprinid genera. Many of the presently rather arbitrarily defined caprinid genera must be restudied before a phylogenetically sound classication of the assemblage can be derived.

[In original manuscript (modified inappreciably by L. R. Cox) DECHASEAUX divided caprinid genera into four informal groups, as follows: 1) forms considered to be most typical representatives of the family *(Caprina, Caprinula, Neocaprina, Orthoptychus, Paracaprinula, Plagioptychus, Praecaprina, Sphaerucaprina)*, 2) variants possibly representing expression of regional differentiation *(Amphitriscoelus, Antillocaprina, Caprinuloidea, Coalcomana, Kipia, Mitrocaprina, Offneria, Planocaprina, Sabinia, Schiosia)*, 3) forms considered to exhibit approach to the Radiolitidae *(Coralliochama, Dictyoptychus, Ichthyosarcolites, Titanosarcolites)*, and 4) imperfectly known

forms questionably assignable to the Caprinidae only because of the presence of accessory cavities or canals *(Bicornucopina, Cryptaulia, Immanitas, Lithocalamus, Palus)*. In my opinion and that of PERKINS, it is sufficient simply to record the grouping of genera as listed and preferably to arrange systematic descriptions alphabetically after the type genus. Group 4 of DECHASEAUX is given under the heading "Superfamily and Family Uncertain."—EDITOR.]

Caprina C. D'ORBIGNY, 1822, p. 105 [**C. adversa;* SD PAQUIER, 1905, p. 69] [=*Gemellaria* MUNIER-CHALMAS, 1873, p. 75 (type, *Caprina communis* GEMMELLARO, 1865); *Cornucaprina* FUTTERER, 1892, p. 87 (type, *Schiosia carinata* BÖHM, 1892)]. AV conical, straight, smaller than FV, which is conical and strongly coiled; AV with projecting tooth anterior to ligamental groove, anterior muscle insertion on thickened area of shell wall, posterior insertion on suberect plate separated from shell wall by accessory cavity divided into smaller cavities by simple radial vertical plates; FV anterior muscle insertion on plate connecting anterior tooth with shell wall, large anterior accessory cavity divided by thin, vertical radial and transverse plates, posterior muscle attachment on shell wall, vertical plate connects anteroventral edge of anterior tooth with ventral shell wall forming a large cavity separated from body cavity; FV with one or two series of pyriform pallial canals in anterior, ventral and posterior regions. *L.Cret.(Urgonian facies)-U.Cret.(Cenoman.)*, Eu.-N.Afr.-N.Am.——FIG. E256,*1;* E257,*2.* **C. adversa,* Cenoman., France; E256,*1*, FV sec., ×0.8; E257,*2a*, AV sec., ×0.5; E257,*2b*, both valves, ×0.11 (E256,*1;* E257,*2a*, after *267c;* E257,*2b*, *695*).

Amphitriscoelus HARRIS & HODSON, 1922, p. 130 [**A. waringi;* M]. Both valves elongate, incurved but not coiled, small; AV tooth narrow, elongate in section, anterior socket large, posterior socket small but joined to large accessory cavity which is undivided, pallial canals more or less rectangular or rounded-triangular limited to anterior, dorsal and posterior regions; FV with small anterior accessory cavity, vertical wall joins anterior tooth with anteroventral border of posterior muscle insertion forming cavity separate from shell cavity, pallial canals same shape and arrangement as in AV. *L.Cret.(Apt.)*, Trinidad-USA(Texas).——FIG. E257,*1.* **A. waringi,* Trinidad; *1a,b*, AV sec., viewed from apex so that posterior is on left, and FV sec., ×0.7 (Perkins, n).

Antillocaprina TRECHMANN, 1924, p. 407 [**Caprinella occidentalis* WHITFIELD, 1897, p. 193; M[1]]. AV more or less conical, FV with coiled beak; FV with conical anterior tooth and crescentic or sigmoidal posterior tooth; internal ligamental groove; no accessory cavities; both valves with numerous small, mostly tabulate, polygonal or oval canals in inner shell wall layers, in teeth and in myophorous plates. *U.Cret.(U.Senon.-Maastricht.)*, W.Indies(Antilles).——FIG. E257,*3.* **A. occidentalis* (WHITFIELD), Maastricht., Jamaica; *3a*, both valves, ×0.2; *3b,c*, AV oblique view and FV int., ×0.3 *(911a)*.

Caprinula D'ORBIGNY, 1847, p. 269 (genus without nominal species); 1850, p. 187 [**Caprina boissyi* D'ORBIGNY, 1839, p. 169; SM]. AV conical, straight; FV conical, loosely coiled; muscle insertions as in *Caprina;* anterior and posterior accessory cavities in both valves and divided by thin radial vertical plates; vertical plate divides cavity joined to socket from shell cavity as in *Caprina;* pallial canals include inner polygonal series and outer pyriform series, polygonal series decreases in diameter from interior of valves outward. *L.Cret.(Alb.)-U.Cret.(Cenoman.-Turon.)*, Eu.-Syria-N.Am.——FIG. E257,*4.* **C. boissyi* (D'ORBIGNY), Turon., France; *4a,b*, FV secs. near commissure and nearer apex, ×1; *4c*, AV sec. near commissure, ×1 (after *267c*); *4d*, both valves, ×0.5 *(695)*.

Caprinuloidea PALMER, 1928, p. 59 [**C. perfecta;* OD]. AV greatly elongated, straight to curved; FV much smaller, open to tightly coiled; teeth in both valves large and projecting, those of FV commonly strongly curved; AV tooth, sockets, and posterior accessory cavity similar to those of *Amphitriscoelus;* FV with vertical plate joining anterior tooth with ventral shell wall forming cavity separated from body cavity, no accessory cavities; pallial canals in both valves throughout shell wall, generally comprise inner polygonal series and outer pyriform series, rounded or polygonal canals may be present in myophorous plates and in teeth; shell cavity, tooth sockets, accessory cavity, and pallial canals may be tabulate. *L.Cret.(Alb.)*, Mexico-USA (Texas)-W. Indies (Cuba-Jamaica).——FIG. E258,*3.* **C. perfecta,* Mexico; FV int. (plate joining ant. tooth with shell wall broken), ×0.7 (Perkins, n). [Also Fig. E224,*3.*]

Coalcomana HARRIS & HODSON, 1922, p. 132 [**Caprina ramosa* BÖHM, 1898, p. 327; M]. Resembles *Caprinuloidea* in external form and internal structures; differs in having pyriform pallial canals only. *L.Cret.(Alb.)-U.Cret.(Cenoman.)*,

[1] The genus was founded on specimens misidentified by TRECHMANN as *Caprinella occidentalis* and which Dr. L. J. CHUBB is describing as a new species, but the conception of the genus is not affected. [Note by L. R. Cox.]

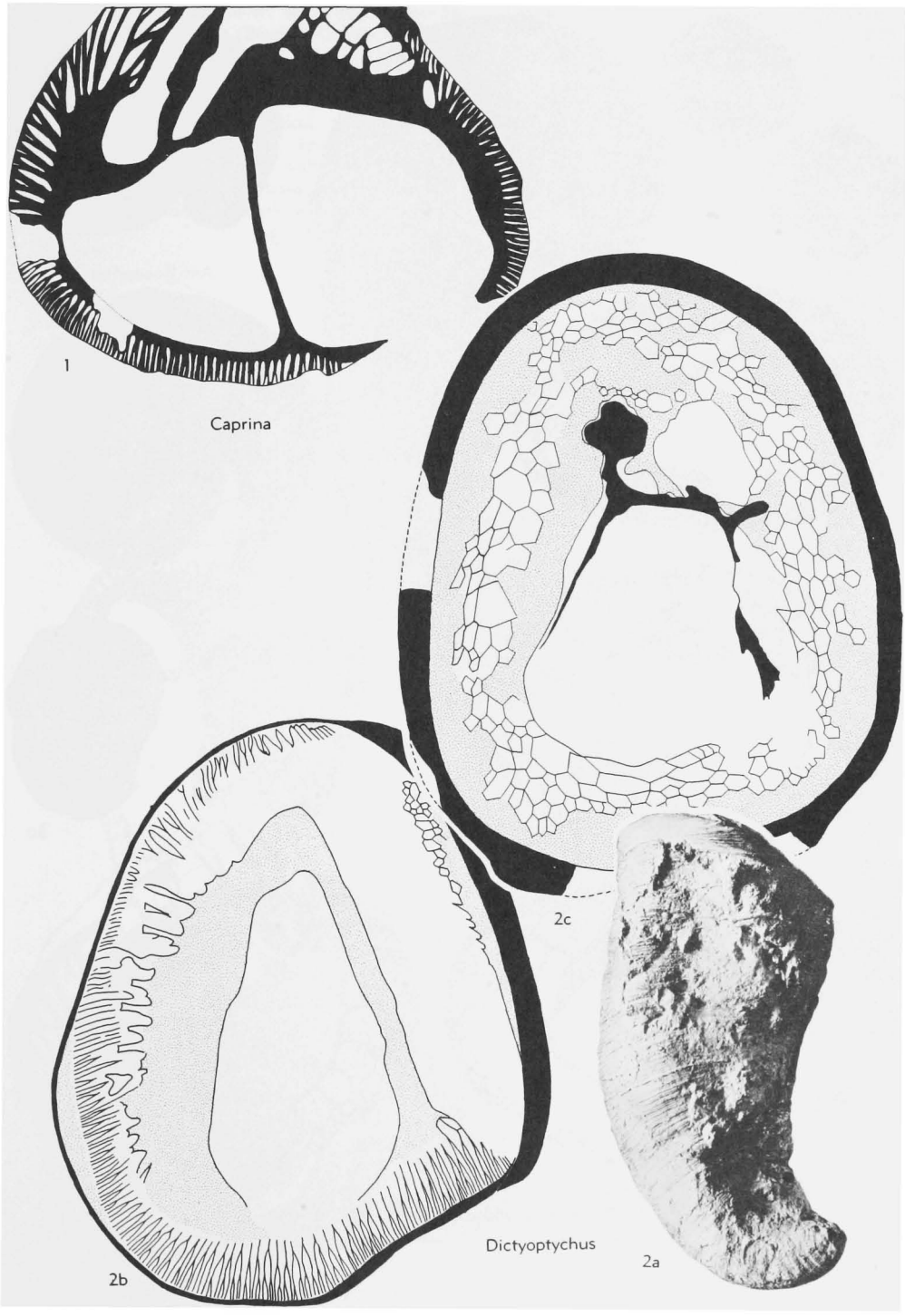

FIG. E256. Caprinidae (p. *N*790, *N*795).

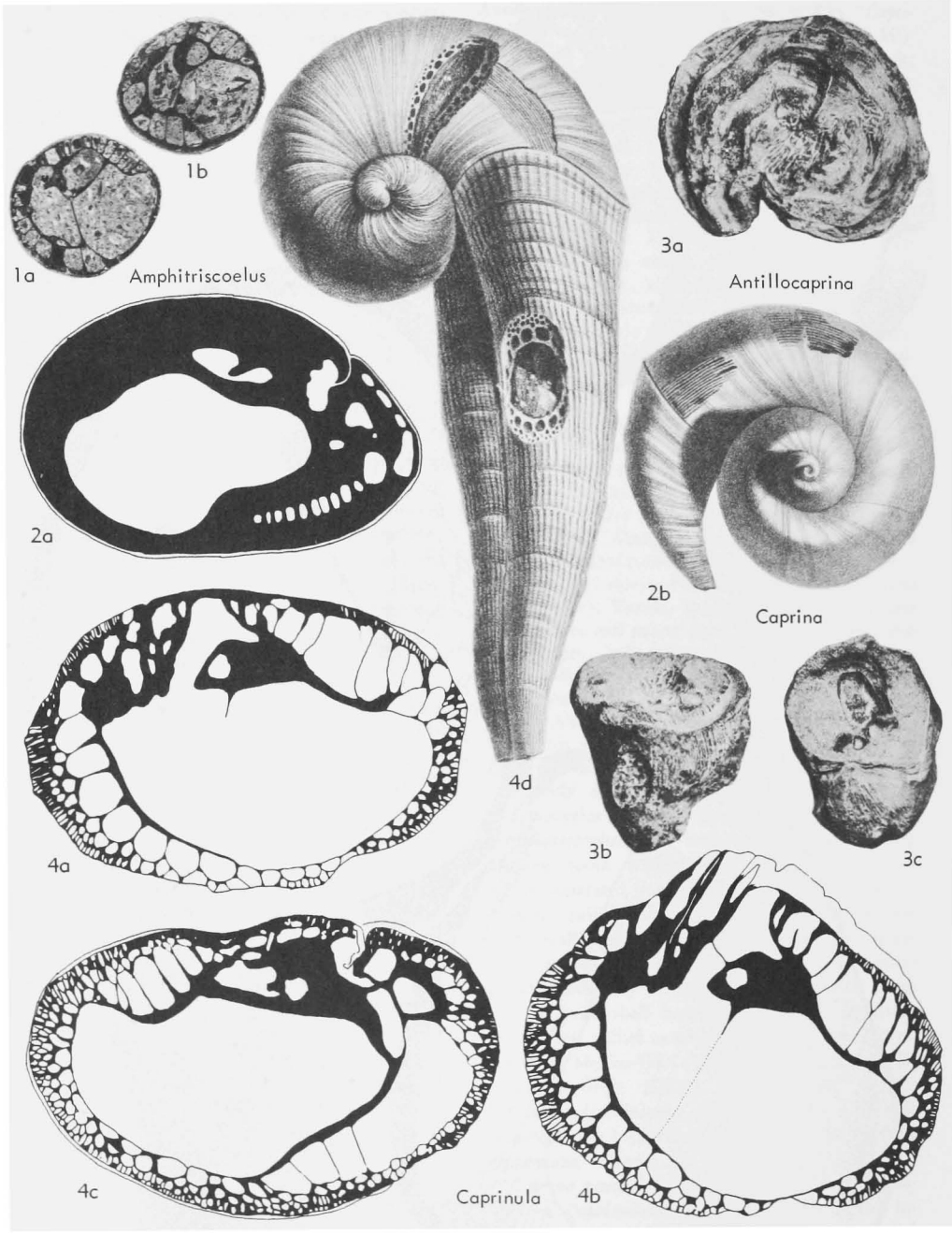

FIG. E257. Caprinidae (p. *N790*, *N792-N793*).

USA (Texas) - Mexico-W. Indies (Cuba).——Fig. E258,*1*. **C. ramosa* (Böhm), Cenoman., Mexico (Coalcoman); *1a,b,* FV and AV secs., ×0.8 (after *270a*).

Coralliochama White, 1885, p. 9 [**C. orcutti;* M]. Inequivalve; AV conical, tall; FV convex, beak broad and incurved; ligament marked by inflection of outer shell wall layer into inner layer; AV muscle insertions on shell wall, no accessory cavities; AV shell wall with small polygonal, closely tabulate canals throughout; FV anterior tooth joined to ventral shell wall by vertical plate as in *Plagioptychus,* no accessory cavities; FV shell wall with wide inner area of polygonal canals and marginal series of radially elongated pyriform canals, closely tabulate as in AV. *U.Cret.(Senon.),* USA(Calif.)-Mexico.——Fig. E258,*2*. **C. orcutti,* Mexico (Baja Calif.); E258,*2a,* both valves, ×0.3; E258,*2b,c,* AV and FV transv. secs., ×0.7 (Perkins, n).

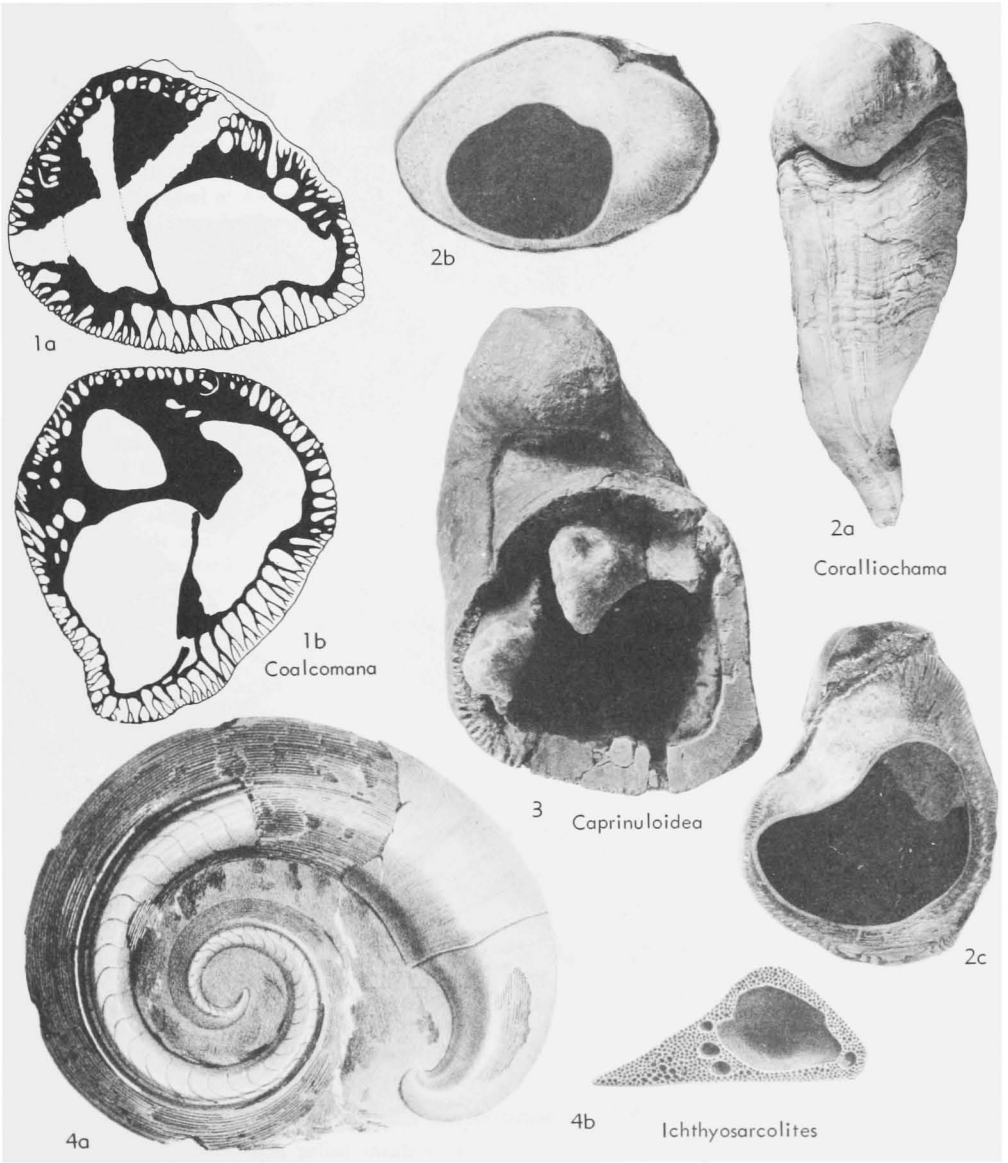

Fig. E258. Caprinidae (p. *N*792-*N*795).

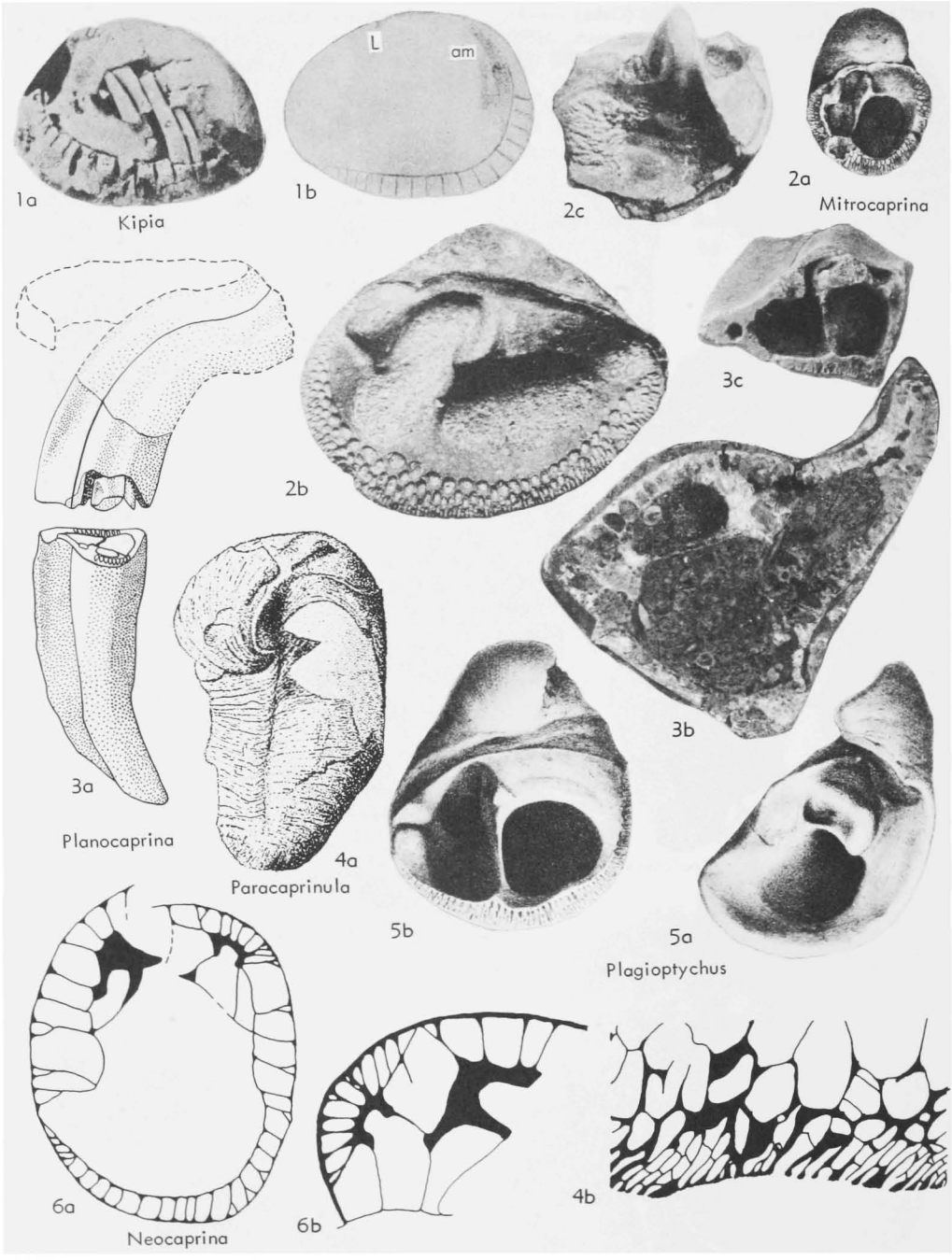

FIG. E259. Caprinidae (p. *N*795-*N*797). [Explanation: *am*, anterior myophore; *L*, ligamental ridge.]

Dictyoptychus DOUVILLÉ, 1905, p. 178 [*pro Polyptychus* DOUVILLÉ, 1904, p. 248 (*non* HUEBNER, 1816)] [**Polyptychus morgani* DOUVILLÉ, 1904; M] [=*Anomoptychus* DOUVILLÉ, 1906, p. 56 (obj.); *Trechmanella* Cox, 1933, p. 388 (obj.)]. Very large, inequivalve; AV conical, slightly incurved, with 2 longitudinal swellings possibly representing siphonal bands; FV much depressed, with eccentric summit; ligamental structures absent, hinge teeth produced, myophorous plates elongate; FV with large accessory cavity behind anterior myophore; AV with accessory cavities outside cardinal structures; AV with thick compact external layer and internal layer with narrow elongate canals separated by bifurcate radial plates as in *Plagioptychus*. *U.Cret.(U.Senon.)*, SW.Asia (Iran).——FIG. E256,*2*. *D. persica* (Cox); *2a*, both valves, ×0.16; *2b*, FV transv. sec., ×0.5; *2c*, transv. sec. at level of AV with projecting teeth and myophores (inner black areas) of FV, ×0.5 *(2a, 176; 2b,c,* after *176)*.

Ichthyosarcolites DESMAREST, 1817, p. 51 [**I. triangularis;* M] [=*Ichthyosarcolithus* HERMANNSEN, 1846 *(nom. van.); Caprinella* D'ORBIGNY, 1847, p. 269 (obj.)]. Very large, inequivalve, strongly carinate; AV curved or loosely coiled with whorls not in contact; FV curved in same direction as AV, smaller; teeth of FV fused with myophores to form single plate which fits into notches in AV shell cavity wall, radiolitid fashion; no ligament; shell cavity obliquely tabulate with tabulae of AV sloping away from commissure toward convex side and those of FV sloping away from commissure toward concave side; both valves with small, rounded-polygonal canals irregularly distributed and few large round canals in some areas, canals not tabulate. *L.Cret.(Urgonian facies)-U.Cret.(Turon.)*, Eu.-N.Afr.-?Iran-Canada-Cuba.——FIG. E258,*4*. **I. triangularis*, Cenoman.; *4a*, both valves, ×0.2; *4b*, transv. sec., ×0.3 *(695)*.

Kipia HARRIS & HODSON, 1922, p. 133 [**K. trinitaria;* M]. AV conical, short; FV capuloid; both valves with rectangular pallial canals formed by simple, thin radial plates and restricted to anterior and ventral shell wall, which is thin where pallial canals are lacking, myophores imperfectly known. *L.Cret.(Apt.)*, W.Indies(Trinidad).——FIG. E259, *1*. **K. trinitaria; 1a,b*, FV from above (shell wall eroded) and transv. sec., ×1.5 *(388a)*.

Mitrocaprina BÖHM, 1895, p. 102 [**Coralliochama bayani* DOUVILLÉ, 1888, p. 725; OD]. Very inequivalve; AV smaller, more or less exogyriform, attachment area very large; FV slightly to highly elevated, coiled; AV posterior muscle insertion on obliquely erect plate, posterior accessory cavity present and not always separated from posterior tooth socket, no pallial canals; FV teeth projecting slightly, no accessory cavities, pallial canals comprise 1 or 2 inner rows of polygonal canals and 1 or more outer rows of pyriform or radially elongate canals. *U.Cret.(Turon.-Maastricht.)*, Eu.-W. Indies(Jamaica-Cuba).——FIG. E259,*2a*. **M. bayani* (DOUVILLÉ), Turon., France; FV int., ×0.7 *(267c)*.——FIG. E259,*2b,c*. *M. vidaldi* DOUVILLÉ, Turon., Spain; *2b,c*, FV and AV int., ×1 *(272)*.——FIG. E260,*3*. *M. tschoppi* (Palmer), Maastricht., Cuba; transv. sec., at level of FV with projecting tooth of AV, ×0.5 *(561)*.

Neocaprina PLENIČAR, 1961, p. 41 [**N. nanosi;* OD]. Known only from transverse sections of FV; anterior muscle insertion larger than posterior; anterior and posterior accessory cavities divided into smaller rectangular or oval cavities by thin radial vertical plates; pallial canals rectangular in section and formed by simple radial plates which bifurcate near outer shell wall anteriorly and posteriorly. *U.Cret.(Cenoman.-Turon.)*, Eu.(Yugosl.).——FIG. E259,*6*. **N. nanosi*, Turon.; *6a,b*, FV transv. sec. and hinge area sec., ×1 *(741b)*.

Offneria PAQUIER, 1905, p. 82 [**O. rhodanica;* OD]. External form resembling *Praecaprina;* AV conical, FV curved; cardinal apparatus and myophore arrangement similar to those of *Praecaprina;* AV with elongate, curved posterior accessory cavity divided by thin radial plates and in some species by discontinuous plate parallel to shell wall, anterior accessory cavity divided similarly, marginal canals when present in ventral areas indistinguishable from subdivided accessory cavities; FV with marginal canals usually around entire valve but may be missing in ventral area, polygonal and pyriform canals present but arrangement irregular. *L.Cret.(Urgonian facies)*, Eu.(S.France).——FIG. E260,*4a,b*. **O. rhodanica; 4a,b*, FV and AV transv. secs., ×0.75 (after *716c*).——FIG. E260, *4c*. *O. interrupta* PAQUIER; FV transv. sec., ×0.75 (after *716c*).

Orthoptychus FUTTERER, 1892, p. 91 [**O. striatus;* M]. AV conical, small; FV strongly inflated with beak incurved; distinguished from *Sphaerucaprina* by presence in FV posterior shell wall of some septa transverse to radial plates. *U.Cret. (Cenoman.)*, Eu.(Alps-Apennines).——FIG. E260, *1*. **O. striatus; 1a,b*, FV and AV int., ×0.5 *(332a)*.

Paracaprinula PIVETEAU, 1939, p. 34 [**P. syriaca;* M]. Resembles *Plagioptychus* externally but less inequivalve; anterior pallial canals polygonal as in *Caprinula*, posterior canals of very unequal size limited by more or less oblique transverse plates. *U.Cret.(Maastricht.)*, SW.Asia(Syria).——FIG. E259,*4*. **P. syriaca; 4a*, both valves, ×0.2; *4b*, shell wall transv. sec., ×2 *(741a)*.

Plagioptychus MATHERON, 1843, p. 114 [**P. paradoxus;* SD KUTASSY, 1934, p. 172]. AV conical and straight or low and twisted; external ligamental groove; FV strongly convex with recurved beak; AV tooth erect and strongly projecting, muscle insertions on shell wall, no pallial canals;

FV muscle insertions on thickened plates projecting above cardinal platform, anterior tooth smaller than posterior, separated by deep socket, vertical plate extending from anterior tooth to ventral shell wall forming cavity separate from shell cavity as in *Caprina,* pallial canals comprise single series of pyriform canals in oldest species but in other species radial plates branch, forming several series of more or less pyriform canals, no accessory cavities. *U.Cret.(Cenoman.-Maastricht.),*

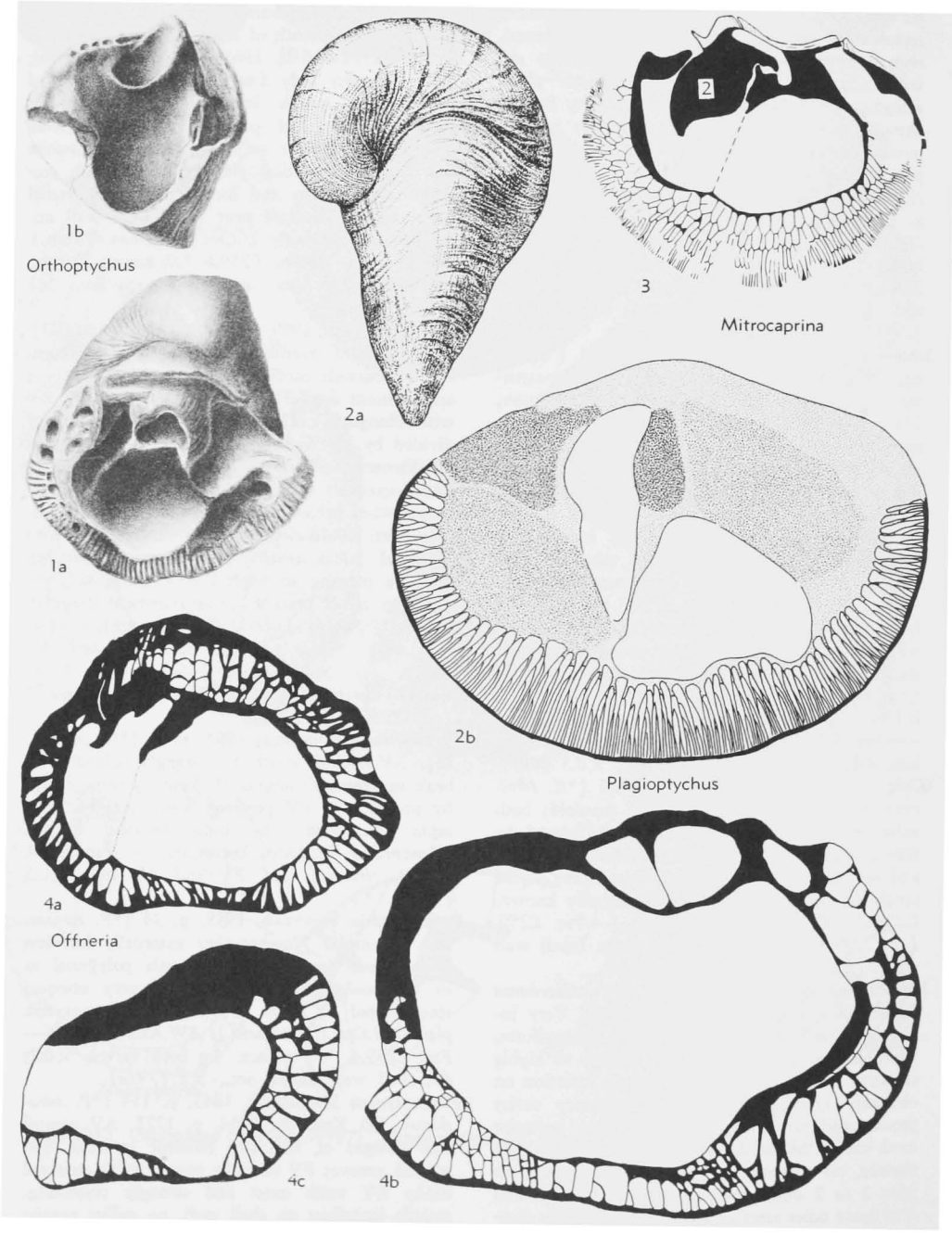

FIG. E260. Caprinidae (p. *N795-N797*). [Explanation: *2*, tooth of AV.]

Eu.-N. Afr.-Mexico-W.Indies(Jamaica-Cuba). ——FIG. E259,*5*. *P. arnaudi* DOUVILLÉ, Turon., France; *5a,b*, AV and FV int., ×0.7 *(267c)*.——FIG. E260,*2a*. **P. paradoxus*, Turon., France; both valves, ×0.4 *(600a)*.——FIG. E260,*2b*. *P. toucasianus* MATHERON, Turon., France; FV transv. sec., ×0.5 (after *267c*).

Planocaprina PALMER, 1928, p. 64 [**P. trapezoides;* OD]. AV conical, straight to slightly curved; FV larger, coiled in open spiral; AV tooth marginal, posterior accessory cavity large and joined to posterior socket as in *Amphitriscoelus;* FV anterior tooth large, curved and marginal, posterior tooth rudimentary; pyriform pallial canals occurring in single series in both valves; polygonal canals absent. *?L.Cret.(Alb.)-U.Cret. (Cenoman.)*, Mexico-?USA(Texas).——FIG. E259, *3*. **P. trapezoides*, Mexico; *3a*, both valves, ×0.3; *3b*, AV transv. sec., ×1.3; *3c*, FV int., ×0.7 (*3a*, Dechaseaux after *714; 3b,c*, Perkins, n).

Praecaprina PAQUIER, 1905, p. 72 [**P. varians;* OD]. External form resembling *Caprina* but much smaller, FV coiling rarely more than 1 whorl, ventral region of both valves marked by longitudinal depression bordered by 2 swellings; AV tooth strongly projecting, both muscle insertions on plates projecting from cardinal platform and separated from shell wall by accessory cavities usually divided into smaller cavities by vertical radial plates; FV anterior tooth larger, erect and median in position, muscle insertions on shell wall and extend from cardinal platform, vertical plate connects anterior tooth with ventral shell wall as in *Caprina*, rounded or oval pallial canals formed by simple radial plates in anterior, posterior and posteroventral areas. *L.Cret.(Urgonian facies)*, Eu.-W.Indies(Trinidad).——FIG. E261,*2;* E262,*2*. **P. varians*, France; E261,*2a*, both valves, ×0.5; E261,*2b,c*, FV and AV int., ×0.7; E262,*2*, FV transv. sec., ×0.75 *(716c)*.

Rousselia DOUVILLÉ, 1898, p. 151 [**R. guilhoti;* M]. AV straight, conical; FV strongly convex; general form and hinge resemble *Monopleura;* FV anterior tooth large, crescentic, near shell cavity, posterior tooth small, marginal; FV muscle insertions on raised thickened areas of shell wall; no ligamental groove or cavity; AV with rounded to polygonal, tabulate canals in some marginal areas. *U.Cret.(Maastricht.)*, Eu.(Pyrenees).——FIG. E261,*1*. **R. guilhoti*, Spain (Lerida); AV int., ×1 *(272)*.

Sabinia PARONA, 1909, p. 303 [**S. aniensis;* SD KUTASSY, 1934, p. 169]. Externally resembling *Plagioptychus;* both valves without accessory cavities; AV pallial canals polygonal to rounded throughout shell wall, few pyriform canals in outer part but not forming continuous series; FV pallial canals comprise an inner wide area of polygonal canals of nearly uniform size and outer marginal row of pyriform canals. *U.Cret.(Senon.)*, Eu.(Apennines-W.Serbia-Turkey).——FIG. E262, *3a*. **S. aniensis*, Maastricht., Apennines; FV sec., ×0.75 (after *719b*).——FIG. E262,*3b*. *S. sublacensis* PARONA, Maastricht., Apennines; AV transv. sec., ×0.75 (after *719b*).

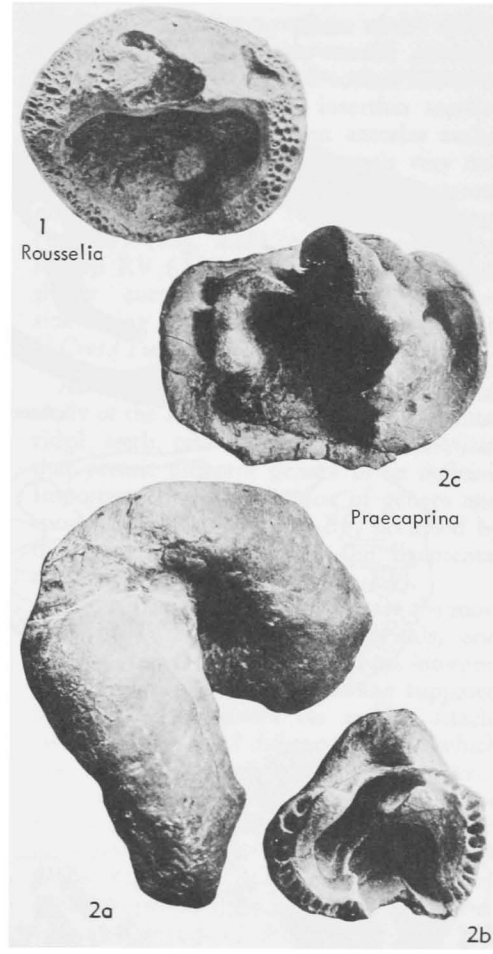

FIG. E261. Caprinidae (p. *N797*).

Schiosia BÖHM, 1892, p. 144 [**S. schiosensis;* OD]. Very inequivalve; AV low, strongly curved; FV larger, elongate, coiled; accessory cavities present in FV and possibly also in AV; FV pallial canals include single pyriform series in anterior, ventral and posterior areas, few polygonal and rounded canals in hinge area; AV interior not known. *U. Cret. (Cenoman.-Senon.)*, Eu.(S. Alps)-NW.Asia Minor(Bithynia).——FIG. E262,*5*. **S. schiosensis*, Turon., S.Alps; FV transv. sec., ×0.75 (after *719a*).

Sphaerucaprina GEMMELLARO, 1865, p. 212 [**S. woodwardi;* M] [=*Sphaerocaprina* DOUVILLÉ,

1910 *(nom. van.)*]. AV resembling that of *Caprina;* FV strongly convex, caplike, beak incurved but not coiled; AV anterior muscle insertion on shell wall, posterior on curved vertical plate extending from tooth to ventral margin, large posterior accessory cavity, no pallial canals;

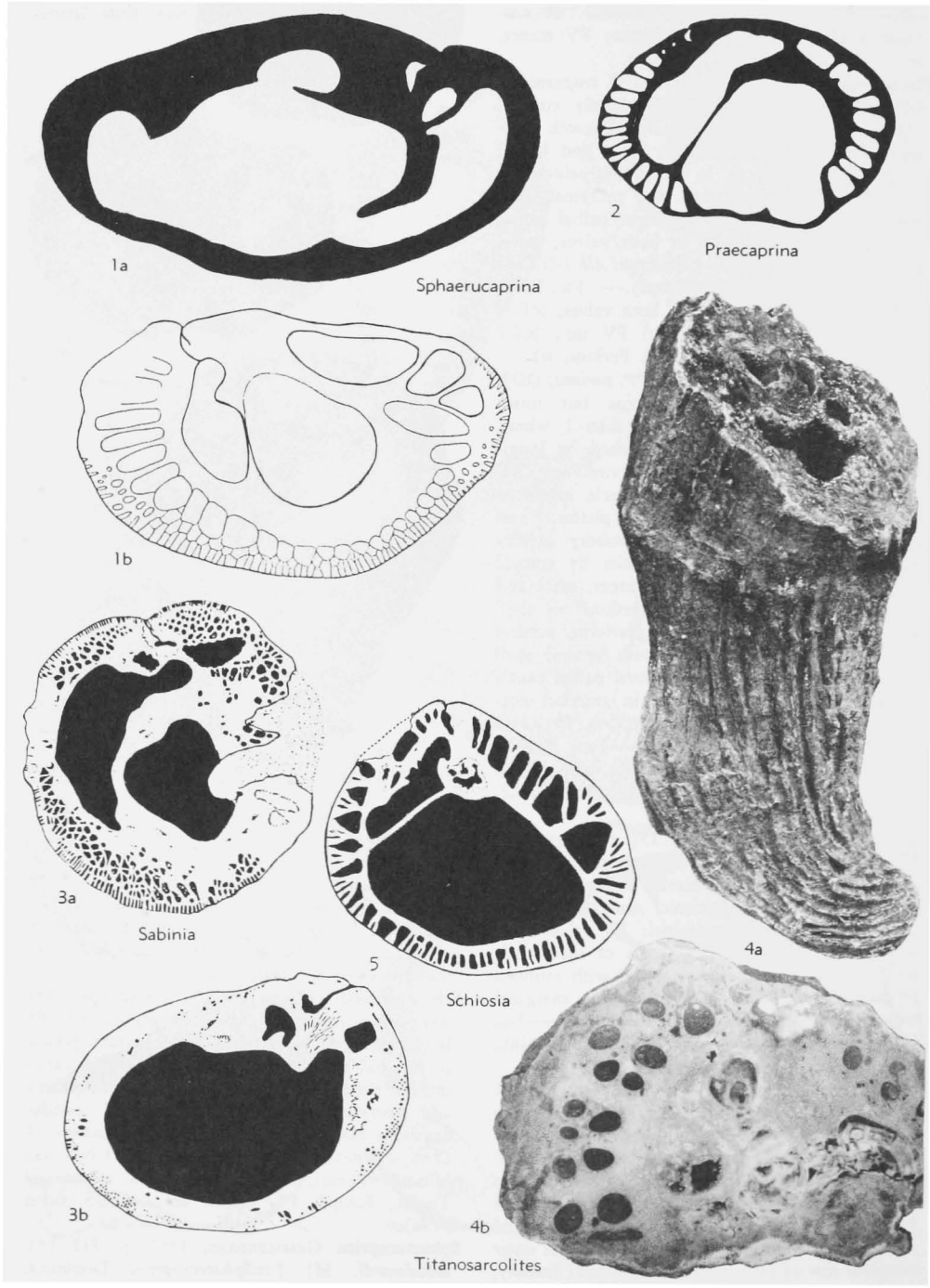

FIG. E262. Caprinidae (p. *N797-N799*).

FV with dorsal and anterior accessory cavities, vertical wall connecting anterior tooth to ventral shell wall as in *Caprina,* anterior, ventral and posterior areas with 1 or 2 rows of polygonal pallial canals and outer row of pyriform pallial canals. *L.Cret.(Alb.)-U.Cret.(Cenoman.),* Eu.-N. Am.-W. Indies (Jamaica).——FIG. E262,*1.* * *S. woodwardi,* Cenoman., Italy; *1a,b,* AV and FV transv. secs., ×0.75 (after *274a*).

Titanosarcolites TRECHMANN, 1924, p. 397 [**Caprinella gigantea* WHITFIELD, 1897, p. 194; M] [=*Diatretus* DOUVILLÉ, 1926, p. 132 (obj.)]. Very large, subequivalve, with both valves curved or coiled; dorsal and anterior surfaces with rounded longitudinal ridges separated by angular furrows, posterior and ventral surfaces with angular ridges or flanges separated by rounded grooves; ligamental groove internal, comma-shaped in transverse section; cardinal apparatus as in *Antillocaprina,* tooth alveoles tabulate; posterior muscle insertion in FV on raised apophysis which fits into alveole of AV, anterior muscle insertion superficial; shell cavity small, tabulate; small polygonal canals throughout shell wall, teeth and myophores; large tubular canals, rounded, oval or reniform, present on anteroventral side only. *U. Cret.(Maastricht.),* USA(Texas)-Mexico-W.Indies (Jamaica-Cuba-Puerto Rico-Virgin Is.).——FIG. E262,*4a.* **T. giganteus* (WHITFIELD), Jamaica; AV ext., ×0.35 *(980a).*——FIG. E262,*4b. Titanosarcolites* sp.; AV transv. sec., ×0.75 (Perkins, n).

Family HIPPURITIDAE Gray, 1848

[Materials for this family prepared by COLETTE DECHASEAUX and A. H. COOGAN, with acknowledgment of assistance by L. R. COX]

Shell conical to elongate-cylindrical and inequivalve. RV (AV) larger than LV (FV) which is operculiform, slightly convex or flat. Internally RV (AV) shell wall has compact smooth inner layer and thicker outer layer which extends toward interior in three or more folds (ligamental ridge and two or more pillars or rays). Pillar nearer ligamental ridge is designated as *"S,"* using the notation devised by DOUVILLÉ and accepted by most authors, and the other (generally more elongate) as *"E"* (Fig. E237, *11*). Teeth and myophore well developed. H-shaped (in transv. sec.) tooth stands between two sockets, anterior one receiving anterior tooth of LV (FV), and between it and inner wall of valve is an accessory cavity. On posterior side of RV (AV), between tooth and pillar *Sp,* are two sockets, that nearer tooth *2* for reception of posterior tooth of LV (AV), and that nearer *Sp* is for posterior myophore of LV (FV) (Fig. E220,*2*). Posterior muscle insertion in RV (AV) on side of socket dorsal to *Sp,* and anterior muscle insertion marked by superficial scar between anterior socket and pillar *Ep.* Cavities or canals very rare in RV (AV). LV (FV) may be porous and commonly has two oval openings (oscules) (Fig. E263,*2b*). In longitudinal section RV (AV) in genera of this family shows curved partitions with concave side facing upward toward living chamber. *U.Cret.(Turon.-Maastricht.).*

All elements observable in morphological study of the Hippuritidae (pores, ligamental ridge, teeth, pillars) occur in combinations that permit different genera to be defined. Important for determination of genera and species is the sector *(L-Sp-Ep)* occupied by the three principal folds—the ligamental ridge *(L)* and the pillars *(Sp, Ep).*

The pillars, pores and oscules are the most curious features of the hippuritids, and paleontologists have long tried to interpret them. DESHAYES and WOODWARD supposed that the pillars served for muscle attachment, but suggested different ways in which this may have been accomplished. BAYLE observed that the three folds have the same structure, and he considered that the muscles were not attached to them but to the wall of the shell. DOUVILLÉ, extending the conclusions reached from his work on *Sphaerulites* and genera of the Requieniidae and Monopleuridae to *Hippurites,* suggested that the pillars correspond to siphonal zones, and accordingly designated them as *"S"* (*sortie,* excurrent) and *"E"* (*entrée,* incurrent). This opinion was accepted widely, with its implication that a hippuritid possessed two siphons serving respectively for outflow and inflow of water currents. YONGE *(1024a)* has advanced other interpretations based on analogies with *Chama.* The presence of oscules in the FV exactly above extremities of the pillars was held to support this hypothesis, for a hippuritid with closed valves could be provided continuously with water circulation through siphons opening outward at the oscules. Oscules are not a constant feature of all Hippuritidae, however, and, according to some accounts, where they exist in earlier

growth stages they may later become obliterated.

Study of the structure of the pillars by means of thin sections has led to alternative hypotheses. KLINGHARDT *(475aa)* and WIONTZEK *(1000)* observed cavities within the pillars and suggested that each pillar was a "siphonal tube" which enclosed the siphon of the living animal. No orifice, however, has been observed at the base of the pillars (Fig. E263,*1c*) through which a siphon could have protruded or a current of water have passed, and it seems probable that the cavities are of secondary origin.

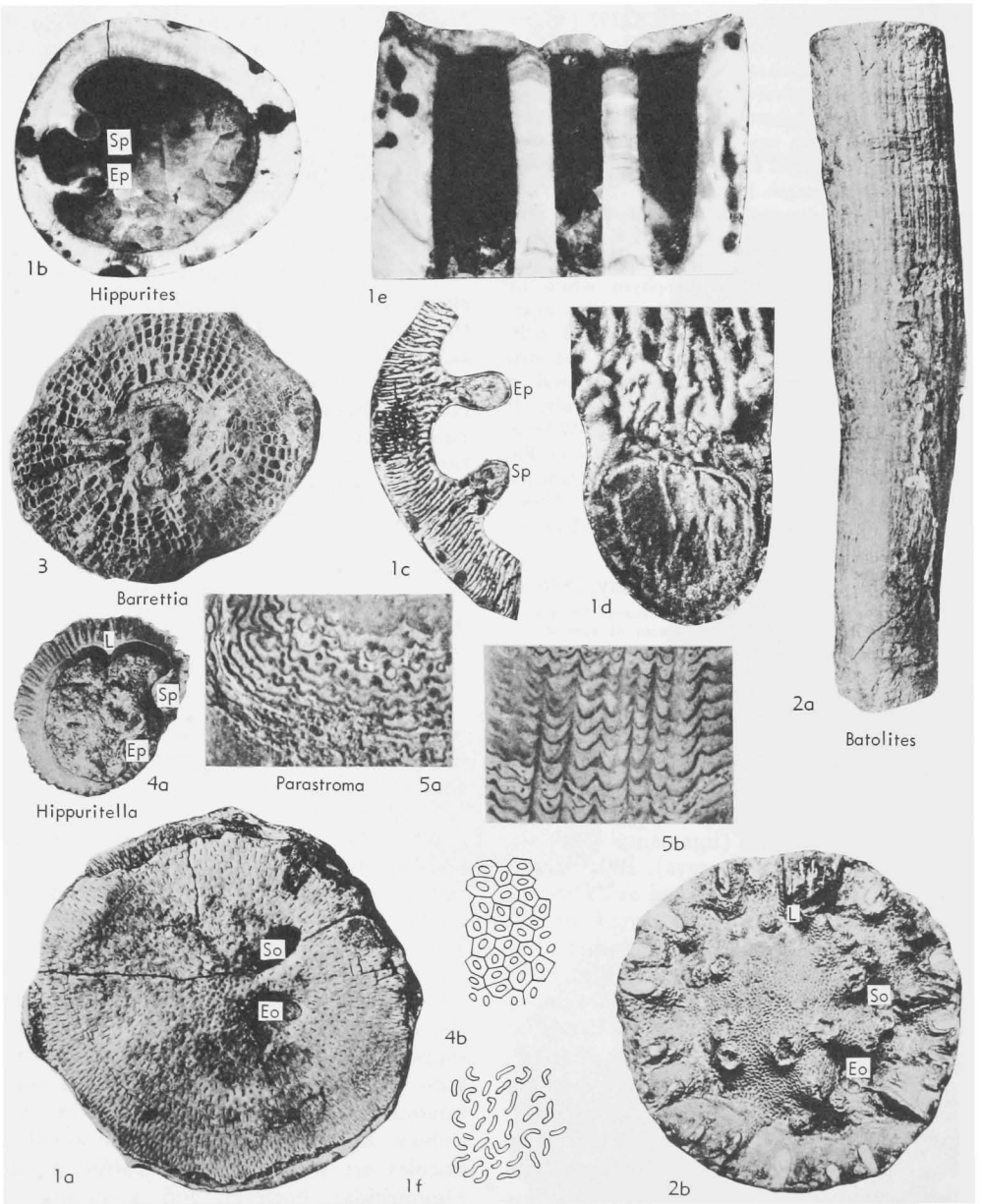

FIG. E263. Hippuritidae (p. *N*801-*N*802). [Explanation: *Eo, So,* oscules; *Ep, Sp,* internal pillars; *L,* ligamental ridge.]

Actually, the pillars are folds of the external layer of the shell (MILOVANOVIĆ, *622, 625;* KÜHN, *491*), similar to other folds known in various hippuritids. A whole series of observations throws doubt on the existence of siphons in the hippuritids, and the hypothesis that long ones were enclosed in the pillars should be rejected.

CHUBB *(131)* has suggested that the sole function of the pillars was to block the oscules of the upper valve when this was pulled down tightly by the adductor muscles, thus interrupting the passage of the respiratory currents through them when necessity arose (Fig. E263,*1e*). The oscules themselves, he suggested, evolved in consequence of the gregarious habit of the hippurites (and other rudists in which they are found), their presence enabling interchange of water between the mantle cavity and the sea above the animal when interchange from the side may have been difficult or impossible.

Another theory recently has been advanced by VOGEL *(942)*, who suggested that the pillars acted as supports of sensory organs or of accessory gills. As there are no living bivalves at all like the hippuritids, it is difficult to decide what role the observed morphological characters played in the biology of the animal.

If the siphons were short or lacking, circulation of water was perhaps provided by the pores. In addition, some authors have ascribed to the pores the function of a filter that screened off impurities harmful to the animal. The arrangement of canals in the FV is complex, but their organization, especially in *Yvaniella* (Fig. E243,*4*) seems to indicate that water circulation was made possible to some extent by this system of perforations when the valves were closed.

As the pillars blocked the oscules completely when the shell was closed, the hippuritids must have had to raise the FV slightly to allow circulation of water for respiration and feeding. The FV is veritably a lid placed over the AV in such a manner that the long teeth and posterior myophore are engaged by the long vertical sockets of the AV. Because of this, any rocking movement about the ligament is impossible and only elevation of the FV above the AV permits separation of one from the other. This lifting could have been effected by pressure in the shell interior, produced possibly by inflation of a soft organ such as the foot.

Hippurites LAMARCK, 1801, p. 104 [**H. bioculata;* M] [=*Orthoceratites* LAMARCK, 1799, p. 81 (suppressed ICZN Op. 613); *Cornucopina* THOMSON, 1802, p. 245 (generic description without nominal species); *Coralliolites* VON SCHLOTHEIM, 1813, p. 36 (type, *C. orthoceratoides;* SD COOGAN, herein); *Pachynus* RAFINESQUE, 1815, p. 140 *(obj.); Dorbignya* WOODWARD, 1862, p. 375 *(obj.); Orbignia* STOLICZKA, 1871 *(nom. van.); Orbignya* FISCHER, 1887, p. 1064 *(nom. van.); non Hyppurites* VON SCHLOTHEIM, 1820, p. 351]. AV nearly cylindrical, smooth, bearing 2 furrows in some but not all species; ligamental ridge short or absent; pillars *Ep* and *Sp* distinct, *L* absent or slightly curved to pointed inflexion of wall; sector *L-Sp-Ep* greater than one-quarter circumference; FV nearly flat, with 2 oscules and simple linear, well-separated pores. *U.Cret.(Turon.-Maastricht),* Eu.-NE. Afr.(Somalia)-Asia-N. Am.-Antilles.——FIG. E263,*1a-e.* **H. bioculata,* U.Cret.(Senon.), France; *1a,* FV ext., ×1.3 *(269); 1b,* transv. sec. viewed toward commissure, AV center pseudopillars *Sp* and *Ep* dark, ×1.7; *1c,* detail ant. part polarized light, ×2.7; *1d,* pillar *Sp,* polarized light, ×13; *1e,* long. sec. AV, pillars white, oscular indentations above pillars, ×2 *(942).*——FIG. E263,*1f. H. canaliculatus* ROLLAND DU ROQUAN, U.Cret., France; linear pores in FV, ×7 *(269).* [Also Fig. E220,*1-2,6.*]

Barrettia WOODWARD, 1862, p. 372 [**B. monilifera;* M] [=*Barretia* MUNIER-CHALMAS, 1873 *(nom. null.)*]. Adult shell very large; AV elongate, recumbent, distinguished by up to 60 or more beaded (moniliform) rays in transverse section; *Sp* and *Ep* distinguishable by their swollen extremities, that of *Sp* being circular and that of *Ep* elongate elliptical; *L* indentifiable by reference to teeth; portion of valve between *L* and siphonal pillars greater than 0.3 of shell circumference; internal layer strongly developed, forming cellular tissue between folds and tabular below shell cavity. FV convex, operculiform, consisting of central boss from which radiate numerous rods, oscule fitting over pillar *Sp,* no *Ep* oscule. *U.Cret. (Campan.-Maastricht.),* W.Indies-Mexico.——FIG. E263,*3.* **B. monilifera,* Jamaica; AV from above, ×0.2 *(981).* [Also Fig. E227,*2;* E237,*10.*]

Batolites DE MONTFORT, 1808, p. 334 [**B. organisans;* OD] [=*Batholites* GABB, 1862 *(nom. van.); Bihippurites* FUTTERER, 1896, p. 263 (type, *B. plicatus* FUTTERER)]. AV long, cylindrical, slender, shaped like organ pipe; internally like *Hippurites,* but differs in having outer shell layer with numerous folds which, however, do not give rise to supplementary pillars projecting toward

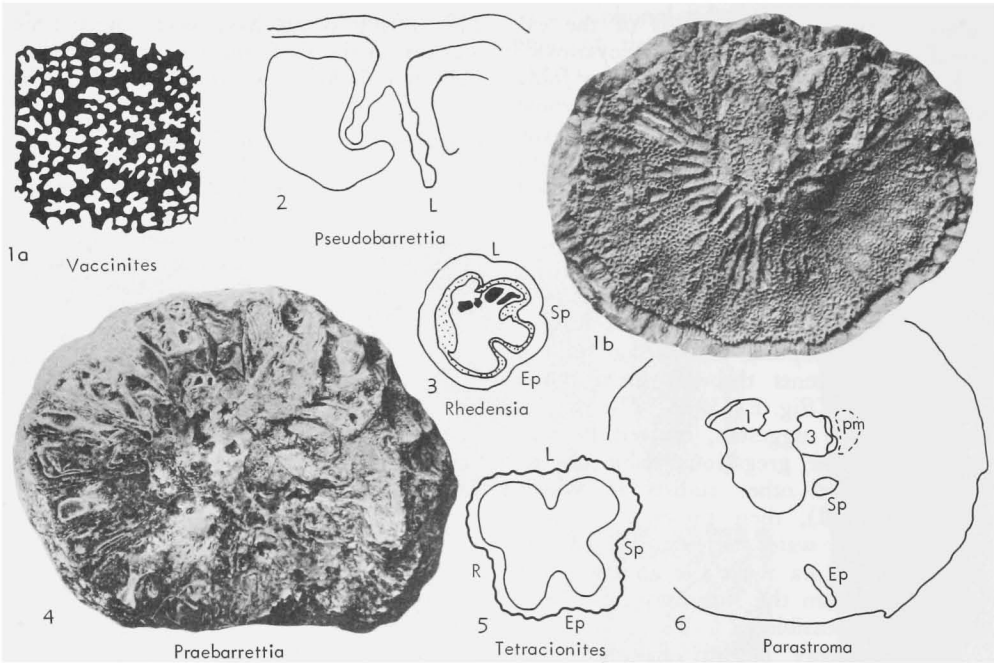

FIG. E264. Hippuritidae *1,3-6;* unrecognizable *(2)* (p. *N*802-*N*803). [Explanation: *Ep, Sp,* internal pillars; *L,* ligamental ridge; *pm,* posterior myophore; *R,* anterior (extra) pillar; *1, 3,* anterior and posterior teeth of FV.]

shell interior; 3 distinct pillars; *L* short, area of pillars about 0.3 of shell circumference. FV with 2 oscules and linear pores. *U.Cret.(Santon.),* France-Austria-USSR.——FIG. E263,*2*. **B. organisans,* Pyrenees; *2a,b,* AV ext. and FV ext. (same individual), ×0.7, ×2 *(269)*. [Also Fig. E237, *11*.]

Hippuritella DOUVILLÉ, 1908, p. 268 [**Hippurites maestrei* VIDAL, 1878, p. 99; OD]. Differs from *Hippurites* in having simple or denticulate pores in FV. *U.Cret.(Turon.-Maastricht.),* Eu.-N.Afr. NE. Afr.(Somalia)-Asia-N. Am.——FIG. E263,*4a*. **H. maestrei* (VIDAL), Santon., France (Pyrenees); AV int. view, ×2 *(269)*.——FIG. E263,*4b*. *H. sulcatoides* DOUVILLÉ, Campan., France; polygonal pores FV, ×3.5 *(269)*. [Also Fig. E224,*1*.]

Parastroma DOUVILLÉ, 1926, p. 133 [**P. sanchezi;* M]. AV wall mainly of small vesicular domelike folded tabulae; rays almost effaced, stems of rays *Ep* and *Sp* rudimentary near outer shell layer, occupying more than 0.3 of shell circumference. FV unknown. *U.Cret. (Campan. - Maastricht.),* Cuba.——FIG. E263,*5*. **P. sanchezi;* details of AV wall, *5a,* transv. sec., *5b,* long. sec., ×3 *(280)*.——FIG. E264,*6*. *P. guitari* (PALMER), Maastricht., Cuba; transv. sec. at level of AV with projecting teeth of FV, ×0.4 *(561)*.

Pironaea MENEGHINI in PIRONA, 1868, p. 511 [**Hippurites polystylus* PIRONA, 1868, p. 508; M] [=*Pironea* MENEGHINI, 1868 *(nom. nud.); Pyronea* MUNIER-CHALMAS, 1873 *(nom. null.); Pironaia* BLANCKENHORN, 1934 *(nom. null.); Peronea* WHITFIELD, 1897 *(nom. null.)*]. Attaining large size; surface of AV with numerous longitudinal furrows; outer shell layer with many infoldings which give rise to secondary pillars or rays, some as prominent as ligamental ridge *(L)* and pillars *(Sp, Ep),* other smaller infoldings located between the more prominent ones and between *Sp* and *Ep;* sector *L-Ep-Sp* less than 0.25 of circumference value. FV flattened, with denticulate pores. *U.Cret.(Campan.-Maastricht.),* Eu.-Afr.-Syria-Asia-N.Am.-Cuba.——FIG. E238,*6*. **P. polystylus* (PIRONA), Maastricht., Italy; transv. sec. AV, ×0.3 *(269)*.

Praebarrettia TRECHMANN, 1924, p. 395 [**Barrettia sparcilirata* WHITFIELD, 1897, p. 245; M]. Shell moderate in size. Differs from *Barrettia* in having fewer (15 to 40) rays which become moniliform only in late growth stages; rays *L, Sp, Ep* clearly distinguished, occupying more than 0.3 of shell circumference. *U.Cret.(?Santon.-Maastricht.),* W. Indies-S.Am.——FIG. E264,*4*. **P. sparcilirata* (WHITFIELD), Jamaica; AV from above, ×0.3 *(981)*. [Also Fig. E238,*3*.]

Rhedensia SÉNESSE, 1939, p. 227 [**R. mutans;* OD]. AV with 3 distinct pillars, *Ep, Sp,* and *L;* pillar *L* elongate, about equal to *Ep,* set at small angle

to teeth; pillars occupying more than 0.25 circumference of shell. FV pores linear, marginally subpolygonal. *U.Cret.(Up.Turon.),* Eu. (France).——Fig. E264,*3*. **R. mutans;* AV transv. sec., ×0.7 *(839)*.

Tetracionites Astre, 1931, p. 269 [**T. mozambicus;* M]. AV small, with 4 external furrows corresponding to 4 internal folds, *Ep, Sp, L,* and anteriorly placed extra pillar *(R);* FV unknown. *U.Cret.(Coniac.),* France-Madag.——Fig. E264,*5*. **T. mozambicus;* diagram. sec. AV, ×1.3 *(22)*.

Torreites Palmer, 1933, p. 99 [**Hippurites (Vaccinites) sanchezi* Douvillé, 1927, p. 27; OD]. AV cylindroconical without well-marked external furrows; internally pillars *Ep, Sp, L* unequal, *L* very long, longer than shell radius; *Sp* twice length of *Ep;* sector *L-Sp-Ep* about 0.25 of circumference; outer shell layer thin, forming less well-developed folds than in *Batolites*. FV depressed-conical, with 3 radial grooves corresponding to *L, Sp* and *Ep* without pores, imperforate outer layer and canaliferous inner layer. *U.Cret. (?Santon.-Campan.),* Cuba.——Fig. E265,*1*. **T. sanchezi* (Douvillé); transv. sec. AV, ×0.6 *(281)*. [Also Fig. E238,*5*.]

Vaccinites Fischer, 1887, p. 1064 [**Hippurites cornuvaccinum* Bronn, 1831, p. 374; M] [=*Pseudovaccinites* Sénesse, 1947, p. 40 (type, *P. pseudolatus major* Sénesse)]. AV cylindroconical, large; 3 distinct pillars, *Ep, Sp,* and *L* occupying less than 0.25 of shell circumference; pillar *L* generally long, angle between *L* and teeth less than 45 degrees; ligamental ridge generally truncate, *Sp* and especially *Ep* tending to be contracted proximally; inner margin of outer shell layer undulating. FV flat to slightly convex; pores reticulate or denticulate, 2 oscules. *U.Cret.(Turon.-Maastricht.),* Eu.-Asia-N. Afr.-W. Indies.——Fig. E264,*1a*. *V. corbaricus* (Douvillé), Coniac., S. France; reticulate pores, ×7 *(269)*.——Fig. E264, *1b*. *V. marticensis* (Douvillé), Coniac., S. France; FV ext., ×1 *(910)*. [Also Fig. E237,*6*.]

[Sénesse, who classified the hippuritids solely on the basis of shape of the FV pores, has maintained that, since their pores are polygonal, species of the group that includes the type of *Vaccinites* are more closely related to *Hippurites* than to the remaining groups included by Toucas and others in *Vaccinites*. Accordingly, he has proposed to unite all hippuritids with reticulate, subreticulate or denticulate pores in a genus named *Pseudovaccinites*. The classification of Toucas is accepted here, however.]

Yvaniella Milovanović, 1938, p. 129 [*pro Ivania* Milovanović, 1936, p. 33 (*non* Fischer *ex* Bayle, 1885)] [**Yvania maestrichtiensis* Milovanović, 1936; M]. AV like *Hippurites*. FV specialized, concave, traversed by simple canals which open on outer surface as small pores and on inner surface as enlarged funnel-shaped pores separated by minutely rugose ridges; at center of valve is tubercle traversed by 2 large canals, walls of which contain fine canals, some opening as minute pores on surface of tubercle. *U.Cret. (Maastricht.),* Eu.(Yugosl.).——Fig. E243,*3-4*. **Y. maestrichtiensis* (Milovanović); *3,* long. sec. FV *(624); 4,* drawing showing both valves from above, ×0.7 *(628)*.

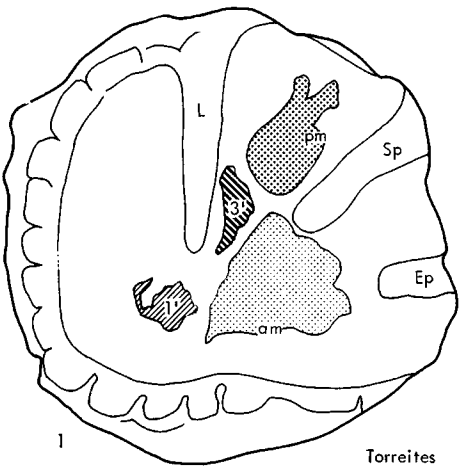

Fig. E265. Hippuritidae (p. *N*803). [Explanation: *am, pm,* anterior and posterior myophores; *Ep, Sp,* internal pillars; *L,* ligamental ridge; *1', 3',* sockets in AV corresponding to teeth in FV.]

UNRECOGNIZABLE HIPPURITID GENERA

Chiapasia Müllerried, 1933, p. 268 *(nom. nud.)*.

Pseudobarrettia Müllerried, 1931, p. 255 [**P. chiapasensis (nom. nud.)*; OD]. Based on pathological anomaly in growth of AV pillar in individuals of a *Barrettia*-like hippuritid. *U.Cret. (Campan.),* Mexico(Chiapas).——Fig. E264,*2*. **P. chiapasensis;* transv. sec. of AV showing pathological duplication of pillar *L* (scale not given, ca. ×1.3 *(651)*.

Family RADIOLITIDAE Gray, 1848

[Materials for this family prepared by Colette Dechaseaux and A. H. Coogan, with acknowledgment of assistance by L. R. Cox]

Inequivalve, RV (AV) conical, LV (FV) operculiform; surface of RV (AV) without furrows but generally with two concave, flat, or convex siphonal bands *(Eb, Sb)* separated by interband; ornament of siphonal bands and interband unlike that of remainder of surface (Fig. E266,*4*); in LV (FV), oscules present in a few genera; structure of shell characteristically cellulo-prismatic; outer layer thick, cellular in texture, walls of cellules formed by radial and transverse funnel-shaped plates which intersect to form hollow prisms with rec-

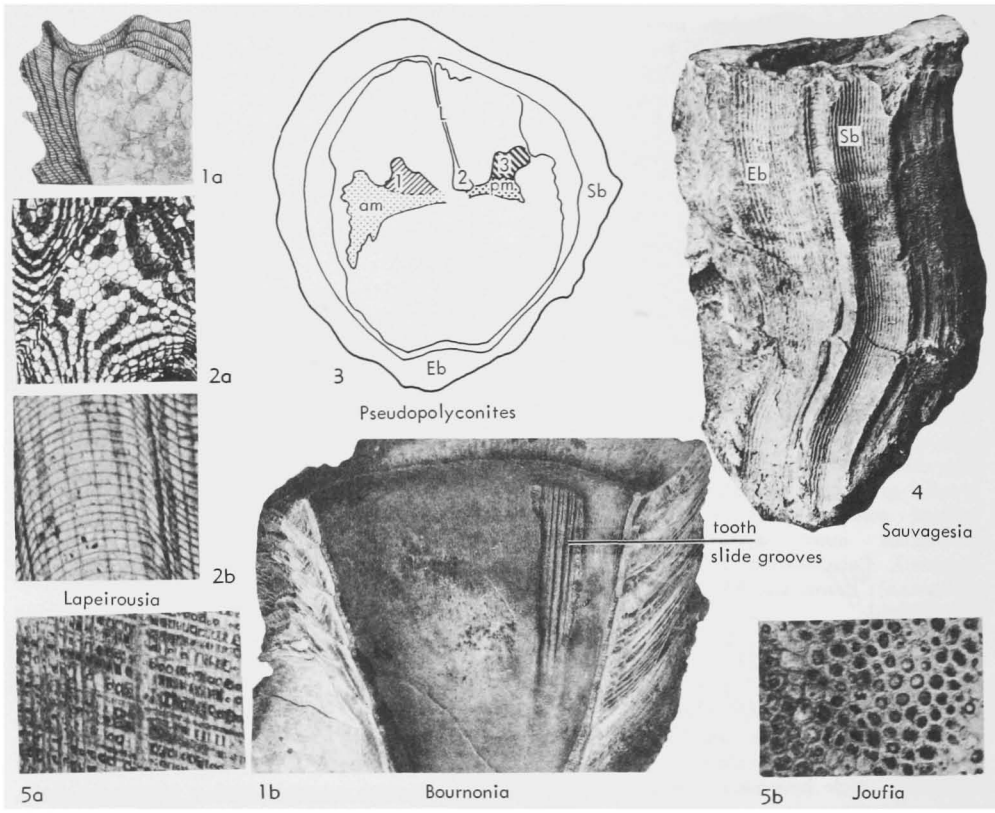

FIG. E266. Morphological features of Radiolitidae.

1. *Bournonia,* U.Cret.(Maastricht.), France; *1a, B. fourtaui* DOUVILLÉ, transv. sec. of part of wall showing quadrangular network of cellulo-prismatic structure, ×0.7 *(251); 1b, B. bournoni* DES MOULINS, AV long. sec. showing reticulate shell wall and on inside of valve fluted groove for reception of sliding tooth of FV, ×0.7 *(251).*
2. *Lapeirousia jouanneti* DES MOULINS, U.Cret. (Maastricht.), France (Charente); *2a,* transv. sec. of part of shell wall showing polygonal cell structure, ×3.3; *2b,* tang. sec. perpendicular to plane of *2a* sec., ×3.3 (Dechaseaux, n).
3. *Pseudopolyconites parvus* MILOVANOVIĆ, U.Cret. (Maastricht.), Serbia; transv. sec. at level of AV with projecting teeth and myophores of FV, ×0.7 *(623).*
4. *Sauvagesia nicaisei* COQUAND, var. *villei* ARNAUD, U.Cret.(Cenoman.), France (Charente); side view ext. AV showing longitudinally fluted surface and position of external finely ribbed *Eb* and *Sb* siphonal bands, ×0.7 *(911).*
5. *Joufia reticulata* BÖHM, U.Cret.(Senon.), Italy; *5a,b,* long. and transv. secs. of part of FV shell wall showing polygonal cell structure, ×6.7 *(905).*

[Explanation: *L,* ligament ridge; *am, pm,* ant. and post. myophores; *Eb, Sb,* siphonal bands; *1, 3,* FV teeth, *2,* AV tooth.]

tangular or polygonal bases; at lip of valve these prisms form network with polygonal or quadrangular mesh (Fig. E266,*1a-2a,b*). Interior of RV (AV) without pillars, but in some forms with low, broad, longitudinal projections of shell wall termed "pseudo-pillars"; hinge, with two teeth in LV (FV) and one tooth in RV (AV); ligamental ridge present or absent; teeth and myophores of LV (FV) forming thick laminae, fluted in some species (Fig. E220,*3*); hinge of RV (AV) commonly reduced to sockets into which teeth of LV (FV) slide (Fig. E266,*1b*); muscles attached to wall of shell in RV (AV); many genera with accessory cavities outside cardinal structures (Fig. E266,*3*). *L. Cret. (Barrem.) - U. Cret. (Maastricht.).*

The major features of the Radiolitidae, siphonal bands and their ornament, presence or absence of a ligamental ridge, and myophore apophyses and wall structure, are characters by which different genera in the family are distinguished. The siphonal bands and pseudopillars have structure similar to that of other parts of the shell, differing chiefly in the greater development of certain layers of cellules. The function of the pseudopillars is still uncertain; the supposition that these structures were re-

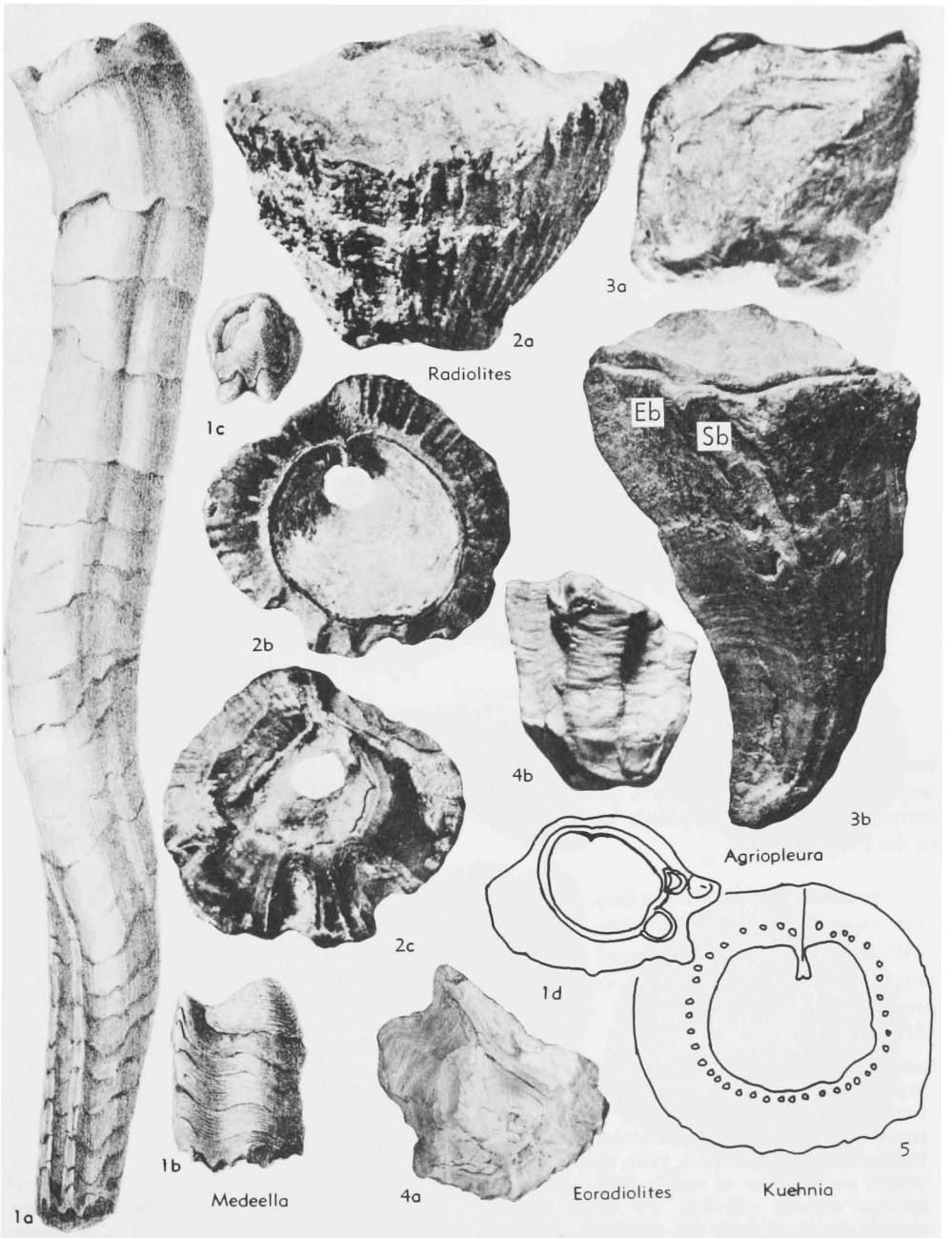

FIG. E267. Radiolitidae (Radiolitinae) (p. N806-N808). [Explanation: *Eb, Sb,* siphonal bands.]

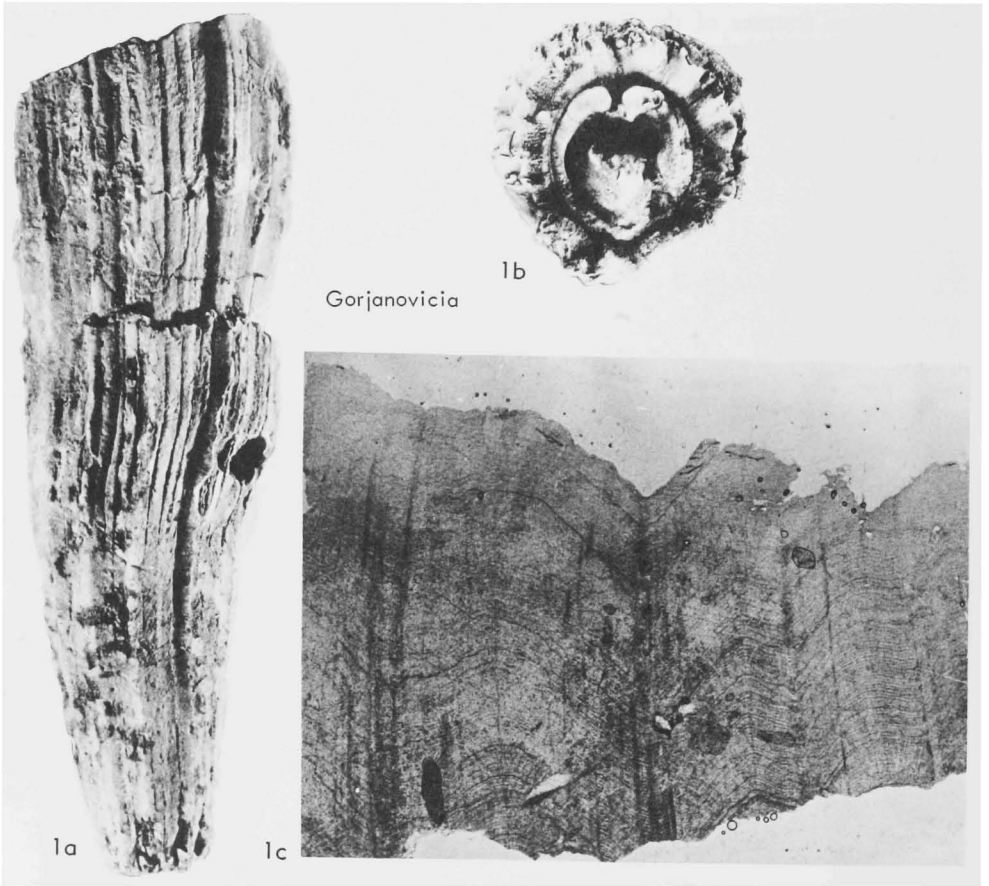

FIG. E268. Radiolitidae (Radiolitinae) (p. *N*807-*N*808).

lated to respiratory or digestive organs is unproved. So far as known, however, all forms with true pseudopillars have oscules in the FV.

Subfamily RADIOLITINAE Gray, 1848

[*nom. transl.* DOUVILLÉ, 1903 (*ex* Radiolitidae GRAY, 1848)]

Wall of RV (AV) composed of quadrangular prismatic cells; posterior ligament present. *L. Cret. (Barrem.) - U. Cret. (Maastricht.).*

Radiolites LAMARCK, 1801, p. 130 [**Ostracites angeiodes* PICOT DE LAPEIROUSE, 1781, p. 40; M] [=*Euradiolites* WIONTZEK, 1934, p. 11 (presumed obj.)]. AV conical, ornamented with strong longitudinal folds over whole valve, siphonal bands smooth accentuations of regular folds, outer wall structure coarsely reticulate. FV small, conical, strongly convex or rarely flat, myophore apophyses present. *U.Cret.(Cenoman.-Maastricht.),* Eu.-N. Afr.-NE.Asia-N.Am.——FIG. E267,*2*. **R. angeiodes* (DE LAPEIROUSE), U. Santon., France (Pyrenees), *2a,* AV lat. post., ×0.9; *2b,c,* AV from above and below, ×2.2 *(23)*. [Also Fig. E220,*4*.]

Agriopleura KÜHN, 1932, p. 78 [*pro Agria* MATHERON, 1878, pl. C-8 (*non* ROBINEAU-DESVOIDY, 1830)] [**Hippurites blumenbachi* STUDER, 1834, p. 107; OD] [=*?Aptyxites* BÖHM, 1919, p. 74 (type, *Radiolites muelleri* WEGNER, 1905, p. 193)]. AV elongate, straight or slightly arched, commonly longitudinally ribbed; surface with 2 unequal concave furrows bordered by longitudinal swellings; siphonal bands in furrows; ligamental ridge well defined. FV wall structure poorly known, probably finely lamellar; operculiform, flat or strongly concave; hinge with 2 slender teeth, thickened areas at their base constituting muscle scars; no myophore apophyses. [Lack of myophore apophyses separates *Agriopleura* from other Radiolitinae.] *L. Cret. (Barrem.) - U. Cret. (Maastricht.),* Eu.-N.Am.——FIG. E267,*3*. **A. blumen-*

bachi (STUDER), Barrem., France; 3*a*, FV ext., ×0.9; 3*b*, both valves lat. view, ×0.9 *(911)*. [Also Fig. E237,*1*; E240,*5*.]

Eoradiolites DOUVILLÉ, 1909, p. 77 [**Radiolites davidsoni* HILL, 1893, p. 106; OD]. AV conical elongate, prominent smooth siphonal bands, large ribbed sockets in dorsal inner wall separated from shell cavity by lateral extension ("transverse septum") of cardinal platform from which lower valve tooth arises, outer wall of coarsely reticulate cells. FV small, operculiform, concave to flat, of fine concentric laminations, myophore apophyses present. *L.Cret.(Alb.)-U.Cret.(Turon.)*, Eu.-Afr.-Asia-N.Am.——FIG. E267,*4*. **E. davidsoni*

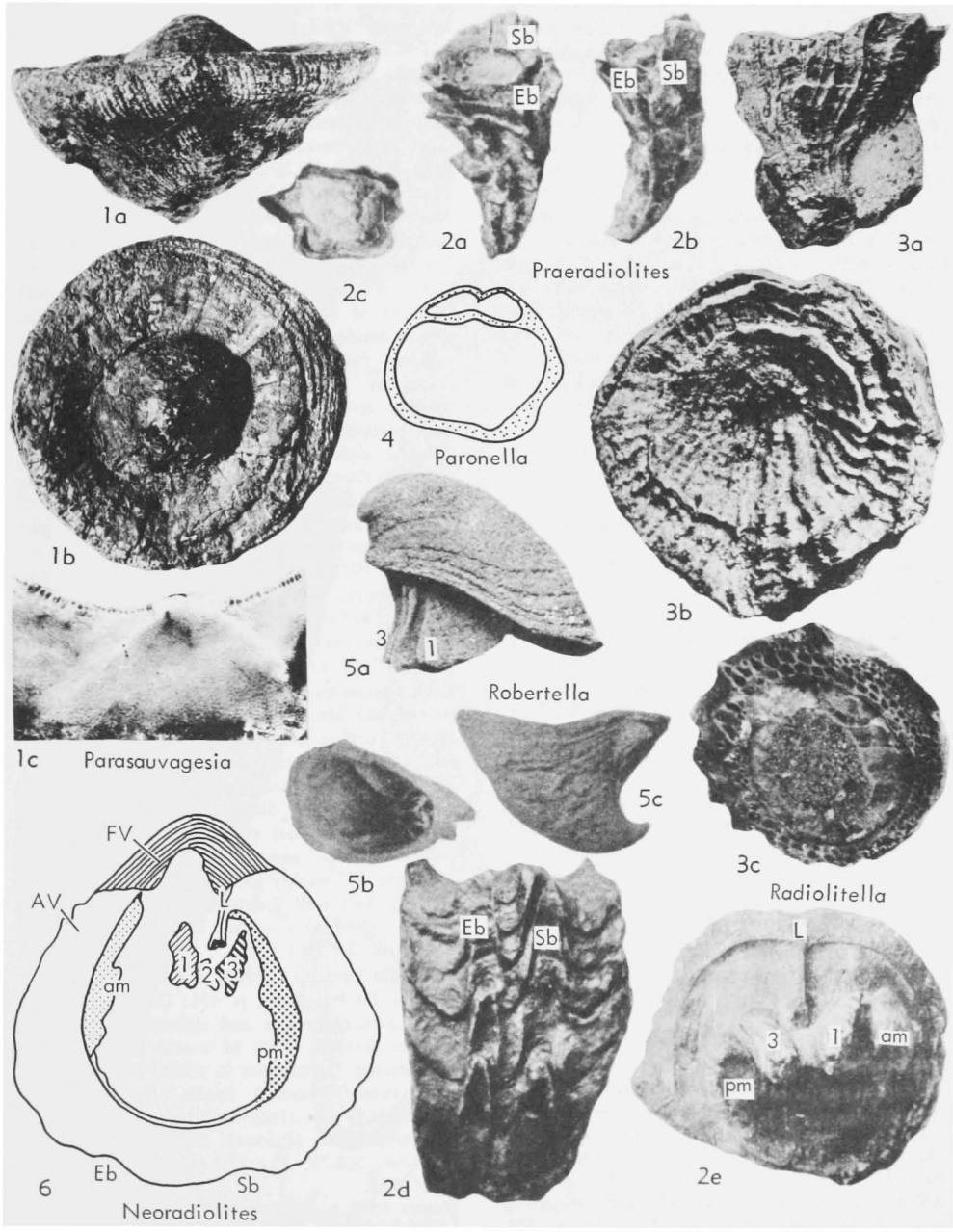

FIG. E269. Radiolitidae (Radiolitinae) (p. *N*808-*N*810). [Explanation: *am*, *pm*, anterior and posterior myophores; *Eb*, *Sb*, siphonal bands; *L*, ligamental ridge; *1*, *3*, teeth of FV; *2*, tooth of AV.]

(HILL), Alb., USA(Texas); *4a*, both valves; *4b*, AV lat. view of siphonal band *Eb*, ×0.9 (Coogan, n). [Also Fig. E237,*2*; E240,*1*.]

Gorjanovicia POLŠAK, 1968, p. 201 [**G. costata*; OD]. AV elongate, cylindrical-conical, slender, longitudinal ribs salient, smooth or with fine zigzag growth lines, commonly pointed and separated by finely costulate furrows; siphonal zones large wide bands, pseudopillars clearly imprinted on internal face have special structure of folds with concave inflexions or are concentric or radially disposed. Regular shell structure lamellar, ligament triangular. FV slightly convex and costulate. Differs from *Medeella* in lacking external folds and in having differently shaped siphonal zones. *U. Cret. (Santon.-L. Campan.)*, Yugosl. (Istria).——FIG. E268,*1*. **G. costata; 1a*, lat. view, *1b*, transv. sec., ×0.7; *1c*, tang. sec., AV, ×4.3 *(746b)*.

Kuehnia MILOVANOVIĆ, 1956, p. 132 [**K. serbica*; OD]. Known only by AV; ligamental ridge well developed, bilobate at extremity; no pseudopillars; circle of tubular cavities in inner part of thick outer shell layer, prismatic cellular structure of which is well defined. *U.Cret.(Santon.-Campan.* boundary), Serbia.——FIG. E267,*5*. **K. serbica;* transv. sec. AV, ×0.45 *(627)*.

Medeella PARONA, 1924, p. 64 [**Radiolites zignana* PIRONA, 1869, p. 419; OD]. AV elongate, cylindrical, longitudinal folds regularly costulate, shell surface covered by fine growth lines, outer wall thick; cylindrical siphonal structure in outer wall of polygonal cells, touching body cavity; myophore apophyses present. *U.Cret.(Turon.-Coniac.-?Santon.)*, Eu.

M. (Medeella). Siphonal bands broadly costulate; FV convex; siphons marked by inflected crescentic slits. *U.Cret.(Turon-Coniac.-?Santon.)* Eu.——FIG. E267,*1*. **M. (M.) zignana* (PIRONA), Italy; *1a-c*, views ventral, lat., and from above, ×0.9 *(740)*; *1d*, AV transv. sec., ×1.8 *(720)*. [Also Fig. E243,*7*.]

M. (Fossulites) ASTRE, 1957, p. 42 [**Medeella undaesaltus* ASTRE, 1954; M]. Longitudinal folds mark surface, siphonal bands salient, smooth or costate, cylindrical siphonal fossettes or cavities in AV outer wall. FV operculiform, flattened, siphons marked by longitudinal arches. Fossettes distinctive. *U.Cret.(L.Coniac.)*, France (Aude).——FIG. E243,*1*. **M. (F.) undaesaltus; 1a*, both valves; *1b*, lat. view AV, *1c*, transv. sec. AV, ×0.9 *(24)*.

Neoradiolites MILOVANOVIĆ, 1935, p. 97 [**N. serbicus;* M]. AV conical, ornamented by fine costae, siphonal zones marked by slight inflections, valve outline irregularly circular, outer wall thick, of coarsely prismatic cells. FV capuloid, superficially like *Robertella*, but with ligament. *U.Cret.(Maastricht.)*, Yugosl.——FIG. E269,*6*. **N. serbicus;* AV transv. sec., at level of AV with projecting teeth of FV and part of dorsal overlap of FV, ×0.75 *(623)*.

Parasauvagesia Cox, 1960, p. 428 [**P. cappadociensis;* OD]. AV depressed conical, longitudinally costate, without well-differentiated siphonal bands; short ligamental ridge and 2 weakly developed pseudopillars present. FV with central domelike elevation and broad, flat brim; no oscules. *U.Cret. (Campan. or Maastricht.)*, Turkey.——FIG. E269, *1*; E270,*7*. **P. cappadociensis;* E269,*1a,b*, lat. and top view, ×0.2; E269,*1c*, AV transv. sec. shell, ×1; E270,*7*, AV transv. sec., ×0.55 *(199)*.

Paronella WIONTZEK, 1934, p. 26 [**P. volzanensis;* M]. AV cylindrical, transverse septum separating shell cavity from tooth sockets; teeth, myophores, outer wall structure and FV unknown; differs from *Distefanella* in having ligament. *U.Cret.(L. Santon.)*, SE.Eu.(Italy).——FIG. E269,*4*. **P. volzanensis;* AV transv. sec., ×0.75 *(998)*.

Praeradiolites DOUVILLÉ, 1902 [1903], p. 467 [**Radiolites fleuriaui* D'ORBIGNY, 1842, p. 181; OD]. AV conical, externally with smooth folds in form of stack of inverted cones, in younger species developed into undulating chevron pattern; siphonal folds convex, plates bent upward, separated by projecting fold; outer wall structure coarsely reticulate. FV operculiform, convex to flat; myophore apophyses present. Stacked, undulating siphonal band folds distinctive. *L.Cret. (Alb.)-U.Cret.(Maastricht.)*, Eu.-N.Afr.-NE.Asia-N.Am.——FIG. E269,*2a-c*. **P. fleuriaui* (D'ORBIGNY), Cenoman., France (Charente); *2a,b*, post. lat. and ant. views, ×0.75; *2c*, view from above, ×0.75 *(911)*.——FIG. E269,*2d*. *P. toucasi* (D'ORBIGNY), Santon., France; AV lat. view, ×0.75 *(911)*.——FIG. E269,*2e*. *P. cylindraceus* (DES MOULINS), Maastricht., France; FV int., ×0.45 *(911)*. [Also Fig. E220,*3*.]

Pseudopolyconites MILOVANOVIĆ, 1935, p. 132 [**P. parvus;* SD MILOVANOVIĆ, 1937, p. 4]. AV conical, shell surface nearly smooth, strong longitudinal folds absent, siphons marked by broad folds, internal inflexion present at incurrent position; ligamental ridge long, displaced dorsally; outer wall of 2 layers, internal prismatic and normal prismatic; siphonal zones with hornlike transverse partitions. FV weakly convex, teeth and myophores present, shell wall 2 layers. *U.Cret.(Maastricht.)*, Yugosl. (Serbia).——FIG. E266,*3*. **P. parvus;* transv. sec. AV, ×1 *(623)*.

Radiolitella DOUVILLÉ, 1904, p. 533 [**Chama forojuliensis* PIRONA, 1869, p. 431; OD]. AV conical, with ligamental ridge and siphonal bands; outer wall in juvenile stages of coarse polygonal cells that become ?rectangular in adult. FV cap-shaped with strong siphonal bands. *U.Cret.(Santon.-Maastricht.)*, Eu.(Italy-Spain).——FIG. E269,*3*. **R. forojuliensis* (PIRONA), Maastricht., Italy; *3a*, lat. view, ×0.75; *3b,c*, FV ext., AV transv. sec., ×2 *(272)*.

[PARONA (1923, p. 61) stated that DOUVILLÉ in designating *Chama forojuliensis* PIRONA as the type of *Radiolitella* figured a specimen from Colle di Medea in the Sorbonne (Paris) collection which corresponds with PIRONA's figures

of *Sphaerulites guiscardiana* PIRONA, 1869, not with *Chama forojuliensis* PIRONA. KÜHN, 1932, accepted PARONA's evaluation listing *Sphaerulites guiscardiana* PIRONA (=*Radiolitella forojuliensis* DOUVILLÉ, *non* PIRONA) as the type of *Radiolitella*.]

Robertella COSSMANN, 1904, p. 254 [*pro Mouretia* DOUVILLÉ, 1903, p. 480 (*non* G. B. SOWERBY, 1835)] [**Mouretia arnaudi* DOUVILLÉ, 1903; M] [=*Sarlatia* DOUVILLÉ, 1910, p. 29 (obj.)]. Nearly equivalve (AV slightly larger than FV), each

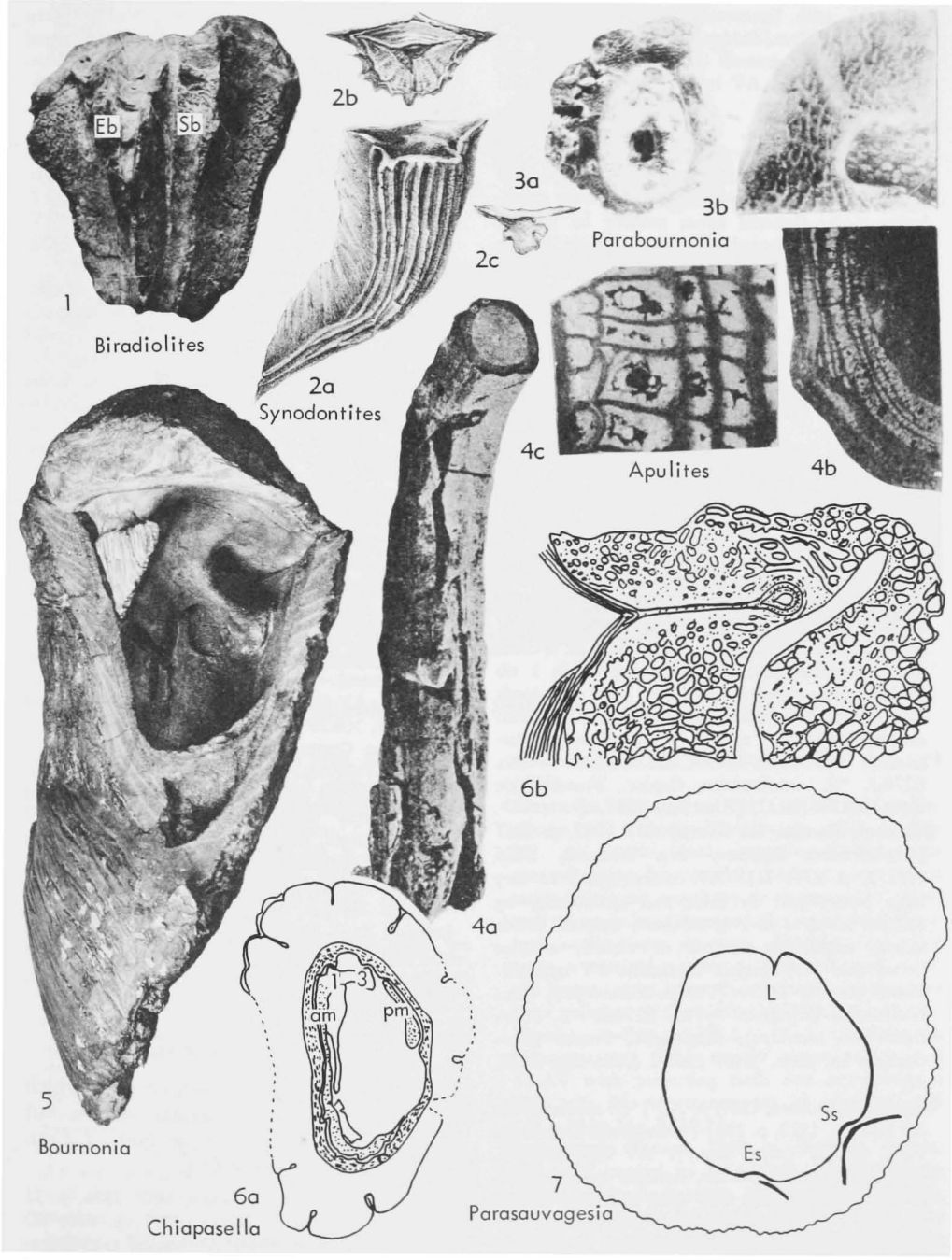

FIG. E270. Radiolitidae (Radiolitinae) *(7)*; (Biradiolitinae) *(1-3,5)*; (Sauvagesiinae) *(4,6)* (p. *N*810-*N*812). [Explanation: *am*, *pm*, anterior and posterior myophores; *Eb*, *Sb*, siphonal bands; *Es*, *Ss*, pseudopillars; *L*, ligamental ridge; *1*, *3*, anterior and posterior teeth of FV.]

valve capuloid in form; shell wall very thin, without well-marked siphonal bands (only 2 very weak undulations or depressions); no attachment scar at extremity of AV, shell seemingly free, resting on sea bottom; cardinal structures typically radiolitid, with ligamental ridge and myophore apophyses. *U.Cret.(Santon.)*, France (Sarlat).——FIG. E269,*5*. **R. arnaudi* (DOUVILLÉ); *5a*, FV side view, ×1.5; *5b,c*, AV int. and side view, ×0.7 *(271)*.

Sphaerulites LAMARCK, 1819, p. 231 (*ex* DELAMÉTHERIE, 1805, *vernac.*) [**S. foliaceus;* M] [=*Spherulites* DE BLAINVILLE, 1824 *(nom. null.)*]. AV broad flattened sphere, external folds undulating slack; siphonal zones marked by sinuses, bordered and separated by folds; internally 2 sinus folds indenting shell cavity; shell structure probably coarsely reticulate. FV flattened, myophore apophyses present, broad, compressed. Foliaceous shape of AV distinctive. *L.Cret.(Apt.)-U.Cret. (Turon.)*, Eu.-N.Afr.——FIG. E220,*5*. **S. foliaceus*, Cenoman., France; AV transv. sec., ×0.3 *(911)*. [Also Fig. E240,*2*.]

Subfamily BIRADIOLITINAE Douvillé, 1902

RV (AV) wall of quadrangular prismatic cells, posterior ligament absent. *U.Cret. (Turon.-Maastricht.)*.

Biradiolites D'ORBIGNY, 1850, p. 230 [**B. canaliculatus* D'ORBIGNY, 1850; SD ICZN pend.] [=*Eubiradiolites* COOGAN, 1966, p. 763 *(obj.)*]. AV conical, more or less produced, straight or arched; siphonal bands smooth, slightly depressed; 1 rib in interband; outer wall of fine cells; AV tooth absent. FV operculiform convex to concave with ornament like that of AV. *U.Cret.(Turon.-Maastricht.)*, Eu.-N. Afr.-Asia-N. Am.-Antilles.——FIG. E270,*1*. **B. canaliculatus*, Coniac., France; side view, ×0.75 *(911)*. [Also Fig. E237,*4*.]

Bournonia FISCHER (*ex* BAYLE, MS), 1887, p. 1067 [**Sphaerulites bournoni* DES MOULINS, 1826 (1827), p. 271; M]. AV conical, small to very large ornamented by folds and sporadically by collared horns as in *Praeradiolites;* siphonal bands salient, undulating smooth or ribbed; anterior dorsal fold may project markedly. FV operculiform, convex. *U.Cret.(Turon.-Maastricht.)*, Eu.-N.Afr.-Asia-W.Indies.——FIG. E270,*5*. **B. bournoni* (DES MOULINS), Maastricht., France (Dordogne); lat. view, ×0.4 *(251)*. [Also Fig. E266, *1*.]

Distefanella PARONA, 1901, p. 205 [**D. salmojraghii;* SD PARONA, 1912, p. 283] [=*Stefanella* DOUVILLÉ, 1901, p. 101 *(nom. van.)*]. AV subcylindrical, elongate, uniformly costate, siphonal bands smooth to finely striate, outer wall thin; internally septum connects dental sockets, dorsal cavity large; AV tooth rudimentary. FV operculiform, cap-shaped. *U. Cret. (Turon. - Senon.)*, Italy-Yugosl.-?Jamaica. ——FIG. E237,*8*. **D. salmojraghii*, Italy; transv. sec. AV, ×0.7 *(719)*. [Also Fig. E224,*2*.]

Milovanovicia POLŠAK, 1968 [**M. heraki;* OD]. AV cylindro-conical, very elongate, straight or slightly curved. External ornamentation of few large massive, elongate folds separated by deep furrows; both with fine longitudinal striae. Siphonal bands costulate as in *Sauvagesia* and *Durania*. Pseudopillars not developed, ligamental crest absent. Shell structure lamellar. FV unknown. Differs from *Petkovicia* in its lamellar shell structure, costulate siphonal bands, external ornamentation, and absence of pseudopillars. *U.Cret. (Turon.)*, Yugosl. (Dalmatia).——FIG. E271,*1*. **M. heraki; 1a*, lat. view, *1b*, transv. sec. AV, ×0.53; *1c*, transv. sec. showing detailed lamellar structure, ×4.8 *(746a)*.

Parabournonia DOUVILLÉ, 1927, p. 55 [**P. hispida;* M]. Shell small; differs from *Bournonia* in having AV wall of denticulated structure of parallel plates connected by spines, according to DOUVILLÉ. Considered as indistinguishable from *Bournonia* or *Biradiolites (810)*. *U.Cret.(Maastricht.)*, W. Indies(Cuba).——FIG. E270,*3*. **P. hispida; 3a*, transv. sec. AV, ×0.75; *3b*, detail of AV outer wall, ×3 *(281)*.

Synodontites PIRONA, 1867, p. 840 [**S. stoppaniana;* M] [=*Syndonites* STOLICZKA, 1871 *(nom. null.)*]. AV pyramidal, elongate, base quadrangular; siphonal bands narrow, smooth; teeth displaced toward center of shell cavity, fused together except at apex. FV operculiform, flat to concave, ornamented like AV. Held to differ from *Biradiolites* by having fused teeth. *U.Cret.(Santon.)*, Eu. (Italy-France).——FIG. E270,*2*. **S. stoppaniana*, Italy; *2a*, AV lat. view, ×0.75; *2b,c*, FV ext. and side view, ×0.75 *(739)*.

Thyrastylon CHUBB, 1956, p. 36 [**Radiolites adhaerens* WHITFIELD, 1897, p. 188; OD]. AV conical or distorted by anterior attachment; siphonal bands deeply sunken, interband rounded. FV conical, convex, brim of valve forms oval oscules above AV siphonal areas; oscules distinctive. *U. Cret.(Maastricht.)*, Jamaica-Cuba-Guatemala-Iran. ——FIG. E243,*2*. **T. adhaerens* (WHITFIELD), Jamaica; *2a*, 2 shells, upper showing oscule *So* in in FV; lower only AV, ×0.7; *2b*, both valves, FV with oscules *Eo* and *So* enclosed, ×0.7; *2c*, transv. sec. AV, ×4 *(131)*.

Subfamily SAUVAGESIINAE Douvillé, 1908

RV (AV) wall composed of cells which are prismatic in longitudinal section but polygonal in transverse section. *L.Cret. (Alb.)-U.Cret.(Maastricht.)*.

Sauvagesia CHOFFAT (*ex* BAYLE, MS), 1886, p. 31 [**Sphaerulites sharpei* BAYLE, 1857, p. 638; SD DOUVILLÉ, 1903, p. 474]. AV conical to cylindro-conical, ornamented with longitudinal ribs;

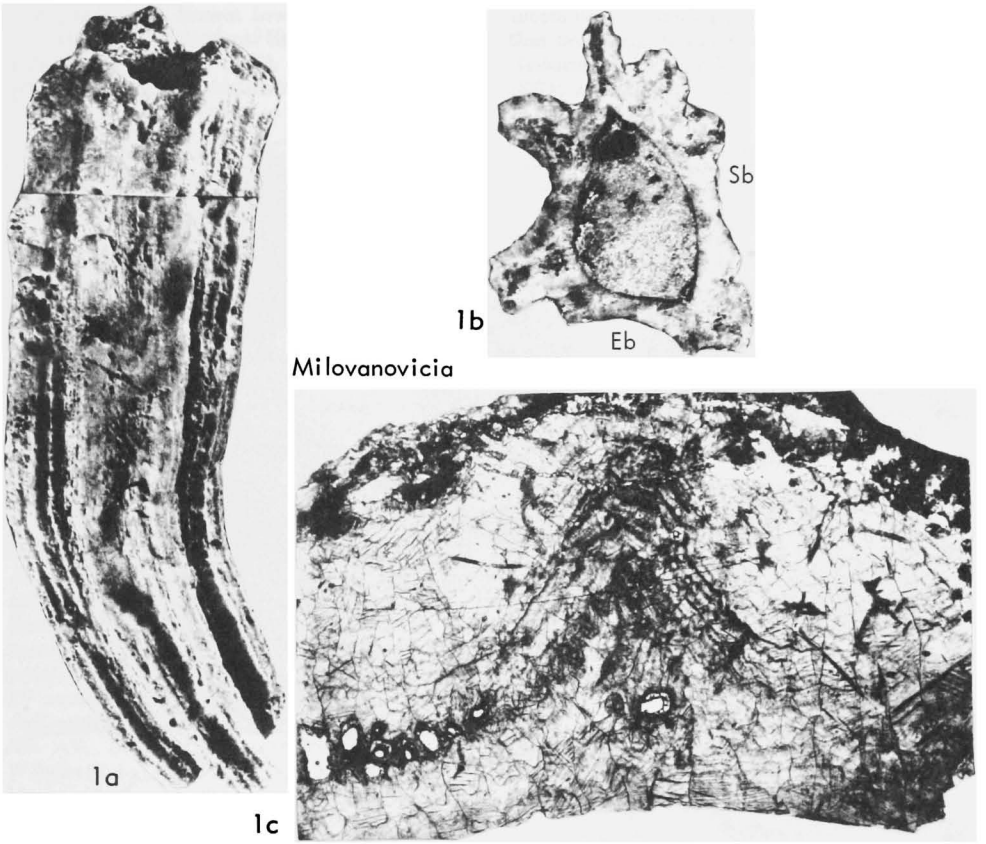

FIG. E271. Radiolitidae (Bioradiolitinae) (p. *N*810). [Explanation: *Eb, Sb,* siphonal bands.]

siphonal bands finely costulate folds, separated by interband that generally bears 2 costae. FV operculiform, with radial folds; ligamental ridge present, most marked in earlier forms. *L.Cret.(Alb.)-U.Cret.(Maastricht.),* Eu.-N.Afr.-N.Am.-Antilles.——FIG. E238,*4*. **S. sharpei* (BAYLE), Turon., Port.; AV, transv. sec., ×0.6 *(268)*. [Also Fig. E266,*4*.]

[The generic name *Sauvagesia,* attributed to BAYLE, was also published in 1886 by DOUVILLÉ (Bull. Soc. Géol. France, Ser. 3, v. 14, p. 393), who cited only one species, *Sphaerulites lusitanicus* BAYLE, 1857, as an example. DOUVILLÉ was misled by a misidentified specimen, for, as pointed out by TOUCAS (*919*, p. 81), this species does not belong to the group to which it was intended to apply the generic name. DOUVILLÉ himself (*268*, p. 669; also *ibid*, ser. 4, v. 2, p. 464) had previously admitted his mistake and the fact that CHOFFAT had interpreted *Sauvagesia* correctly. The best course seems to be to attribute the name to CHOFFAT and to apply for the suppression of its publication by DOUVILLÉ, should this prove to have priority.]

Apulites TAVANI, 1958, p. 173 [**A. giganteus;* M]. AV very elongate, with longitudinal costae; outer wall thin, of subquadrangular cells; siphonal zones marked by finely costate folds; ligamental ridge lacking. FV unknown. May be a biradiolitine. *U.Cret.(Senon.),* SE.Eu.(Italy).——FIG. E270,*4*. **A. giganteus; 4a,* AV lat. view, ×0.75; *4b,* AV transv. sec., ×1.1; *4c,* detail of AV wall, ×4 *(905)*.

Chiapasella MÜLLERRIED, 1931, p. 243 [**Corallio-chama radiolitiformis* TRECHMANN, 1924, p. 406; M]. AV conical, short, expanding rapidly, ornamented with longitudinal folds among which striated siphonal zone may be distinguished. Outer wall of irregular polygonal cells; cortex folded into wall locally along periphery. FV high and coiled as in a caprinid, convex or flattened, shell material brown, outer layer of club-shaped canals, inner layer cellular. *U.Cret.(Maastricht.),* Mexico-Cuba-Jamaica.——FIG. E270,*6*. **C. radiolitiformis* (TRECHMANN), Cuba; *6a,* AV transv. sec. at level of AV with projecting teeth and myophores of FV, ×4; *6b,* AV transv. sec. of infolding, ×3 *(67)*. [Also Fig. E238,*1*.]

Dechaseauxia TAVANI, 1949, p. 21 [**D. costata;* M]. AV conical to cylindrical, ornamented by salient longitudinal costae, siphonal bands narrow, marked externally by costate sulci, internally consisting of polygonal cells in regular parallel rows; siphonal zones connected next to shell cavity by 2 rows of polygonal cells; ligamental ridge absent.

FV unknown; genus distinguished by continuous 2-row polygonal wall, siphonal structure and lack of ligament. *U.Cret.(Maastricht.)*, N.Afr.(Somalia). ——Fig. E239,*1*. **D. costata; 1a,* lat. view, ×0.2; *1b,* transv. sec. viewed toward commissure, ×3; *1c,* AV detail of wall structure, ×4.5 *(904)*.

Durania Douvillé, 1908, p. 309 [**Hippurites cornupastoris* des Moulins, 1827, p. 288; OD]

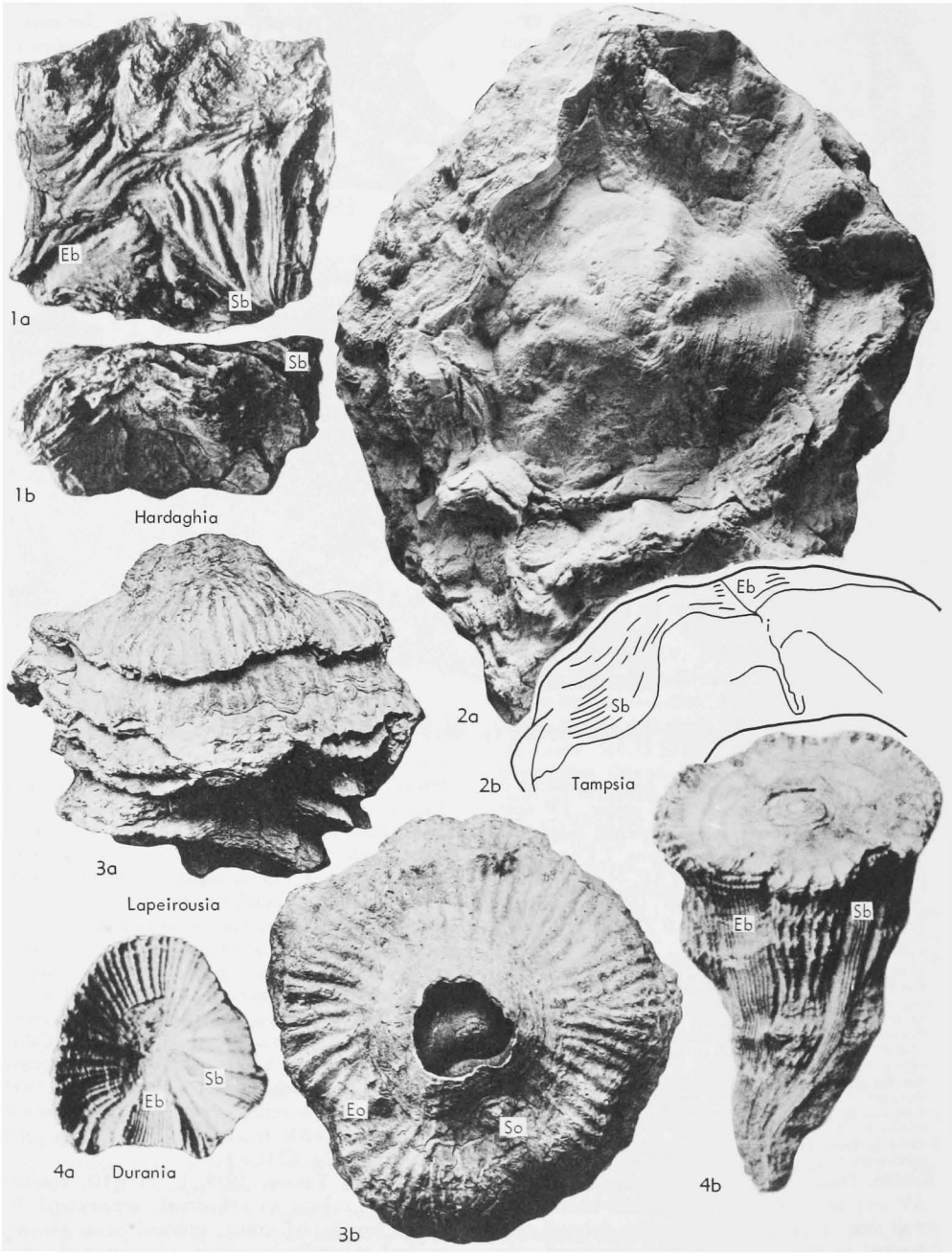

Fig. E272. Radiolitidae (Sauvagesiinae) *(1-2,4)*, (Lapeirousiinae) *(3)* (p. *N*811-*N*813). [Explanation: *Eb, Sb,* siphonal bands; *Eo, So,* oscules; *i,* incisure.]

[=*Duranius* DOUVILLÉ, 1910 *(nom. null.)*]. AV cylindrical, short or elongate, siphonal bands concave, smooth or ribbed, ligamental ridge absent; bifurcating radial furrows on upper surface of outer wall in many species. FV operculiform. *L. Cret.(Alb.)-U.Cret.(Maastricht.)*, Eu.-N.Afr.-Asia-S.Am.-N.Am.——FIG. E272,*4*. **D. cornupastoris* (DES MOULINS), U.Cret.(Turon), France; *4a,b*, FV ext., side view both valves, ×0.7 *(911)*. [Also Fig. E237,*9*.]

Hardaghia TAVANI, 1949, p. 19 [**H. quadrata;* M]. AV pyramidal, depressed toward quadrangular base, ornamented by thick radial ribs; siphonal bands weakly marked externally, internally *Sb* marked by deep sulcus; ligamental ridge lacking. FV flat, siphonal bands deep, narrow grooves; teeth and myophores absent. Distinguished by pyramidal shape and lack of cardinal apparatus. *U. Cret. (Maastricht.)*, E. Afr. (Somalia).——FIG. E272,*1*. **H. quadrata; 1a,b*, FV ext. and lat. view both valves, ×0.7 *(904)*. [Also Fig. E240,*3*.]

Tampsia STEPHENSON, 1922, p. 4 [**T. bishopi;* OD]. AV conical, elongate outer wall thick, cells subrectangular to polygonal, siphons marked by inflections, anterior *Eb* shallow and extended by narrow depressed slit that cuts outer wall to body cavity; dentition, muscle attachments unknown. FV small bosslike cap, weakly folded over AV shell cavity with thin brim over peripheral surface AV. *U.Cret.(Campan.-Maastricht.)*, Mexico-W.Indies(Cuba).——FIG. E272,*2a*. *Tampsia* sp., Mexico (Cardenas); FV ext., ×0.7 (Coogan, n; courtesy R. Meyers, Univ. Texas).——FIG. E272, *2b*. **T. bishopi*, Mexico; AV transv. sec. showing *Sb* and *Eb* inflections and incisure *(i)*, ×0.7 (Dechaseaux after Stephenson). [Also Fig. E238, *2*.]

Subfamily LAPEIROUSIINAE Kühn, 1932

RV (AV) wall of irregular polygonal cells, ligamental ridge reduced or absent, siphonal zones marked by development of tubular structure (pseudopillars) in outer wall. LV (FV) with oscules marking siphonal openings. *U. Cret. (Santon.-Maastricht.)*.

Lapeirousia BAYLE, 1878, p. 110 [**Sphaerulites jouanneti* DES MOULINS, 1827, p. 246; M] [=*Lapeirouseia* KÜHN, 1932 *(nom. van.)*]. AV cylindrical to depressed convex, wall thick, pseudopillars well developed, bulge into shell cavity; externally siphonal bands indented, shell ribbed; ligamental ridge absent. FV operculiform, flat or convex, internally with 2 oscules. *U.Cret.(Santon.-Maastricht.)*, Eu.-Asia-N.Afr.——FIG. E272,*3*. **L. jouanneti* (DES MOULINS), U. Maastricht., France (Charente); *3a,b*, side view and FV ext., ×0.33 *(911)*. [Also Fig. E266,*2*.]

Dubertretia COX, 1965, p. 731 [*pro Kelleria* MILOVANOVIĆ, 1938, p. 137 (*non* GURNEY, 1928)] [**Dubertretia kelleri* COX (=*Lapeirousia jouanneti* KELLER, 1933, *non* DES MOULINS sp.); OD] [=*Keleria* MILOVANOVIĆ, 1957 *(nom. nud.)*]. AV arched cone, surface with strong folds like *Praeradiolites* which indent half of outer wall; siphonal bands concave, pseudopillars subequal, well developed, ligamental ridge lacking, no lower valve tooth. LV unknown. *U.Cret.(Maastricht.)*, Syria. ——FIG. E273,*1*. **D. kelleri; 1a,b*, AV transv. sec. and lat. view, ×0.5 *(468)*. [Also Fig. E237, *7*.]

Katzeria SLIŠKOVIĆ, 1966, p. 176 [**K. hercegovinaensis;* OD]. AV conical-cylindrical; outer wall nearly without lamellae, those present of radiate structure; inner edge of outer wall has one row of massive prismatic cells next to inner wall; pseudopillars triangular in cross section, with radial and concentric lamellae. FV unknown. May be a bioradiolitine. Differs from *Petkovicia* in having prismatic cells on inner edge of outer wall. *U.Cret.(low. Campan.-Maastricht.)*, Eu.(Yugosl.). ——FIG. E273,*3*. **K. hercegovinaensis;* AV transv. sec., ×3 *(847a)*.

Lapeirousella MILOVANOVIĆ, 1938, p 89 [**L. orientalis;* OD]. AV conical with more or less regular longitudinal ribs; no ligamental ridge, pseudopillars weakly developed and projecting only slightly, with simpler structure than in *Praelapeirousia;* pseudopillar *Ss* with large prisms at center and small ones at sides. *U.Cret.(Campan.)*, Yugosl. (Serbia).——FIG. E273,*6*. **L. orientalis;* AV transv. sec. pseudopillar *Ss;* ×11 *(626)*.

Osculigera KÜHN, 1932, p. 165 [**O. cleggi;* OD]. AV shaped like *Lapeirousia,* with 2 primary pseudopillars and multiple secondary warty bumps irregularly spaced in outer wall forming small swelling of inner edge where they touch shell cavity, ligamental ridge absent; FV unknown. Distinguished by multiple small pseudopillars. *U. Cret.(Senon.)*, SW.Asia (Iran).——FIG. E273,*2*. **O. cleggi;* AV transv. sec., ×0.5 *(488)*.

Petkovicia KÜHN & PEJOVIĆ, 1959, p. 979 [**P. prima;* OD]. AV high-conical, strongly ribbed, not foliaceous; siphonal bands broad, flattened, separated by furrow on which is 1 rib; outer wall of shell wall very finely cellular, slight internal bulges corresponding to siphonal zones, which are differentiated within wall of shell, narrowing from interior to their outer, convex border. *U. Cret.(Santon.)*, Yugosl.(Serbia).——FIG. E273,*5*. **P. prima; 5a,b*, AV lat. view, and transv. sec. 2 cm. below commissure, ×0.75, ×1.3; *5c*, drawing of *5b*, ×1.3 *(495)*.

Praelapeirousia WIONTZEK, 1934, p. 28 [**P. kossmati;* M]. AV conical?, siphonal bands externally round projecting ribs, internally of few large cells, not swelling into shell cavity, interband broad; reduced ligamental ridge present; lower valve tooth

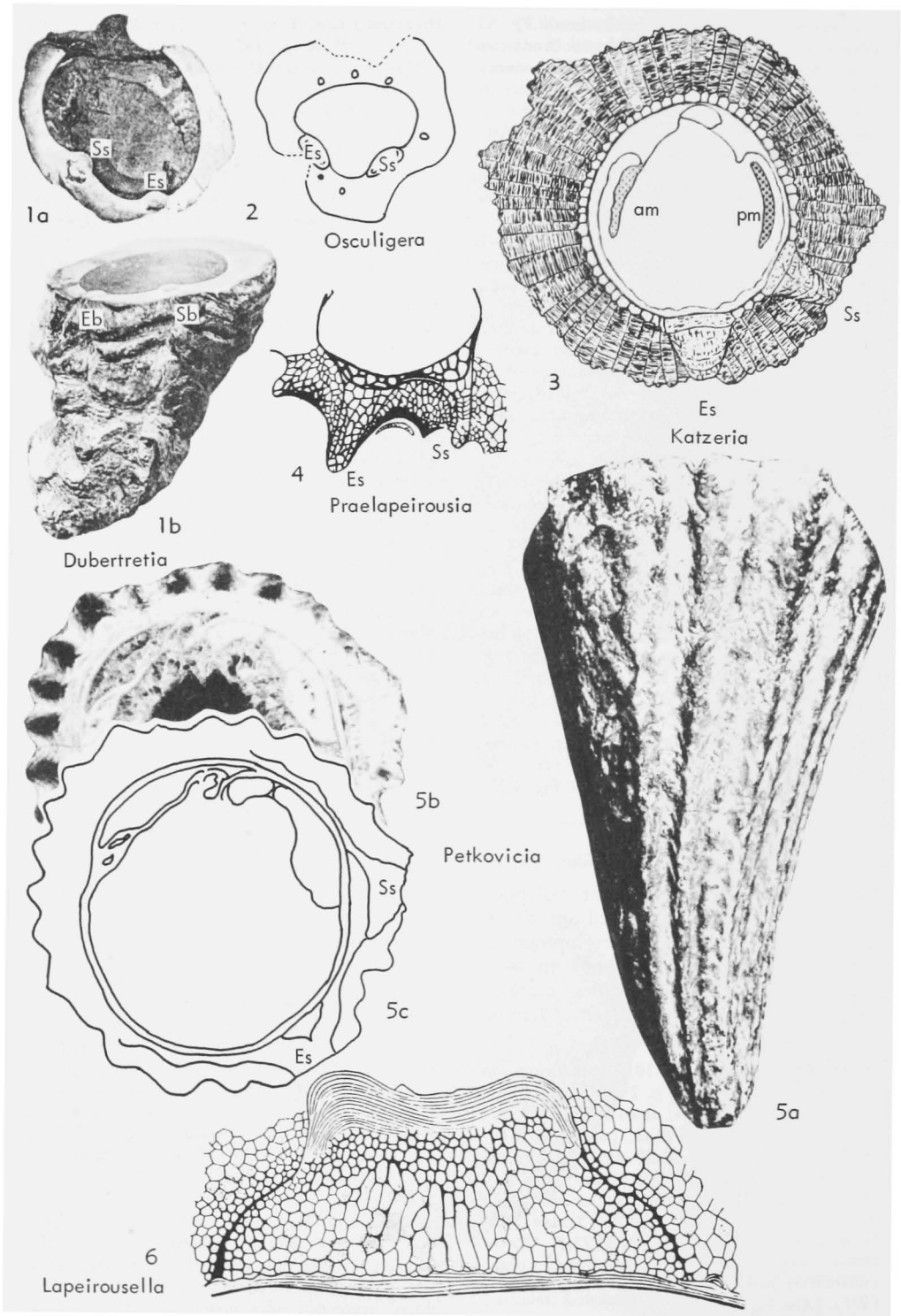

FIG. E273. Radiolitidae (Lapeirousiinae) (p. *N*813, *N*815). [Explanation: *am*, *pm*, anterior and posterior myophores; *Eb*, *Sb*, siphonal bands; *Es*, *Ss*, pseudopillars.]

absent. FV flat, concentrically layered; ribs few; 2 oscules mark siphonal opening. *U.Cret.(Santon)*, Eu.-N.Afr.——FIG. E273,*4*. **P. kossmati;* AV transv. sec., ×2 *(998)*.

Vautrinia MILOVANOVIĆ, 1938, p. 86 [**Lapeirousia syriaca* VAUTRIN, 1933, p. 31; OD]. AV conical, ornamented by ribs, no siphonal bands externally, but internally 2 prominent pseudopillars swell inner edge of wall; AV tooth unknown; outer wall of regular radial folds of complex irregular structure. FV operculiform, convex, of compact lamellae, with 2 oscules. *U.Cret.(Maastricht.)*, SW.Asia (Syria-Turkey-Iran).——FIG. E274,*2*. **V. syriaca* (VAUTRIN), Syria; AV transv. sec. of pseudopillar, ×0.5 *(933)*. [Also Fig. E243,*5-6*.]

Subfamily UNCERTAIN

Arnaudia FISCHER (*ex* BAYLE, MS), 1887, p. 1064 [**Hippurites arnaudi* COQUAND, 1859, p. 985; M]. AV conical, ornamented by longitudinal costae; siphonal bands weak broad inflexions internally and externally; ligamental ridge lacking; outer wall thin, compact, detail structure unknown. FV operculiform, concave, ornamented with radial ribs. Long considered a hippuritid, it lacks pillars in lower valve and pores in upper valve. *U.Cret.(Senon.)*, France (Charente).——FIG. E274,*3*. **A. arnaudi* (COQUAND); *3a,b*, side view of shell cluster and transv. sec. at level of AV with pendent teeth and post. myophore of FV, ×0.7, ×1.1 *(269, 910)*.

[*Arnaudia* has been universally classified with the Hippuritidae since BAYLE described it and was so considered by DOUVILLÉ *(269)* and TOUCAS *(910)*. KÜHN *(493)* reexamined the type in the École des Mines in Paris and concluded that *Arnaudia* is a radiolitid, probably evolved from *Agriopleura*.]

Colveraia KLINGHARDT, 1921, p. 23 [**C. variabilis;* OD]. Shell depressed, both valves with numerous longitudinal ribs, siphonal bands convex; hinge teeth weak, muscle scars on wall of shell; outer layer of AV composed of irregular hollow prisms, that of FV not prismatic but laminated; next layer (pseudocanal layer) in FV penetrating more or less deeply into valve interior and riddled with elliptical cavities which may invade teeth and myophores. Structure of this layer constitutes an essential generic character. *U.Cret.(Maastricht.)*, Eu.(NE.Italy).——FIG. E274,*1*. **C. variabilis;* lat. view both valves, ×0.7 *(475)*. [Also Fig. E240, *4*.]

Joufia BÖHM, 1897, p. 180 [**J. reticulata;* M]. AV conical, nearly smooth, ligamental ridge present, siphonal bands weak inflexions or lacking; outer wall of 2 layers; inner finely reticulate lamellar layer and outer layer with canals. FV oval, caplike, of 3 shell layers, inner layer of lamellar reticulate structure, middle layer of polygonal canals arranged 4 together with one in center, and outermost layer of concentric laminae; myophores present. Wall structure distinctive. *U.Cret.(Senon.-Maastricht.)*, Eu.(Italy).——FIG. E266,*5*.

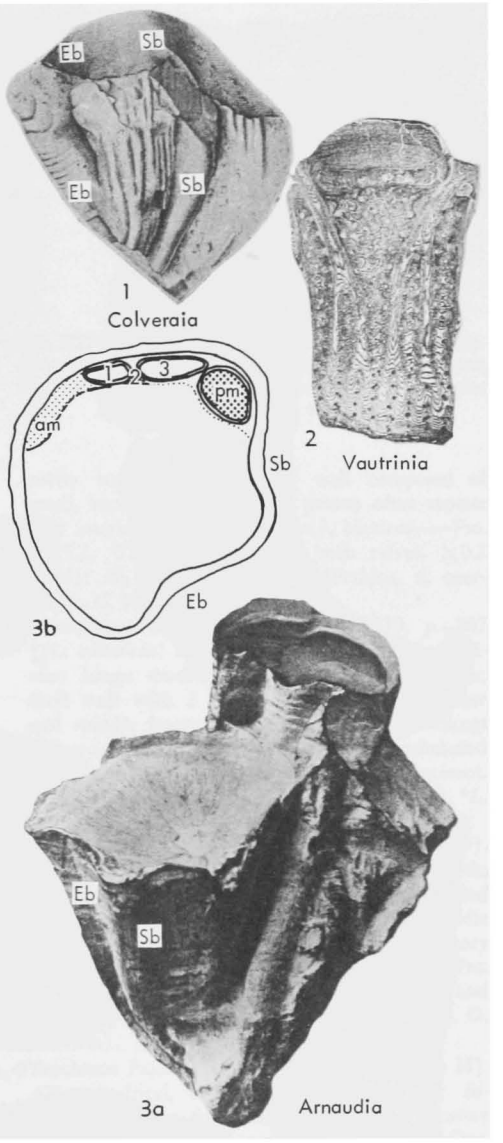

FIG. E274. Radiolitidae (Lapeirousiinae) *(2)*, (Subfamily uncertain) *(1,3)* (p. *N*815). [Explanation: *am, pm*, anterior and posterior myophores; *Eb, Sb*, siphonal bands; *1, 3*, teeth of FV; *2*, tooth of AV.]

**J. reticulata; 5a,b*, FV polygonal cells long. and transv. secs., ×6.7 *(905)*. [Also Fig. E240,*6*.]

UNRECOGNIZABLE RADIOLITID GENERA

Acardo BRUGUIÈRE, 1797, pl. 172 (generic name without nominal species, with illustration). Used by CUVIER in 1830 to include the genera *Radiolites, Sphaerulites, Hippurites, Batolites* and *Calceola*.

Birostrites LAMARCK, 1819, p. 230 [**B. inaequiloba,* an internal mold]. Held by ROQUAN (1841) to be internal mold of *Sphaerulites* and by TOUCAS (1907-09) of *Praeradiolites hoeninghausi.*

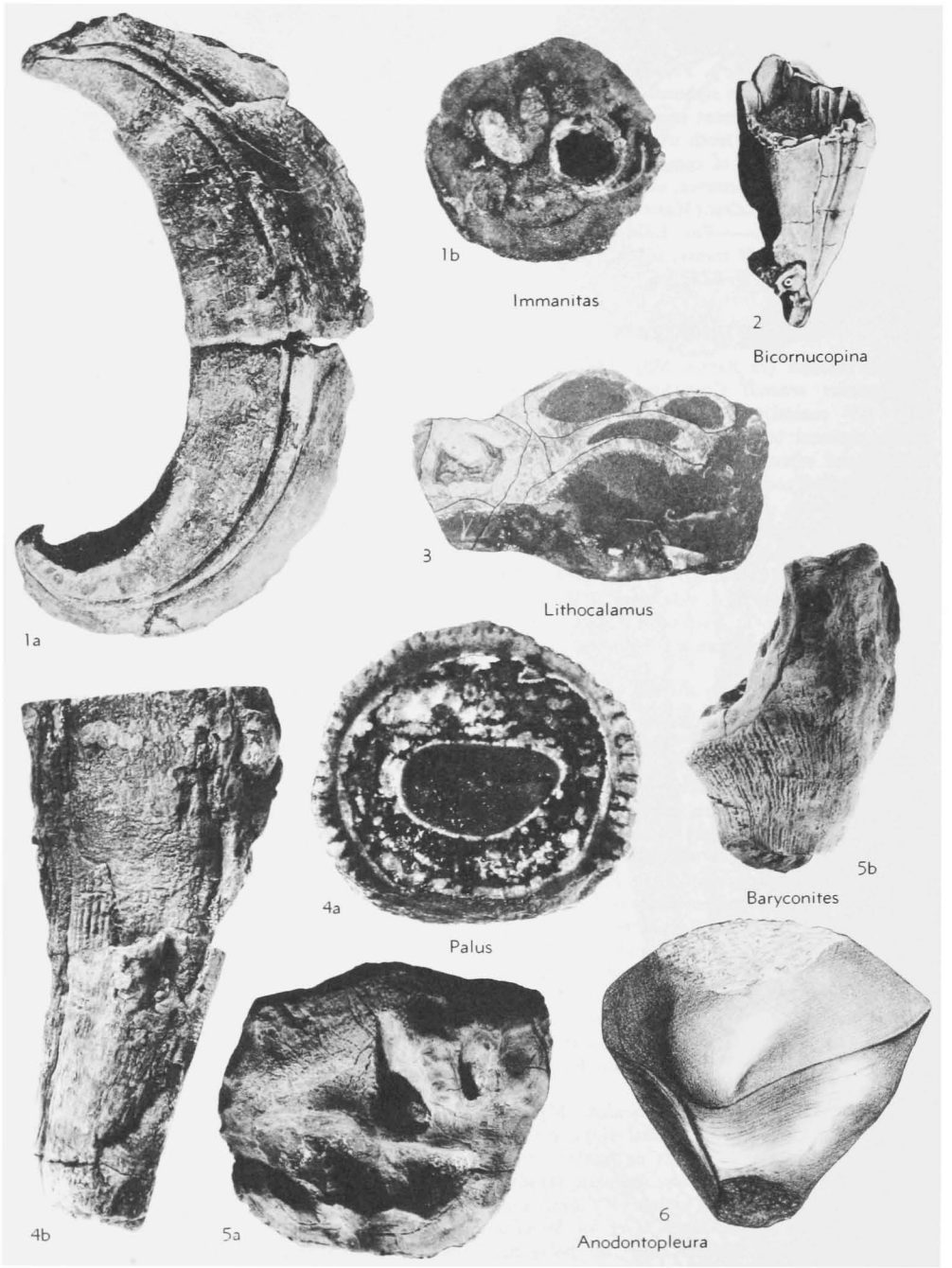

FIG. E275. Family Uncertain (p. *N*817).

Bisphaerulites BAYLE, 1857, p. 680 [*nom. nud.*].

Diplidia MATHERON, 1842, p. 111 [**Diplidia unisulcata;* M]. Poorly known, type species probably represented by mold of *Praeradiolites coquandi* BAYLE.

Jodamia DEFRANCE, 1822, p. 230 [**J. bilinguis;* SD KÜHN, 1932]. Internal mold, possibly of *Praeradiolites* (Toucas, 1907-09).

Laskarevia MILOVANOVIĆ, 1960, p. 371 [*nom. nud.*, generic name without nominal species].

Rajkaia MILOVANOVIĆ, 1960, p. 367 [*nom. nud.*, generic name without nominal species].

Rhytoides ZEKELI, 1854, p. 206 [*nom. nud.*, generic name without nominal species].

Trommia KLINGHARDT, 1935, p. 38 [*nom. nud.*, generic name without nominal species, with figure].

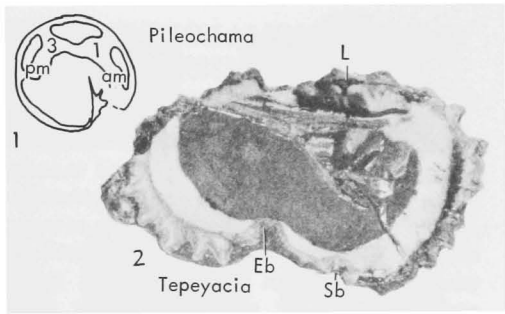

FIG. E276. Family Uncertain (p. *N*817). [Explanation: *am, pm,* anterior and posterior myophores; *Eb, Sb,* siphonal bands; *L,* ligament; *1, 3,* anterior and posterior teeth of FV.]

Family UNCERTAIN

[Materials for this section prepared by B. F. PERKINS and A. H. COOGAN]

Anodontopleura FELIX, 1891, p. 167 [**A. speciosa;* M]. Externally resembles *Monopleura;* hinge and muscle insertions unknown. *L.Cret.(Neocom.),* Mexico.——FIG. E275,*6*. **A. speciosa;* both valves, dorsal view, ×0.5 *(301a)*.

Baryconites PALMER, 1928, p. 51 [**B. multilineatus;* OD]. AV robust, conical, shell wall thick, externally with 2 wide flat siphonal bands separated by narrow ridge, cardinal platform large, anterior muscle insertion large and triangular, large posterior muscle insertion elongate and narrow, anterior tooth socket much larger than posterior, tooth erect and radially elongate, shell cavity small and septate, ligamental groove mostly internal; FV unknown. [This genus has been considered to be related to *Polyconites* and *Horiopleura* but irregularly spaced radial plates in dorsal shell wall suggest a possible relationship to radiolitids.] *U.Cret.(Cenoman.),* Mexico.——FIG. E275,*5*. **B. multilineatus; 5a,b,* AV int., post. view, ×0.35 (Perkins, n, courtesy L. G. Hertlein).

Bicornucopina HOFMANN, 1912, p. 219 [**B. petersi;* M] [=*Bicornucaprina* NEAVE, 1939 *(nom. null.)*]. Inequivalve; AV elongate, conical, slightly curved; FV strongly curved; wall of both valves with system of radial canals toward interior and smaller canals toward exterior, as in *Caprinula;* hinge insufficiently known to determine affinities. *L.Cret. (mid-Neocom.),* Eu.(Hung.).——FIG. E275,*2*. **B. petersi;* AV ext., ×0.5 *(412a)*.

Cryptaulia POČTA, 1889, p. 50 [**C. triangulum;* SD KUTASSY, 1934, p. 181]. AV straight or slightly curved; longitudinal canals in shell wall; hinge unknown. *U.Cret.(Cenoman.),* Eu.(Czech.).

Immanitas PALMER, 1928, p. 28 [**I. anahuacensis;* OD]. Equivalve, very large, both valves curved to loosely coiled; surface with 3 ridges separated by furrows, ridges correspond to 3 cavities extending length of both valves near surface; hinge teeth rudimentary, on concave side of shell; shell cavity small, tabulate; shell wall composed of small, rounded or polygonal prisms often septate near interior. *U.Cret.(Cenoman.),* Mexico.——FIG. E275,*1*. **I. anahuacensis; 1a,* both valves, ×0.2 *(714); 1b,* valve sec., ×0.35 (Perkins, n, courtesy L. G. Hertlein).

Lithocalamus LUPHER & PACKARD, 1930, p. 207 [**L. colonicus;* M]. Known only by AV; gregarious; hinge tooth weak; no accessory cavities; shell wall with 2 layers corresponding to inner and middle layers of *Coralliochama* shell except that cross sections of canals are more rounded and outer row of larger, elliptical canals is present. *U.Cret.(Senon.),* USA(Ore.).——FIG. E275,*3*. **L. colonicus;* AV secs., ×0.5 *(552)*.

Palus PALMER, 1928, p. 28 [**P. corrugata;* OD]. Only AV known, straight, with small tooth; muscle insertions superficial; tooth sockets reduced to grooves; shell wall composed of 3 layers, middle one with polygonal canals and possibly accessory cavities. *U. Cret. (Cenoman.),* Mexico.——FIG. E275,*4*. **P. corrugata; 4a,b,* AV transv. sec. and lat. view, ×1.5, ×1 (Perkins, n, courtesy L. G. Hertlein).

Pileochama PARONA, 1901, p. 211 [**P. cremai;* M]. AV cylindrical, FV capuliform; resembling *Biradiolites* except for presence of accessory cavity behind each muscle insertion of FV. *?U.Cret. (Cenoman.-Senon.),* range poorly defined; Italy (Apennines).——FIG. E276,*1*. **P. cremai,* transv. sec. AV, ×0.7 *(719)*.

Tepeyacia PALMER, 1928, p. 46 [**T. corrugata;* OD]. AV small, conical, flattened, ornamented externally with angular ribs; siphonal bands *Eb* and *Sb* deep grooves, ligamental ridge present, no myophores observed, hinge area weakly developed; wall of two layers; thin outer finely lamellar layer and thicker massive opaque inner layer. FV unknown. May be a monopleurid. *L.Cret.(?Alb.),* Mexico-W.Indies(?Cuba-?Jamaica).——FIG. E276,*2*. **T. corrugata,* Mexico; transv. sec., ×0.7 *(714)*.

Subclass ANOMALODESMATA Dall, 1889

[*nom. transl. et correct.* KEEN, 1963 (*ex* Anomalodesmacea DALL, 1889)] [Diagnosis by N. D. NEWELL]

Relatively short to elongate, nestling to fossorial forms with ventrally fused mantle lobes; equivalve to subequivalve; generally approximately isomyarian; hinge margin characteristically thickened or enrolled, edentulous, or with one amorphous tooth and corresponding socket in one or each valve, lateral teeth absent; ligament opisthodetic or absent, where present associated in many genera with separate resilium and lithodesma; many genera said to have nacreous endostracum; living forms eulamellibranchiate; a few, septibranchiate. *?L.Ord., M.Ord.-Rec.*

Recent and many fossil representatives, extending far back into the early Paleozoic (e.g., *Rytimya, Cuneamya, Sphenolium*) have radial rows of very small tubercles. It may be that this delicate ornament, easily worn away, was present in most members of the subclass. Clearly this is a group of great antiquity and possibly it should include genera placed provisionally in the Cryptodonta and elsewhere. The Anomalodesmata include many of the Desmodonten of NEUMAYR and all of PELSENEER's Septibranchiata.

Order PHOLADOMYOIDA Newell, 1965

[Diagnosis by N. D. NEWELL]

Ordinal characters same as those of subclass Anomalodesmata. *?L.Ord., M.Ord.-Rec.*

Superfamily EDMONDIACEA King, 1850

[*nom. transl.* NEWELL, 1965 (*ex* Edmondiidae KING, 1850)] [Materials for this superfamily prepared by N. D. NEWELL]

Equivalve, isomyarian, generally more or less inequilateral; ovoid; ligament opisthodetic, external, short, attached in well-defined groove and supported by strong nymphs and thin hinge plate; essentially edentulous. *U.Dev.-U.Perm.*

Family EDMONDIIDAE King, 1850

Equivalve, evenly convex shells with incurving prosogyre or orthogyre beaks; surface generally without radial ornamentation, nearly smooth or rugose, lunule and escutcheon lacking or obscure; pallial line entire or with very shallow sinus. *U.Dev.-U.Perm.*

Edmondia DE KONINCK, 1841, p. 66 [**Isocardia unioniformis* PHILLIPS, 1936; OD] [=*Allorisma* KING, 1844, p. 315 (type, *Sanguinolaria sulcata* PHILLIPS, 1936; OD); *Aediculus* GISTL, 1848, p. 9 (obj.); *Broeckia* DE KONINCK, 1885, p. 19 (type, *B. latissima*; SD NEWELL, herein); *Pseudedmondia* FISCHER, 1887, p. 1100 (type, *P. puzosi* DE KONINCK, =*Cardiomorpha puzosiana* DE KONINCK, 1842; M); *Edmondiella* CHERNYSHEV, 1950, p. 74 (type, *Sanguinolaria sulcata* PHILLIPS, 1836; OD); *Allorismiella* ASTAFIEVA-URBAJTIS, 1962, p. 36 (type, "*Allorisma sulcata* of HIND, 1899" =*Hiatella sulcata* FLEMING, 1828 and *Sanguinolaria sulcata* PHILLIPS, 1836; OD]. Ovoid to elongate elliptical, evenly gibbous, without lateral carinae or sulci; margins closed; beaks small, prosogyre, situated one-fourth to one-third behind anterior margin; surface generally with somewhat irregular concentric ridges or growth lines; hinge plate internally reinforced by nearly parallel internal ridge. *U.Dev.-U.Perm.*, cosmop.——FIG. F1,*4a*. **E. unioniformis* (PHILLIPS), L.Carb., Ire.; LV ext., ×1 (Hind, 1899).——FIG. F1,*4b*. *E.* sp., L.Perm.(Getaway), Guadalupe Mts., USA(Tex.); RV int. ×1 (Newell, n).

Cardiomorpha DE KONINCK, 1841, p. 101 [**Isocardia oblonga* SOWERBY, 1825; SD WOODWARD, 1854] [=*Isoculia* M'COY, 1862, explan. pl. 8, fig. 15 (type, *I. corrugata;* M)]. Similar to *Edmondia* but with very prominent, strongly prosogyre umbones and beaks; surface smooth; internal characters unknown. *L.Carb.*, Eu.-N.Am.——FIG. F1,*5*. **C. oblonga* (SOWERBY), Ire.; *5a-c*, LV ext., ant., hinge views, ×0.5 (Hind, 1898).

Superfamily PHOLADOMYACEA Gray, 1847

[*nom. transl.* N. D. NEWELL, 1965] [Materials for this superfamily prepared by N. D. NEWELL, with additions as recorded]

Equivalve, ovoid to elongate shells, generally elongate, with simple, external ligament. *?L.Ord., M.Ord.-Rec.*

Family ORTHONOTIDAE S. A. Miller, 1877

[Materials for this family prepared by N. D. NEWELL and AURÈLE LA ROCQUE]

Soleniform Paleozoic bivalves characterized by concentric folds and posterior gape; lunule and escutcheon generally absent; hinge and internal characters unknown. *M.Ord.-M.Dev.*

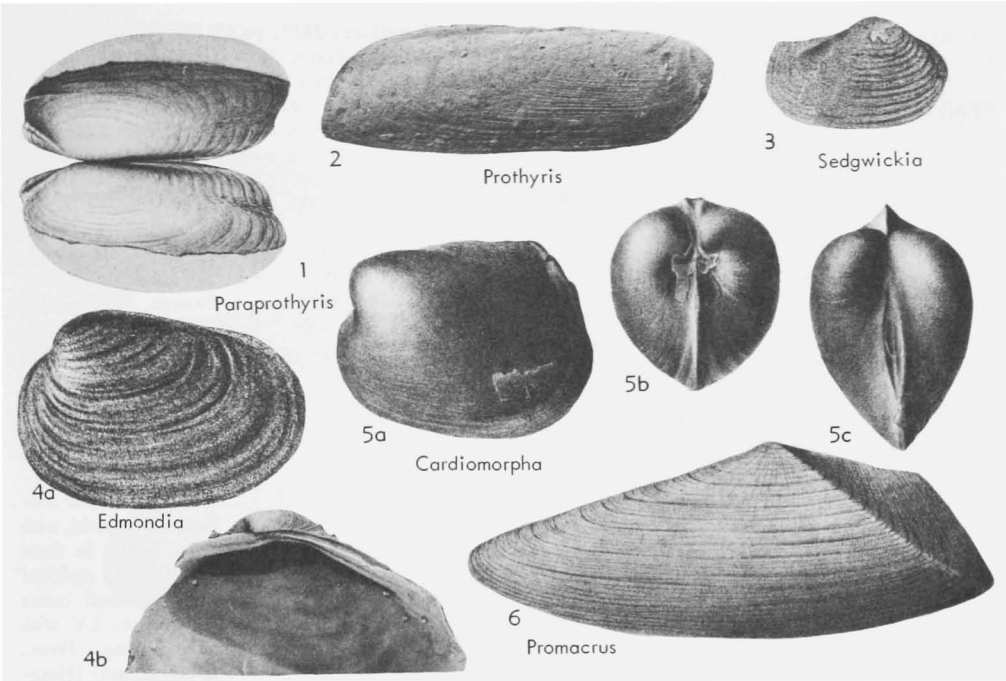

FIG. F1. Edmondiidae *(4-5);* Grammysiidae *(1-3,6)* (p. *N*818, *N*822-*N*823).

Orthonota CONRAD, 1841, p. 50 [**O. undulata;* SD CONRAD, 1866]. Very elongate, more than 4 times longer than height, gaping slightly posteriorly; beaks about 0.2 length behind front margin; anterior surface with concentric growth lines and, on postumbonal slope, strong concentric undulations and radial folds; ligament enclosed in linear fold on cardinal margin; edentulous. *M.Ord. (Llandeil.-Caradoc.)-M.Dev.(Hamilton.),* N.Am.-Eu.——FIG. F2,*2*. **O. undulata,* M.Dev.(Hamilton.), USA(N.Y.); bivalve specimen, composite mold, ×1 *(379)*.

Palaeosolen HALL, 1885, p. 483 [**Orthonota siliquoidea* HALL, 1870; M]. Similar to *Orthonota* but with beaks nearly terminal; postumbonal slope marked by shallow diagonal sulcus and umbonal ridge; surface marked by fine growth lines which may become regular and coarse on postumbonal area; posterior end quadrately truncate, widely gaping; anterior end with narrow gape. *L.Dev.-M.Dev.,* Eu.(Ger.)-USA.——FIG. F2,*1*. **P. siliquoidea* (HALL), M.Dev.(Hamilton.), USA(N.Y.); RV, composite ext.-int. mold, ×1 *(379)*.

Family GRAMMYSIIDAE S. A. Miller, 1877

[=Sanguinolitidae S. A. MILLER, 1877] [Materials for this family prepared by N. D. NEWELL and AURÈLE LA ROCQUE]

Oval to elongate forms characterized by smooth surface or concentric ornamentation; radial ribs commonly subordinate; ligament elongate; nymphs obscure; lunule and escutcheon commonly present; posterior umbonal ridge well defined in majority of genera; pallial line entire; hinge edentulous. [A poorly known, probably heterogeneous grouping of convenience.] *?L.Ord., M.Ord.-U.Perm.*

Grammysia DE VERNEUIL, 1847, p. 696 [**G. hamiltonensis* (=**Pterinea bisulcata* CONRAD, 1838); M]. Ovoid, gibbous; lunule and escutcheon well defined; characteristically with concentric folds and 2 oblique radial sulci with intervening fold extending backward from beaks to near middle of ventral margin; edentulous; pallial line simple, radially striate. *L.Dev.-U.Dev.,* cosmop.——FIG. F3, *10*. **G. bisulcata* (CONRAD), M.Dev., USA(N.Y.); *10a,b,* lat. and front views of RV int. mold, ×0.7 *(379)*.

Alula GIRTY, 1912, p. 3 [**A. squamulifera;* OD]. Externally similar to *Solenomorpha* but with fine radial costellae over surface in front of posterior umbonal carina; dorsal margin gently concave, ventral margin convex; RV with single platelike anterior and posterior tooth with possibly small rounded cardinal tooth below beaks; pallial line unknown. *L.Perm.,* N.Am.——FIG. F3,*12*. **A. squamulifera,* Lykins F., USA(Colo.); RV ext., ×2 (Girty, 1912).

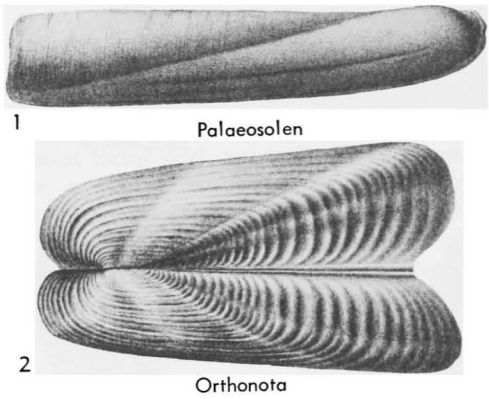

FIG. F2. Orthonotidae (p. *N819*).

?Cimitaria HALL & WHITFIELD, 1869, p. 66 [**Cypricardites recurvus* CONRAD, 1842; SD HALL, 1885]. Shell elongate, subrectangular, falcate or trapezoid; anterior end short and rounded; posterior end elongate, truncate; umbonal ridge angular and commonly strongly defined; surface marked by strong concentric lines of growth and by fine radial costellae; lateral sulcus extends slightly backward from umbones to basal margin; hinge marked by narrow, elongate ligament groove; lunule and escutcheon well defined; internal features and hinge unknown. [COOPER, 1931.] *M. Dev.-U.Dev.*, E.USA.——FIG. F3,*7*. **C. recurva* (CONRAD), M.Dev.(Hamilton.), N.Y.; *7a,b*, cardinal view and RV ext., ×0.5 *(379)*.

Cuneamya HALL & WHITFIELD, 1875, p. 90 [**C. miamiensis;* OD] [=*Ceromyopsis* MEEK, 1872, p. 327 (type, *Cardiomorpha? obliquata* MEEK, 1872); *Sphenomya* HALL, 1883, pl. 62 (type, *Grammysia cuneata* HALL, 1883; OD)]. Subrhomboidal, tapering backward for maximum height at prominent, nearly terminal umbones and strongly incurved beaks to obliquely truncate posterior margin; lunule and escutcheon well developed; posterior umbonal ridge rounded and broad; lateral sulcus broad, faint, oblique; anterior surface with uniform concentric ornamentation; posterior slope smooth; without marginal gape. *M.Ord.(Trenton.)-M.Dev.(Hamilton.)*, N.Am.——FIG. F3,*3*. **C. miamiensis*, U.Ord., USA (Ohio); *3a,b*, hinge view and RV ext., ×1 *(381)*.

?Davidia HICKS, 1873, p. 49 [**D. ornata;* SD NEWELL, herein]. Subtriangular, with submedian beaks and rounded, nasute, anterior and posterior extremities; posterior and anterior umbonal carinae near cardinal border; surface smooth except for faint radial costellae over ?posterior end of shell. *L.Ord.(Tremadoc.)*, Wales.——FIG. F3,*4*. **D. ornata*, St. Davids; *4a*, ?LV evt., ×1; *4b*, surface, enl. *(406)*.

?Glossites HALL, 1885, p. 49 [**G. lingualis;* OD] [=*?Elymella* HALL, 1885, p. 50 (type, *E. nuculoides;* OD)]. Shell elliptical, beaks anterior, small, appressed; hinge line long, gently arcuate; posterior umbonal ridge rounded; surface smooth or sublamellose, with or without faint radial costellae; lunule and escutcheon distinct; muscle scars shallow. *L.Dev.(Chapman Ss.)*, USA (Maine)-*U.Dev.* USA(N.Y.)-Eu.-Afr.; *L.Miss.*, USA(Iowa-Ohio).——FIG. F3,*6*. **G. lingualis*, U.Dev.(Chemung), USA(N.Y.); RV ext., ×1 *(379)*.

Grammysioidea WILLIAMS & BREGER, 1916, p. 133 [**G. princiana;* OD]. Similar to *Grammysia*, but lacks regular concentric ornamentation and either lacks radial sulcus or shows only single shallow lateral sulcus. *Sil.(Clinton.)-U.Dev.*, USA (Nev.)-E.N.Am.-S.Am.-Eu.——FIG. F3,*5*. **G. princiana*, L.Dev.(Moose R. Ss.), USA(Maine); RV ext., ×0.5 *(986)*.

?Leinzia MENDES, 1949, p.11 [**Solenomorpha similis* HOLDHAUS, 1918; OD]. Elongate pterioid, with anterior auricle; strong umbonal carina in front of narrow, flattened, smooth or carinate siphonal area; body of shell in front of umbonal carina with coarse, concentric ornamentation; LV with single cardinal socket; laterals lacking. *Perm.*, S.Am. (S.Brazil).——FIG. F4,*5*. **L. similis* (HOLDHAUS), Passa Dois F.; LV ext., ×1 (Mendes, 1949).

?Palaeocorbula REED, 1932, p. 63 [**P. difficilis;* M]. Moderately inflated, strongly inequivalve, RV smaller than LV, suboval, longer than high; anterior end projecting, sharply rounded; umbones submedian; surface ornamented with numerous, regular, sharp, equidistant, concentric ridges, some of which abruptly thin out or coalesce at weak anterior sulcus in front of which concentric ridges are only about half as numerous; lunule lacking; escutcheon well defined, narrow; interior unknown. *L.Perm.*, India(Kashmir).—FIG. F3,*9*. **P. difficilis*, agglomeratic slates, *9a,b*, lat. and post. views of RV, ×1 (Reed, 1932).

?Pholadella HALL, 1869, p. 63 [**P. newberryi;* SD HALL, 1885] [=*Cercomyopsis* MEEK, 1871, p. 71 (type, *Allorisma pleuropistha* MEEK, 1871; OD); *Grammysiopsis* CHERNYSHEV, 1950 (type, *G. irregularis;* OD)]. Shell elongate, gibbous; beaks about 0.25 distance behind anterior margin; umbones and umbonal ridge prominent; anterior end rounded or obliquely truncate; laterally compressed posterior truncate; broad, lateral sulcus extending directly downward from beaks to ventral indentation; surface marked by strong concentric undulations which may be confined to anterior part of shell; distinct costae originating at umbo extend across central or greater portion of shell body, leaving anterior and cardinal area free of radial ornamentation; cardinal margin marked by broad ligament groove, lunule and escutcheon well defined; hinge, pallial and adductor impressions unknown. *L.Dev.(Coblenz.)*, Ger.; *L.Miss.*, E.USA; *M.Penn.-*

U.Penn., C.USA; *U.Carb.*, USSR(Urals).——Fig. F3,*11*. **P. newberryi*, L.Miss.(Waverly.), USA (Ohio); LV ext., ×1 *(379)*.

?**Promacrus** Meek, 1871 p. 4 [**P. nasutus;* OD]. Anterior end attenuated and produced; posterior end higher and obliquely truncated; beaks ranging in position from median to slightly anterior or posterior; umbonal ridge well defined; without lunule and escutcheon; surface smooth or in some shells with radial costellae over umbonal region;

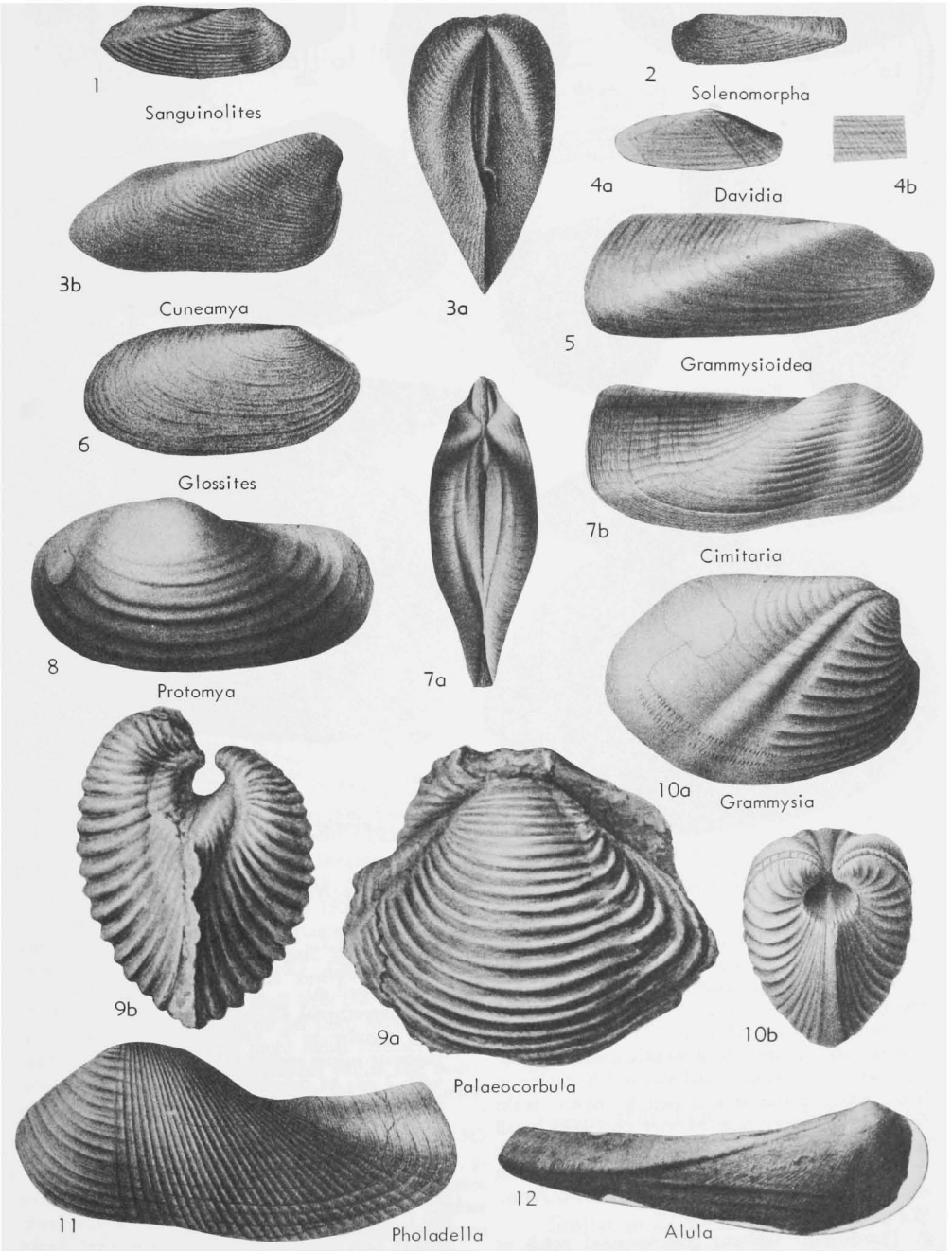

Fig. F3. Grammysiidae (p. *N*819-*N*823).

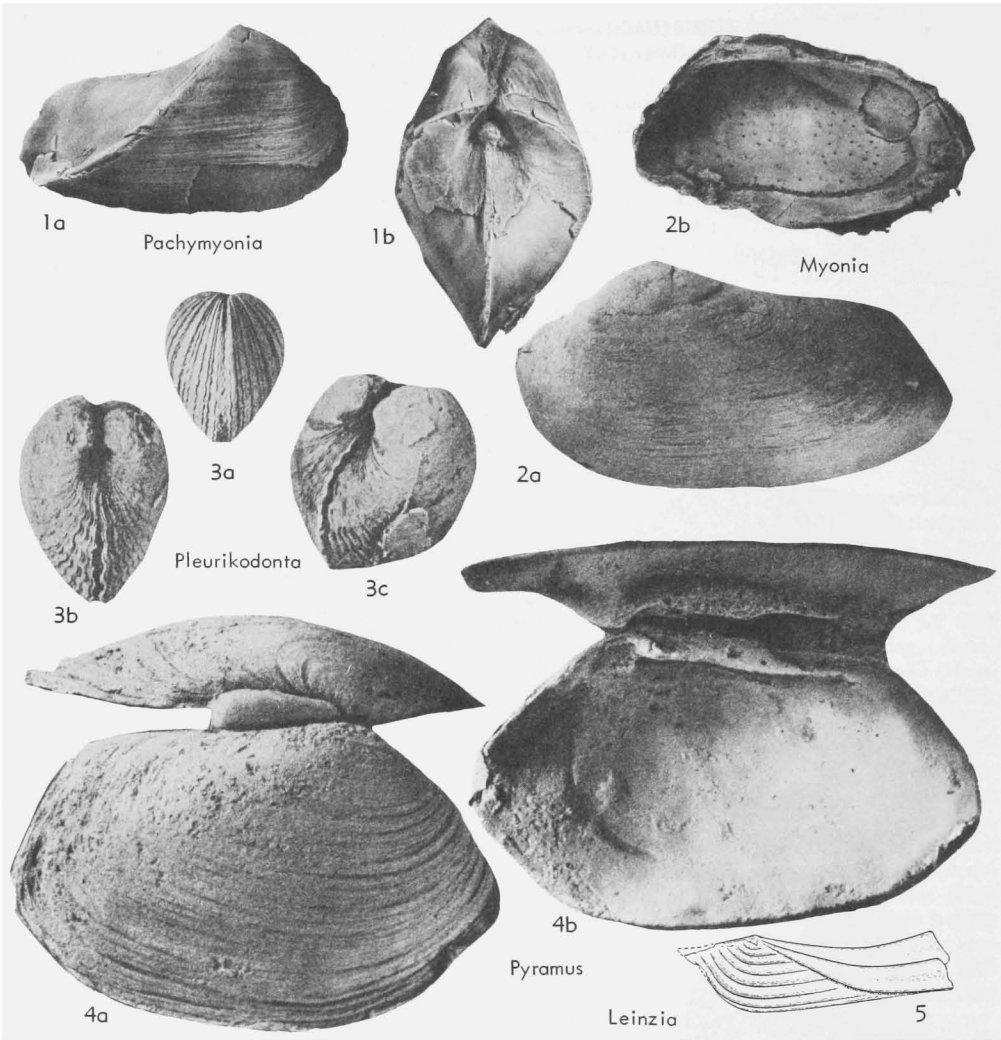

FIG. F4. Grammysiidae *(5)*; Megadesmidae *(1-4)* (p. *N*820, *N*825-*N*827).

hinge and pallial line unknown. *L.Miss.*, N.Am. ——FIG. F1,*6*. **P. *nasutus*,* L.Miss.(Chouteau), USA(Mo.); LV ext., ×0.6 (Meek, 1872).

?Prothyris MEEK, 1871, p. 4 [**P. elegans*; OD] [=*Prothyris* MEEK, 1869, p. 172 *(nom. nud.)*]. Elongate-oblong, smooth or weakly costellate; gaping slightly behind, or closed and widely gaping in front, where hiatus is increased by notch; beaks depressed and very near anterior end, with small ridge extending from anterior side of each beak to corner of anterior notch; dorsal margin without escutcheon or lunule; ?edentulous. *L.Dev.-U.Perm.*, W.Eu.-N.Am.-S.Am.(Brazil).

P. (Prothyris). Without posteroventral notch or sulcus. *L.Dev.-U.Perm.*, W.Eu.-E.USA-C.USA. ——FIG. F1,*2*. **P. (P.) elegans* MEEK, U.Penn. (Willard Sh.), USA(Neb.); RV ext., lectotype, ×2 (Newell, n).

P. (Paraprothyris) CLARKE, 1913 [**P. (P.) knodi*; M]. Similar to *P. (Prothyris)* but with broad posterior sulcus ending in marginal notch, surface with 2 sets of concentric ornamentation forming herringbone pattern below posterior sulcus. *L.Dev. (Ponta Grossa Sh.)*, E.Am.(Brazil).——FIG. F1,*1*. **P. (P.) knodi*; bivalved individual, LV below, ×1 *(138)*.

?Protomya HALL, 1885, p. 52 [*pro Palaeomya* HALL, 1885, p. 52 (*non* ZITTEL & GOUBERT, 1861)] [**P. oblonga*; OD]. Elongate, oval; beaks submedian, incurved, prominent; umbonal slope

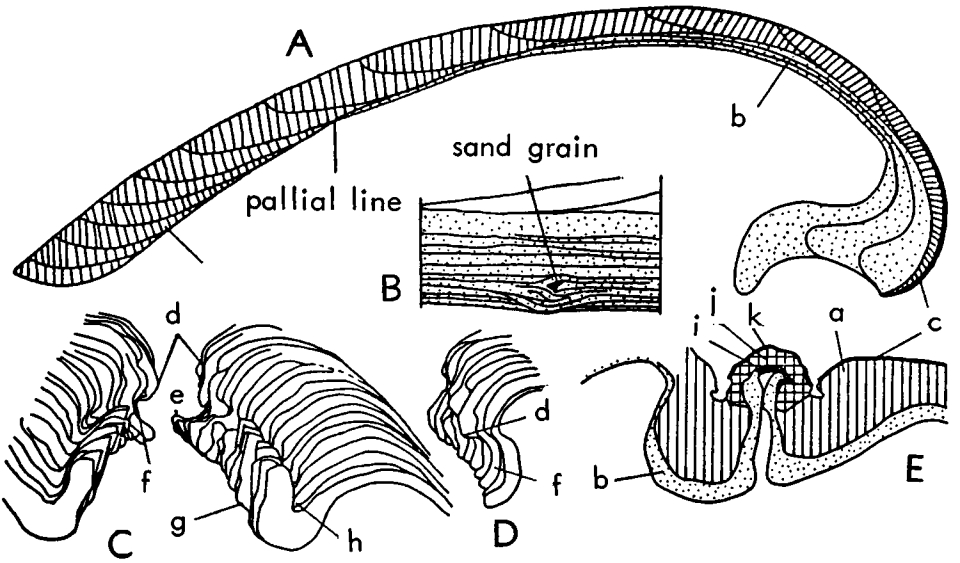

FIG. F5. Morphological features of *Megadesmus.*——*A, B. M. nobilissimus,* semidiagrammatic long. sec. of LV showing shell layers, ×1.5, and long. sec. of inner layer showing lamellae secreted around sand grain, ×7.5.——*C, D. M. globosus,* superposed serial secs. of hinge viewed from post. end *(C)* and ant. view of umbonal secs. of LV showing socket *(D),* ×1.——*E. M. nobilissimus,* transv. sec. of ligament. [Explanation: *a,b,* outer and inner shell layers; *c,* periostracum; *d,* beak; *e,* tooth; *f,* socket; *g,* nymph; *h,* ligament groove; *i, j, k,* inner, outer, and periostracal layers of ligament.] (Runnegar, 1965).

gibbous above; surface with fine growth lines and strong concentric undulations; cardinal line long, nearly straight; ligament external; hinge and pallial line unknown. *M.Dev.,* USA(N.Y.).——FIG. F3,*8.* **P. oblonga,* Hamilton, N.Y.; LV int. mold, ×*0.7 (379).*

Sanguinolites M'COY, 1844, p. 47 [**S. discors;* SD STOLICZKA, 1871] [=*Cercomyopsis* SANDBERGER, 1881, p. 247 (type, *C. acutirostris;* OD); *Sphenotus* HALL, 1885, p. 33 (type, *Sanguinolites arcaeformis* HALL & WHITFIELD, 1869; SD S.A.MILLER, 1889); *?Eopleurophorus* ELIAS, 1957, p. 780 (type, *Cypricardia? tricostata* PORTLOCK, 1843; OD)]. Shell elongate; umbones small, gibbous, incurved and contiguous, placed in anterior 0.2 of shell; anterior convex part of shell with coarse concentric ornamentation, sharply set off from flattened post-umbonal area by 1 or more radial carinae; lunule and escutcheon well developed; pallial line entire. *U.Dev.-Perm.,* cosmop.——FIG. F3,*1.* **S. discors,* L.Carb., Ire.; RV ext., ×1 (M'Coy, 1844).

Sedgwickia M'COY, 1844, p. 61 [**S. attenuata;* SD STOLICZKA, 1871] [=*?Fuchsella* DAHMER, 1942, p. 145 (type, *Sphenotus maillieuxi* ASSELBERGHS, 1930; M)]. Elongate, more or less gibbous; anterior end rounded, posterior edge subtruncate; umbones prominent, placed well forward, slightly prosogyre; surface smooth or with low concentric ridges; defined ligament nymphs behind beaks; lunule, escutcheon and radial carinae lacking; hinge unknown, ?edentulous. [The relationship between this genus and *Myonia* DANA, 1847, is uncertain.] *Miss.-Perm.,* cosmop.——FIG. F1,*3.* **S. attenuata,* L.Carb., Marsden, Eng.; RV ext., ×1 (M'Coy, 1844).

Solenomorpha COCKERELL, 1903, p. 559 [*pro Solenopsis* M'COY, 1844, p. 47 (*non* WESTWOOD, 1840)] [**Solenopsis minor* M'COY; M]. Subcuneiform, tapering posteriorly from maximum height at beaks near anterior end; anterior end closed; posterior end gaping slightly; umbonal carina conspicuous; narrow lunule and escutcheon present; surface smooth, without radial ornamentation; hinge unknown; pallial line entire. *L.Dev.-U.Perm.,* cosmop.——FIG. F3,*2.* **S. minor* (M'COY), L.Carb., Ire.; LV ext., ×1 (M'Coy, 1844).

Family MEGADESMIDAE Vokes, 1967

[*nom. correct.* NEWELL, herein (*pro* Megadesmatidae VOKES, 1967, *nom. subst. pro* Pachydomidae FISCHER, 1886, based on invalid generic name, ICZN *Code,* Art. 11e)]
[Materials for this family prepared by N. D. NEWELL]

Similar to Edmondiidae but many genera more clearly adapted for burrowing; liga-

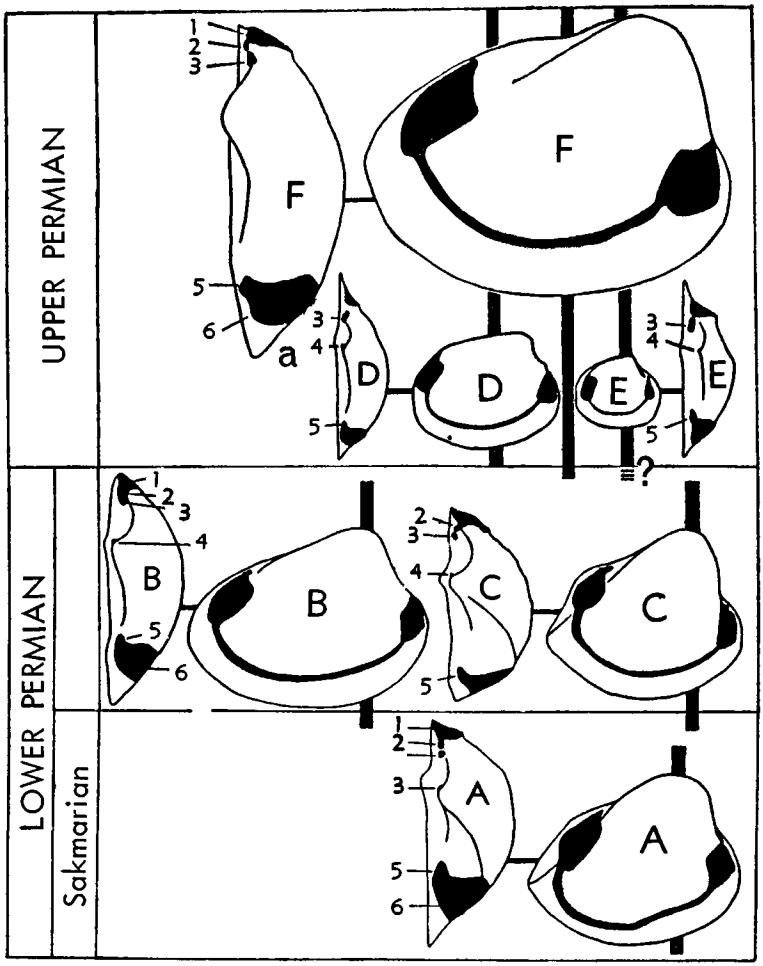

FIG. F6. Musculature and pallial lines shown on internal molds of early to late species of *Megadesmus* and *Astartila* (stratigraphic ranges indicated by heavy vertical lines).——*A. M. globosus.*——*B. M. nobilissimus.*——*C. M. gryphoides.*——*D. A. intrepida.*——*E. A. elegans.*——*F. M. grandis.* [Explanation: *1*, ant. adductor; *2*, pedal protractor; *3*, ant. pedal resractor; *4*, umbonal pedal retractor; *5*, post. pedal retractor; *6*, post. adductor.] (Runnegar, 1965).

ment short, nymphs very prominent with a single blunt tooth in RV and rarely in LV. *U.Carb.-Perm.*

Some of the more important features of shell structure, hingement, and musculature are illustrated in Figures F5-7, based on studies by RUNNEGAR (1965, *805a*).

Megadesmus SOWERBY, 1839, p. 14 [**M. globosus;* SD WOODWARD, 1854, p. 262] [=*Pachydomus* MORRIS, 1845, p. 271 (*nom. van. pro Megadesmus* SOWERBY, 1839, *non Megadesma* BOWDICH, 1822); *Cleobis* DANA, 1847, p. 154 (type, *Cleobis grandis* DANA, 1847; SD NEWELL, 1956, p. 10)]. Large equivalve, asymmetrical shells ornamented with coarse to medium imbricate growth lamellae and fine to medium concentric ribs; with sporadic obscure radial costae; micro-ornament consisting of radial rows of minute papillae, hinge with dental process in RV produced by fold in dorsal anterior valve margin, and socket in LV resulting from depression of valve edge; ligament external, opisthodetic, parivincular, supported by strong nymphs set in well-defined escutcheon; adductors subequal, the anterior smaller; 2 pedal muscle scars (protractor and retractor) situated above anterior adductor, and single retractor adjoining posterior adductor; third retractor scar in and on anterior side

of umbonal cavity; pallial line simple, radially striated; shell inside pallial line commonly pitted by insertions of mantle; shell and ligament of 3 layers: periostracum, outer lamellar layer and inner (?nacreous) layer (Runnegar, 1965). *Perm.*, Australia-Tasmania-India-Argentina.——FIG. F8, *4a-c.* **M. globosus* (SOWERBY), L.Perm. (Allandale F.), Harper's Hill, Hunter Valley, New S. Wales; *4a,* LV view of shells, ×0.5 (Sowerby, 1838); *4b,* dorsal view of lectotype, ×0.5 (Runnegar); *4c,* RV ext., ×0.5 *(805a).*——FIG. F8,*4d. M. gryphoides* DE KONINCK, E.Australia; latex cast of interior showing that front of dorsal margin slightly overlaps that of LV, ant. part of which fits into shallow groove in front of LV tooth, ×0.5 (Runnegar, n).

Astartila DANA, 1847, p. 155 [**A. intrepida;* SD STOLICZKA, 1871, p. xix]. Small, ovate shells with gently convex posterior umbonal slopes and low, forwardly directed beaks; ornament varying from regular imbricate growth lamellae to irregularly spaced concentric threads; radial ornament of low, wide costae may be present; shell surface covered with radial rows of minute papillae; ligament external and opisthodetic, attached behind well-developed nymphs set in narrow escutcheon; lunule usually absent; RV with single upright tooth derived from fold in valve margin; LV with deep to shallow socket of type found in *Megadesmus* specimens with well-developed radial ornament having weakly developed megadesmid dentition; adductor scars subequal, the anterior smaller and deeper, commonly having several lobes on the posterior-dorsal edge; a single, deep, oval pedal scar occurring above anterior adductor and a large pedal retractor scar attached to upper edge of posterior adductor; a third pedal scar on rear side of umbonal cavity; pallial line simple and radially striate. *L.Perm.*, Australia.

[*Astartila* differs from *Megadesmus* in the following respects. 1) Because of the narrow, deep escutcheon, the upper margin of the valve behind the umbo is gently convex. In *Megadesmus* the escutcheon is broader and less steeply inclined so that it is mechanically possible for the umbones to project above the posterior margin of the valves. 2) Only one pedal scar occurs above the anterior adductor. The scar that is present is ovoid and deeply impressed so that it is almost certainly the scar that has been termed the anterior pedal retractor in *Megadesmus*. In one specimen of *Astartila intrepida* there is a differentiation of the edge of the adductor which may represent the protractor scar. However, as the edge of the adductor is commonly lobed, it is probable that this is merely an exaggerated development of a single lobe. The absence of a scar does not necessarily imply the absence of a pedal protractor muscle since BLOOMER (1901, p. 40) has described a species of *Solen* in which the protractor muscle is attached to the anterior adductor and not to the shell. If this were true in species of *Megadesmus* or *Astartila* it may account for the more or less complete merging of the protractor and adductor scars (RUNNEGAR, 1965, *805a*).]

A. (Astartila). Species lacking well-developed radial ornamentation. *L.Perm.*, Australia.——FIG. F8,*3.* **A. (A.) intrepida* DANA, U.Marine, Wallongong, NewS.Wales; *3a-c,* RV ext., latex cast of hinge int., shell front, ×1; *3d,* hinge ext., ×0.7 *(668).*

A. (Pleurikodonta) RUNNEGAR, p. 247, 1965 [**P. elegans*, OD]. Internally like *A. (Astartila)* but ornamented with obscure radial costae which are reflected by inflections in growth lamellae and

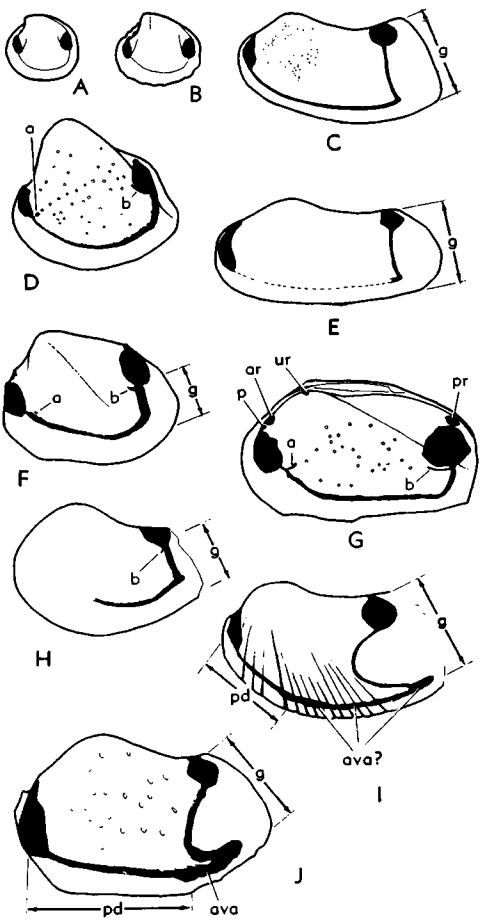

FIG. F7. Muscle scars and pallial lines on internal molds of representative Megadesmidae and Pholadomyidae (Runnegar, 1965).——*A. Astartila (Astartila) intrepida* DANA.——*B. A. (Pleurikodonta) elegans* RUNNEGAR.——*C. Chaenomya leavenworthensis* (MEEK).——*D. Megadesmus gryphoides* (DE KONINCK).——*E. Chaenomya?* sp.——*F. Pyramus laevis* (SOWERBY).——*G. Myonia valida* DANA.——*H. Vacunella* sp. cf. *V. waterhousei* (DUN).——*I. Pholadomya gigantea* (SOWERBY).——*J. Vacunella curvata* (MORRIS). [Explanation: *a,* muscles of uncertain significance; *ar,* anterior retractor; *ava,* accessory ventral adductor; *g,* siphonal gape; *p,* protractor; *pd,* pedal gape; *pr,* posterior protractor; *ur,* umbonal retractor.]

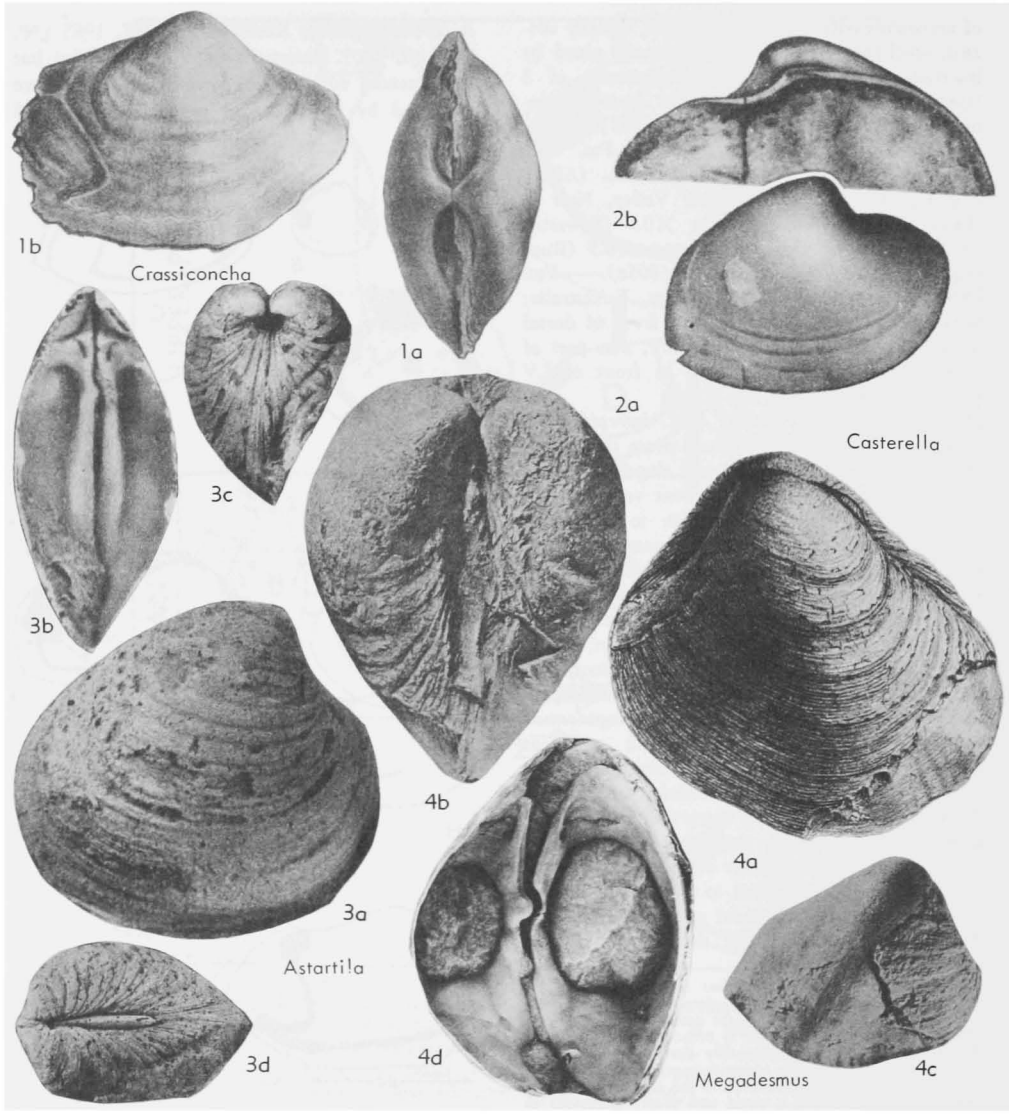

FIG. F8. Megadesmidae (p. *N824-N826*).

crenulations in valve margins; megadesmid dentition of *A. (Astartila)* wholly or partially replaced by costae which interlock in front of beaks. *L.Perm.(M.Bowen Beds)*, Queensl.——FIG. F4,*3*. **A. (P.) elegans* (RUNNEGAR); *3a-c*, ventral, ant. and oblique views of latex cast, ×1 (Runnegar, 1965).

Casterella MENDES, 1952, p. 100 [**C. gratiosa;* M]. Similar to *Megadesmus* but with pallial sinus and thin hinge plate. *Perm.(Corumbatai F.)*, S.Am. (S.Brazil).——FIG. F8,*2*. **C. gratiosa; 2a,b*, RV ext. and hinge views, ×1.5 (Mendes, 1952).

?**Crassiconcha** NECHAEV, 1894, p. 316 [**C. stuckenbergi;* M]. Equivalve; smooth; beaks submedian; lunule and escutcheon well marked; front end projecting, narrowly rounded; lateral surfaces divided approximately into thirds by broad shallow sulci; deep pallial sinus; hinge unknown. *U.Perm.*, Eu.(E.USSR)-E.Greenl.——FIG. F8,*1*. **C. stuckenbergi*, Kazan., USSR; *1a*, hinge view and *1b*, ext., ×0.7 (Nechaev, 1894).

Myonia DANA, 1847, p. 158 [**M. elongata;* SD FLETCHER, 1932] [=*Maeonia* DANA, 1849 (*nom. van. pro Myonia* DANA, 1847)]. Shell elongate,

lenticular, with small umbones; tapering backward as viewed from above and side; posterior end obliquely truncate; obscure sulcus extending from beaks to ventral margin, usually bounded behind by posterior umbonal ridge; cardinal teeth lacking or obscure; margins not gaping; pallial line continuous, but radially striate; mantle within pallial line attached to shell by scattered deep pits. *U.Carb.-Perm.,* New S. Wales-Kashmir-S. Am. (Brazil)-USSR(NE.Sib.).

[*Myonia* is placed in the Megadesmidae rather than in the Edmondiidae because of its very strong outward rolled nymphs; at least some examples (Fig. F4,*2b*) show the usual cardinal boss characteristics of the subfamily.]

M. (Myonia). Umbonal ridge rounded or with weak carina. *U.Carb.-Perm.,* New S. Wales-Brazil-Sib.——Fig. F4,*2a.* **M. (M.) elongata* Dana, Gerringong, New S. Wales; LV ext., ×0.34 *(668).* ——Fig. F4,*2b. M. (M.) carinata,* U.Marine Ser., south coast, New S. Wales; RV int., ×0.4 (Newell, n).

M. (Pachymyonia) Dun, 1932, p. 411 [**P. morrisii* Etheridge, 1919; OD]. Umbonal ridge very strong, angular. *Perm.,* New S.Wales.——Fig. F4,*1.* **M. (P.) morrisii* (Etheridge), L.Marine Ser., New S.Wales; *1a,b,* RV ext., hinge view, ×0.5 (Newell, n).

Pyramus Dana, July 1847, p. 156 [**P. myiformis;* SD Newell, 1856] [=*Notomya* M'Coy, Nov. 1847, p. 303 (type, *N. securiformis;* SD Stoliczka, 1871); *Pyramia* Dana, 1849 (*nom. van. pro Pyramus* Dana, 1847); *Clarkia* deKoninck, 1877 (obj.)]. Similar to *Myonia* but with slight posterior gape and shallow pallial sinus; pallial line not striate and interior of shell not pitted within pallial line; 1 large tooth in each valve below beaks. *L.Perm.(U.Marine),* New S.Wales; *Perm.? (Corumbatai F.),* S.Am.(S.Brazil).——Fig. F4,*4.* **P. myiformus,* L.Perm.(U.Marine), Blackhead, New S.Wales; *4a,b,* latex cast viewed from right; int. same, RV; both ×1 *(668).*

Family PHOLADOMYIDAE Gray, 1847

[*nom. correct.* King, 1850 (*pro* Pholadomyadae Gray, 1847)] [=Arcomyidae Fischer, 1887] [Materials for this family prepared by L. R. Cox, with additions by N. D. Newell]

Shell equivalve (except in *Girardotia*), with wide range of size, ovate, oblong or subtrigonal, subequilateral to (more commonly) strongly inequilateral, moderately to strongly inflated; most forms gaping at posterior end and some with narrower anterior gape; ostracum thin (except in some *Pachymya* and in *Machomya*), nacreous, although commonly altered in fossilization; surface bearing small pustules, aligned radially or concentrically in many forms. Hinge edentulous; cardinal margin thickened below and behind beak and bearing strong nymph in each valve for support of external, opisthodetic ligament; small internal ligament (resilium) also present below beak in Recent type species of *Pholadomya,* but not observed in any fossil forms, internal characters of most being inadequately known; pallial sinus present in most forms but absent in a few. *Miss.-Rec.*

Fischer recognized two distinct families, Pholadomyidae and Arcomyidae, supposing the fine surface pustules present in the latter group to be absent in the former. It is now known that the surface is finely pustulose in some Lower Tertiary *Pholadomya* (Fig. F9,*1f*), however, and it seems probable that this delicate ornament, which is easily worn away, was present both in the holotype of the Recent type species and in numerous fossil representatives of the genus.

Pholadomya G.B. Sowerby, 1823 [**P. candida;* SD Gray, 1847, p. 194] [=*Pholadomyaea* Fleming, 1828 *(nom. null.); Pholadomia* Swainson, 1835 *(nom. null.); Phaladomya* Meek, 1858 *(nom. null.); Pholadomye* Deshayes, 1860 *(nom. null.); Pholdomya* Conrad, 1865 *(nom. null.); Pholodomya* Hector, 1886 *(nom. null.); Pholadonya* Dall, 1905 *(nom. null.)*]. Medium-sized to large, ovate to subtrigonal, strongly inequilateral, ventricose, most so anteriorly; umbones broadly rounded to subangular, of variable prominence, more or less anteriorly placed; valves gaping posteriorly to variable extent, anterior gape narrow or absent; pustulation of surface very delicate; ornament usually strongly developed, but weak in some forms and consisting of radial ribs or ridges, commonly bearing tubercles, and of concentric undulations or rugae; pallial sinus broad, of moderate depth. *U.Trias.-Rec.,* cosmop.

[Although several Recent species from various parts of the world have been described under *Pholadomya,* the type species is the only one resembling the numerous fossil forms in size and shape. The remainder are relatively small shells, some of which belong to the genus *Panacea* Dall (see below), while some others, particularly certain very small forms from the Antarctic, should probably be included in one or more new genera. All known Recent Pholadomyidae are moderately deep- to deep-water forms, whereas the Mesozoic species of the family are found commonly in shallow-water sediments. No satisfactory subgeneric classification of the numerous species of *Pholadomya* has yet been achieved and a thorough revision of the genus would result in the recognition of many more subgeneric groups than those here distinguished.]

P. (Pholadomya) [=*Flabellomya* Rollier, 1911, p. 231 (type, *Lutraria ambigua* J. Sowerby, 1819, p. 48; SD Cox, herein)]. Elongate-ovate, with broad and not prominently protruding umbones; dorsal umbonal ridge, bordering an escutcheon, present or absent. *U.Trias.-Rec.,* cosmop.——Fig. F9,*1a-d.* **P. (P.) candida* G.B. Sowerby, Rec., Carib.; *1a-c,* holotype, RV ext., RV int. (showing pallial line), and dorsal view of both valves (all

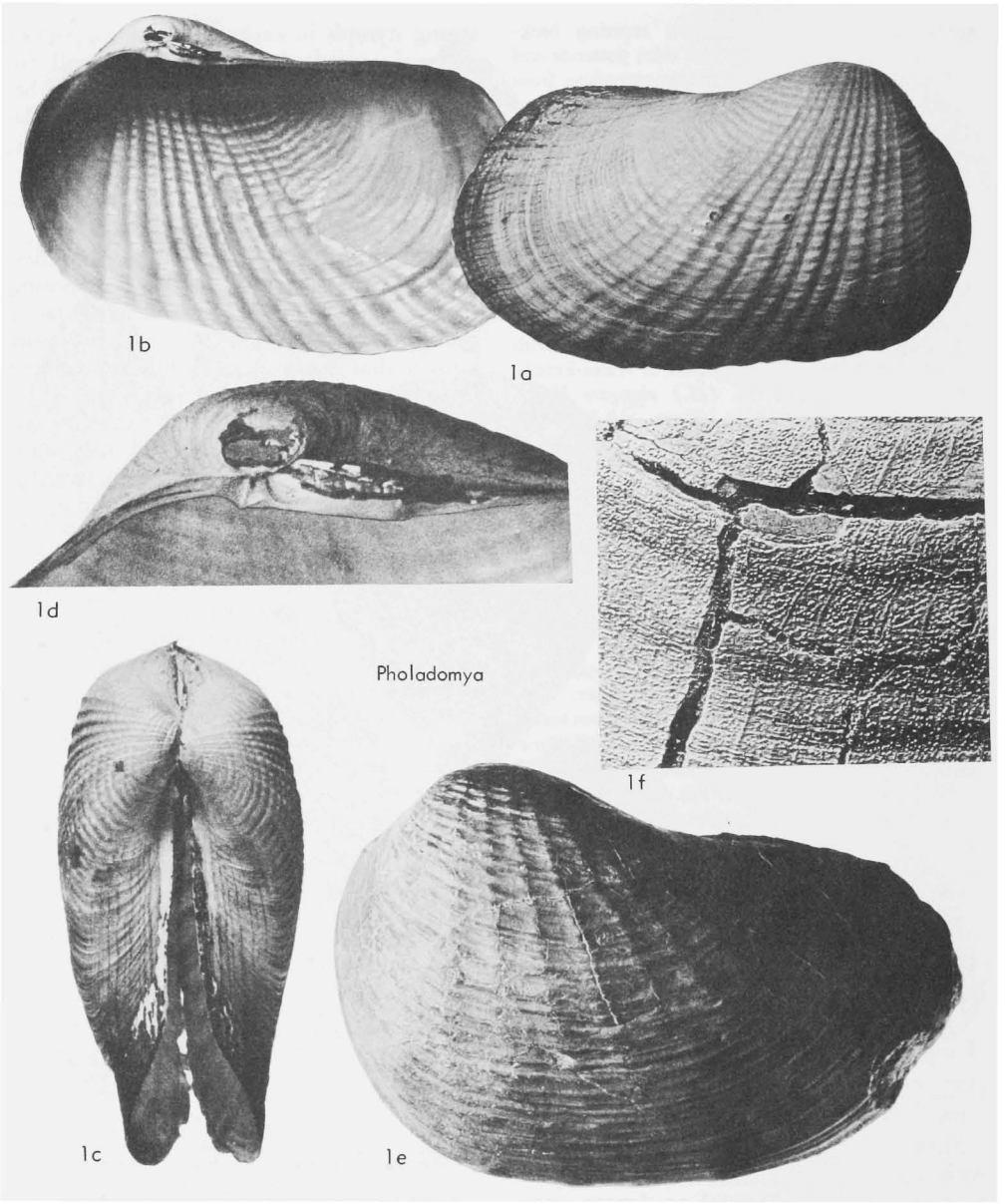

FIG. F9. Pholadomyidae (p. *N827-N829*).

×0.7); *1d,* hinge region of RV showing ligamental nymph and shallow rhombic subumbonal pit for internal ligament, small, obtusely angular projection of margin below it (×2) (Cox, n). ——FIG. F9,*1e*. *P. (P.) ambigua* (J. SOWERBY), L.Jur.(Lias.), Eng.; LV ext., ×0.7 (Cox, n).—— FIG. F9,*1f*. *P. (P.) leonensis* STENZEL, KRAUSE & TWINING, Eoc., USA(Tex.); pustulose ornament, ×4 (Stenzel, Krause & Twining, 1957).

P. (Bucardiomya) ROLLIER in COSSMANN, 1912, p. 215 [*pro Bucardia* ROLLIER, 1911, p. 231 (*non* SCHUMACHER, 1817)] [**Pholadomya bucardium* AGASSIZ, 1842, p. 77; SD Cox, herein] [=*Bureiomya* VORONETZ, 1937, p. 58 (type, *Pholadomya polymorpha* D'ORBIGNY, 1850, p. 360; SD Cox, herein)]. Subtrigonal or obliquely oval, not greatly elongated; umbones prominent and subangular in most species; no escutcheon; strength

of radial ribbing very variable. *L.Jur.(Toarc.)-L.Tert.*, cosmop.——Fig. F10,*1a*. **P. (B.) bucardium* Agassiz, M.Jur.(Bathon.), Switz.; LV ext., ×0.7 (Moesch, 1874).——Fig. F10,*1b,c*. *P. (B.) lirata* (J. Sowerby), M.Jur.(Bathon.), Eng.; *1b,c*, LV ext., both valves dorsal, ×1 (Cox, n).——Fig. F10,*1d*. *P. (B.) margaritacea* (J. Sowerby), U.Eoc., Italy; RV ext., ×1 (Moesch, 1874).

P. (Procardia) Meek, 1871, p. 184 [**Isocardia?*

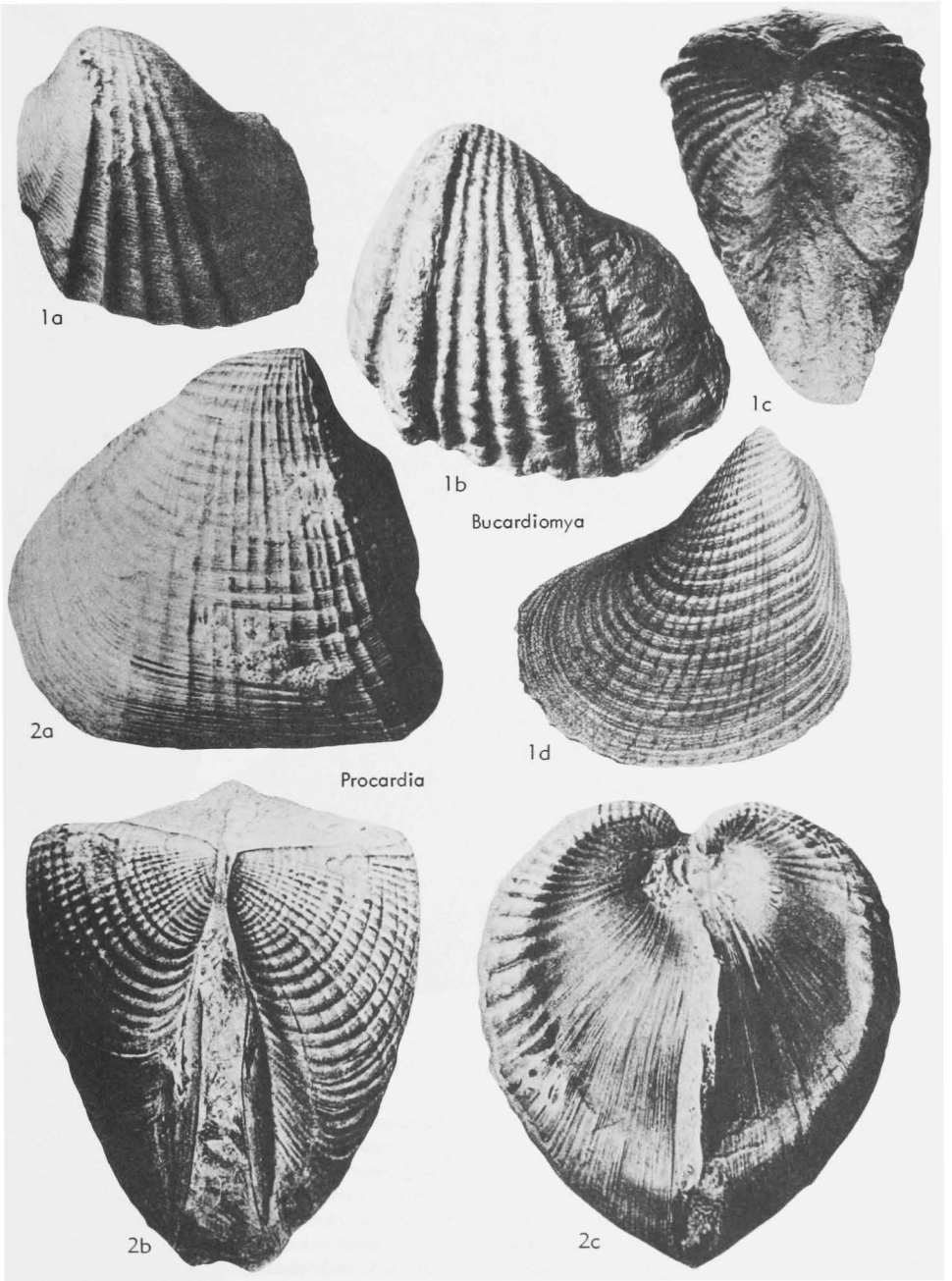

Fig. F10. Pholadomyidae (p. *N*828-*N*830).

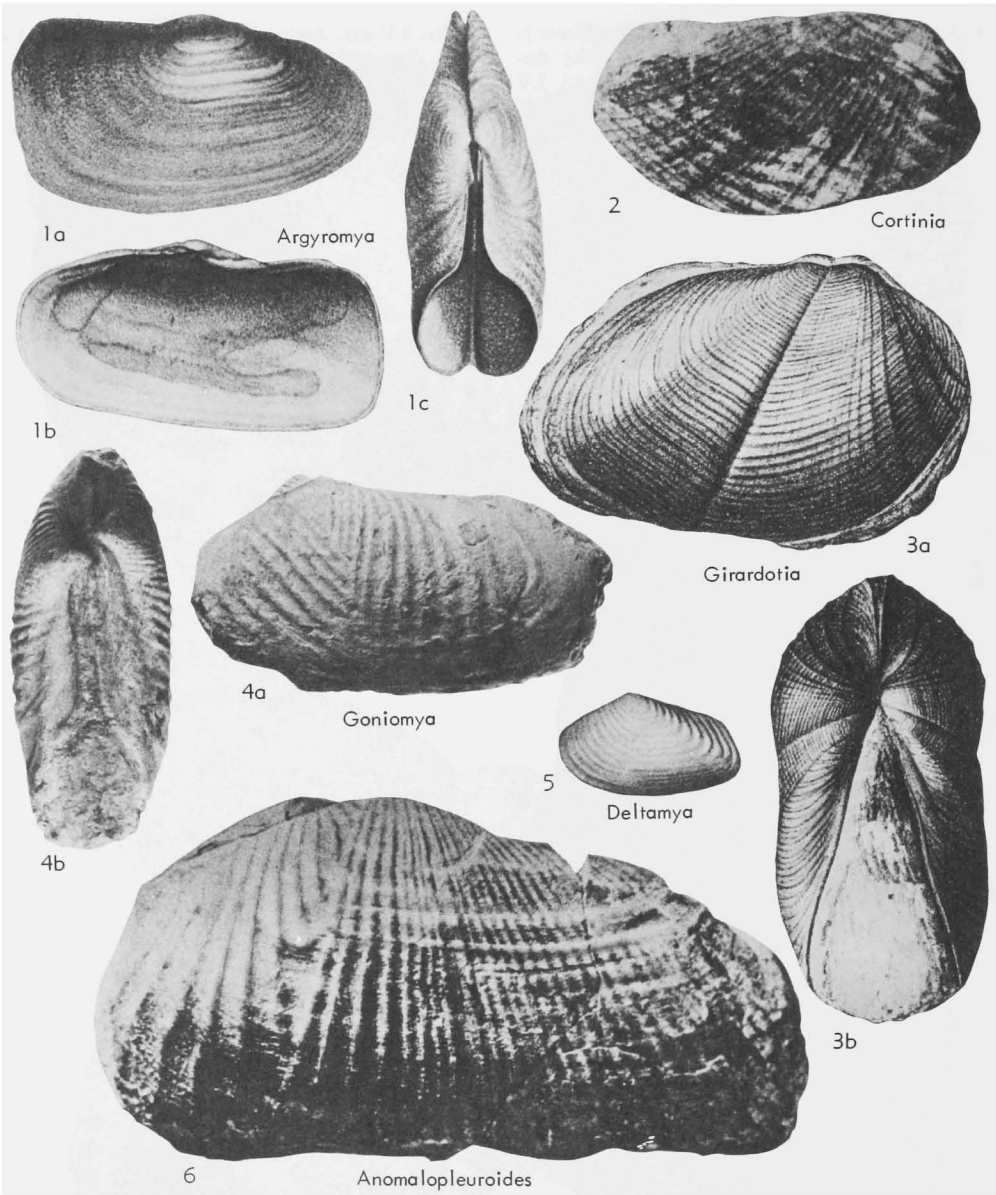

FIG. F11. Pholadomyidae (p. *N*830-*N*832).

hodgei MEEK, 1871, p. 183; M]. Relatively short, subtrigonal or oblong, with prominent umbones and strongly incurved, prosogyrous beaks; anterior end short, truncated, flattened or impressed, with still more impressed lunule under beaks; escutcheon distinctly bordered; flank ornamented with narrow radial costae and concentric ridges. *U.Jur.(Callov.)-U.Cret.(Turon.)*, cosmop.——FIG. F10,*2*. *P. (P.) decussata* (MANTELL), U.Cret. (Cenoman.), Eng.; *2a-c*, RV ext., both valves dorsal and ant. views, ×1 (Woods, 1909).

Anomalopleuroides Cox, 1962 [*pro Anomalopleura* LEONARDI, 1948, p. 62 (*non* KLEINE, 1916)] [**Anomalopleura elisae* LEONARDI, 1948; M]. Small-medium sized, elongate-ovate, fairly strongly inflated, with wide posterior gape; umbones obtusely rounded, scarcely protruding, placed at about anterior third of length; posterior two-thirds of shell

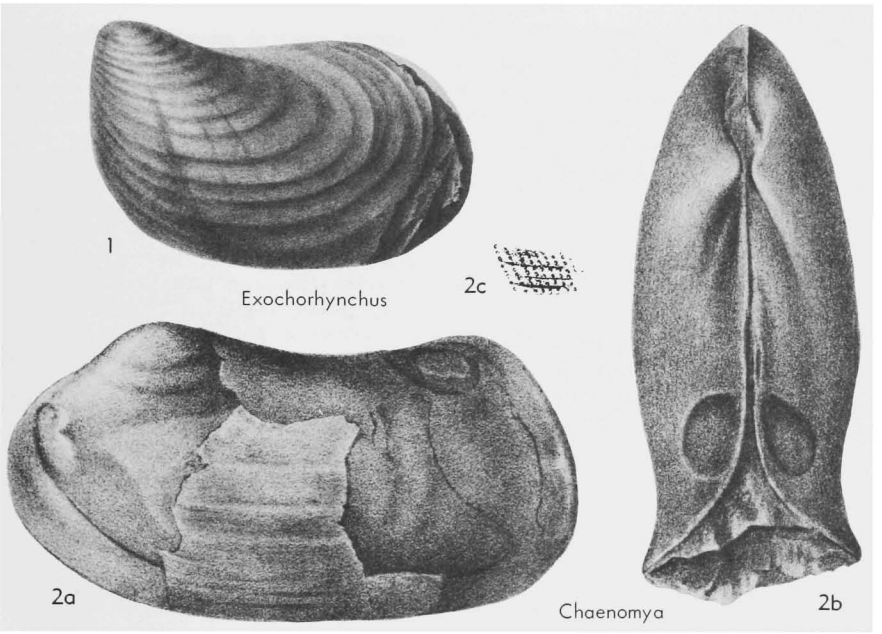

FIG. F12. Pholadomyidae (p. *N*831).

ornamented with narrow, closely spaced radial ribs, anterior third with more widely spaced, oblique, steep ribs which meet last rib of radial series in acute angle; internal characters unknown. *U.Trias.*, Austria(S.Tirol).——FIG. F11,*6*. **A. elisae* (LEONARDI); LV ext., ×1.3 (Leonardi, 1948).

Argyromya FISCHER, 1887, p. 1166 [**Glycimeris margaritacea* LAMARCK, 1818, p. 458; OD (cited as *"Panopaea margaritacea* DESHAYES")] [=*Aigyromya* DONCIEUX, 1911 *(nom. null.)*]. Medium-sized, oblong, subequilateral, moderately inflated, most so posteriorly, where very wide gape occurs; anterior gape narrow; umbones narrow, scarcely protruding; surface with irregular growth rugae; pustules minute, radially aligned, seen only in earlier growth stages; pallial sinus narrow and deep. *M.Eoc.*, Eu.(France).——FIG. F11,*1*. **A. margaritacea* (LAMARCK); *1a-c*, RV ext., RV int., and dorsal view of both valves, all ×1 (Deshayes, 1856).

Chaenomya MEEK, 1864, p. 42 [**Allorisma? leavenworthensis* MEEK & HAYDEN, 1858; M]. Shell smooth or ornamented with concentric folds; umbones prominent, situated about 0.25 of shell length from anterior margin; subcylindrical at beaks; without lateral sulcus or ventral sinus; siphonal gape extreme, equal to cross section of shell, or flaring slightly; pallial sinus deep. *Penn.-Perm.*, USA(Mid-Cont.); *Perm.*, Australia.——FIG. F12,*2*. **C. leavenworthensis* (MEEK & HAYDEN), U.Penn.; *2a,b*, LV lat. and hinge view of both valves, ×1; *2c*, detail of shell surface, enl., (Meek, in Meek & Hayden, 1864). [NEWELL]

Cortinia LEONARDI, 1948, p. 63 [**C. catharinae;* M]. Small, obliquely oval, inequilateral, *Pholadomya*-like but with obtuse ridge running from umbo toward posteroventral angle; ornamented with pustulose radial threads and with undulations which follow growth lines or are slightly oblique to them; internal characters unknown. *U.Trias.*, Austria(S.Tirol).——FIG. F11,*2*. **C. catharinae;* RV ext., ×2 (Leonardi, 1948).

Cosmomya HOLDHAUS, 1913, p. 446 [**C. egregia;* M]. Medium-sized, moderately inflated, with broadly rounded, well protruding, rather anteriorly placed umbo; ornament consisting of posterior series of steep, oblique ribs, some zigzagging posteriorly and bending up in V anteriorly, and of anterior series of ribs which are only slightly oblique to growth lines and meet the posterior series along shallow groove descending from umbo to ventral margin; internal characters unknown. *"Below Werfen beds," i.e. pre-Lower Trias.*,[1] Asia(Niti Pass, Himalayas), (Dickins & Shah, 1965).

Exochorhynchus MEEK & HAYDEN, 1864, p. 42 [**Allorisma? altirostrata* MEEK & HAYDEN, 1858; M]. Similar to *Wilkingia* but with terminal beaks; hinge and interior unknown. *Miss.-Penn.*, W.Eu.-N.Am.——FIG. F12,*1*. **E. altirostratus*, U.Penn., USA(Kans.), LV ext., ×0.7 (Meek & Hayden, 1864). [NEWELL]

[1] The type species of *Cosmomya*, thought by HOLDHAUS to be derived from Jurassic rocks, is probably Permian and seems to be congeneric with *Palaeocosmomya, fide* J. M. DICKINS (ed.).

Girardotia DE LORIOL, 1903, p. 133 [**G. elegans;* M]. Small to medium-sized, oval, slightly to moderately inequilateral, gibbose, with wide posterior and narrow anterior gape; slightly inequivalve, RV smaller; umbones broadly rounded, scarcely protruding; RV with radial groove, LV with ridge in some species and groove in others, running from umbo to posterior part ventral margin; ornament consisting of narrow concentric ribs present on entire surface or on anterior part only, and of concentric ridges; internal characters unknown. *M.Jur.-U.Jur.(Bajoc.-Kimmeridg.),* Eu.——FIG. F11,*3*. **G. elegans,* U.Jur.(Oxford.), France; *3a,b,* RV ext., and dorsal view of both valves showing gape, both ×1 (de Loriol, 1903).

Goniomya AGASSIZ, 1841, p. 275 [**Mya angulifera* J. SOWERBY, 1819, p. 46 (=**Mya intersectans* SMITH, 1817, p. 92; SD HERRMANNSEN, 1847, p. 486)] [=*Gonomya* AGASSIZ, 1838 *(nom. nud.); Gonyomya* HAUER, 1853 *(nom. van.); Gonimya* NECHAEV, 1894 *(nom. null.); Goniomyaa* PCHELINTSEV, 1924 *(nom. null.)*]. Small to medium-sized, ovate, moderately to strongly elongate and inequilateral, with broadly rounded to subangular umbones protruding slightly above dorsal margin; beaks almost orthogyrous; inflation moderate; posterior gape relatively wide, anterior gape narrow; diagonal ridge obtuse, rounded off; escutcheon shallow, its bordering ridges ill-defined except near umbones; anterior and posterior parts of surface with discordant ribbing; hinge structure unknown; pallial sinus present. *L.Jur.(L. Lias.)-Eoc.*

G. (Goniomya) [=*Lysianassa* MÜNSTER, 1838 (*non* EDWARDS, 1830); *Rhombomya* SACCO, 1901, p. 133 (type, *Lysianassa rhombifera* GOLDFUSS, 1840, p. 264)]. Ornament consisting of anterior and posterior series of steep oblique ribs inclined toward one another; in some species these meet along line from umbo to ventral margin forming series of V's, and in others they are separated by intervening rib parallel with growth lines or by almost smooth area. *L.Jur.(L.Lias.)-U.Cret. (Turon.),* cosmop.; *Eoc.,* Eu.(Italy).——FIG. F11,*4*. **G. (G.) intersectans* (SMITH), M.Jur. (Bathon.), Eng.; *4a,b,* LV ext., dorsal of both valves, ×1 (Cox, n).

G. (Deltamya) BURMEISTER, 1914, p. 21 [**D. jboehmi;* M]. Ribs on posterior and median parts of surface parallel with growth lines, those on anterior part slightly oblique to them but weak. *U.Cret.(Senon.),* Eu.(Ger.).——FIG. F11,*5*. **G. (D.) jboehmi* (BURMEISTER); LV ext., ×1 (Burmeister, 1914).

Homomya AGASSIZ, 1843, p. 154 [**Mactra gibbosa* J. SOWERBY, 1813, p. 91; SD HERRMANNSEN, 1847, p. 541]. Resembling *Pholadomya (Pholadomya)* in shape except that in some species umbones are less prominent; without radial ribbing, unless in earliest stages of growth; hinge margin smooth, uninterrupted; pallial sinus deep. *M.Trias. (Muschelkalk)-U. Jur. (Portland.),* cosmop. [The commoner Muschelkalk species which have been referred to this genus seem better included in *Pachymya (Arcomya).*]——FIG. F13,*3*. **H. gibbosa* (SOWERBY), M.Jur.(Bathon.), Eng.; *3a,b,* LV ext., both valves dorsal (holotype), ×0.7 (Cox, n).

Machomya DE LORIOL, 1868, p. 517 [**Panopaea dunkeri* D'ORBIGNY, 1850, p. 47 (*pro Solen jurensis* DUNKER, 1847, p. 131, incorrectly treated by D'ORBIGNY as a secondary homonym of *"Panopaea jurensis* BRONGNIART, 1821," presumably a mistake for *Mya? jurassi* BRONGNIART, 1821); M]. Resembling more compressed and elongate species of *Pachymya (Arcomya)* in external characters; interior of each valve with low oblique rib near anterior margin; ostracum moderately thick; details of hinge and pallial line unknown. *M.Jur.-U.Jur.(Bathon.-Kimmeridg.),* Eu.——FIG. F13,*2*. **M. jurensis* (DUNKER), U.Jur.(Kimmeridg.), France; *2a-c,* LV ext., both valves dorsal; LV ext. showing impression of internal rib; all ×1 (de Loriol, 1868).

?Molukkana KRUMBECK, 1923, p. 219 [**M. seranensis;* M]. Oblong, strongly inequilateral, with broad, moderately protruding, almost orthogyrous, well anteriorly placed umbones and rounded-off diagonal umbonal ridge; ostracum thick, ligamental nymph solid; hinge edentulous; pallial line and adductor scars unknown; ornament of irregular concentric undulations. [Possibly inseparable from *Pachymya (Pachymya)* but imperfectly known.] *U.Trias.(Nor.),* Indon.

Neoburmesia YABE & SATO, 1942, p. 251 [**N. iwakiensis;* OD]. Medium-sized, elongate-oblong, with prominent, anteriorly placed, broadly rounded umbones well incurved to orthogyrous beaks; strongly inflated, most so at mid-length; posterior gape moderately wide; strong carina in each valve from umbo to posteroventral angle, delimiting broad, elongate, partly concave posterior area, while on other side of umbo weaker radial ridge delimits small anterior area; escutcheon long, narrow, bordered by distinct ridges; median part of surface bearing radial and concentric ribs with tubercles at their intersections; posterior and anterior areas with weak concentric ornament only; internal characters unknown. *U.Jur.,* Japan.——FIG. F13,*1*. **N. iwakiensis; 1a,b,* LV ext. and dorsal view of both valves, ×1 (Tamura, 1960).

Osteomya MOESCH, 1874, p. 19 [**Mya dilata* PHILLIPS, 1829, p. 155 (cited as *"dilatata"*); M] [=*Goniomeris* CHOFFAT, 1893, p. 37 (type, *G. gaudryi;* M); *Uromya* ROLLIER, 1913, p. 262 (type, *Mya dilata* PHILLIPS; SD COSSMANN, 1921, p. 27); *Eurychasma* COSSMANN, 1915, p. 9 (type, *E. combesi;* M)]. Medium-sized, elongate-oblong, strongly

inequilateral, with broad, only slightly protruding, opisthogyrous umbones placed from anterior third to quarter of length; some specimens upcurved posteriorly; inflation moderately strong; shell truncated vertically posteriorly and with wide gape corresponding to complete cross section of shell; anterior gape absent or very narrow; ornament consisting of weak concentric undulations, irregu-

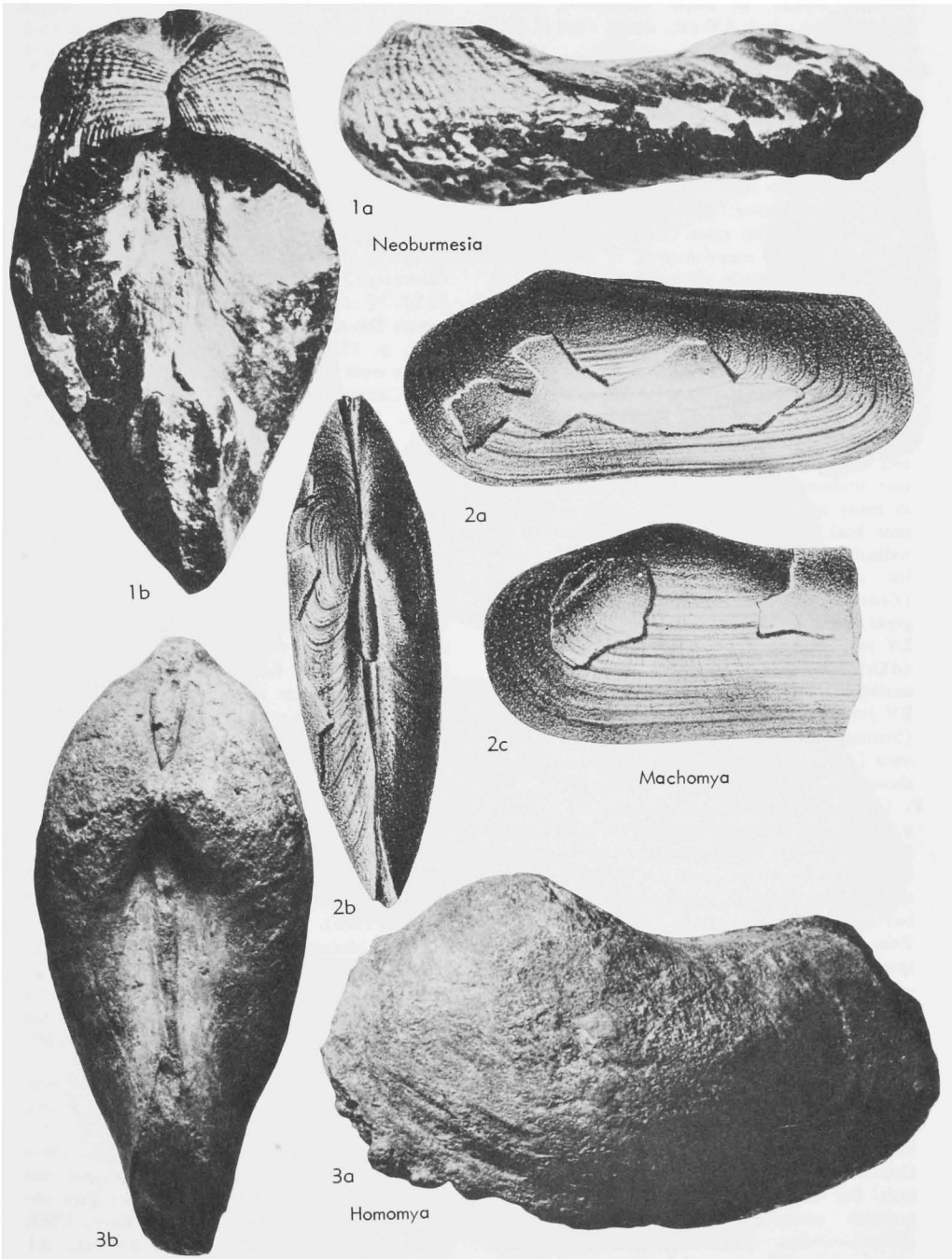

FIG. F13. Pholadomyidae (p. *N*832).

larly arranged except on anterodorsal part of surface; pustules relatively conspicuous, in closely spaced radial rows; internal characters unknown. *L.Jur.(Toarc.)-U.Jur.(Callov.),* Eu.-Madag.-E.Afr. ——Fig. F14,*1*. **O. dilata* (Phillips), M.Jur. (Bajoc.), Eng.; *1a,b,* LV ext., dorsal view of both valves, ×1 (Cox, n).

Pachymya J. de C. Sowerby, 1826, p. 1 [**P. gigas;* M]. Oblong, moderately to strongly inequilateral, with broad, only slightly protruding, almost orthogyrous umbones; posterior gape slight to moderate; most species with umbonal ridge, crossing most inflated part of shell, running diagonally to posteroventral corner; pallial line distant from shell margins; pallial sinus (where known) small or absent; surface unornamented in most species except for fine, radially aligned pustules, but with concentric undulations in some Triassic forms. *M.Trias.-U.Cret.,* cosmop.

P. (Pachymya) [=*Cratomya* Rollier, 1913, p. 287 (type, *Arcomya liesbergensis* Rollier, 1913, p. 286; M)]. Medium-sized to large, with umbones placed well anteriorly; moderately to strongly inflated, with diagonal ridge prominent; escutcheon broad, scarcely impressed, bordered by obtuse umbonal ridges; ostracum relatively thick in many species; hinge margin much thickened near beak and commonly with irregular longitudinal rugosities; ligamental nymphs stout; pallial sinus small or absent. *M.Trias.-U.Cret. (Cenoman.),* cosmop.——Fig. F14,*2a,b*. **P. (P.) gigas* Sowerby, U.Cret.(Cenoman.), France; *2a,b,* LV ext., and dorsal view of both valves, ×0.5 (d'Orbigny, 1843-47).——Fig. F14,*2c*. *P. (P.) austinensis* Shumard, L.Cret.(Alb.), USA(Tex.); RV int. showing hinge and pallial line, ×0.45 (Stanton, 1947).——Fig. F14,*2d*. *P. (P.) latissima* (Agassiz), U.Jur.(Oxford), Switz.; LV int., showing pallial line, ×0.7 (Rollier, 1913).

P. (Arcomya) Roemer (*ex* Agassiz, MS), 1839, p. 43 [**Solen helveticus* Roemer (*ex* Thurmann, MS), 1839; M]. Medium-sized, relatively weakly inflated; position of umbones variable; hinge structure not observed; pallial line (where known, but not seen in type species) without sinus. *M. Trias.-U.Cret.(Turon.),* cosmop. [The Triassic species have been included mostly in *Homomya.*] ——Fig. F15,*2a,b*. **P. (A.) helvetica* (Roemer), U.Jur.(Kimmeridg.), Switz.; *2a,b,* RV ext. and dorsal views of both valves, ×1 (Agassiz, 1843). ——Fig. F15,*2c*. *P. (A.)* sp., U.Jur., Scot.; RV int. mold showing pallial line, ×1 (Cox, n).

P. (Trichomyella) Cox, *nom. subst.* herein [*pro Trichomya* Crickmay, 1936, p. 558 (*non* Ihering, 1900, p. 87)] [**Trichomya amphitrite* Crickmay, 1936; OD]. Resembling *P. (Arcomya)* but without diagonal ridge; radial lines of pustules conspicuous. *U.Jur.(Callov.),* USA (Wyo.).——Fig. F15,*1*. **P. (T.) amphitrite* (Crickmay); RV ext., ×1.3 (Crickmay, 1936).

Palaeocosmomya Fletcher, 1946, p. 401 [**P. teicherti;* OD]. Medium-sized, ovate or oblong, variably elongated; with broadly rounded, unprotruding or slightly protruding umbones situated at or in front of the anterior third of length, and with feebly prosogyrous beaks; inflation moderate, posterior gape wide; escutcheon distinctly bordered; posterior 0.7 of surface bearing 2 convergent series of steep, oblique ribs which meet to form V's, anterior third with broader ribs which are only slightly oblique to growth lines; radial groove crossing latter series of ribs (that is, not marking boundary between them and V-shaped ribs) runs almost perpendicularly from umbo to ventral margin; internal characters unknown. [Regarded by Dickins & Shah (1965) as subgenus of *Cosmomya.*] *Perm.,* Australia-Greenland.——Fig. F15,*7*. **P. teicherti;* LV ext., ×1 (Cox, n).

Panacca Dall, 1905, p. 143 [*pro Aporema* Dall, 1903, p. 1532 (*non* Scudder, 1890)] [**Pholadomya arata* Verrill, 1881, p. 301; OD] [=*Notomya* Cotton, 1931, p. 342 (*non* M'Coy, 1847) (type, *Pholadomya tasmanica* Hedley & May, 1914, p. 132; OD); *Panacea* Salisbury, 1932 *(nom. null.)*]. Shell small for family, gibbous, subtriangular, inequilateral, anterior end more or less truncated and flattened transversely; anterior margin commonly sinuate and meeting anterodorsal margin in well-defined angle; beaks slightly prosogyrous; posterior gape narrow or absent; most species ornamented with unevenly spaced, narrow radial ridges absent from anterior end of shell (one species with radial threads only); surface pustules very fine; pallial line with shallow sinus; hinge margin simple, very little thickened; ligament entirely external. *Rec.,* cosmop. [Deep water. About seven known species are typical; *Pholadomya loveni* Jeffreys and *P. pacifica* Dall, which some authors have included in *Panacca,* disagree with the above diagnosis in being less trigonal and inequilateral.]——Fig. F15,*3a,b*. **P. arata* (Verrill), W.Atl.; side and ant. views RV, ×1 (Verrill, 1882, 1884).——Fig. F15,*3c,d*. *P. locardi* Dall, E.Atl.; LV ext. and RV int., ×1.3 (Locard, 1898).

Parilimya Melvill & Standen, 1899, p. 202 [**Pholadomya (Parilimya) haddoni;* M]. Small, oval, subequilateral, evenly and only moderately inflated; margins with narrow anterior but no posterior gape; ornament of weak radial threads; pallial line not observed; ligament entirely external; dorsal margin with toothlike thickening in front of beak in both valves. *Rec.,* Torres Straits.

Pentagrammysia Chernyshev, 1950, p. 22 [**P. altaica,* OD]. Superficially similar to *Undulomya* Fletcher, 1946, in form and ornamentation but without posterodorsal furrows; posterior gape obscure, if present. *L.Carb.,* Kuznetsk Basin, USSR (Sib.).——Fig. F16,*4*. **P. altaica;* RV ext., ×1 (Ebersin,1960). [Newell]

Praeundulomya DICKINS, 1957, p. 10 [**P. concentrica;* OD]. Medium-sized, oblong, elongate, with broad, scarcely protruding, well anteriorly placed umbones and prosogyrous beaks; inflation moderate, posterior gape narrow; escutcheon narrow, elongate, distinctly bordered; flank with 2 dorsal grooves like those of *Undulomya* but shallower; ornament consisting of irregular undula-

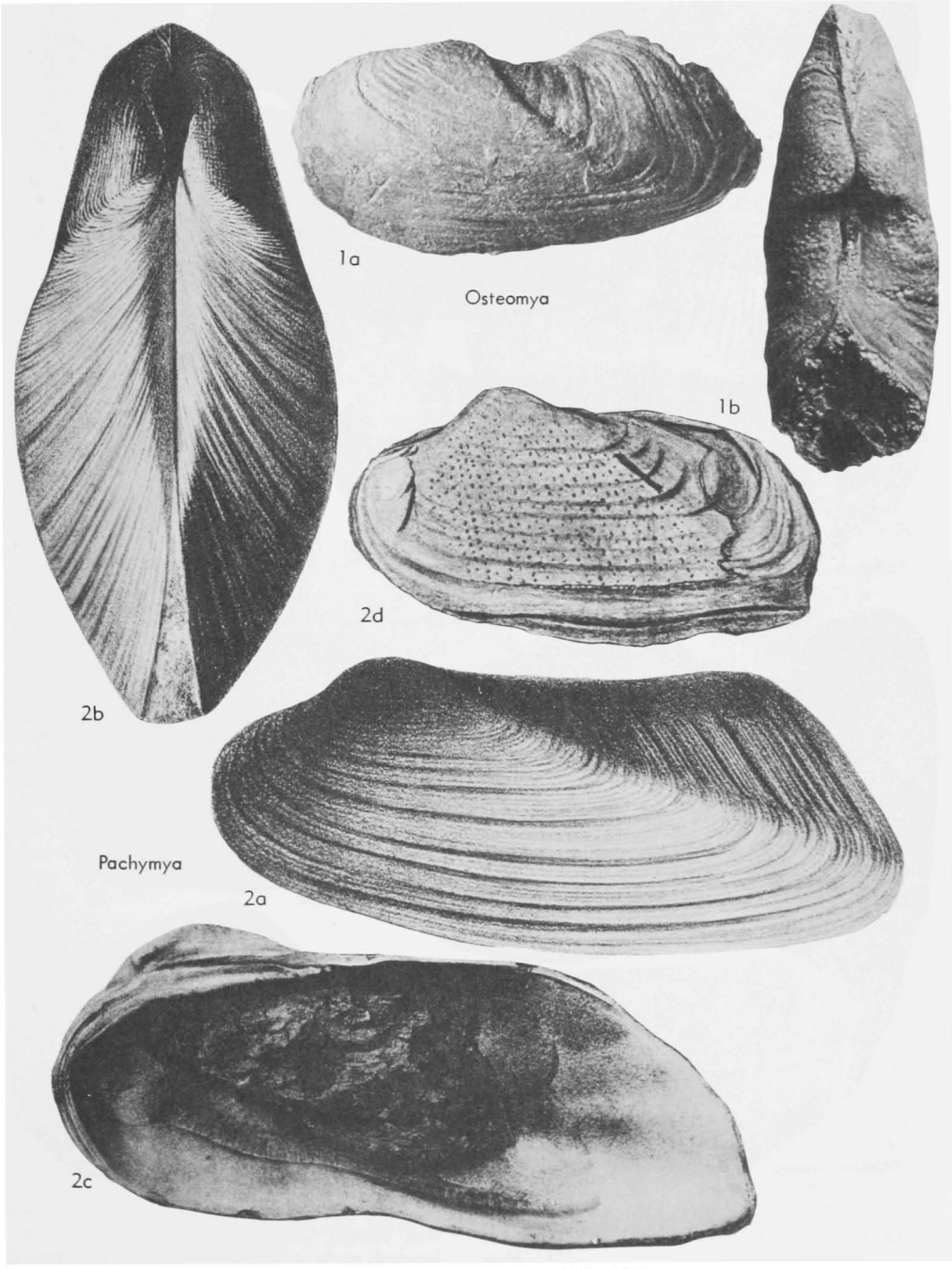

FIG. F14. Pholadomyidae (p. *N*833-*N*834).

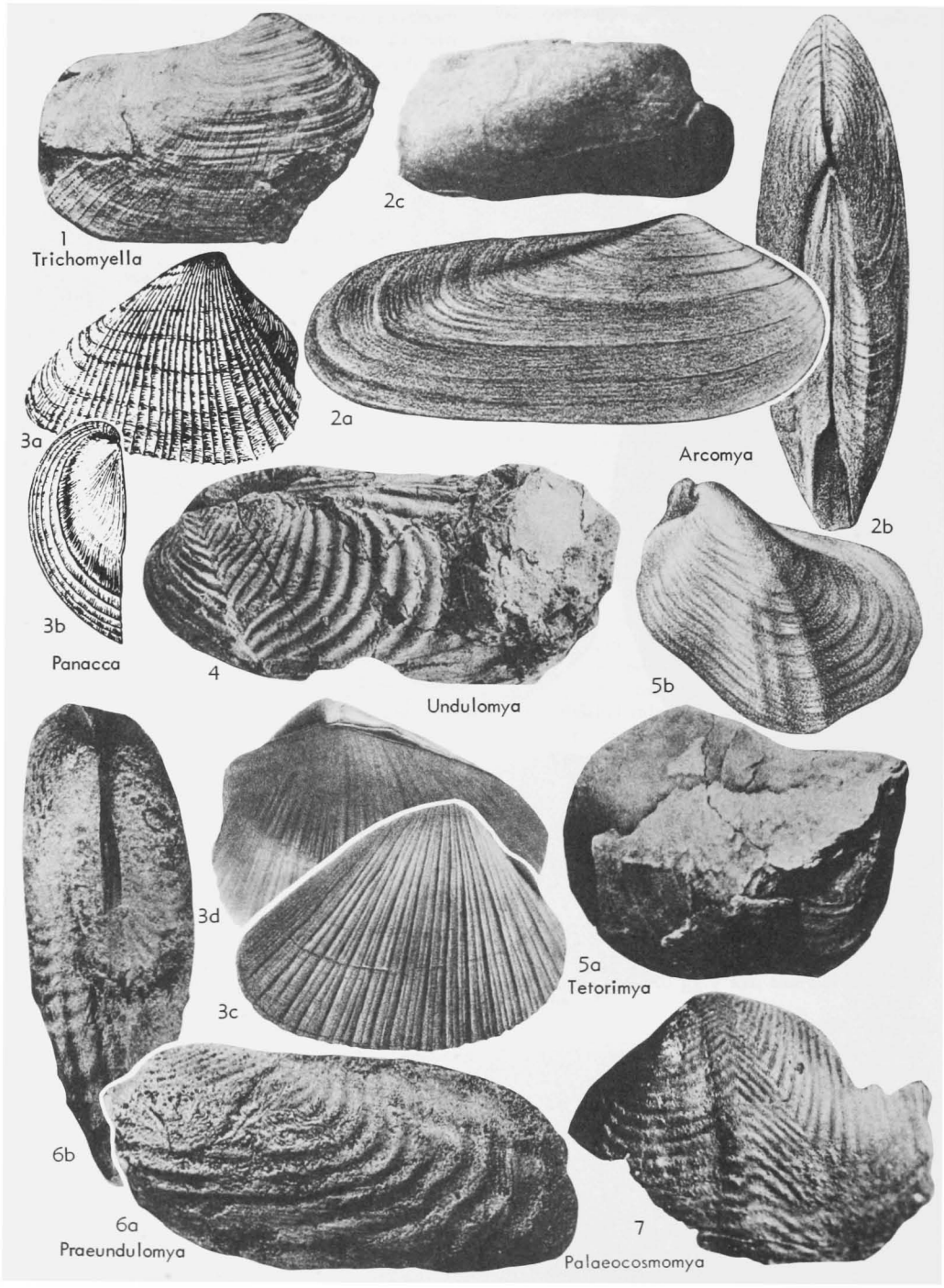

FIG. F15. Pholadomyidae (p. *N*834-*N*835, *N*837-*N*838).

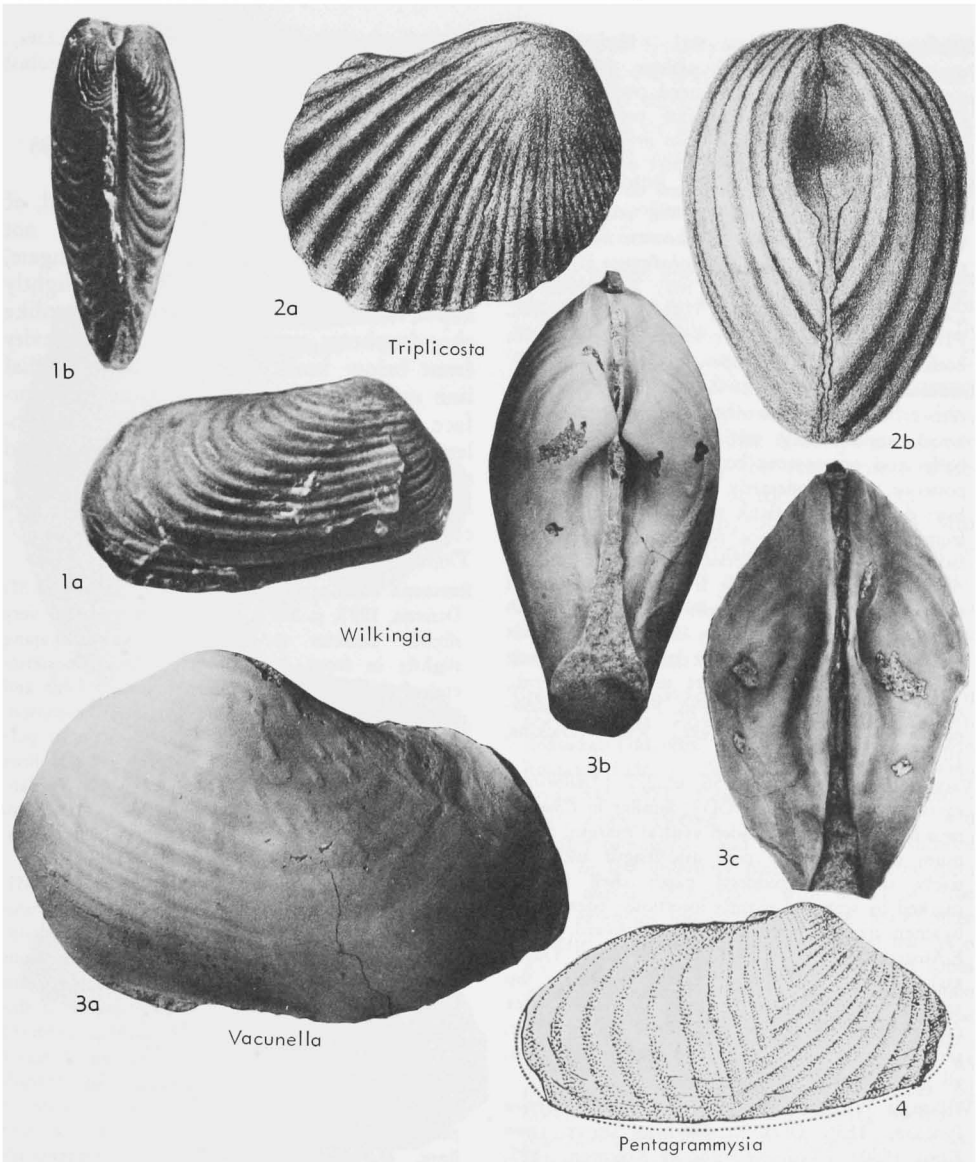

FIG. F16. Pholadomyidae (p. *N*834, *N*837-*N*838).

tions, which, although almost concentric, are slightly oblique to growth lines on most parts of surface; V-shaped ribs absent; internal characters unknown. *L.Perm.*, Australia-?Kashmir-S. Am.(Peru).——FIG. F15,*6*. **P. concentrica*, W. Australia; *6a,b*, LV ext. (imperfect anteriorly) and dorsal view of both valves, ×1 (Dickins, 1957).

Tetorimya HAYAMI, 1959, p. 159 [**T. carinata*; OD]. Medium-sized, trapezoidal, highest near posterior end, well inflated, most so along diagonal (which may form distinct ridge) from umbo to posteroventral angle of shell; posterior gape narrow or absent; umbo narrow, protruding, placed well anteriorly and incurved to prosogyrous beak; anterior part of ventral margin with broad sinus to which radial sulcus of flank corresponds; pallial line with deep sinus; surface with coarse growth rugae; internal features of hinge unknown. *U.Jur.*, Japan-Alaska-USSR.——FIG. F15,*5a*. **T. carinata*, Japan; RV ext., ×1 *(392)*.——FIG. F15,*5b*. *T. panderi* (EICHWALD), Alaska; LV ext., ×1 (Eichwald, 1871).

?Triplicosta COOPER, 1897, p. 333 [**Pholadomya*

(Triplicosta) progressiva; M]. Medium-sized, ovate, not much elongated, gibbose, strongly inequilateral, with broadly rounded, well anteriorly placed umbones; with moderate posterior gape; ornament of rounded radial ribs which are relatively broad on the posterior part of the surface and margins and clearly arranged on the anterior part; internal characters unknown; ostracum relatively thick, not nacreous in known fossil specimens. [While included in *Pholadomya* it is also suggested that this species may be related to *Cardita* or *Petricola.*] *?Eoc.*, USA(Calif.).——FIG. F16,*2*. **T. progressiva* (COOPER); *2a,b,* RV ext., both valves ant., ×1 (Cooper, 1897).

Undulomya FLETCHER, 1946, p. 391 [**U. pleiopleura;* OD]. Medium-sized, elongate-ovate, with broad, unprotruding, well anteriorly placed umbones and prosogyrous beaks; inflation moderate, posterior gape moderately wide; escutcheon shallow; dorsal part of flank with 2 grooves running from umbo to posterior margin; ornament consisting of 2 convergent series of straight or curved ribs which meet along line from umbo to ventral margin; ribs of posterior series strongly oblique to growth lines, while obliquity of anterior series is variable and they are almost concentric in some specimens; internal characters unknown. *Perm.*, Australia-Afr.(Madag.).——FIG. F15,*4*. **U. pleiopleura,* W.Australia; LV ext., ×0.7 (Dickins, 1956).

Vacunella WATERHOUSE, 1956, p. 277 [**Allorisma curvatum* MORRIS, 1845; OD]. Similar to *Chaenomya* but with more rounded ventral margin, maximum shell convexity near mid-length and relatively small posterodorsal gape; shell interior marked by scattered mantle insertions; edentulous; ligament nymphs heavy and rolled outward. *Perm.*, E.Australia.——FIG. F16,*3*. **V. curvatum* (MORRIS), L.Perm., Wollongong, New S. Wales; *3a,* top view of LV int. mold; *3b,* same, int. hinge, latex cast showing interior of amphidetic ligament; *3c,* same showing pallial sinus and mantle insertions, all ×0.4 (Newell, n). [NEWELL]

Wilkingia WILSON, 1959, p. 401 [**Venus elliptica* PHILLIPS, 1836; OD] [=*Allorisma* AUCTT. (*non* KING, 1850); *?Tellinomorpha* DE KONINCK, 1885, p. 90 (type, *T. cuneiformis;* OD)]. Elongate oval, subcylindrical at beaks; beaks placed 0.2 to 0.25 behind front margin; anterior and posterior extremities rounded, dorsal and ventral margins subparallel; broad, shallow sulcus extending ventrally from umbones across anterior half of valves; escutcheon and elongate lunule present; umbonal ridge broad and poorly developed; valves marked by regular broad and rounded concentric folds; radial rows of small papilli present, especially on posterodorsal area; adductor scars shallow, without buttresses; shallow pallial sinus present; with or without narrow posterior gape; ligament nymphs short and weak; hinge edentulous. *Miss.-Perm.*, cosmop.——FIG. F16,*1*. **W. elliptica* (PHILLIPS), L.Carb., Eng.(Redesdale); *1a,b,* RV and cardinal views, ×1 (Wilson, 1959). [NEWELL]

Family BURMESIIDAE Healey, 1908

[Materials for this family prepared by L. R. Cox]

Medium-sized, equivalve, thin-shelled, of moderate convexity, well elongated, not strongly inequilateral; hinge line elongate, umbones broad and protruding only slightly above it; each valve with narrow, spoonlike chondrophore extending into shell cavity from below beak; no hinge teeth; pallial line and adductor scars not observed; surface elaborately ornamented with radial riblets together with concentric folds and threads, radial riblets predominating on middle of each valve; whole surface also covered with rows of minute granules. *U. Trias.-L.Jur.(Lias.).*

Burmesia HEALEY, 1908, p. 58 [**B. latouchii;* SD DIENER, 1923, p. 247]. Elongate-ovate, beaks very slightly anterior to mid-length; valves gaping slightly in front, more widely behind; posterior end of shell ornamented with concentric folds and subordinate radial threads, anterior end commonly bearing depressed folds which are almost perpendicular to hinge line and cross growth lines obliquely. *U. Trias.-L. Jur.(Lias.),* Asia(Jordan-Burma-Indonesia-Japan).——FIG. F17,*1*. *B. lirata* HEALEY, U.Trias.(Rhaet.), Burma; pair of valves, RV below, ×1 (Healey, 1908).

Prolaria HEALEY, 1908, p. 60 [**P. sollasi;* M]. Presumed posterior end of shell forming rostrum-like projection truncated at its extremity and situated in relatively dorsal position with deep sinus below it; sharp sigmoidally curved carina runs in each valve from umbo to lower corner of this projection; predominant radial ribbing confined to posteromedian part of surface; strong, irregular concentric folds with subordinate radial threads cover anterior half of surface, while posterior projection is unornamented except for growth lines. *U.Trias.(Rhaet.),* Asia(Burma-Armenia-Indon.).——FIG. F17,*2a,b*. **P. sollasi,* Burma; *2a,* part of RV ext., showing posterior projection, *2b,* more complete but crushed RV, both ×1 (Healey, 1908).——FIG. F17,*2c,d*. *P. armenica* ROBINSON, Armenia; *2c,d,* RV ext. and dorsal view of both valves, post. extremity broken away, ×1 (Kiparisova, 1947).

Family CERATOMYIDAE Arkell, 1934

[=Ceromyidae FISCHER, 1887 (invalid because based on junior homonym)] [Materials for this family prepared by L. R. Cox]

Shell ovate, longer than high, inequilateral, moderately to strongly inflated, some

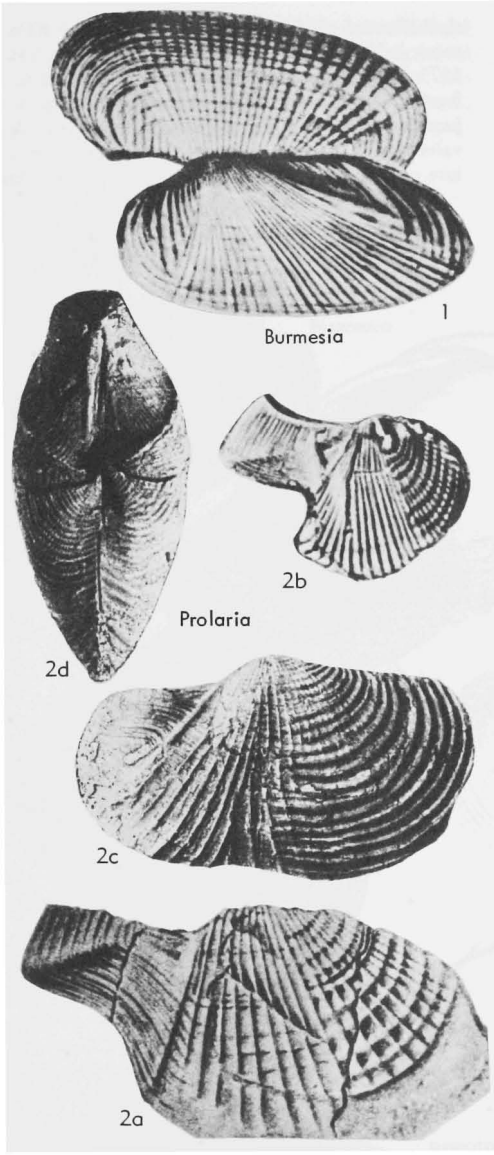

FIG. F17. Burmesiidae (p. *N*838).

specimens inequivalve; valve margins closed or with narrow posterior gape; shell wall rather thin; beaks prosogyrous; no demarcated lunule or escutcheon; ligament opisthodetic, subinternal, located between reflected and thickened posterodorsal margin of LV and overlapping margin of RV, which has subinternal thickening protruding into cavity of valve, giving rise in *Ceratomya* and *Gresslya* to slit extending back from beak on internal mold of many specimens; true hinge teeth absent, replaced by thickenings or protuberances of dorsal margins; pallial line variable; surface with variously oriented plications or unornamented except for minute pustules present in some forms. *U.Trias.-U.Jur., ?Mio.*

The hinge apparatus is so closely similar in *Ceratomya* and *Gresslya* that their union in the same family seems justified, especially as the earlier species of *Ceratomya* (e.g., *C. petricosa* of the Lias) lack the external ribbing which renders some of the later species so much unlike *Gresslya* in appearance. Nevertheless, the two genera differ greatly in the form of the pallial line.

It seems most improbable that the Miocene genus *Ceromyella* was (as thought by its author, SACCO) a survivor of the Ceratomyidae, but, for lack of definite evidence as to its affinities, it is here listed under this family, but with a query.

Ceratomya SANDBERGER, 1864, p. 16 [*nom. subst. pro Ceromya* AGASSIZ, 1842] [*non Ceromya* ROBINEAU-DESVOIDY, 1830] [**Isocardia excentrica* ROEMER, 1836, p. 106; ICZN pend.] [=*Ceromia* STOLICZKA, 1871 *(nom. null.)*]. Medium-sized to large, ovate, gibbose, especially anteriorly, with strongly prosogyrous and in some species incoiled, more or less anteriorly placed beaks; some specimens slightly inequivalve, with umbo of either valve extending more anteriorly than that of other; no gape of valve margins; posterodorsal margin of RV with thin outer flange separated from subinternal thickening by groove in which ligament was inserted, corresponding groove on upper (outer) side of reflected margin serving same purpose in LV; anterodorsal margin of RV much thickened below beak in some species; adductor scars small; pallial line bending up sharply posteriorly, shallowly sinuate in some species; surface smooth or (more commonly) with concentric or oblique undulations. *L.Jur.-U.Jur.*, cosmop.—— FIG. F18,*1a*. **C. excentrica* (ROEMER), *U.Jur.(L. Kimmeridg.)*, France; LV ext., ×1 *(549)*.—— FIG. F18,*1b-d*. *C. aalensis* (QUENSTEDT), M.Jur. (Bajoc.), France; *1b-d*, LV int., RV int., and int. mold showing pallial line and adductor scars, all ×0.7 (Benecke, 1905).——FIG. F18,*1e*. *C. petricosa* (SIMPSON), L.Jur.(M.Lias.), Eng.; LV ext. of a smooth species, ×1.3 (Cox, n).——FIG. F18,*1f*. *C. bajociana* (D'ORBIGNY), M.Jur.(Bajoc.), Eng.; transv. sec. through hinge region short distance behind beaks, LV and RV as oriented, former position of ligament dotted, ×2 (Cox, n).

?**Ceromyella** SACCO, 1901, p. 133 [**C. miotaurina;* M]. Like *Ceratomya* in shape but only 6 mm. long; internal characters unknown. *Mio.(Helvet.),* N.Italy.

Gresslya AGASSIZ, 1843, p. 202 [**Lutraria gregaria* ZIETEN, 1833, p. 85; SD HERRMANNSEN, 1847, p. 490, as "*Lutraria gregaria* GOLDFUSS"] [=*Gresslyia* BRONN, 1848 *(nom. van.); Greslya* D'ORBIGNY, 1850 *(nom. null.); Gressluya* PAETEL, 1875 *(nom. null.)*]. Ovate, usually with cuneiform tendancy, moderately elongate, umbones not prominent, that of RV slightly higher than LV; valves with narrow posterior gape; hinge structure as defined for family, slit extending back from

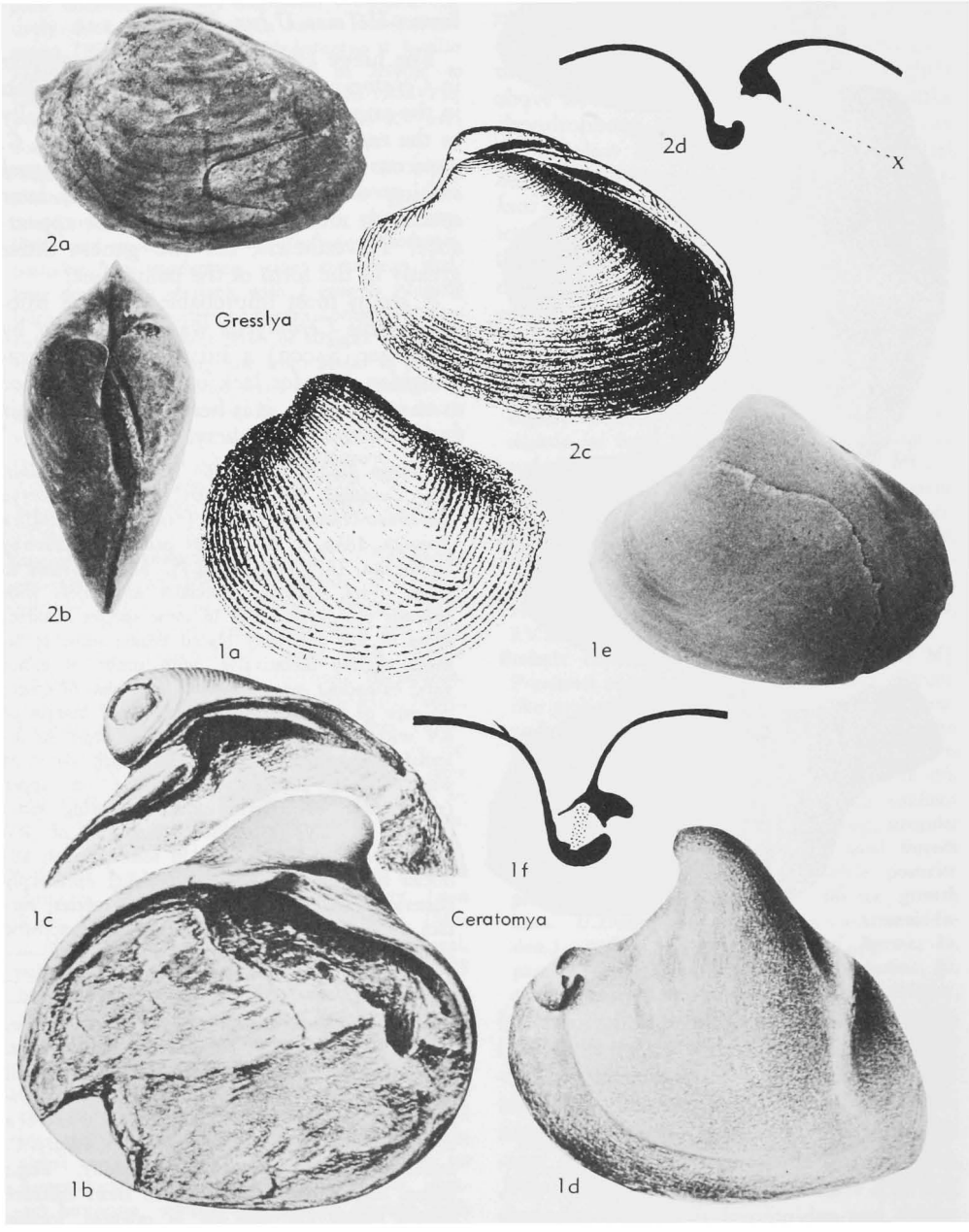

FIG. F18. Ceratomyidae (p. *N*839-*N*841).

beak on internal molds of RV even better defined and more constant than in *Ceratomya;* both valves in some specimens with a weak tooth-like callosity of the antero-dorsal margin near the beak; pallial line with a deep sinus; surface without conspicuous ornament but bearing very fine pustules or puncta radially aligned. *L.Jur.-U.Jur.,* cosmop. ——Fig. F18,*2a,b. G. peregrina* (Phillips), U. Jur.(Oxford), Eng.; *2a,b,* LV int. mold showing pallial sinus, dorsal view of both valves showing slit extending back from beak in RV, ×1.3 (Cox, n).——Fig. F18,*2c. *G. gregaria* (Zieten), M. Jur.(Bajoc), Ger.; LV ext., ×1 (Schmidtill, 1926). ——Fig. F18,*2d. G. abducta* (Phillips), M.Jur. (Bajoc.), Eng.; transv. sec. through hinge region short distance behind beaks, LV and RV as oriented, edge marked "X" giving rise to the slit on internal molds; ×3.3 (Cox, n).

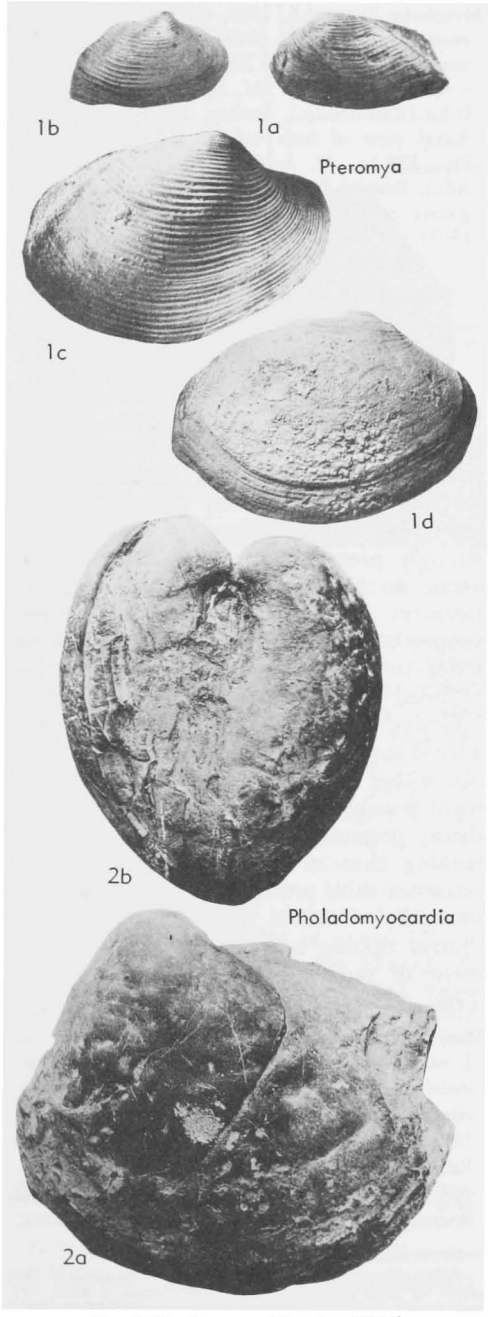

Fig. F19. Ceratomyidae (p. *N*841).

?**Pholadomyocardia** Szajnocha, 1889, p. 88 [**P. jelskii;* M]. Large, inequivalve, gibbose, slightly longer than high; valves with a broadly trigonal body and a flattened winglike postero-dorsal extension; umbones placed well anteriorly, protruding moderately, prosogyrous, the right one higher than the left; surface with a few broad, irregular, concentric folds; internal characters unknown. *Jur.,* S.Am.(Peru).——Fig. F19,*2. *P. jelskii, 2a,b,* LV ext. and ant. view of both valves, ×0.5 (Szajnocha, 1889).

Pteromya Moore, 1861, p. 505 [**P. crowcombeia;* SD Stoliczka, 1871, p. xv]. Subovate, subequilateral or inequilateral to a varying extent, not strongly inflated, slightly to moderately inequivalve, right valve the more gibbose and with its umbo the more elevated; valve margins not gaping; umbones broad, protruding very little; posterodorsal and posterior margins forming continuous, strongly convex curve or else meeting in obtuse angle, in which case very obtuse posterior ridge may be present in one or both valves; hinge structure as in *Ceratomya* and *Gresslya;* adductor scars and pallial line not yet observed, the latter probably without a sinus; surface with concentric undulations or ridges, or merely with coarse growth threads. *U.Trias.(L. Rhaet.)-L.Jur.(L. Hettang.),* Eu.——Fig. F19,*1a,b. *P. crowcombeia,* L.Rhaet., Eng.; *1a,b,* LV ext., and RV ext., of different specimens, ×1 (Cox, n).——Fig. F19,*1c,d, P. tatei* (Richardson & Tutcher), L.Hettang., Eng.; *1c,d,* RV ext. with and without posterior ridge, all ×1 (Cox, n).

Family MYOPHOLADIDAE Cox, 1964

[Materials for this family prepared by L. R. Cox]

Shell medium-sized, elongate-ovate, some specimens with slight tendency to be rostrate posteriorly; umbones broadly rounded, scarcely protruding, situated anterior to mid-length and strongly incurved to slightly prosogyrous beaks; inflation of shell strong below umbones, diminishing regularly in posterior direction; valve margins with

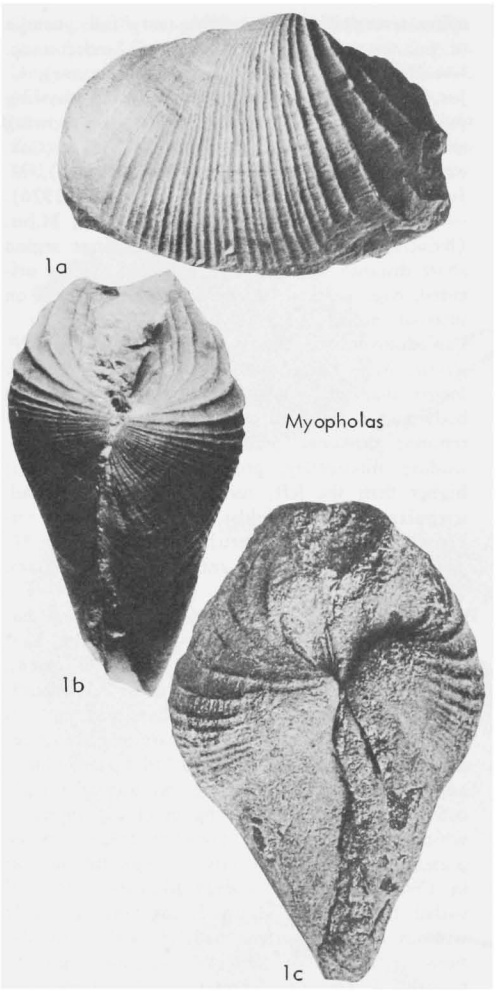

FIG. F20. Myopholadidae (p. N842).

rather wide posterior and narrow anterior gape; ornament of narrow radial ribs which are widely separated on anterior part of surface and relatively closely arranged on median part; in some species strong and fairly closely arranged ribs continue almost to posterior extremity, but in others posterior end of shell is sparsely ribbed or almost smooth; dorsal margin of RV overlapping that of LV, with subinternal ligament lying between them, as in *Ceratomya* and *Gresslya;* sharp edge of thickening of dorsal margin of right valve which projects into cavity of valve gives rise to groove extending back from beak on internal mold, as in those two genera; adductor scars and pallial line unknown; ostracum thin, probably originally nacreous internally. *M.Jur. (Bathon.)-L.Cret.(U.Alb.).*

Myopholas DOUVILLÉ, 1907, p. 107 [**Pholadomya multicostata* AGASSIZ, 1842, p. 52; OD]. Characters and distribution of family. *M.Jur.-L.Cret.,* Eu. ——FIG. F20,*1a,b.* **M. multicostata* (AGASSIZ), U.Jur.(Kimmeridg.), Switz.; *1a,b,* RV ext. and dorsal view of both valves, ×1 (Cox, n).—— FIG. F20,*1c. M. ledouxi* DOUVILLÉ, L.Cret.(U. Alb.), France; dorsal view of both valves showing groove on RV of internal mold, ×1 (Douvillé, 1907).

Family PLEUROMYIDAE Dall, 1900

[*nom. correct.* ZITTEL, 1903 (*pro* Pleuromyacidae DALL, 1900, *ex* ZITTEL MS)] [Materials for this family prepared by L. R. Cox]

Shell of medium size, equivalve, oval, oblong or trapeziform, moderately to strongly inflated, with narrow to moderately wide posterior gape; umbones situated within anterior half and usually well toward anterior end of shell, broadly rounded, not strongly protruding; no demarcated dorsal areas; no true hinge teeth; main part of ligament external, opisthodetic, with short supporting nymphs; below and slightly anterior to the beak of each valve is short, rounded protuberance of margin, slightly hollowed out above, and behind protuberance is small niche; protuberance of RV fits above that of the left, a small internal ligament possibly occupying the space between them; postero-dorsal margin of RV overlapping that of LV; pallial sinus deep; ostracum thin, probably originally nacreous internally. Surface with or without concentric ribbing and with a delicate ornament of radial rows of minute pustules. *Trias.-L.Cret.*

Pleuromya AGASSIZ, 1842, p. 439 [**Mya gibbosa* J. DE C. SOWERBY, 1823, p. 19 (=**Donacites alduini* BRONGNIART, 1821, p. 555); M] [=*Myacites* VON SCHLOTHEIM, AUCTT.[1]; *Anaplomya* KRAUS, 1843, p. 130 (type, *A. lutraria;* M); *Anoplomya* KRAUS, 1850 *(nom. null.); Hapalomya* ROEDER, 1882, p. 102 (type, *H. fragilis;* M); *Hapalomia* ROEDER, 1882 *(nom. null.); ?Fogiella* KRUMBECK,

[1] This generic name, applied particularly to shells of this genus by some early authors, merely denoted a fossil *Mya* and is not available for purposes of nomenclature (Zool. Code, 1961, Art. 20).

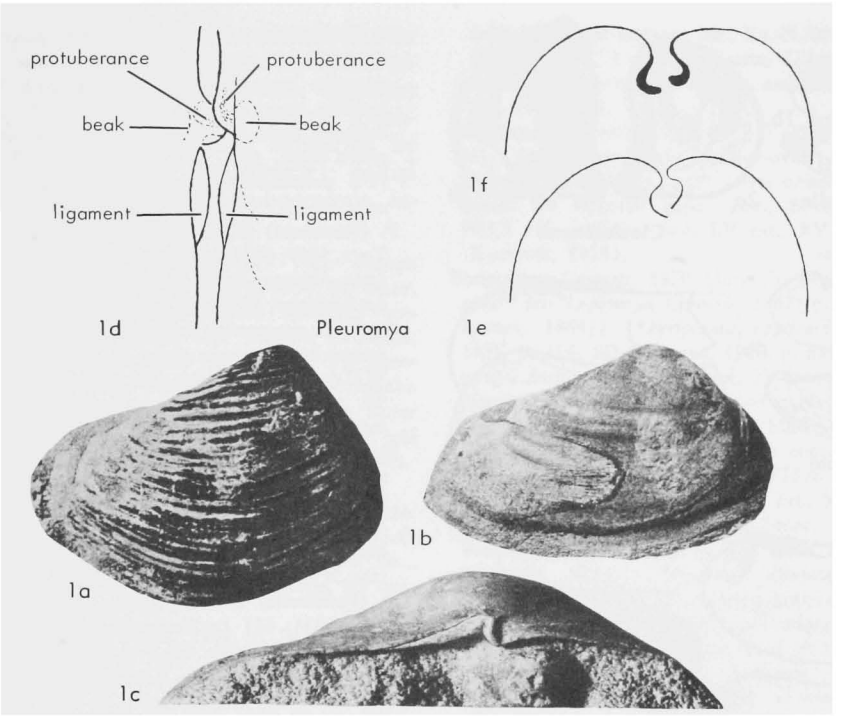

FIG. F21. Pleuromyidae (p. *N*842-*N*843).

1913, p. 57 (type, *F. deningeri;* M)]. Characters of family. *Trias.-L.Cret.,* cosmop.——FIG. F21,*1a.* **P. alduini* (BRONGNIART), U.Jur.(U.Oxford Clay), Eng.; RV ext., ×1 *(19f).*——FIG. F21,*1b. P. uniformis* (J.SOWERBY), U.Jur.(Oxford), Eng.; RV composite ext.-int., showing pallial line, etc. (not retouched), ×1 (Cox, n).——FIG. F21,*1c. P. uniformis,* U.Jur.(Corallian Beds), Eng.; LV hinge tilted slightly toward observer, showing protuberance just anterior to beak, ×2 (Cox, n).——FIG. F21,*1d. P. marginata* AGASSIZ, M.Jur.(Bathon.), France; diagram showing relation between protuberances of hinge margins of valves, LV on left, enl. (Douvillé, 1907).——FIG. F21,*1e,f. P. uniformis,* M.Jur.(Inf. Oolite), Eng.; *1e,f,* transverse sections through dorsal region of slightly separated valves, on left, *1e* just behind, *1f* just in front of beaks, ×2 (Cox, n).

Superfamily PANDORACEA Rafinesque, 1815

[*nom. transl.* STEWART, 1930 (*ex* Pandoridae RAFINESQUE, 1815)] [Materials for this superfamily prepared by MYRA KEEN with additions as recorded]

Sedentary to burrowing forms, shell material nacreous, at least inner layer; mostly thin, somewhat elongate or gaping, inequivalve; hinge without regular heterodont dentition but hinge margin variously reinforced by buttresses or denticles; ligament and resilium sheathed with a calcareous layer or lithodesma in many forms. *U.Trias.-Rec.*

Family PANDORIDAE Rafinesque, 1815

[*nom. correct.* GRAY, 1840 (*pro* family Pandoracia RAFINESQUE, 1815)] [Materials for this family prepared by MYRA KEEN]

Compressed, inequivalve, dorsal border of one valve overlapping other; ligament wanting, resilium internal, reinforced in some by elongate lithodesma; dorsal margin edentulous but with laminar buttresses beside the resilium; pallial line entire. *Oligo.-Rec.*

Pandora BRUGIÈRE, 1797 (genus without species) [**Solen inequivalvis* LINNÉ, 1758; SM LAMARCK, 1799] [=*Calopodium* RÖDING, 1798 (obj.); *Trutina* BROWN, 1827 (type, *T. solenoidea,* =*Solen pinna* MONTAGU, 1803; M)]. Of medium size, flat, thin, RV flatter than LV, dorsal border convex; anterior end rounded, posterior rostrate. *Oligo.-Rec.,* N. Am.-S. Am.-C.Am.-Eu.-Pac.-Ind.O.

P. (Pandora). Sculpture of RV feebly concentric; without lithodesma. *Oligo.-Rec.,* W.N.Am.-Eu.-

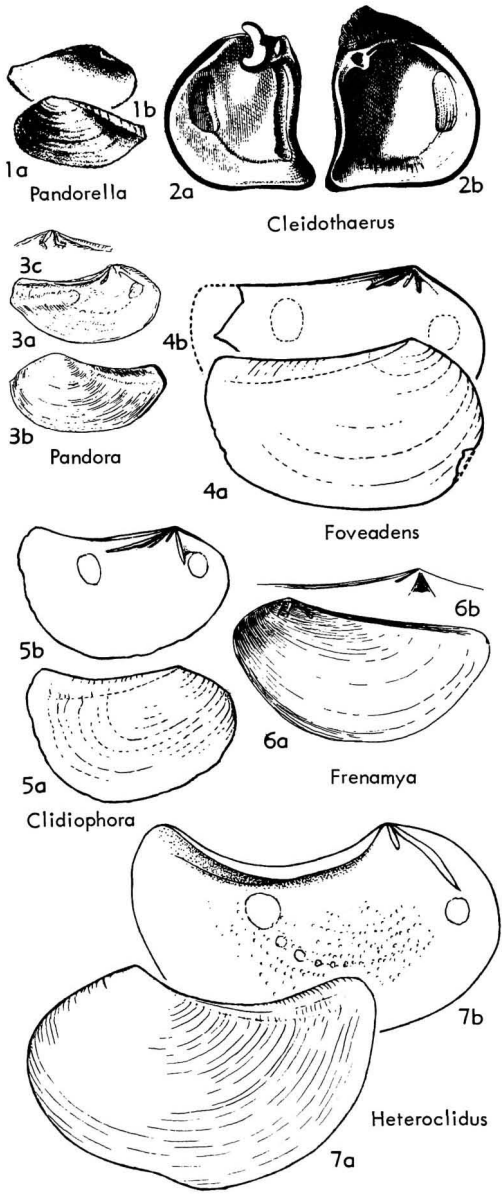

FIG. F22. Pandoridae *(1,3-7)*; Cleidothaeridae *(2)* (p. *N*843-*N*844).

W.Pac.——FIG. F22,*3*. **P. (P.) inaequivalvis* (LINNÉ), Rec., Eu.; *3a-c*, LV int., ext., RV hinge, ×1 *(7c)*.

P. (Clidiophora) CARPENTER, 1864 [**P. claviculata* CARPENTER, 1856; OD]. With 3 laminae in either valve; lithodesma present. *Mio.-Rec.*, E.N. Am.-W.N.Am.-C.Am.——FIG. F22,*5*. **P. (C.) claviculata* CARPENTER, Rec., W.Mex.; *5a,b*, RV ext., LV int., ×0.7 (Stanford Univ. specimen).

P. (Foveadens) DALL, 1915 [**F. panamensis;* OD]. Hinge with 2 diverging laminae in RV, posterior longer and higher; LV with 2 short laminae close together; sheet of shelly material bridging bases of laminae, forming cavities between them. *Rec.*, W.C.Am.——FIG. F22,*4*. **P. (F.) panamensis* (DALL),; *4a,b*, holotype, RV ext., LV int., ×2 (U.S. National Museum).

P. (Frenamya) IREDALE, 1930 [**Coelodon patulus* TATE, 1889; OD] [=*Coelodon* CARPENTER, 1865 (*non* AUDINET-SERVILLE, 1882) (type, *P. ceylanica* SOWERBY, 1835; SD STOLICZKA, 1871)]. Sculpture of concentric wrinkles; LV with laminae united by transverse plate; no lithodesma. *Rec.*, W.C.Am.-S.Pac.-W.Pac.-Ind.O.——FIG. F22,*6*. **P. (F.) patula* (TATE), S.Australia, *6a,b*, RV int, LV hinge, ×2 (Cotton, 1938).

P. (Heteroclidus) DALL, 1903 [**P. punctata* CONRAD, 1837; OD]. With 1 laminar buttress in LV, 3 in RV; lithodesma present. *Plio.-Rec.*, W.N.Am.-C.Am.——FIG. F22,*7*. **P. (H.) punctata* CONRAD, Rec., USA(Calif.); *7a,b*, LV ext., int., ×1 (Stanford Univ. specimen).

P. (Pandorella) CONRAD, 1863 [**P. arenosa* CONRAD, 1834; M] [=*Kennerlia* CARPENTER, 1864 (type, *K. bicarinata;* SD STOLICZKA, 1870) (*Kennerleya, Kennerleyia, Kennerlyia,* spelling errors)]. With radial ribbing in RV; lithodesma wanting. *Mio.-Rec.*, E.N.Am.-W.N.Am.-S.Am. ——FIG. F22,*1*. **P. (P.) arenosa* CONRAD, Mio., USA(Va.); *1a,b*, LV ext., int., ×1 (Conrad, 1838).

Family CLEIDOTHAERIDAE Hedley, 1918

[=Chamostreidae FISCHER, 1887] [Materials for this family prepared by MYRA KEEN]

Shell attached by right valve; one cardinal tooth in LV; ligament wanting but resilium present, submerged, with lithodesma. *Mio.-Rec.*

Cleidothaerus STUTCHBURY, 1830 [**C. chamoides* (=**Chama albida* LAMARCK, 1819; M] [=*Chamostrea* HERRMANNSEN, 1846 (latinization of "Camostrée" DE BLAINVILLE, 1825, *ex* ROISSY MS); OD (obj.); "*Chamostraea* ROISSY, 1805, AUCTT." (fictitious reference)]. Inequivalve, fixed on anterior slope; hinge of RV with large pit; lithodesma long, curved. *Mio.-Rec.*, Australasia.—— FIG. F22,*2*. **C. albidus* (LAMARCK), Rec., S. Australia; *2a,b*, LV int., RV int., ×0.5 *(307)*.

Family LATERNULIDAE Hedley, 1918

[=Anatinidae GRAY, 1840 (invalid, based on junior homonym); Cercomyacidae CRICKMAY, 1936] [Materials for this family prepared by MYRA KEEN and L.R. COX]

Subequivalve, elongate, gaping posteriorly; umbones not at all or only slightly pro-

truding, with transverse external slit, or with internal plate represented by slit on internal molds; hinge edentulous; ligament (where known) on two projecting spoon-shaped chondrophores, each supported by thin oblique buttress (or clavicle); pallial sinus broad; shell thin, subnacreous internally *(526). U.Trias.-Rec.*

Laternula RÖDING, 1798, p. 155 [**L. anatina* (=*Solen anatinus* LINNÉ, 1758, p. 673); SD GRAY, 1847, p. 190] [=*Auriscalpium* MEGERLE VON MÜHLFELD, 1811 (obj.; M); *Anatina* LAMARCK, 1818 (*non* SCHUMACHER, 1817) (obj.; T); *Butor* GISTEL, 1848 (*non* FORSTER, 1827) (*pro Anatina* LAMARCK); *Butorella* STRAND, 1928 (*pro Butor* GISTEL)]. Thin subcylindrical, posterior end roundly gaping. *U.Cret.-Rec.*, N.Am.-Eu.-Pac.-Ind.O.

L. (Laternula). Surface nearly smooth; posterior gape wide. *U.Cret.-Rec.*, N.Am.-Eu.-S.Pac.-Ind.O. ——FIG. F23,*1*. **L. (L.) anatina* RÖDING, Rec., E.Indies; *1a,b*, LV int., with RV hinge, LV ext., ×0.7 *(307)*.

L. (Laternulina) HABE, 1952, p. 266 [**Anatina japonica* LISCHKE, 1872, p. 107 (=*A. flexuosa* REEVE, 1863, sp. 5); OD]. Surface with wrinkled undulations; gape narrower than in *L. (Laternula)*. *Rec.*, W.Pac.——FIG. F23,*2*. **L. (L.) flexuosa* (REEVE), Japan; LV view of shell, ×1 (Habe, 1952).

Anatimya CONRAD, 1860, p. 276 [**Pholadomya (A.) anteradiata;* SD SHIMER & SHROCK, 1944, p. 414]. Oblong, subequilateral, with concentric furrows anteriorly and radiating lines posteriorly; hinge unknown. *U.Cret.*, E.N.Am.——FIG. F23,*3*. **A. anteradiata* (CONRAD), USA(N.J.); LV view, ×0.7 (Whitfield, 1907).

Cercomya AGASSIZ, 1843, p. 143 [**C. pinguis;* OD] [=*?Kercomya* GRESSLY, 1838 *(nom. nud.)*]. Elongate, subequilateral to distinctly inequilateral, compressed, with tapering posterior end, upcurved in some species; umbones level with posterodorsal margin or almost so; posterior umbonal ridges well defined; umbonal slit or impression of internal umbonal plate observed in some species; hinge and pallial line unknown; surface bearing minute, radially aligned pustules. *U.Trias.-Cret.*, cosmop.

C. (Cercomya). Flanks with concentric folds, posterodorsal area smooth. *U.Trias.-Cret.*, cosmop. ——FIG. F23,*7a,b*. **C. (C.) pinguis* AGASSIZ, M.Jur.(Bajoc.), Switz.; *7a,b*, LV ext., and dorsal views, ×1 (Agassiz, 1843).——FIG. F23,*7c,d*. *C. (C.)* sp. aff. *C. (C.) gurgitis* (PICTET & CAMPICHE), L. Cret.(Alb.), Eng.;*7c,d*, RV ext., and dorsal view, ×0.7 (Woods, 1909).

C. (Capillimya) CRICKMAY, 1936, p. 558 [**Capillimya capillifera;* OD]. With punctate radial striae on posteroventral sector and concentric folds on rest of surface. *Jur.*, Eu.-N.Am.——FIG. F23,*6*. *C. (C.) striata* AGASSIZ, U.Jur.(L. Kimmeridg.), France; *6a,b*, RV ext. and dorsal views, ×1 (de Loriol, 1872).

Clistoconcha SMITH, 1910, p. 217 [**C. insignis;* M]. Small, irregularly oblique-ovate; chondrophores small, buttress large; valves united in adult except for siphonal gape. *Rec.*, S.Afr.——FIG. F23,*5*. **C. insignis; 5a,b*, LV ext., RV int., ×4 (Kuehnelt, 1958).

Periplomya CONRAD, 1870 (July 7), p. 76 [*nom. subst. pro Leptomya* CONRAD, 1867, p. 15 (*non* ADAMS, 1864)] [**Periploma applicata* CONRAD, 1858, p. 324; SD GARDNER, 1916, p. 633] [=*Plicomya* STOLICZKA, 1870 (Sept. 1) (*pro Leptomya* CONRAD)]. Like *Laternula*, but with chondrophores tapering and attached to buttress; slit anterior, oblique, long; surface with concentric ribbing. *U.Cret.*, E.N.Am.——FIG. F23,*4*. **P. applicata* (CONRAD), USA(Tenn.); RV ext., ×1 *(951)*.

Platymyoidea COX, 1964, p. 42 [*nom. subst. pro Platymya* AGASSIZ, 1843, p. 180 (*non* ROBINEAU-DESVOIDY, 1830)] [**Platymya dilatata* AGASSIZ; OD]. Ovate-oblong, not tapering posteriorly, compressed, with broad, scarcely protruding umbones between middle and anterior third of length; internal umbonal plate well developed; hinge unknown; ornament of irregular concentric folds strongest at anterior end of shell. *L.Jur.-L.Cret.*, Eu.(Switz.-France-Eng.).——FIG. F23,*8*. *P. rostrata* (AGASSIZ), L.Cret.(Neocom.), France; *8a,b*, LV ext. and dorsal views, ×0.7 *(696)*.

Plectomya DE LORIOL, 1868, p. 525 [**Tellina rugosa* RÖMER, 1836, p. 120 (*non* PENNANT, 1777) (=*Anatina subrugosa* D'ORBIGNY, 1850, p. 49)] [=*?Rhynchomya* AGASSIZ, 1843, p. 152 (type, *Cercomya gibbosa* AGASSIZ, possibly founded on imperfect specimens of *A. subrugosa*)]. Oblong, compressed, some specimens with trigonal tendency; umbones near mid-length; oblique internal umbonal plate present; hinge and pallial line unknown; ornament consisting of folds which follow or are slightly oblique to growth lines and are best developed at ends of shell; minute, radially aligned granules are also present. *U.Jur.(U.Kimmeridg.) - L.Cret.(Apt.)*, Eu.(Ger.-Switz.-France-Eng.)-Afr.(Congo).——FIG. F23,*9*. **P. subrugosa* (D'ORBIGNY), U.Jur.(Portland.), France; *9a,b*, LV ext. and both valves showing variability, ×1 (de Loriol, 1868, 1872).

Family LYONSIIDAE Fischer, 1887

[Materials for this family prepared by MYRA KEEN]

Thin, subnacreous, inequivalve, beaks not slit; hinge edentulous; ligament sunken or submarginal, lithodesma present, median; pallial sinus distinct *(508, 522). Eoc.-Rec.*

Lyonsia TURTON, 1822 [**Mya striata* MONTAGU, 1815 (=**M. norwegica* GMELIN, 1791); M] [=*Hiatella* BROWN, 1827 (*non* BOSC, 1801) (obj.); *Magdala* BROWN, 1827 (obj.; M); *Osteodesma* DESHAYES, 1830, AUCTT. (*non* DE BLAINVILLE, 1825); *Myatella* BROWN, 1833 (obj.; M); *Pandorina* SCACCHI, 1833 (*non* BORY ST. VINCENT, 1827) (obj.; M)]. Sculpture of radial lines. *Eoc.-Rec.*, W.N.Am.-Eu.

L. (Lyonsia). Elongate, posterior end attenuate,

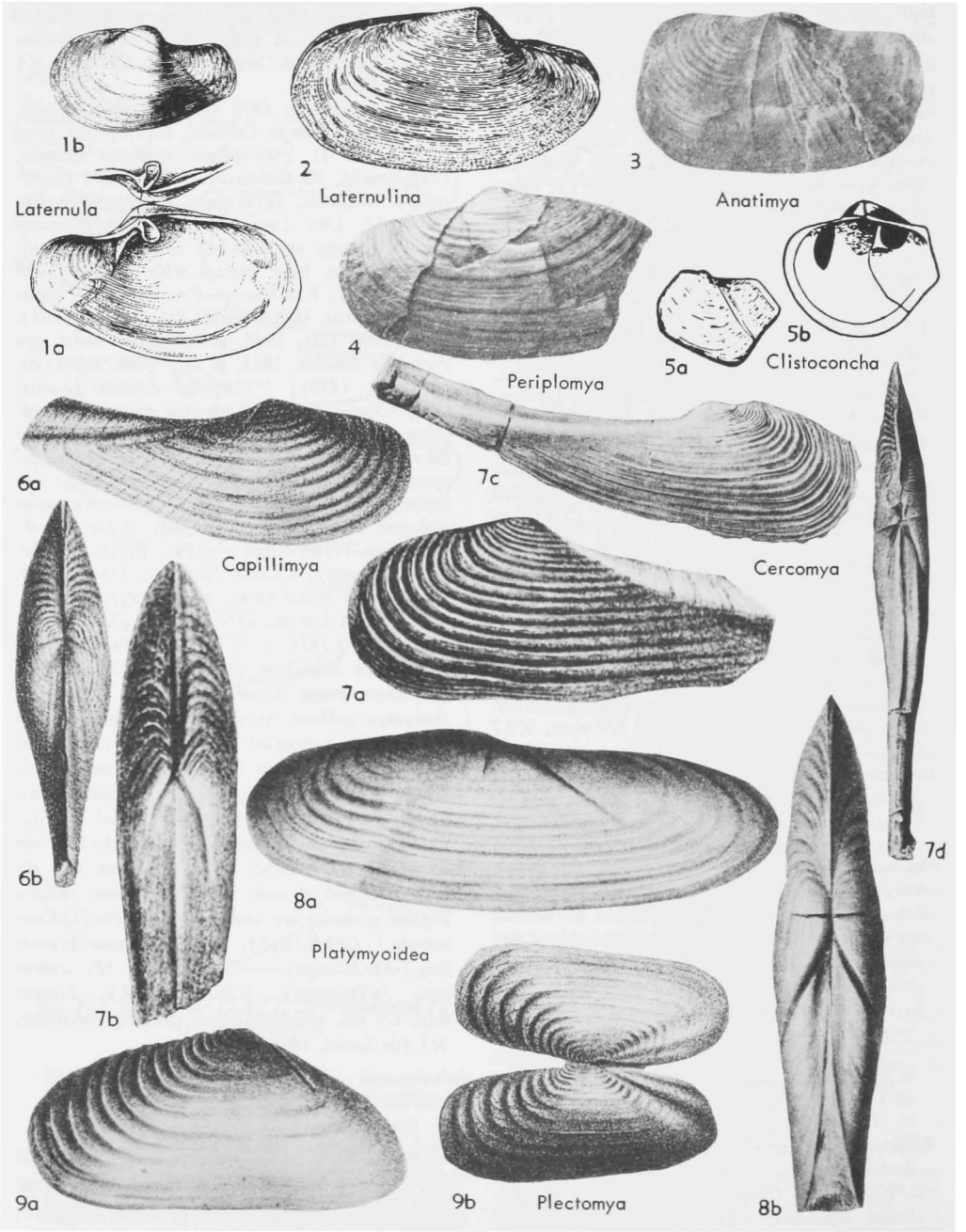

FIG. F23. Laternulidae (p. *N*845).

slightly gaping; sculpture of radial striations and raised threads. *Eoc.-Rec.,* N.Am.-Eu.——Fig. F24,*1*. **L. (L.) norwegica* (Gmelin), Rec., Eng.; *1a,b,* LV ext., int., *1c,* RV hinge, ×1 *(7c)*.

L. (Bentholyonsia) Habe, 1952 [**Allogramma (B.) teramachii* Habe, 1952; OD]. Sculpture of radial granules but not ribs; lithodesma large; posterior end short, gaping. *Rec.,* W.Pac.——Fig. F24,*3*. **L. (B.) teramachii* (Habe), Japan; *3a-d,* RV ext., int., LV and RV hinges, ×1 (Habe, 1952).

L. (Endomargarus) Cossmann, 1887 [**L. heberti* Deshayes, 1857; OD]. Shape irregular because of nestling habit; sculpture of radial punctuations. *Eoc.,* Eu.——Fig. F24,*2*. **L. (E.) heberti* Deshayes, France; *2a,b,* LV, RV int., ×3 *(160)*.

Allogramma Dall, 1903 [**Lyonsia formosa* Jeffreys, 1881; OD]. Valves with radial and vertical undulations; posterior end gaping. *Rec.,* Eu.-N.Am.-NW.Afr.-Pac.——Fig. F24,*6*. **A. formosum* (Jeffreys), NW.Afr.; *6a-c,* LV ext., int., dorsal view of both valves, ×2 *(852)*.

Entodesma Philippi, 1845 [**E. chilensis;* M] [=*Tetragonostea* Herrmannsen, 1849 (*ex* Deshayes, vernac.) (type, *Mya solemyalis* Lamarck, 1818; M); *Philippina* Dall & Simpson, 1901 (type, *Lyonsia beana* d'Orbigny, 1853; OD)]. Periostracum thickened; shell irregularly rhomboidal, deformed by nestling; resilifer in each valve relatively small. *Rec.,* N.Am.-S.Am.-S.Pac.

E. (Entodesma). Small to medium-sized, not gaping; periostracum adherent; commensal with sponges and tunicates. *Rec.,* W.Indies-W.S.Am.-N.Am.-S.Pac.——Fig. F24,*4*. **E. (E.) chilense* Philippi, W.S.Am.; LV ext., ×1 *(124b)*.

E. (Agriodesma) Dall, 1909 [**Lyonia saxicola* Baird, 1863; M]. Large, gaping ventrally; periostracum conspicuously thick, leathery, friable; ligament large. *Rec.,* W.N.Am.——Fig. F24,*7*. **E. (A.) saxicola* (Baird), USA(NW. coast); *7a,b,* LV ext., RV int., ×0.3 (Reeve, 1875).

E. (Phlycticoncha) Bartsch & Rehder, 1940 [*nom. subst. pro Phlyctiderma* Bartsch & Rehder, 1939 (*non* Dall, 1899)] [**Lyonsia lucasana* Bartsch & Rehder, 1939; OD]. Narrowed anteriorly, periostracum thin; surface with radial rows of pustules obsolete near margins. *Rec.,* W.C.Am.-W.S.Am.——Fig. F24,*10*. **E. (P.) lucasanum* (Bartsch & Rehder), W.Mexico; *10a,b,* LV ext., RV int., ×1 (Stanford Univ. specimen).

Mytilimeria Conrad, 1837 [**M. nuttallii;* M]. Thin, fragile, ventricose, with thin, adherent periostracum; beaks subspiral; hinge edentulous but with one or more ligamental pits; muscle scars small, pallial sinus inconspicuous. *Rec.,* W.N.Am.——Fig. F24,*8*. **M. nuttallii,* USA(Calif.); *8a,b,* RV int., ext., ×1 *(7c)*.

Ostomya Conrad, 1874 [**O. papyria;* M] [=*Himella* H.Adams, 1860 (*non* Dallas, 1852) (type, *H. fluviatilis;* M); *Anticorbula* Dall, 1898 *(pro Himella); Guianadesma* Morrison, 1943 (type, *G. sinuosum;* OD)]. Thin, concentrically plicate; hinge with spoon-shaped process and small tooth near apex in LV; RV with oblique chondrophore. [Estuarine.] *U.Oligo.-Rec.,* S.Am.——Fig. F24,*5*. **O. papyria,* Plio., Peru; RV ext., ×2 (Conrad).

Family MARGARITARIIDAE Vokes, 1964

[Materials for this family prepared by Myra Keen]

Shell moderately large, subcylindrical, gaping, nearly smooth except for some widely spaced radial ribs and surface irregularities; inner layer nacreous; hinge area wide but without teeth, beaks low; adductor muscle scars unequal in size, posterior elongate, anterior rounded; pallial line entire or only slightly sinuate. *Mio.*

Margaritaria Conrad, 1849 [**Pholadomya abrupta* Conrad, 1832; M] [=*Actinomya* Mayer, 1870 (obj.; OD)]. Differing from *Panopea,* which it resembles, by edentulous hinge, radial ribbing, and nacreous shell material. *Mio.,* E.N.Am.——Fig. F24,*9*. **M. abrupta* (Conrad), USA(Md.); *9a,b,* LV ext., RV int., ×0.5 (Glenn, 1904).

Family MYOCHAMIDAE Bronn, 1862

[Materials for this family prepared by Myra Keen]

Inequivalve, free or sessile, subnacreous; hinge edentulous, dorsal margins overlapping; ligament external or wanting, resilium internal; pallial sinus small. *Mio.-Rec.*

Myochama Stutchbury, 1830 [**M. anomioides;* M]. Sessile, attached by RV and modified in form by surface of attachment. *Mio.-Rec.,* Australasia. ——Fig. F25,*1*. **M. anomioides; 1a,b,* LV ext., RV int., ×1 *(305)*.

Myadora Gray, 1840 [**Pandora brevis* Sowerby, 1829; M] [=*Myodora,* spelling error]. Free, resembling *Pandora,* with flattened cardinal area on either side of beaks. *Mio.-Rec.,* Australasia-W.Pac.

M. (Myadora). Surface irregular but not squamose; RV convex, LV flat; hinge with triangular resilifer; pallial sinus rather shallow. *Mio.-Rec.,* Australasia-W.Pac.——Fig. F25,*3*. **M. (M.) brevis* (Sowerby), Rec., Australia; *3a-c,* RV int., LV ext., RV int., ×1 *(124b, 305)*.

M. (Hunkydora) Fleming, 1948 [**Thracia transenna* Suter, 1913 (=**T. australica novozelandica* Reeve, 1859); OD]. Surface squamose or granular, with low concentric folds; hinge with bladelike resilifer obliquely directed backward;

pallial sinus broader, deeper, and more open than in *M. (Myadora)*. *U.Plio.-Rec.*, N.Z.——Fig. F25,*4*. **M. (H.) novozelandica* (Reeve), Rec.; *4a*, LV hinge, ×4; *4b,c*, LV ext., int., ×1.3 (Fleming, 1948).

M. (Myadoropsis) Habe, 1960 [**Thracia transmontana* Yokoyama, 1922; OD]. Somewhat inflated; hinge with 2 distinct toothlike knobs below umbo in RV; pallial sinus deep. *Pleist.-Rec.*, W.Pac.-Australasia.——Fig. F25,*2*. **M. (M.) transmontana* (Yokoyama), Rec., Japan; *2a,b*, RV int., ext., ×2.5 (Habe, 1960).

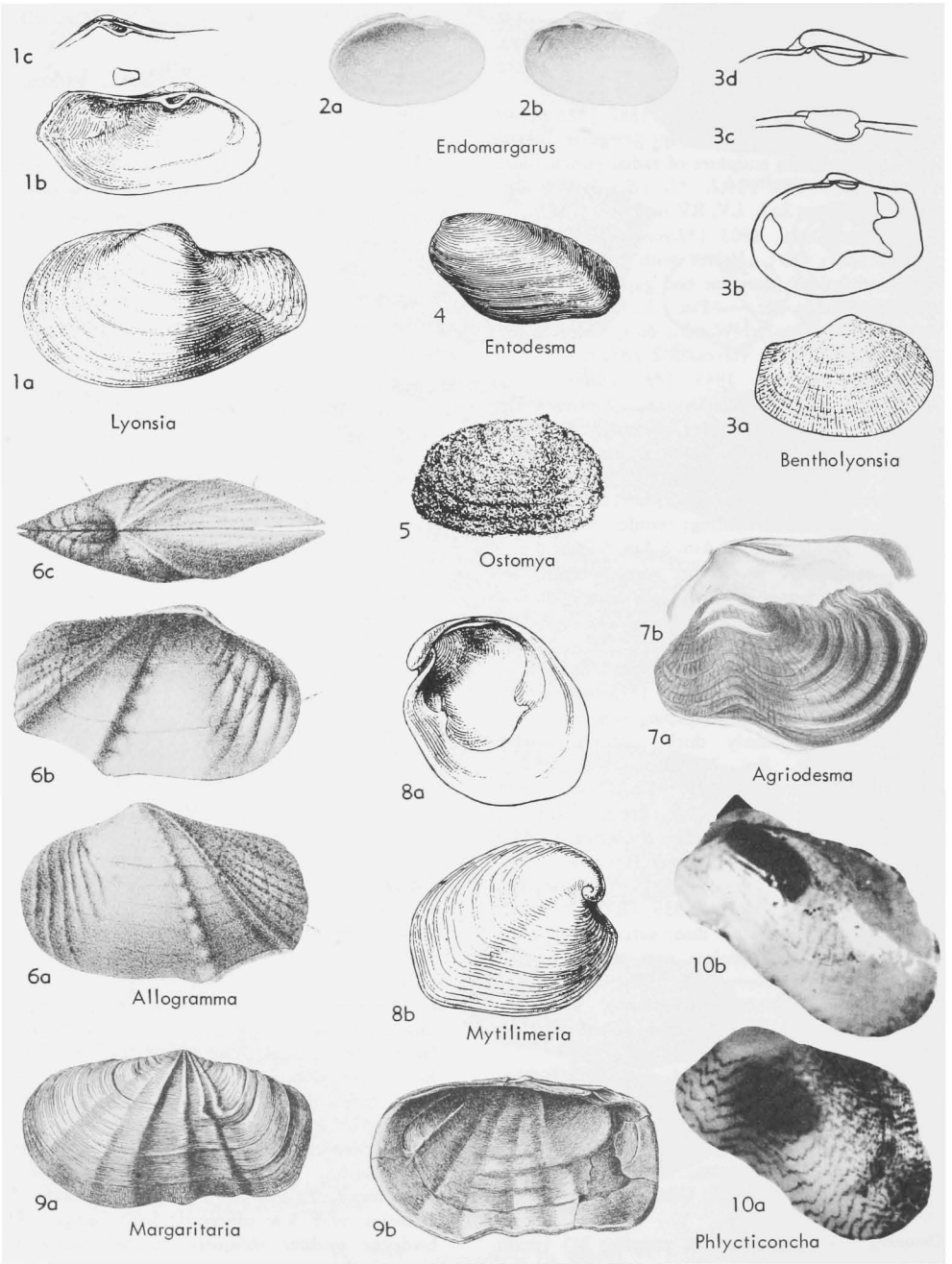

Fig. F24. Lyonsiidae *(1-8,10)*; Margaritariidae *(9)* (p. *N*846-*N*847).

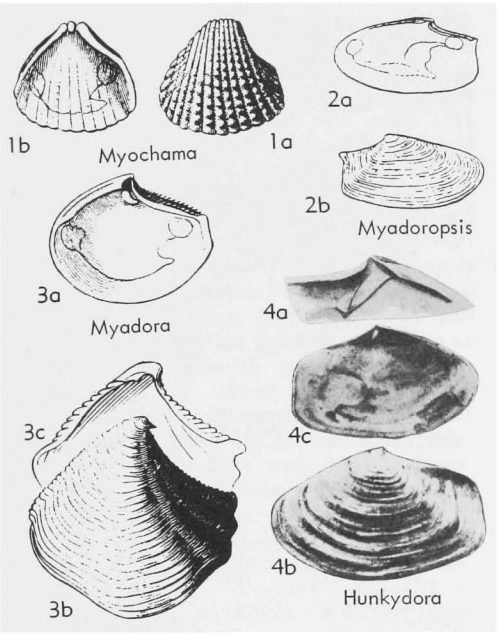

FIG. F25. Myochamidae (p. *N*847-*N*848).

Family PERIPLOMATIDAE Dall, 1895

[*nom. correct.* DALL, 1900 (*pro* Periplomidae DALL, 1895)]
[Materials for this family prepared by MYRA KEEN]

Subnacreous, strongly inequivalve; beaks with a slit; hinge edentulous, resilium in two spoon-shaped chondrophores directed anteriorly or downward; pallial sinus mostly wide but shallow *(524)*. *U.Cret.-Rec.*

Periploma SCHUMACHER, 1817 [**P. inaequivalvis* (=**Corbula margaritacea* LAMARCK, 1801); M]. Thin, RV more convex than LV and overlapping it, surface granular, beaks opisthogyrate; chondrophores supported by clavicle in most forms. *U.Cret.-Rec.,* cosmop.

P. (Periploma). Ovate-quadrate, smooth; anterior muscle scar long and narrow, posterior small and crescentic; pallial sinus short, rounded. *U.Cret.-Rec.,* N.Am.-S.Am.-E.Asia-Eu.——FIG. F26,*1*. **P. (P.) margaritaceum* (LAMARCK), Rec., W.Indies; *1a-c,* LV int., LV view of both valves, RV hinge, ×1 (H. Adams & A. Adams).

P. (Aelga) SLODKEVICH, 1935 [**Tellina besshoensis* YOKOYAMA, 1924; OD]. Large, ovate-quadrate, with undulating concentric sculpture; chondrophores massive and shallow, clavicle long, curved. *Oligo.-Mio.,* NE.Asia.——FIG. F26,*7*. **P. (A.) besshoense* (YOKOYAMA), Mio., Japan; *7a,b,* RV ext., dorsal view of both valves, ×0.5 (Makiyama, 1957).

P. (Albimanus) PILSBRY & OLSSON, 1935 [**P. (A.) pentadactylus;* OD]. Strongly inequilateral, longer than high, with 5 grooved ribs projecting

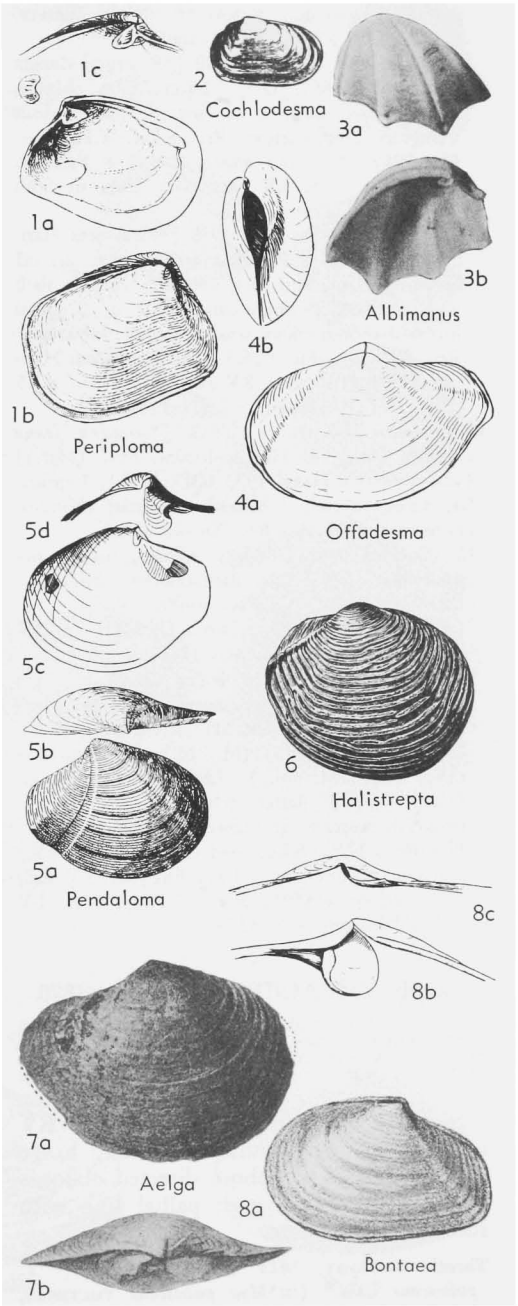

FIG. F26. Periplomatidae (p. *N*849-*N*850).

at margins; inequivalve, LV smaller. *Rec.*, W.C.Am.——Fig. F26,*3*. **P. (A.) pentadactylus*, W. Panama; *3a,b*, RV ext., int., ×1 (Pilsbry & Olsson, 1935).

P. (Halistrepta) Dall, 1904 [**P. sulcata;* M]. Sculpture of irregular concentric ribs. *Rec.*, W.N. Am.-W.Pac.——Fig. F26,*6*. **P. (H.) sulcatum*, USA(Calif.); RV ext., ×0.8 (Dall).

P. (Offadesma) Iredale, 1930 [**P. angasi* Crosse & Fischer, 1864; OD[. Large, thin, oblique, chondrophore directed downward; pallial sinus triangular, deep, narrow. *Rec.*, S.Pac.-W.Pac.——Fig. F26,*4*. **P. (O.) angasi* Crosse & Fischer, S.Australia; *4a,b*, LV ext., post. view of both valves, ×0.5 (Cotton, 1938).

P. (Pendaloma) Iredale, 1930 [**P. micans* Hedley, 1901; OD]. Posterior area rostrate, set off by rib; periostracum thin, obliquely ridged; shell with concentric undulations and 1 or 2 radial furrows; chondrophore small, directed downward. *Rec.*, S.Pac.——Fig. F26,*5*. **P. (P.) micans* Hedley, E.Australia; *5a-c*, RV ext., dorsal, int., ×1.5 *(396)*; *5d*, RV hinge, ×7 (Hedley).

Cochlodesma Couthouy, 1839 [**Anatina leana* Conrad, 1831; SD Herrmannsen, 1847 (Mar.)] [=*Aperiploma* Habe, 1952 (OD, obj.)]. Lenticular, subequilateral; lithodesma present; chondrophore buttressed. *Mio.-Rec.*, Eu.-Atl.-Pac.

C. (Cochlodesma). Slightly inflated, surface not granulose; lithodesma cartilaginous. *Mio.-Rec.*, Eu.-W.Atl.-S.Pac.-NW.Pac.——Fig F26,*2*. **C. (C.) leanum* (Conrad), Rec., USA(Mass.); RV ext., ×1 (Gould & Binney, 1870).

C. (Bontaea) Brown, 1844 (*ex* Leach MS) (in synonymy of *Ligula praetenuis* [**Chama praetenuis* Pulteney, 1799; M] [=*Galaxura* Gray, 1852 (ex Leach MS) (M, obj.); *Calcaraea* Récluz, 1868 (M, obj.)]. Less rounded than *C. (Cochlodesma)*, flatter, posterior somewhat attenuated; surface granulose; lithodesma small. *Plio.-Rec.*, N.Eu.-S.Eu.——Fig. F26,*8*. **C. (B.) praetenue* (Pulteney); Rec., Eng., *8a*, LV ext., ×1 (Jeffreys, 1869); Rec., Norway, *8b,c*, LV and RV hinges, ×2 *(857)*.

Family THRACIIDAE Stoliczka, 1870

[*nom. transl.* Dall, 1903 (*ex* Thraciinae Stoliczka, 1870)] [=Osteodesmacea Deshayes, 1839 (invalid family-group name, Code Art. 11, e); Osteodesmidae Hörnes, 1859 (invalid family-group name, Code Art. 11, e)] [Materials for this family prepared by Myra Keen]

Smooth, nonnacreous, inequivalve (RV larger), surface granular in most; hinge edentulous; chondrophore directed obliquely toward posterior end; pallial line with sinus *(510)*. *Jur.-Rec.*

Thracia Sowerby, 1823 (*ex* Leach MS) [*"*T. pubescens* Lam." (=**Mya pubescens* Pulteney, 1799); SD Anton, 1839] [=*Throna* Carpenter, 1859 *(nom. null)*; *Osteodesma* de Blainville, 1825 (OD, obj.); *Odoncineta* Costa, 1829 (type, *O. papyracea;* M); *Odontocineta, Cinetodonta (nom. van. pro Odoncineta)*; *Corymya* Agassiz, 1843 (type, *Mya depressa* Sowerby, 1823, *non* Donovan, 1802, =*Corimya pinguis* Agassiz, 1845; M; Jur., Eu.); *Corimya, Coromya (nom. null.)*; *Homoeodesma* Fischer, 1887 (type, *T. conradi* Couthouy, 1839; M); *Eximiothracia* Iredale, 1924 (type, *T. speciosa* Angas, 1869; OD); *Cetothrax* Iredale, 1949 (type, *T. alciope* Angas, 1872, =*Anatina imperfecta* Lamarck, 1818; OD)]. Oblong, somewhat inflated, nearly equilateral, posterior end broadly truncate and set off by low ridge; periostracum present in some. *Jur.-Rec.*, Eu.-N.Am.-Pac.-Atl.-Afr.-Arctic.

T. (Thracia). Concentrically striate; surface granulate; beaks touching and perforate; ligament external; cardinal plate with fissure occupied by lithodesma; chondrophore moderately long. *Jur.-Rec.*, Eu.-N.Am.-Pac.——Fig. F27,*11*. **T. (T.) pubescens* (Pulteney), Rec., Eng.; *11a-c*, LV int., RV hinge, LV view both valves, ×1 (H. Adams & A. Adams, 1858).

T. (Crassithracia) Soot-Ryen, 1941 [**T. crassa* Becher (=**T. septentrionalis* Jeffreys, 1872); OD]. Solid, smooth, periostracum present, thin, shining, except on posterior truncation; chondrophore very narrow, horizontal. *Rec.*, N.Atl.,——Fig. F27,*2*. **T. (C.) septentrionalis* Jeffreys, Norway; *2a*, RV ext., ×0.5; *2b,c*, RV and LV hinges, enl. *(857)*.

T. (Ixartia) Gray, 1852 (*ex* Leach MS) [**Mya distorta* Montagu, 1803; M] [=*Rupicola* Fleuriau, 1802 (*non* Brisson, 1760) (obj.); *Pelopia* H.Adams, 1868 (*non* Meigen, 1800) (type, *P. brevifrons;* M); *Rupicilla* Schaufuss, 1869 (*pro Rupicola)*]. Distorted by nestling habit, inequilateral; chondrophore free from hinge plate posteriorly; pallial sinus large. *Rec.*, Eu.-W.N.Am.-S.Afr.——Fig. F27,*3*. **T. (I.) distorta* (Montagu); Eng.; *3a*, LV ext., ×1 (Jeffreys, 1869); Norway, *3b,c*, hinge, lat. and ventral views, ×2 *(857)*.

T. (Lampeia) MacGinitie, 1959 [**T. (L.) adamsi; OD*]. Chondrophore buttressed, forming depression under beaks. *Rec.*, Arctic.——Fig. F27,*8*. **T. (L.) adamsi*, USA(Alaska); *8a,b*, LV ext., RV ext., ×1; *8c,d*, RV and LV hinges, ×3 (MacGinitie, 1959).

T. (Trigonothracia) Yamamoto & Habe, 1959 [**T. (T.) nomurai;* OD]. Small, thin, chondrophore small, trigonal, directed downward. *Rec.*, W.Pac.——Fig. F27,*5*. **T. (T.) nomurai*, Japan; *5a,b*, LV ext., int., ×2 (Yamamoto & Habe, 1959).

Asthenothaerus Carpenter, 1864 [**A. villosior;* M]. Edentulous, surface somewhat granular; cartilage below umbones, not in chondrophore; pallial sinus large. *Rec.*, E.C.Am.-W.N.Am.——Fig.

F27,*10*. **A villosior*, W.Mex.; *10a-c*, LV ext., int., RV int., ×2.5 (specimen, U.S.Natl.Mus.).

Bushia DALL, 1886 [**B. elegans;* M]. Resembling *Asthenothaerus* but surface without granulations; ligament external; apices solid within, supporting resilium. *Rec.*, W.Indies-C.Am.-S.Am.——FIG. F27,*12a*. **B. elegans*, W.Indies; LV ext., ×3 (Dall, 1889).——FIG. F27,*12b,c*. *B. panamensis*

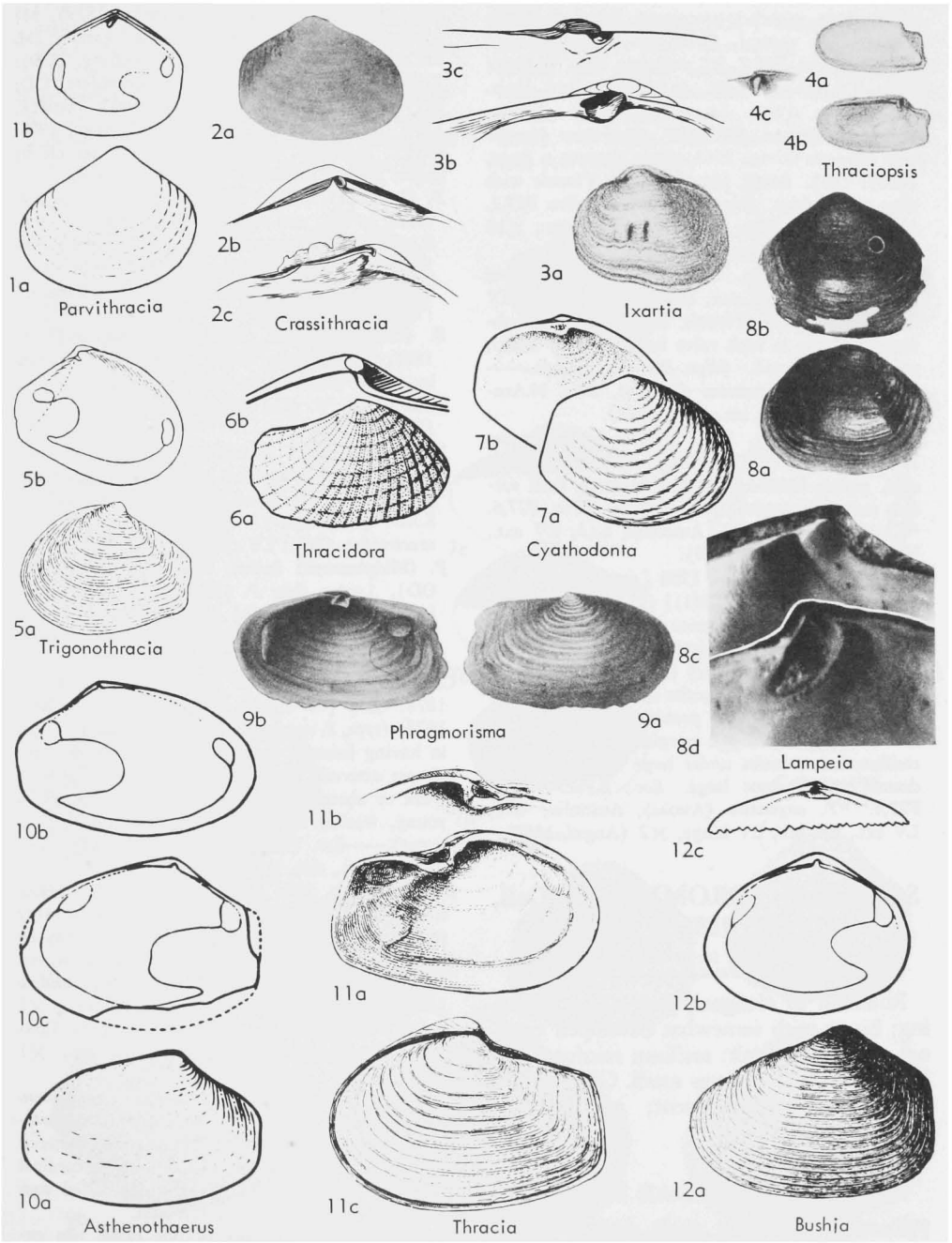

FIG. F27. Thraciidae (p. *N*850-*N*852).

DALL, Panama; *12b,c,* RV int., LV oblique view inside apex, ×2 (specimen, U.S.Natl.Mus.).

Cyathodonta CONRAD, 1849 [**C. undulata;* M]. With strong undulating and somewhat oblique folds; beaks nonperforate; resilium small, chondrophore short, rounded, prominent, lithodesma thin, semicircular, vertical. *Pleist.-Rec.,* N.Am.-C.Am.-S.Am.——FIG. F27,*7.* **C. undulata,* Rec., W.Mex.; *7a,b,* RV ext., LV int., ×0.5 (Stanford Univ. specimen).

Parvithracia FINLAY, 1927 [**P. suteri* (*pro Montacuta triquetra* SUTER, 1913) (*non* VERRILL & BUSH, 1898); OD]. Small, like miniature *Thracia* with deep pallial sinus. *Mio.-Rec.,* S.Pac.——FIG. F27,*1.* **P. suteri,* Rec., N.Z.; *1a,b,* LV ext., RV int., ×10 (modifled from Suter, 1913).

Phragmorisma TATE, 1894 [**Thracia watsoni* SMITH, 1885; SD LAMY, 1931]. Inequivalve, RV larger, resembling *Thracia* but with large subumbonal plate in each valve hanging from umbo; pallial sinus broad. *Oligo.-Rec.,* Australasia.——FIG. F27,*9.* **P. watsoni* (SMITH), *Rec.,* N.Australia; *9a,b,* RV ext., int., ×0.5 *(852).*

Thracidora IREDALE, 1924 [**Thraciopsis arenosa* HEDLEY, 1904; OD]. Oblong, equilateral, ventricose, gaping behind; ligament external; shell surface radially granular. *Rec.,* S.Pac.——FIG. F27,*6.* **T. arenosa* (HEDLEY), Australia; *6a,b,* RV ext., hinge, ×6 (Hedley, 1904).

Thraciopsis TATE & MAY, 1900 [*pro Alicia* ANGAS, 1867 (*non* JOHNSON, 1861)] [**Alicia angustata* ANGAS, 1867; SD STOLICZKA, 1871] [=*?Thracidentula* GARRARD, 1961 (type, *T. perulae;* OD)]. Inequivalve, quadrate, very inequilateral, posterior end short and truncate; beaks not fissured; interior subnacreous; hinge with posterior callosity in RV and a socket in LV, with marginal plate anteriorly; resilium below beaks under large triangular lithodesma; pallial sinus large. *Rec.,* S.Pac.——FIG. F27,*4.* **T. angustata* (ANGAS), Australia; *4a-c,* LV ext., RV int., LV hinge, ×2 (Angas, 1867).

Superfamily POROMYACEA Dall, 1886

[*nom. transl.* DALL, 1895 (*ex* Poromyidae DALL, 1886)]
[Materials for this superfamily prepared by MYRA KEEN]

Rounded to elongate, generally not gaping; hinge with somewhat developed cardinal and lateral teeth; resilium reinforced by lithodesma; pallial sinus small. Gills scantily reticulate or even absent; mantle lobes united. *Cret.-Rec.*

Family POROMYIDAE Dall, 1886

Rounded-quadrate; shell surface granulate in most, tending toward radial ribbing; interior subnacreous to nacreous; ligament external; hinge with cardinal tooth in one valve. *Cret.-Rec.*

Poromya FORBES, 1844 [**P. anatinoides* (=**Corbula granulata* NYST & WESTENDORP, 1839); M] [=*Embla* LOVÉN, 1847 (type, *E. korenii;* M, =*Corbula granulata* NYST & WESTENDORP, 1839); *Ectorisma* TATE, 1892 (type, *E. granulata;* OD; =*P. laevis* SMITH, 1885); *Questimya* IREDALE, 1930 (type, *P. undosa* HEDLEY & PETTERD, 1906; OD)]. Nacreous, thin, posterior slope set off by angle; surface granular. *Cret.-Rec.,* cosmop.

P. (Poromya). Hinge with strong cardinal in RV, socket in LV, and ridgelike *PII. Cret.-Rec.,* Eu.-E.N.Am.-W.N.Am.-worldwide (deep water).——FIG. F28,*1.* **P. (P.) granulata* (NYST & WESTENDORP), Rec., Atl.; *1a,b,* RV ext., LV hinge, ×3 *(124b).*

P. (Cetomya) DALL, 1889 [**P. elongata* DALL, 1886; SD GLIBERT, 1936]. Hinge teeth obsolete in adult; pallial sinus wanting. *Rec.,* Atl.——FIG. F28,*4.* **P. (C.) elongata* DALL; LV ext., ×1 (Dall, 1889).

P. (Dermatomya) DALL, 1889 [**P. (D.) mactroides;* M]. Surface not granular; hinge strong; pallial sinus developed. *Rec.,* W.N.Am.-S.Am.-S.Afr. (deep water).——FIG. F28,*5.* **P. (D.) mactroides,* Chile; LV ext., ×1.5 (Dall, 1890).

P. (Mioporomya) SACCO, 1901 [**M. taurinensis;* OD]. Larger than *P. (Poromya),* with heavier hinge and strong radial sulci. *Mio.,* Eu.——FIG. F28,*10.* **P. (M.) taurinensis* (SACCO), Italy; *10a-d,* RV ext., int., LV int., ext., ×1 (Sacco, 1901).

Cetoconcha DALL, 1886 [**Lyonsia bulla* DALL, 1878; OD] [= *Silenia* SMITH, 1885 (*non* RYE, 1873) (type, *S. sarsii;* M)]. Differing from *Poromya* in having fossettes smaller and upturned, resilium almost external, ligament obsolescent; hinge teeth weak or absent except cardinal in RV, present in young, weaker in adult. *Rec.,* Atl.-S.Pac. (deep water).——FIG. F28,*8.* **C. bulla* (DALL), Atl.; *8a,b,* LV int., ext., ×2 (Dall, 1889).

Cymella MEEK, 1864 [**Pholadomya undata* MEEK & HAYDEN, 1856; OD]. Small, ovate, with many regular concentric undulations, crossed midway by some radial lines impressed on crests of waves. *U.Cret.,* N.Am.——FIG. F28,*7a.* **C. undata* (MEEK & HAYDEN), USA(Mont.); LV ext., ×1 (Meek, 1876).——FIG. F28,*7b,c. C. bella* CONRAD, USA(N.J.); *7b,c,* RV int., LV int., ×1 (Meek, 1876).

Liopistha MEEK, 1864 [**Cardium elegantulum* ROEMER, 1852 (*non* BECK, 1842) (=**L. elegantulata* VOKES, 1956); OD]. Thin, ovate, posterior end somewhat attenuate; hinge with 2 cardinal teeth, no laterals; ligament external; pallial area indistinct. *U.Cret.,* N.Am.-Afr.-Asia.

L. (Liopistha). Sculpture of fine radial ribs except on dorsal part of posterior slope. *U.Cret.,*

N.Am.-Afr.——Fig. F28,*2*. **L. elegantulata* Vokes, USA(Tex.); *2a*, RV ext., ×1; *2b*, sculpture, ext. (Roemer, 1852).

L. (Psilomya) White, 1874 (*ex* Meek MS) [**L. (P.) meekii*; M]. Radial ribs present as rows of granules or spines. *U.Cret.*, N.Am.-Asia.——Fig. F28,*3*. **L. (P.) meekii*, USA(Utah); RV ext., ×1 (White, 1874).

Neaeroporomya Cossmann, 1887 [**Corbula argentea* Lamarck, 1807; OD]. Shell subnacreous, without surface punctations; posterior slope with concentric folds; single tooth in each valve, no internal fossette or posterior lamella; pallial line sinuous. *Eoc.*, Eu.——Fig. F28,*6*. **N. argentea* (Lamarck), France; *6a*, LV ext., ×3 (Vincent, 1898); *6b,c*, RV, LV hinges, ×3 (Cossmann, 1914).

Pseudocuspidaria Eames, 1951 [**Cuspidaria lakiensis* Cox, 1938; OD]. Resembling *Cuspidaria* in outline but larger; subequivalve; sculpture of strong concentric folds; shell very thin, nacreous within. *Eoc.*, Asia.——Fig. F28,*9*. **P. lakiensis* (Cox), NW.India; *9a,b*, both valves dorsal, RV ext., ×1 (Cox, 1938).

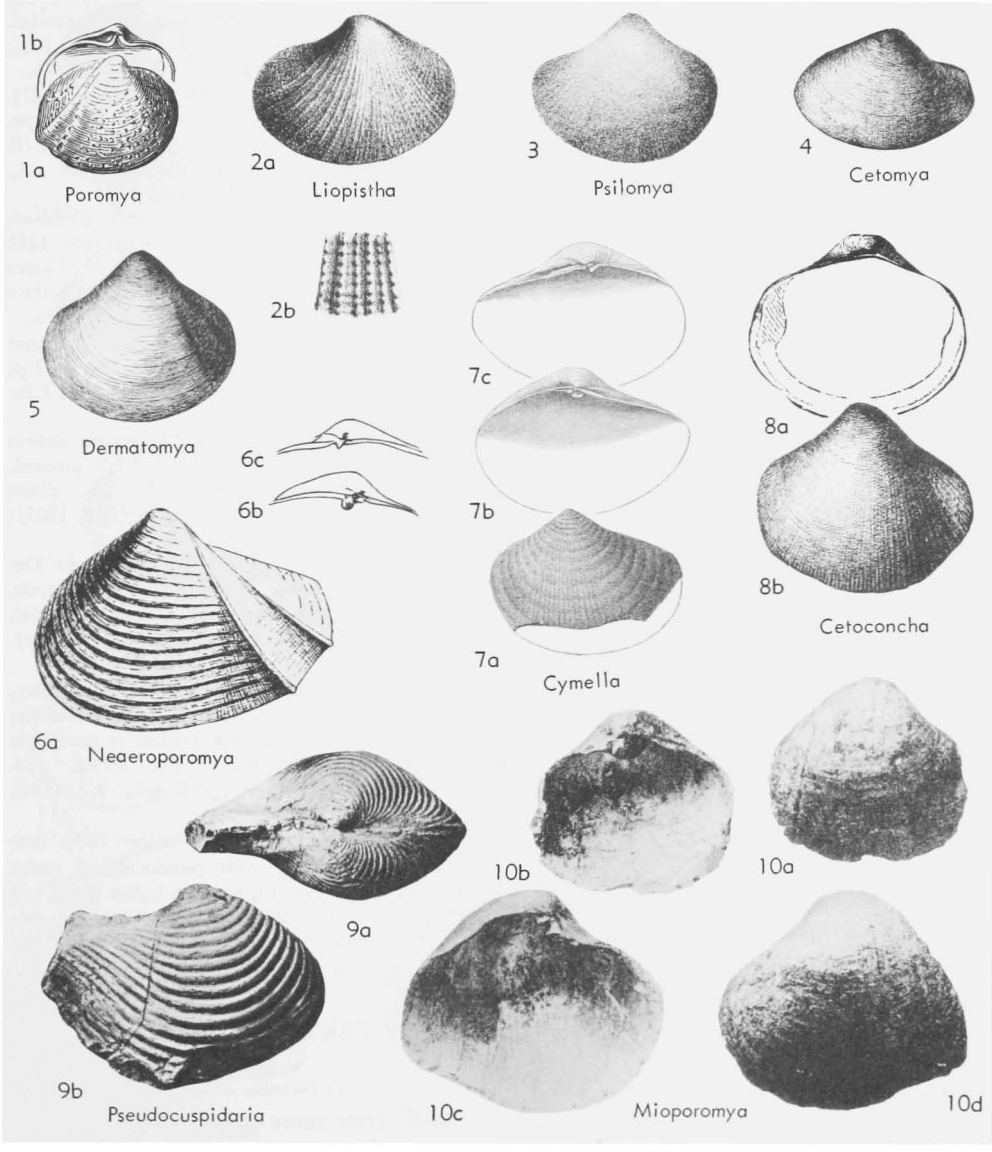

Fig. F28. Poromyidae (p. *N*852-*N*853).

Family CUSPIDARIIDAE Dall, 1886

Small to medium-sized, thin, ovate, mostly strongly rostrate; hinge with external ligament; resilium on small resilifer; hinge teeth present or absent. Carnivorous pelecypods, gill lamellae forming muscular partition across mantle cavity. *U.Cret.-Rec.*

Cuspidaria Nardo, 1840 [**C. typus* (*=*Tellina cuspidata* Olivi, 1792); M] [=*Neaera* Griffith, 1834 (*non* Robineau-Desvoidy, 1830) (type, *N. chinensis;* M); *Aulacophora* Jeffreys, 1882 (*non* Chevrolat, 1842) (type, *N. lamellosa* Sars, 1858; SD Keen, herein); *Vulcanomya* Dall, 1886 (type, *V. smithii, nom. dub.;* M)]. Inequivalve, LV more convex; hinge with resilifer and one or more teeth; posterior end of shell strongly rostrate. *U.Cret.-Rec.,* Eu.-N.Am.-Atl.-Pac.-Medit.-IndoPac.

C. (Cuspidaria). Hinge with single posterior lateral tooth in RV; exterior of shell feebly sculptured; resilium in chondrophore or fossette that is inclined and attached by posterior edge. *U.Cret.-Rec.,* Eu.-N.Am.——Fig. F29,*5*. **C. (C.) cuspidata* (Olivi), Rec., Medit.; *5a-c,* LV int., ext., RV hinge, ×1 (H. Adams & A. Adams, 1858).

C. (Halonympha) Dall, 1886 [**Neaera claviculata* Dall, 1881; OD]. Smooth or concentrically striate; hinge with single tooth, acute cardinal in RV; fossette small, central; posterior clavicular rib in each valve. *Rec.,* Atl.——Fig. F29,*6*. **C. (H.) claviculata* (Dall), Carib.; *6a,b,* RV ext., int., ×2 *(216)*.

C. (Leiomya) A. Adams, 1864 [**Neaera adunca* Gould, 1861; M]. Smooth, hinge with anterior cardinal in each valve; RV with anterior and posterior laterals, LV without laterals. *Rec.,* Pac.

C. (Pseudoneaera) Sturany, 1902 [**P. thaumasia;* M] [=*Bendoneaera* Cossmann, 1904 *(nom. van.)*]. Rostrum short, pointed; hinge with shallow fossette, anterior and posterior laminae in RV and denticle in LV in front of fossette. *Rec.,* IndoPac.——Fig. F29,*12*. **C. (P.) thaumasia* (Sturany), Red Sea; *12a-c,* LV ext., LV and RV hinges, ×5 (Sturany, 1902).

C. (Rhinoclama) Dall, 1886 [*pro Rhinomya* A. Adams, 1864 (*non* Robineau-Desvoidy, 1830)] [**Neaera philippinensis* Hinds, 1843; SD Stoliczka, 1871] [=*Luzonia* Dall, 1890 (obj.; OD)]. Surface concentrically striate, not granulate; hinge without cardinal teeth. *Rec.,* Pac.——Fig. F29,*13*. **C. (R.) philippinensis* (Hinds), Philip.Is.; *13a-c,* RV ext., int., LV int., ×7.5 (type specimens, British Museum).

C. (Tergulina) Noszky, 1939 [**Neaera (T.) sulcosa;* M]. Surface with fine concentric ribs. *Oligo.,* Eu.——Fig. F29,*4*. **C. (T.) sulcosa* (Noszky), Hung.; RV ext., ×1.3 (Noszky, 1939).

C. (Tropidomya) Dall, 1886 [*pro Tropidophora* Jeffreys, 1882 (*non* Troschel, 1847)] [**Neaera abbreviata* Forbes, 1843; SD Dall, 1886] [=*Goniophora* Jeffreys, 1883 (*non* Phillips, 1848) (*pro Tropidophora* Jeffreys, 1882, *non* Troschel, 1847)]. With anterior cardinal in each valve, no lateral teeth. *Rec.,* Atl.-Medit.——Fig. F29,*3*. **C. (T.) abbreviata* (Forbes), Medit.; RV ext., ×3 (Forbes & Hanley, 1848).

Austroneaera Powell, 1937 [**A. brevirostris;* OD]. Thin, smooth, rostrum poorly developed; LV edentulous, RV with laterals; sinus broad, rounded. *Rec.,* S.Pac.——Fig. F29,*7*. **A. brevirostris,* N.Z.; *7a-c,* RV ext., int., LV int., ×5 (Powell, 1937).

Boriesia Doncieux, 1911 [**B. cossmanni;* OD]. Shape and sculpture somewhat as in *Cardiomya;* hinge unknown. *Paleoc.,* Eu.——Fig. F29,*10*. **B. cossmanni,* Ypres., France; *10a,b,* RV ext., both valves dorsal, ×2 (Doncieux, 1911).

Cardiomya A. Adams, 1864 [**Neaera gouldiana* Hinds, 1843; M] [=*Spathophora* Jeffreys, 1882 (*non* Amyot & Serville, 1843) (type, *Neaera curta* Jeffreys, 1876; SD Keen herein)]. Surface radially ribbed. *U.Cret.-Rec.,* N.Am.-C.Am.-Pac.

C. (Cardiomya). RV with prominent posterior lateral tooth. *U. Cret.-Rec.,* N.Am.-Pac.——Fig. F29,*2*. **C. (C.) gouldiana* (Hinds), Rec., E.Indies; RV ext., ×1.5 *(124b)*.

C. (Bowdenia) Dall, 1903 [**Cuspidaria distira;* OD]. Without laterals; margin of RV grooved. *Mio.,* E.C.Am.——Fig. F29,*1*. **C. (B.) distira* (Dall), Jamaica; *1a,* LV ext., ×6 (Dall, 1903); *1b,c,* LV int., RV int., ×6 *(1005)*.

?Fabagella Cossmann, 1887 [**Corbula faba* Deshayes, 1824; OD]. Carinate, umbones acute, lunule deep; hinge edentulous, fossette triangular. *Eoc.,* Eu.——Fig. F29,*9*. **F. faba* (Deshayes), France; *9a,b,* LV int., RV hinge, ×3 *(160)*.

Myonera Dall, 1886 [**Neaera paucistriata* Dall, 1885; OD]. Sculpture radiating or concentric; hinge without teeth; fossette vertical or posteriorly directed. *Rec.,* Atl.-Pac.——Fig. F29,*8*. **M. paucistriata* (Dall), Atl.; LV ext., ×2 (Dall, 1890).

Plectodon Carpenter, 1864 [**P. scaber;* OD]. Surface granular; hinge with pseudocardinal under small external ligament; resilium below beaks, not in fossette. *Plio.-Rec.,* E.N.Am.-W.N.Am.——Fig. F29,*11*. **P. scaber; 11a-c,* LV ext., int., RV int., ×2 (Stanford Univ. specimen).

Family VERTICORDIIDAE Stoliczka, 1871

[=Euciroidae Dall, 1894]

Small (few more than 25 mm. in diameter), cordate, nacreous within, more or less

strongly ribbed radially; hinge mostly weak or with one or two low teeth. *Paleoc.-Rec.*

Verticordia SOWERBY, 1844 (*ex* WOOD MS) [**Hippagus? cardiiformis* SOWERBY, 1844; M] [=*Trigonulina* D'ORBIGNY, 1846 (type, *T. ornata;* M) *Iphigenia* COSTA, 1850 (*non* SCHUMACHER, 1817) (type, *Hippagus acuticostatus* PHILIPPI, 1844; OD); *Hippella,* AUCTT. (*non* MÖRCH, 1861)]. Small to minute, ligament external; ribs well developed. *Paleoc.-Rec.,* Eu.-Carib.-N.Am.-C.Am.-Pac.

V. (Verticordia). Ribs raised, well spaced; lunule deep in LV, shallower in RV; hinge with cardinal in RV, lateral behind beaks in LV. *Paleoc.-Rec.,* Eu.-Carib.-W.N.Am.-C.Am.-W.Pac.——FIG. F30, *2. *V. (V.) cardiiformis* (SOWERBY), Plio., Eng.; *2a,b,* LV ext., int., ×2 *(1004).*

V. (Spinosipella) IREDALE, 1930 [**V. ericia* HEDLEY, 1911; OD]. Borders of ribs prickly; lunule wanting. *Rec.,* Pac.——FIG. F30,*5. *V. (S.) ericia* HEDLEY, S.Australia; *5a,b,* RV ext., hinge, ×4; *5c,* surface detail, ext. (Cotton, 1938).

V. (Vertambitus) IREDALE, 1930 [**V. vadosa*

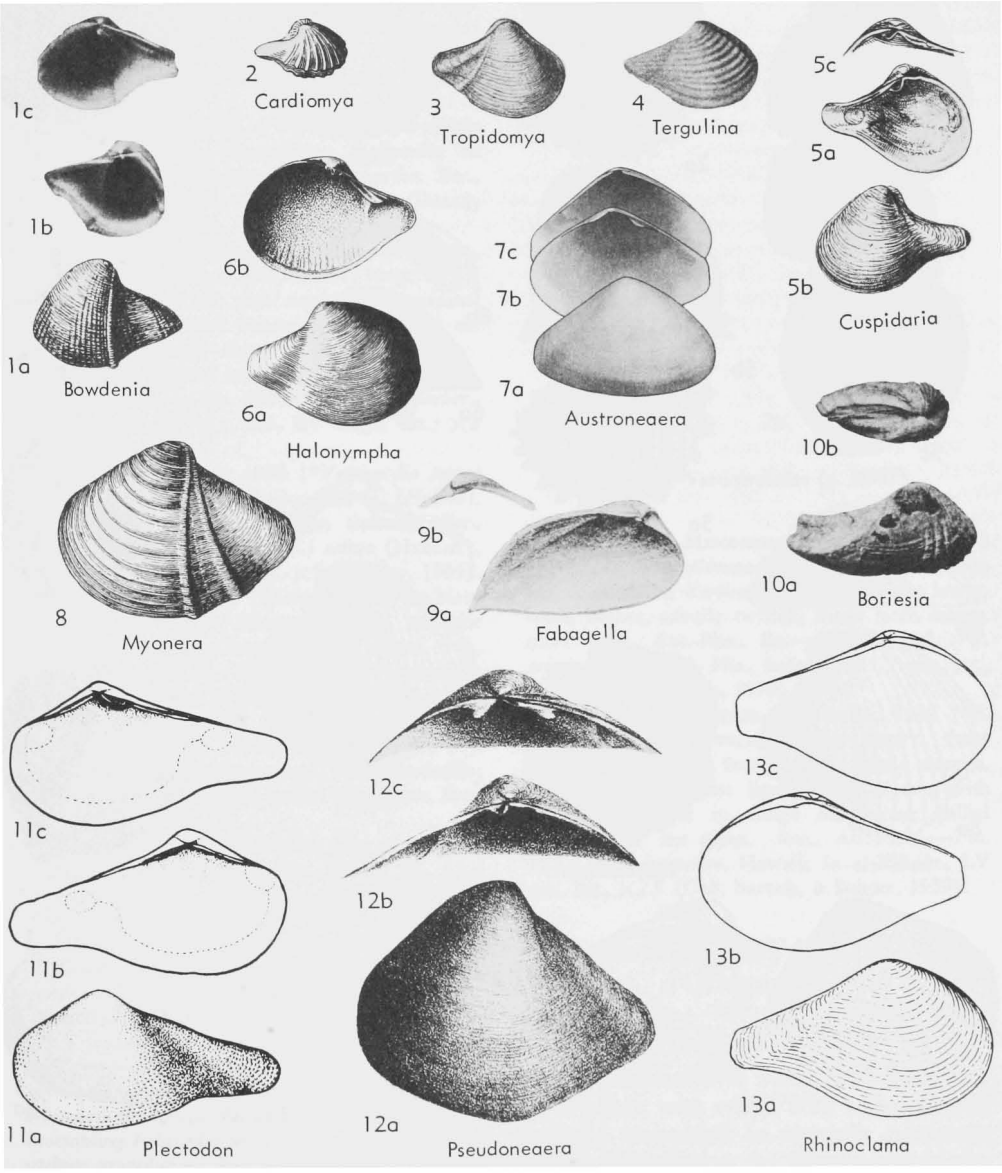

FIG. F29. Cuspidariidae (p. *N*854).

HEDLEY, 1907; OD]. Minute, solid, granose, hinge heavy. *Rec.,* S.Pac.——FIG. F30,7. ******V. (V.) vadosa* HEDLEY, Australia; *7a-d,* LV ext., dorsal, LV and RV hinges, ×10 (Hedley, 1907).

V. (Vertisphaera) IREDALE, 1930 [******V. cambrica;* OD]. Thin, nearly smooth, ribs as fine radial threads; hinge narrow. *Rec.,* S.Pac.——FIG. F30,6. ******V. (V.) cambrica* IREDALE, Australia; *6a,b,* LV dorsal, int., ×2.5 (Hedley, 1907).

Euciroa DALL, 1881 (in synon.) [******Verticordia elegantissima* DALL, 1881; M]. Relatively large, with numerous granular ribs; lunule and escutcheon present; resiliary ossicle triangular, wider behind. *Rec.,* Atl.-Pac.

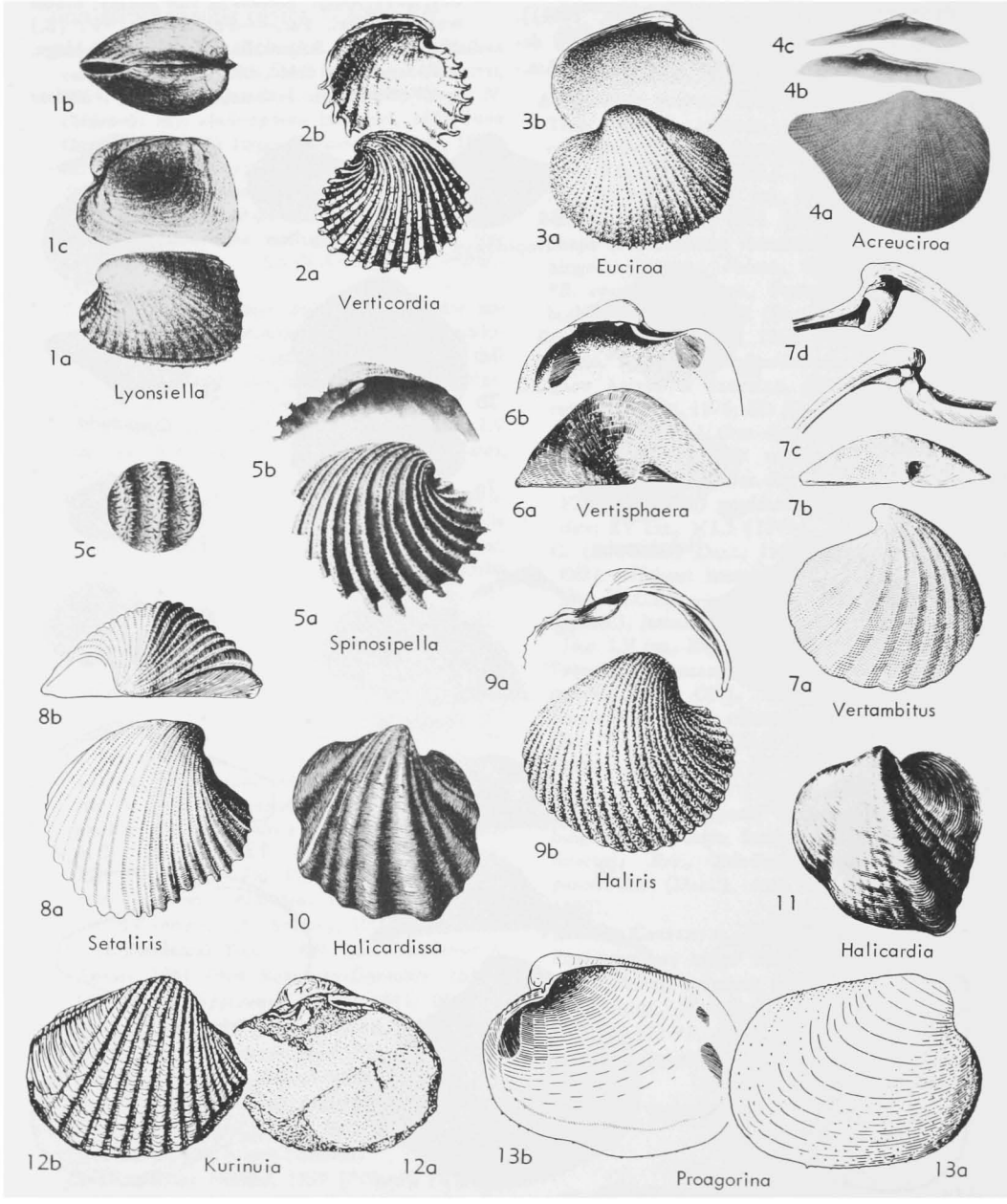

FIG. F30. Verticordiidae (p. *N*854-*N*857).

E. (Euciroa). Valves subequal, hinge well developed. *Rec.*, Atl.-Pac.——Fig. F30,*3*. **E. (E.) elegantissima* (Dall), Carib.; *3a,b*, LV ext., int., ×2 *(216)*.

E. (Acreuciroa) Thiele & Jaeckel, 1931 [**E. (A.) rostrata*; M]. Hinge weak; LV broadened. *Rec.*, Pac.——Fig. F30,*4*. **E. (A.) rostrata*, Japan; *4a-c*, RV ext., RV and LV hinges, ×0.6 (Thiele & Jaeckel, 1931).

Halicardia Dall, 1895 [**Mytilimeria flexuosa* Verrill, 1881; OD] [=*Haloconcha*, auctt., spelling error]. Dorsal margin flaring at ends; surface of shell granular; hinge obsolete, lunule in RV larger; lithodesma asymmetrical, right limb longer; shell slightly inequivalve. *Rec.*, Atl., Pac.——Fig. F30,*11*. **H. flexuosa* (Verrill), N.Atl.; RV ext., ×1 (Verrill, 1881).

Halicardissa Dall, 1913 [**Verticordia perplicata* Dall, 1890; OD]. Resembling *Halicardia* in form, few-ribbed; soft parts as in *Verticordia*. *Rec.*, Pac.——Fig. F30,*10*. **H. perplicata* (Dall), Galapagos Is.; RV ext., ×1 (Dall, 1890).

Haliris Dall, 1886 [**Verticordia fischeriana* Dall, 1881; OD]. Globose, lunule shallow; hinge of RV as in *Verticordia*, LV with single small cardinal and short stout lateral behind beak; resiliary ossicle short, quadrate. *Rec.*, Atl.-Pac.

H. (Haliris). Ventral margin even, shell rounded. *Rec.*, Atl.-Pac.——Fig. F30,*9*. **H. (H.) fischeriana* (Dall), W.Atl.; *9a,b*, RV hinge, ext., ×3 *(216)*.

H. (Setaliris) Iredale, 1930 [**Verticordia setosa* Hedley, 1907; OD]. Smaller than *H. (Haliris)*, more quadrate, ventral margin sinuous. *Rec.*, S.Pac.——Fig. F30,*8*. **H. (S.) setosa* (Hedley), N.Z.; *8a,b*, RV ext., dorsal, ×5 (Hedley, 1904).

Kurinuia Marwick, 1942 [**Trigonia areolata* Marshall, 1919; OD]. Ribless area on posterior slope, crossed only by low concentric ridges. *Eoc.*, N.Z.——Fig. F30,*12*. **K. areolata* (Marshall); *12a,b*, RV int., ext., ×1.3 (Marwick, 1942).

Lyonsiella G. Sars, 1872 (*ex* M. Sars MS) (in synon.) [**Pecchiolia abyssicola* Sars, 1872; M]. Quadrate, thin, ligament internal, with lithodesma; hinge weak to edentulous; pallial line entire. *Rec.*, Atl.-Pac.

L. (Lyonsiella). Surface ribbed, ribs granular in some. *Rec.*, Atl.-Pac.——Fig. F30,*1*. **L. (L.) abyssicola* (Sars), N.Atl.; *1a-c*, LV ext., both valves dorsal, RV int., ×4 *(829)*.

L. (Proagorina) Iredale, 1930 [**L. quadrata* Hedley, 1907; OD]. Surface granular, with some radial furrows, granules prickly; hinge edentulous. *Rec.*, S.Pac.——Fig. F30,*13*. **L. (P.) quadrata* Hedley, Australia; *13a,b*, RV ext., int., ×6 (Hedley, 1907).

Laevicordia Seguenza, 1876 [**Verticordia (L.) orbiculata* Seguenza, 1876; SD Soot-Ryen, 1966]. Resembling *Policordia* but more rounded, with fine surface granulation. *Plio.-Rec.*, Eu.-Atl.-Pac.

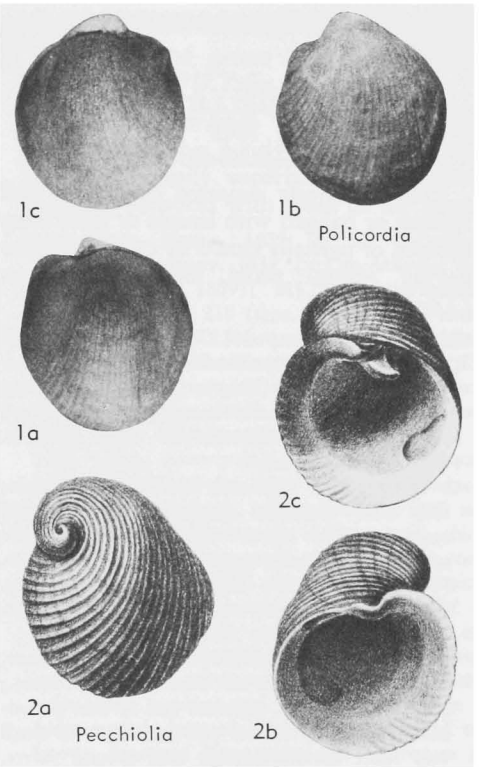

Fig. F31. Verticordiidae (p. *N857*).

Pecchiolia Savi & Meneghini in Murchison, 1850 [**P. argentea* (=*Chama arietina* Brocchi, 1814); M]. Resembling *Verticordia* but larger, ribs lower, beaks higher, spirally twisted; hinge tooth larger, more solid. *Eoc.-Plio.*, Eu.——Fig. F31,*2*. **P. arietina* (Brocchi), Plio., Italy; *2a-c*, LV ext., int., RV int., ×1 (Hörnes, 1870).

Policordia Dall, Bartsch, & Rehder, 1939 [**P. diomedea*; OD] [=*Laevicordia*, auctt. (*non* Seguenza, 1876)]. Small, ovate, nearly smooth, with fine radial ribs; ligament in groove, with lithodesma below it; hinge edentulous; pallial sinus small, not deep. *Rec.*, Atl.-Pac.——Fig. F31,*1*. **P. diomedea*, Hawaii; *1a-c*, RV int., LV ext., int., ×2.5 (Dall, Bartsch, & Rehder, 1939).

Superfamily CLAVAGELLACEA d'Orbigny, 1844

[*nom. transl.* Thiele, 1934 (*ex* Clavagellidae d'Orbigny, 1843] [Materials for this superfamily prepared by Myra Keen and L. A. Smith]

Shell nacreous, free when young, degenerate in adult; with one or both valves at least partially embedded in elongate calcareous tube, an adaptation for burrowing; hinge-

plate wanting; ligament external. *U.Cret. (Turon.)-Rec.*

Family CLAVAGELLIDAE d'Orbigny, 1843

[=Aspergillidae Gray, 1858]

Tube anteriorly rounded or discoid and smooth or fringed with simple or branching tubules, or partially closed by calcareous disc having several pedal foramina. *U.Cret. (Turon.)-Rec.*

Clavagella Lamarck, 1818 [**C. echinata;* SD Children, 1823] [=*Bacilia* Gray, 1858 (*ex* Valenciennes MS) (obj.); *Clavigella,* spelling error]. One valve never merging with tube and both adductors persistent in adult. *U.Cret. (Turon.)-Rec.,* cosmop.

C. (Clavagella). Siphonal end of tube simple; tube free, elongate, clavate, compressed and symmetrical in shape; with irregular spinelike tubules on anterior portion of tube. *U.Cret. (Turon.) - Rec.,* Eu. - India - Australasia.——Fig. F32,*1*. **C. (C.) echinata* Lamarck, Eoc.(Lutet.-Barton.), Paris Basin; ×0.4 *(823)*.

C. (Bryopa) Gray, 1847 [**C. aperta* Sowerby, 1823; OD] [=*Tiria* de Gregorio, 1886 (obj.; SD Smith, 1962)]. Siphonal end of tube periodically expanded, anterior end smooth; with small very short tubules through tube around valves. *U.Oligo.-(Aquitanian)-Rec.,* Medit. - Ind.O. - Pac. ——Fig. F32,*8*. **C. (B.) aperta* Sowerby, Rec., Malta; ×0.3 *(124b)*.

C. (Dacosta) Gray, 1858 [**C. australis* Sowerby, 1829; M]. Siphonal end of tube not expanded, anterior end smooth, rounded; with small very short tubules through tube around valves. *Rec.,* W.Pac.——Fig. F32,*9*. **C. (D.) australis* Sowerby, Australia; ×0.6 (Sowerby in Reeve, 1872, mod.).

C. (Stirpulina) Stoliczka, 1870 [**C. coronata* Deshayes, 1824; OD] [=*Styrpulina,* spelling error; may prove to be synonym of *Tubolana* Bivona-Bernardi, 1832 (type, *T. digitata,* =*Aspergillum bacillaris* Deshayes, 1830, M); *Tubulana (nom. null.)*]. Siphonal end of tube periodically expanded, anterior end with tubules formed only in terminal corona; tube long and with more or less distinct anterior slit. *U.Cret.(Turon.)-Rec.,* N.Am.-Eu.-Asia.——Fig. F32,*2*. **C. (S.) coronata* Deshayes, *U.Eoc.(Barton.),* Paris Basin; ×0.67 *(124b)*.

Humphreyia Gray, 1858 [**Aspergillum strangei* A. Adams, 1854; M] [=*Humphreysia,* spelling error]. Tube twisted and irregularly square in cross section; both valves united into single plate forming most of anterior baglike cavity. *Rec.,* W.Pac.——Fig. F32,*7*. **H. strangei* (A. Adams), Australia; ×0.8 *(124b)*.

Penicillus Bruguière, 1789 [**P. javanus* (=*Serpula penis* Linné, 1758); SD Habe, 1952] [=*Brechites* Guettard, 1770 *(nonbinom.); Penecilli* daCosta, 1776 (vernacular) *(Penecillus, Peni-*

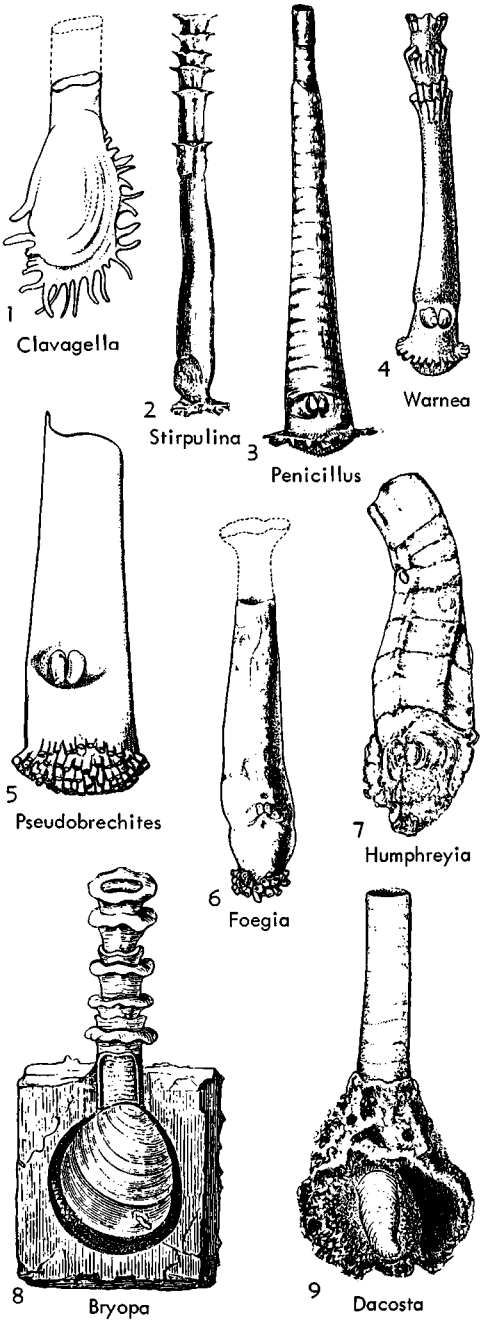

Fig. F32. Clavagellidae (p. *N*858-*N*859).

cellus, nom. null.); Verpa RÖDING, 1798 (obj.); *Aquaria* PERRY, 1811 (type, *A. radiata;* SD SMITH, 1962, obj.); *Arytene* OKEN, 1815 (obj.; rejected ICZN, 1956); *Bunodus* DE BLAINVILLE, 1817 *(nom. nud.) (ex* GUETTARD, *nonbinom.*); *Arytaena* OKEN, 1817 (obj.) (*Arythaena, Arytene,* spelling errors); *Aspergillum* LAMARCK, 1818 (obj.) (*Adspergillum, Aspergillium, Aspergillus,* spelling errors); *Clepsydra* SCHUMACHER, 1817 (obj.) (*Clepydra,* spelling error)]. Both valves merging with tube; tube circular in cross section; anterior adductor degenerate, posterior adductor absent in adult. *U.Oligo.(Aquitan.)-Rec.,* IndoPac.-Australia-Pac.-Japan-Eu.

P. (Penicillus). Siphonal end of tube simple; anterior end fringed with single row of distinct simple tubules; anterior disc with slit. *U.Oligo. (Aquitan.) - Rec.,* IndoPac. - Australia.——FIG. F32,*3*. **P. (P.) penis* (LINNÉ), Rec., Singapore; ×0.3 (Haas, 1935).

P. (Foegia) GRAY, 1847 [*"Aspergillum novaezelandiae"* (=**P. novaezelandiae* BRUGUIÈRE, 1789); OD]. Umbo almost covered with swollen prominence; fringe indistinct, of short thick tubules, formed like hole in disc. *U.Oligo.(Aquitan.)-Rec.,* IndoPac.-W.Pac.——FIG. F32,*6*. **P. (F.) novaezelandiae* BRUGUIÈRE, Rec., Australasia; ×0.8 (Reeve, 1860).

P. (Pseudobrechites) MAGNE, 1941 [**Aspergillum leognanum* HOENINGHAUS, 1827; OD]. Similar to *P. (Penicillus),* but fringe tubules shorter, less distinct, and anterior disc without central slit. *U.Oligo.(Aquitan.),* Eu.——FIG. F32,*5*. **P. (P.) leognanus* (HOENINGHAUS); ×0.67 (Peyrot, 1920).

P. (Warnea) GRAY, 1858 [**Aspergillum australe* CHENU, 1843; SD STOLICZKA, 1871]. Tube cylindrical, siphonal end with series of plaited ruffles; fringe distinct, of single series of thick simple tubules. *Plio.-Rec.,* Red Sea-Australasia-Japan.——FIG. F32,*4*. **P. (W.) australis* (CHENU), Rec., Australasia; ×0.55 *(305)*.

Subclass UNCERTAIN

Order CONOCARDIOIDA Neumayr, 1891

[*nom. correct* NEWELL, 1965 (*ex* order Conocardiiden NEUMAYR, 1891)] [Materials for this order prepared by C. C. BRANSON, AURÈLE LAROCQUE, and N. D. NEWELL]

Characters of genus *Conocardium. M. Ord.-U.Perm., ?U.Trias.*

Superfamily CONOCARDIACEA Miller, 1889

[*nom. transl.* NEWELL, 1965 (*ex* Conocardiidae MILLER, 1889)]

Characters of genus *Conocardium. M. Ord.-U.Perm., ?U.Trias.*

Family CONOCARDIIDAE Miller, 1889

Characters of genus *Conocardium. M. Ord.-U.Perm., ?U.Trias.*

Only *Conocardium* is recognized currently within this poorly understood group. Hence, the family, superfamily, and ordinal traits are identical with those of the genus.

Conocardium BRONN, 1835, p. 92 [**Cardium elongatum* SOWERBY, 1812 (=*Conchiolithus rostratus* MARTIN, 1809); M] [=*Pleurorhynchus* PHILLIPS, 1836, p. 210 (type, *Cardium hibernicum* SOWERBY, 1812; SD BRANSON, LAROCQUE & NEWELL, herein); *Lichas* STEININGER, 1837, p. 231 (type, *L. antiquus;* M); *Hippocardia* BROWN, 1843, p. 97 (type, *Cardium hibernicum* SOWERBY, 1812; M); *Rhipidocardium* FISCHER, 1887, p. 1036 (type, *Conocardium amygdala* BARRANDE, 1881; M)]. Equivalve, alate anteriorly, produced posteriorly in elongate, tubular rostrum; shell surface minutely ornamented; shell material thick, inlaid by vertically set partitions which form more or less submerged radial ribs appearing as external ribs in some species, or weathering in relief by exfoliation of smooth outer prismatic layer and terminating as alternating denticulations at ventral margin; 1 or more ridges or septa in each valve curve upward and inward along hinge to form conical, forward directed receptacles of unknown function; hinge ankylosed in mature individuals, edentulous; some species distinctly carinate behind beaks and at least in some species carinae serving as attachment for collar of prismatic texture (*Schleppe, éventail,* fringe, flange, *Kragen,* hood); ventral anterior margin gaping, denticulate. *M.Ord.(Chazyan)-U.Perm.(Capitan.), ?U.Trias.,* cosmop.——FIG. G1,*1*. **C. rostratum* (MARTIN), L.Carb., Eng.; *1a-c,* hinge, ventral and LV views of holotype, ×1 (Hind, 1900); *1d,* RV ext., ×1 (Hind, 1900).——FIG. G1,*2*. *C. herculeum* (DEKONINCK), L.Carb., Belg.(Tournai); *2a,b,* LV ext., LV int., ×1 (Hind, 1900); *2c,* hinge view of another individual, ×1 (*a,* ligament furrow?; *b,* muscle scar? and septum; *x,* ligament furrow) (Hind, 1900).——FIG. G1,*3*. *C. ventricosum* (HALL), M.Dev., USA(Iowa); *3a,b,* restoration seen from ventral side; both approx. ×1 (BRANSON, n).

BIVALVE GENERA UNCERTAINLY ASSIGNED TO FAMILIES

Families, and likewise genera tentatively assigned to them, are arranged alphabetically. All are considered to be nomenclaturally sound but some may be *nomina oblita.*

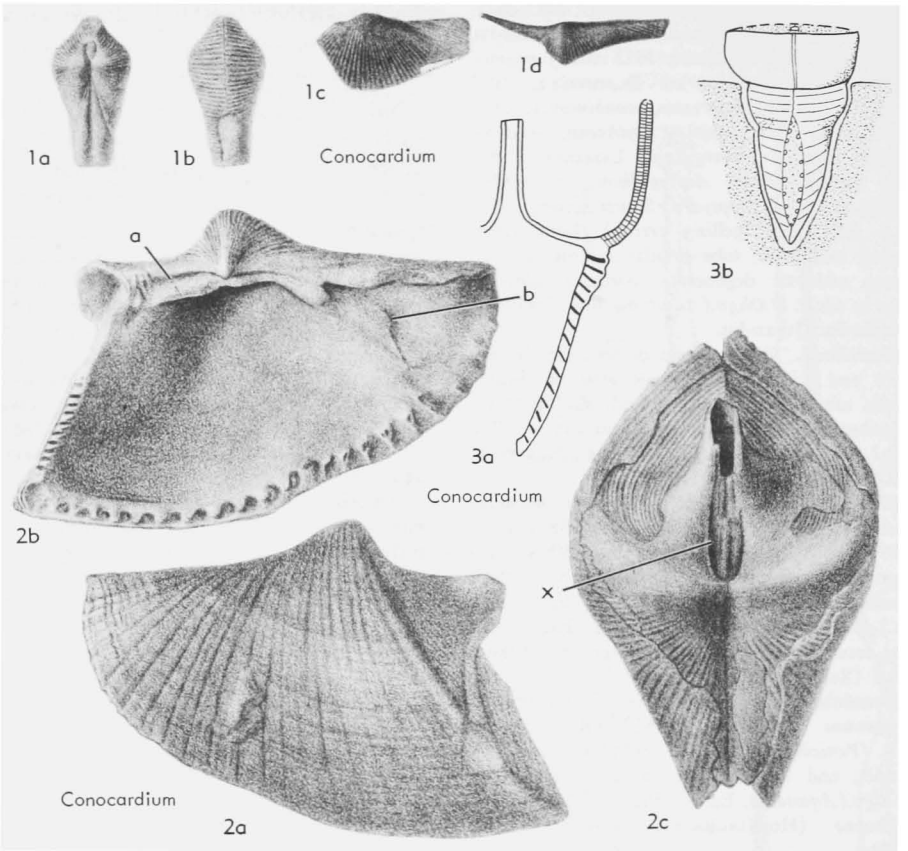

FIG. G1. Conocardiidae (p. *N*859).

ANTHRACOSIIDAE (p. *N*406)

Amnigeniella BETEKHTINA, 1966 (?1967) [**Anthraconauta kumsassiana* RAGOZIN, 1960; OD]. *U.Carb.-L.Perm.*, USSR(W.Sib.). [Not an anthracosiid, but may be near *Procopievskia* (nonmarine Myalinidae).] [WEIR]

ARCIDAE (p. *N*250)

Arclites SCHLOEPFER, 1821.
Calliarca CONRAD, 1866.
Cucullea MICHELIN, 1838.
Cyphoxis RAFINESQUE, 1818.
Hataiarca NODA, 1966, p. 114 (as subgenus of *Anadara*) [**H. kakchataensis* HATAI & NISIYAMA, 1949; OD]. *Mio.-Rec.*, Japan.
Kikaiarca NODA, 1966, p. 127 [**Anadara (Kikiarca) Kikaizimana* NONURA & ZINBO, 1934; OD]. *Pleist.(Ryukyu Ls.)*, Japan.
Pectinarca SACCO, 1898.
Polyodonta MEGERLE, 1811.
Scaphura GRAY, 1842.
Thyas GRAY, 1857.
Tosarca NODA, 1965, p. 120 [**Anadara (Tosarca) tosaensis* NODA, 1965; OD]. *Plio.*, Japan.

ARCTICIDAE (p. *N*645)

Ambonicardia WHITFIELD, 1885.
Bradicardia LORIOL, 1891.
Bruntrutia COSSMANN, 1902.
Kobya LORIOL, 1901.

AVICULOPECTINIDAE (p. *N*335)

Schizopecten KOBAYASHI, 1936.

CAPRINIDAE (p. *N*789)

Caprinus MONTFORT, 1810.

CARDIIDAE (p. *N*583)

Avardaria ANDRUSSOV, 1923.
Callicardia CONRAD, 1873.
Cardiarlus DUMERIL, 1806.
Cartissa HERMANNSEN, 1848.

CHAMIDAE (p. *N*518)

Camostraea DESHAYES, 1830.

CORBICULIDAE (p. *N*665)

Limnocyrena MARTINSON, 1961. *Mesoz.*

ETHERIIDAE (p. *N*466)

Caillaudiana BOURGUIGNAT, 1880.
Chambardiana BOURGUIGNAT, 1880.
Niloticiana BOURGUIGNAT, 1880.

GRAMMYSIIDAE (p. *N*819)

Goldfussia CASTELNAU, 1843.
Rhombocardia MEEK & WORTHEN, 1866.

HIPPURITIDAE (p. *N*799)

Campiloceratites FORTIS, 1778.

LIMOPSIDAE (p. *N*264)

Feliciella LAMY, 1934.

LUCINIDAE (p. *N*492)

Loripoderma POLI, 1795.

LYMNOCARDIIDAE (p. *N*590)

Suchumca SENINSKI, 1905.

MACTRIDAE (p. *N*595)

Cycladina BERTHOLD, 1827.
Villarita DUNKER, 1846.

MACTROMYIDAE (p. *N*511)

Ferrata ROEDER, 1882 (subj. syn. of *Unicardium*, according to COX).

MARGARITIFERIDAE (p. *N*414)

Damaris SWAINSON, 1823.

MODIOMORPHACEA FAMILY UNCERTAIN (p. *N*393)

Coxiconcha BABIN, 1966, p. 281 [**Lyonsia britannica* ROUAULT, 1851; OD]. *Tert.(Dandeil.)*, Eu. (France).

MODIMORPHIDAE (p. *N*393)

Taimyria LUTKEVICH, 1951 [**T. taimyrensis;* OD]. *L.Perm.*, USSR(W.Sib.). [WEIR]

MUTELIDAE (p. *N*463)

Berpolis LEACH, 1825.
Dentina MEGERLE, 1841.

MYALINIDAE (p. *N*289)

Hoplomytilus SANDBERGER, 1856.
Myalinoptera FRECH, 1891.

MYTILIDAE (p. *N*271)

Callitriche POLI, 1791.
Callitricoderma POLI, 1798.
Ciboticola IREDALE, 1939.
Dactylus MÖRCH, 1861.
Pisima MÖRCH, 1834.
Pseudomodiolus BETEKHTINA, 1966 (?1967) [*? (First included species, *Anthraconauta vulgaris* KHALFIN; first fully described species, *P. ella* BETEKHTINA, 1967)]. [WEIR]
Septiola BITTNER, 1895.
Sinomytilus THIELE, 1934.
Stenolema DALL, BARTSCH & REHDER, 1939.

PARALLELODONTIDAE (p. *N*256)

Areocuculla COSSMANN, 1923.

PECTINACEA FAMILY UNCERTAIN (p. *N*332)

Protopalliolum SADYKOV, 1962, p. 66 [**P. kazanli;* OD]. *Dev.*, USSR(Kazakhstan).

PTERIIDAE (p. *N*302)

Unionum DALL, 1890 (new name for *Unionium* LINK, 1807).

PTERINEIDAE (p. *N*298)

Stainieria MAILLIEUX, 1930.

RADIOLITIDAE (p. *N*803)

Enargetes FISCHER DE WALDHEIM, 1830.

REQUIENIIDAE (p. *N*779)

Arietina CONRAD, 1853.

TEREDINIDAE (p. *N*722)

Teredarius DUMERIL, 1806.

TRIDACNIDAE (p. *N*594)

Tridacnoides KRUEGER, 1823.

UNIONIDAE (p. *N*415)

Abakaniella BETEKHTINA, 1966(?1967) [**Anthracomya magna* CHERNYSHEV; OD]. *M.Carb.*, USSR (W.Sib.). [WEIR]
Brussiella BETEKHTINA, 1966(?1967) [**B. curta;* OD]. *U.Perm.*, USSR(Sib.). [WEIR]
Sinomya POGOREVICH, 1951 [**S. kriegeri;* OD]. USSR (W.Sib.). [WEIR]

UNIONACEA FAMILY UNCERTAIN (p. *N*411)

Abbreviatiana BOURGUIGNAT, 1881.
Acalliana BOURGUIGNAT, 1881.
Adamiana BOURGUIGNAT, 1881.
Aegericiana LOCARD, 1889.
Alpecanusiana LOCARD, 1889.
Amnicusiana LOCARD, 1889.
Anatiniana BOURGUIGNAT, 1881.
Arealiana BOURGUIGNAT, 1881.
Arnouldiana LOCARD, 1890.
Arrosiana LOCARD, 1890.
Asticusiana LOCARD, 1889.
Ateriana LOCARD, 1889.
Avoniana BOURGUIGNAT, 1881.
Aximedia RAFINESQUE, 1820.
Baryana LOCARD, 1889.
Batavusiana LOCARD, 1889.
Beccariana LOCARD, 1890.
Berenguieriana LOCARD, 1889.
Brebissoniana LOCARD, 1889.
Briandiana BOURGUIGNAT, 1881.
Brotiana BOURGUIGNAT, 1881.
Camuriana LOCARD, 1890.
Carvalhoiana LOCARD, 1890.
Coelatura CONRAD, 1853.
Collobiana LOCARD, 1890.
Complanatiana LOCARD, 1890.
Courquiniana LOCARD, 1889.
Crassiana LOCARD, 1889.
Cygnaeana BOURGUIGNAT, 1881.
Cyrtusiana LOCARD, 1889.
Depressiana BOURGUIGNAT, 1881.
Despontainiana LOCARD, 1889.
Diplasma RAFINESQUE, 1831.
Ellipsaria RAFINESQUE, 1820.
Ellipsopsiana BOURGUIGNAT, 1881.
Ellipsopsiana LOCARD, 1889.
Elongatiana LOCARD, 1890.
Embiana LOCARD, 1890.
Eydyusiana LOCARD, 1889.
Falsusiana LOCARD, 1889.
Fusculusiana LOCARD, 1889.
Gallandriana BOURGUIGNAT, 1881.
Gallicusiana LOCARD, 1889.
Gastrodiana BOURGUIGNAT, 1881.
Gestrouana LOCARD, 1890.
Glyciana BOURGUIGNAT, 1881.
Granigeriana LOCARD, 1889.
Gravidiana LOCARD, 1890.
Heckingiana LOCARD, 1889.
Hemisolasma RAFINESQUE, 1831.
Hispaniana LOCARD, 1889.
Holandriana LOCARD, 1889.
Humbertiana LOCARD, 1890.
Idriniana LOCARD, 1890.
Illuviosiana FAGOT, 1885.
Incrassatiana LOCARD, 1890.
Jacqueminiana LOCARD, 1889.
Joannisiana LOCARD, 1889.
Jourdheuiliana BOURGUIGNAT, 1881.
Jousseaumeana LOCARD, 1889.
Lacanniciana LOCARD, 1880.
Lapidosus SIMPSON, 1900.
Lemotheuxiana LOCARD, 1889.
Letourneuxiana LOCARD, 1890.
Leucosilla RAFINESQUE, 1831.
Limnoica GRAY, 1857.
Locardiana LOCARD, 1889.
Lusitaniana BOURGUIGNAT, 1881.
Machadoiana LOCARD, 1890.
Macilentiana BOURGUIGNAT, 1881.
Macrosteniana LOCARD, 1890.
Mancusiana LOCARD, 1889.
Mariana LOCARD, 1889.
Mariolana LOCARD, 1890.
Melasiana LOCARD, 1889.
Meretricisiana LOCARD, 1889.
Meretrixiana LOCARD, 1890.
Metaptera RAFINESQUE, 1820.
Milletiana BOURGUIGNAT, 1881.
Moquiniana LOCARD, 1889.
Moreletiana LOCARD, 1889.
Mucidusiana LOCARD, 1889.
Nanusiana LOCARD, 1889.
Nemrodia PALLARY, 1939.
Notopala COTTON, 1935.
Notopalena IREDALE, 1943.
Nubilusiana LOCARD, 1889.
Ogerieniana LOCARD, 1890.
Ovuliana LOCARD, 1890.
Pammegaliana BOURGUIGNAT, 1881.
Parreyssiana BOURGUIGNAT, 1884.
Penchinatiana LOCARD, 1889.
Perniana LOCARD, 1889.
Picardiana BOURGUIGNAT, 1881.
Pisaniana LOCARD, 1889.
Piscimaliana BOURGUIGNAT, 1881.
Platteniciana BOURGUIGNAT, 1881.
Platyrhynchoidiana LOCARD, 1889.
Ponderosiana BOURGUIGNAT, 1881.
Pseudocaelatura GERMAIN, 1921.
Pseudoglyciana LOCARD, 1890.
Rayana LOCARD, 1890.
Requieniana LOCARD, 1889.
Rhombeidiana LOCARD, 1889.
Rockanaia DE MORRETES, 1941.
Rossmassleriana BOURGUIGNAT, 1881.
Rossmassleriana LOCARD, 1890.
Rostratiana BOURGUIGNAT, 1881.
Rostratiana LOCARD, 1889.
Rumanicana LOCARD, 1890.
Sandriana LOCARD, 1889.
Schizostoma SCHLUETER, 1838.
Scrupeana LOCARD, 1890.
Securilla DROUET, 1855.
Simonisiana LOCARD, 1889.
Socardiana LOCARD, 1889.
Spengleriana BOURGUIGNAT, 1881.
Sperchinusiana LOCARD, 1889.

Spondaeana LOCARD, 1890.
Sturmiana LOCARD, 1890.
Tricassiniana LOCARD, 1890.
Tumidusiana LOCARD, 1889.
Turtoniana LOCARD, 1889.
Unioniformiana LOCARD, 1890.
Ventricosiana BOURGUIGNAT, 1881.
Vietuliana LOCARD, 1890.
Viliaeana LOCARD, 1889.
Villanana FUGOT, 1892.
Westerlundiana BOURGUIGNAT, 1881.

VENERIDAE (p. *N670*)

Radiocrista DALL, 1901 [**Venus pulcherrima* DESHAYES, 1860; OD]. DALL assigned this genus to Veneracea, but the age and locality of the type was unknown at the time of description. It could be a *Protocardia* or a *Trigonia*. [KEEN]

CLASS, ORDER, AND FAMILY UNCERTAIN

Allocardium HALL, 1883.

Anomianella DE RYCKHOLT, 1847, p. 45 [**A. proteus;* M]. *L.Carb.(Tournais.)*, Eu.(Belg.). [NEWELL]

Arnoldia MAYER, 1887 [**A. consecta;* M].

Aviculomya HOLZAPFEL, 1889 [**A. peralata;* OD]. Shell thin, much swollen; beaks pointed, spirally enrolled, small; anterior wing rather large, continuing as ridge on dorsal margin behind beaks; posterior wing very large, not distinctly separated from main body of shell. Dentition and pallial line unknown. Ligament probably external, lying between shell surface and ridgelike prolongation of anterior wing. *L.Carb.*, Eu.(Ger.).——FIG. H1, *10*. **A. peralata*, Liebstein (near Herborn); RV ext., ×1 (Holzapfel, 1889). [LAROCQUE]

Barcoona FINLAY, 1926, p. 526 [*pro Pachydomella* ETHERIDGE, JR., 1907, p. 325 (*non* ULRICH, 1891)] [**Pachydomella chutus* ETHERIDGE; M]. Small (length 8 mm. or less), subtrigonal, subequilateral, longer than high, equivalve, compressed, relatively thick-shelled; umbones obtusely angular, scarcely incurved; hinge supposedly edentulous; muscle scars and pallial line unknown; surface unornamented except for well-marked growth rugae. *L.Cret.*, Australia(Queensl.).——FIG. H1, *2*. **B. chutus* (ETHERIDGE); LV, ×3 (Etheridge, 1907). [Cox]

Binghami BROWN, 1827 [**B. paradoxus;* M].

Bitubulites BLUMENBACH, 1803.

Blainvilla CHIAJE, 1829.

Bleta DE GREGORIO, 1930, p. 17 [**B. elegans;* M]. Genus founded on strongly convex, acutely triangular, subequilateral valve about 25 mm. high with strong growth rings; internal characters unknown. *U.Trias.*, Sicily. [Cox]

Carnidia BITTNER, 1901, p. 6 [**C. pannonica;* SD DIENER, 1923, p. 223]. Small smooth, very gibbose, trigonally subquadrate, only slightly inequilateral, with well-marked posterodorsal angle and diagonal ridge delimiting narrow posterior area; posterior margins with broad gape; internal characters unknown. *U.Trias.*, Eu.(Hung.-Austria).——FIG. H1,*3*. **C. pannonica*, Veszprém, Hung.; *3a*, RV lat.; *3b*, dorsal view; *3c*, posterior end showing gape, all ×3 (Bittner, 1901). [Cox]

Ceratoconcha KRAMBERGER-GORJAHOVIC, 1889.

Conchites SCHLAEPFER, 1821.

Costulopteria PAUL, 1941.

Cruciella KOKEN, 1913, p. 35 [**Nucula inflata* WISSMANN in MÜNSTER, 1841, p. 20 (*non* J. DE C. SOWERBY, 1827) (=*Megalodon klipsteini* BITTNER, 1895, p. 22; OD]. Small to medium-sized, gibbose, ovately cuneiform, inequilateral, slightly inequivalve; umbones at anterior 0.25 or 0.3 of length, that of LV higher than RV; lunule wide, cordiform; escutcheon deep, with well-defined bordering ridges; weak diagonal ridge commonly present; ligament apparently external, opisthodetic; hinge margin thickened below beak in RV, forming toothlike process received in recess of LV, hinge otherwise edentulous; pallial line entire; shell wall rather thin; exterior smooth or with weak concentric folds. *U.Trias.(Carn.)*, Austria(S.Tyrol).——FIG. H1,*1*. **C. klipsteini* (BITTNER), Heiligenkreuz; *1a*, LV lat.; *1b*, ant. view showing greater prominence of LV umbo, both ×2 (Bittner, 1895). [Cox]

Cyclostrea GENTIL, 1902.

Cyrenolimopsis HABE, 1953.

Delia DE LORIOL, 1891, p. 246 [**D. amaena;* M]. Medium-sized, equivalve, moderately and evenly inflated, suboval, slightly longer than high; umbones moderately prominent, just posterior to midlength; lunule present but no bordered escutcheon; ligament external, opisthodetic; internal characters unknown; surface smooth except for growth lines. *U.Jur.(Oxford.)*, Eu.(Switz.).——FIG. H1, *12*. **D. amaena; 12a*, RV lat.; *12b*, dorsal view, both ×1 (de Loriol, 1891). [Cox]

Diptyxis OPPENHEIM, 1889.

Donacites GMELIN, 1793.

Dorsomya DE RYCKHOLT, 1847, pl. 10, fig. 20 [**D. dorsata;* M]. [NEWELL]

Ectenoptera ULRICH, 1894, p. 485 *(nom. nud.)*. [NEWELL]

Elasmatium CLARKE, 1904, p. 293 [**E. gowandense;* OD]. *U.Dev.(Naples)*, USA(N.Y.). [NEWELL]

Elliptoidea TASCH, 1961 [**E. vulgaris;* OD]. Similar to stunted *Palaeanodonta*. *Perm.(Leonard.)*, USA(Kans.). [WEIR]

Ensia DE GREGORIO, 1930, p. 21 [**Pleuromya? (Ensia) pumila;* M]. Genus founded on small, sublunate, smooth shell with moderately prominent, almost terminal umbo; internal characters unknown. *Trias.*, Eu.(Sicily). [Cox]

Gibboconcha DE GREGORIO, 1930, p. 30 [**G. sicula;*

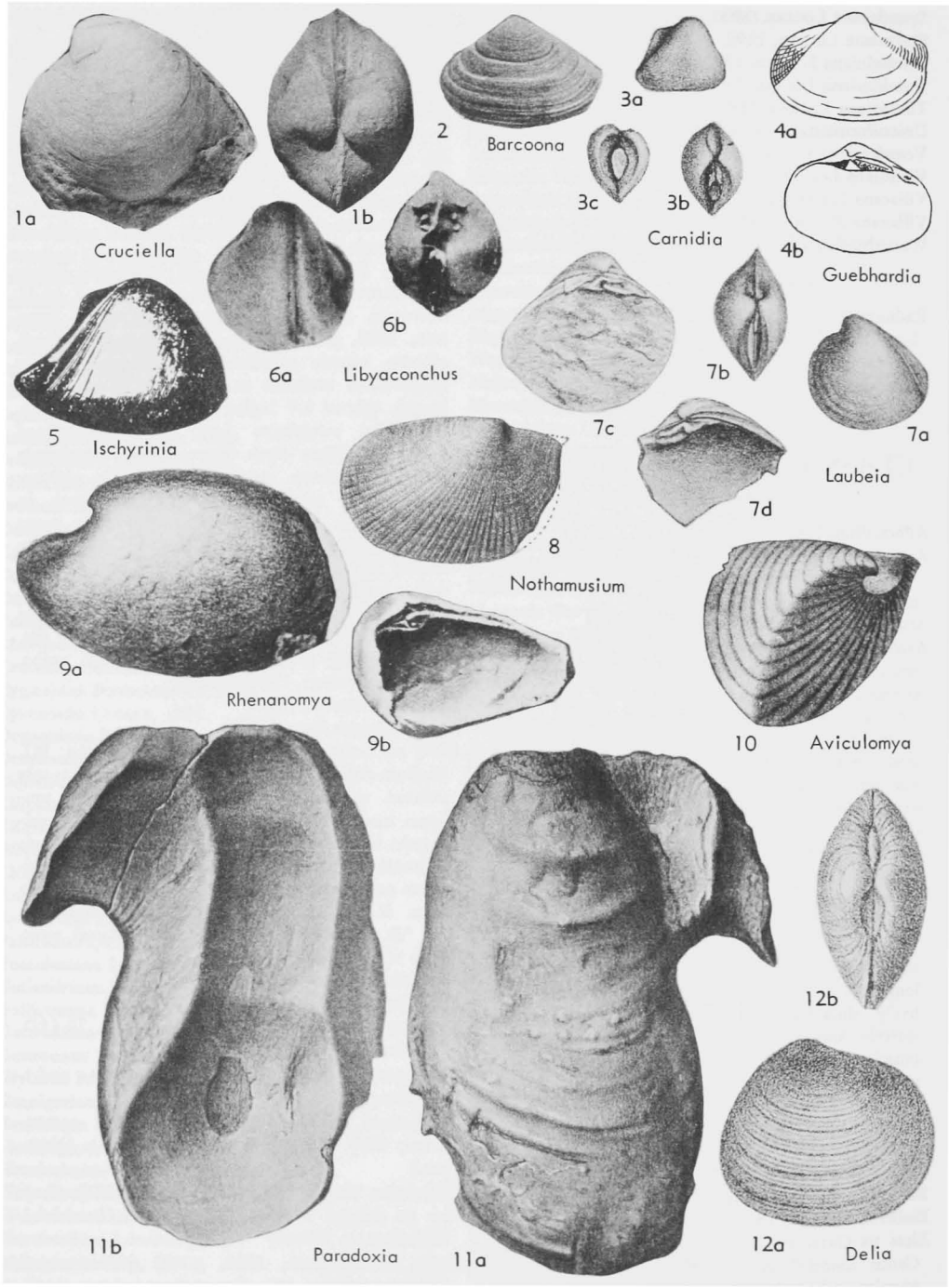

Fig. H1. Class, Order and Family Uncertain (p. *N*864).

M]. Genus founded on fragment of small, concentrically ribbed, subtrigonal, strongly inequilateral shell; internal characters unknown. Possibly young *Cardinia* or *Astarte*. *L.Jur.(Lias.)*, Sicily. [Cox]

Gingillum DE GREGORIO, 1930, p. 27 [**G. lindum;* M]. Medium-sized, smooth, obliquely oval, higher than long, with narrow submedian umbo and short, arcuate dorsal margin; internal characters unknown. *L.Jur.(Lias.)*, Italy(Sicily). [Cox]

Guebhardia COSSMANN, 1905, p. 841 [**G. veneriformis;* M]. Small, oblong-oval, subequilateral, moderately inflated, with broad, slightly protruding umbo and posterior umbonal ridge bordering narrow, radially costulate posterior area; surface otherwise smooth; anterior end with shallow radial sulcus forming lower border of slightly swollen anterodorsal region; ligament external, opisthodetic; 1 strong cardinal tooth in each valve, in LV posterior to that of RV, which occupies median position below beak; 1 short, thick posterior lateral in each valve; adductor scars & pallial line unknown. *M.Jur.(Bathon.)*, Eu.(S. France).——FIG. H1,*4*. **G. veneriformis*, Courmes, Alpes-Maritîmes; *4a,b*, LV lat., ext., int., both ×1.3 (Cossmann, 1905). [Cox]

Hadrodon YEN, 1952.

Ischyrinia BILLINGS, 1866, p. 52 [**I. winchelli;* SD S. A. MILLER, 1889] [=?*Technophorus* MILLER, 1889, p. 541 (type, *T. faberi;* M)]. Equivalve, inequilateral; 2 strong ridges radiating from beak to extended posteroventral extremity; hinge and musculature unknown. *M.Ord.-U.Ord.*, E.N.Am. ——FIG. H1,*5*. **I. winchelli*, U.Ord., Can.(Anticosti I.); RV ext., ×1 (Billings, 1866). [NEWELL]

Laevipinna PAUL, 1941.

Laubeia BITTNER, 1895, p. 116 [**Cardita strigilata* KLIPSTEIN, 1845, p. 255; M]. Small, slightly inequivalve, LV larger than RV; oval, strongly inequilateral; umbones prosogyrate, presence of diagonal ridge variable, deep escutcheon bordered by sharp ridge present in each valve; LV with 2 teeth, more dorsal of which is bifid, consisting of short posterior limb directed radially from beak and larger, longitudinally directed anterior limb, 2nd tooth below and parallel to this anterior limb; RV with single bifid tooth consisting of short radial posterior limb and longer longitudinal anterior limb; lateral teeth absent; pallial line and adductor scars unknown; surface smooth. *U.Trias.(Carn.)*, Austria(S. Tyrol).——FIG. H1,*7*. **L. strigilata* (KLIPSTEIN), St. Cassian; *7a*, LV ext.; *7b*, dorsal view; *7c*, hinge teeth of LV; *7d*, hinge teeth of RV; all ×1.3 (Bittner, 1895). [Cox]

Libyaconchus HASSAN, 1957, p. 135 [**L. parvus;* OD]. Small (<5 mm. long), suborbicular, gibbose, slightly inequivalve; umbones broadly rounded, that of RV more prominent; beaks prosogyrous; RV with strong cardial tooth, recurved in socket of LV; pallial line obscure; pedal retractor scars conspicuous, paired, on posterodorsal side of anterior adductor; ornament of strong radial ribs, some specimens also with radial sulcus posterior to mid-length in each valve, sulcus of RV with median rib. *U.Cret.* or *Paleoc.(Dan.)*, Esna Shales, Egypt.——FIG. H1,*6*. **L. parvus; 6a*, RV, int. mold; *6b*, dorsal view of bivalve int. mold, showing pedal retrack scars; both ×5 (Hassan, 1957). [Cox]

Liocardia AGASSIZ, 1842, p. 26 [Virtual *nom. nud.* without included nominal species.] Said to be close to *"Ceromya"* [*Ceratomya*] in external characters, but closer to *Isocardia* in other respects [Cox]

Macrodonta COSTA, 1845.

Megagrypha SPREISTERSBACH, 1922, p. 419 [**M. dahmeri;* OD]. *L.Dev.*, Eu.(Ger.). [LAROCQUE]

Mellaca MABILE, 1899.

Modioptera SCHINDEWOLF, 1924, p. 275 *(nom. nud.)*. [NEWELL]

Nothamusium HIND, 1904, p. 159 [**N. radiatum;* SD NEWELL, herein]. Equivalve, very inequilateral, obliquely ovate, prosogyre with beaks about 0.3 distance behind anterior extremity of hinge; posteroanterior margin subquadrate; free border ornamented by bifurcating flattened costae; hinge unknown. *L.Cam.*, Eu.(Ire.-Eng.-Scot.).——FIG. H1,*8*. **N. radiatum*, Eng.(Staffords.); RV ext., ×1 (Hind, 1904). [NEWELL]

Omalia DE RYCKHOLT, 1847 *(nom. oblit.), L.Carb.*, Eu.(Belg.). [NEWELL]

Onkogrypha SPRIESTERSBACH, 1925, p. 418 [**Megogrypha (Onkogrypha) cullmanni;* M]. *L.Dev.*, Eu.(Ger.). [NEWELL]

Opisenia ETALLON, 1862.

Osteophorus PHILIPPI, 1893.

Ostreavicula BLANCKENHORN, 1934, p. 179 [**O. dayi;* M]. Large, quadrate, oysterlike, LV feebly convex, RV slightly concave; no clearly demarcated posterior wing; RV with anterior auricle bordered posteriorly by narrow incision running from beak toward anterior margin; hinge structure and musculature unknown; surface bearing narrow dichotomous ribs. *U.Cret.(Turon.)*, Syria. [Cox]

Paradoxia KRUMBECK, 1923, p. 101 [**P. timorensis;* M]. Known only by single valve, possibly LV; with attachment area at tip; large, very thick-shelled, oval, higher than long, with large, down curved, hooklike ?posterior wing with median external crest; broad, dorsoventrally elongated cardinal area, without median depression, occupying posterior half of inner side and curved in posterior direction of dorsal end; visceral cavity shallow, single adductor scar occupying position dorsal to median; surface with uncertain rugae and a few wartlike protuberances. *L.Jur.(mid. Lias., Pliensbach.)*, E.Indies(Timor).——FIG. H1, *11*. **P. timorensis; 11a,b*, ?LV ext., int., ×0.7 (Krumbeck, 1923). [Cox]

Patogocardia DOELLO-JURADO, 1946.

Planktomya SIMROTH, 1896 [**P. henseni;* OD]. *Rec.*, Atl.

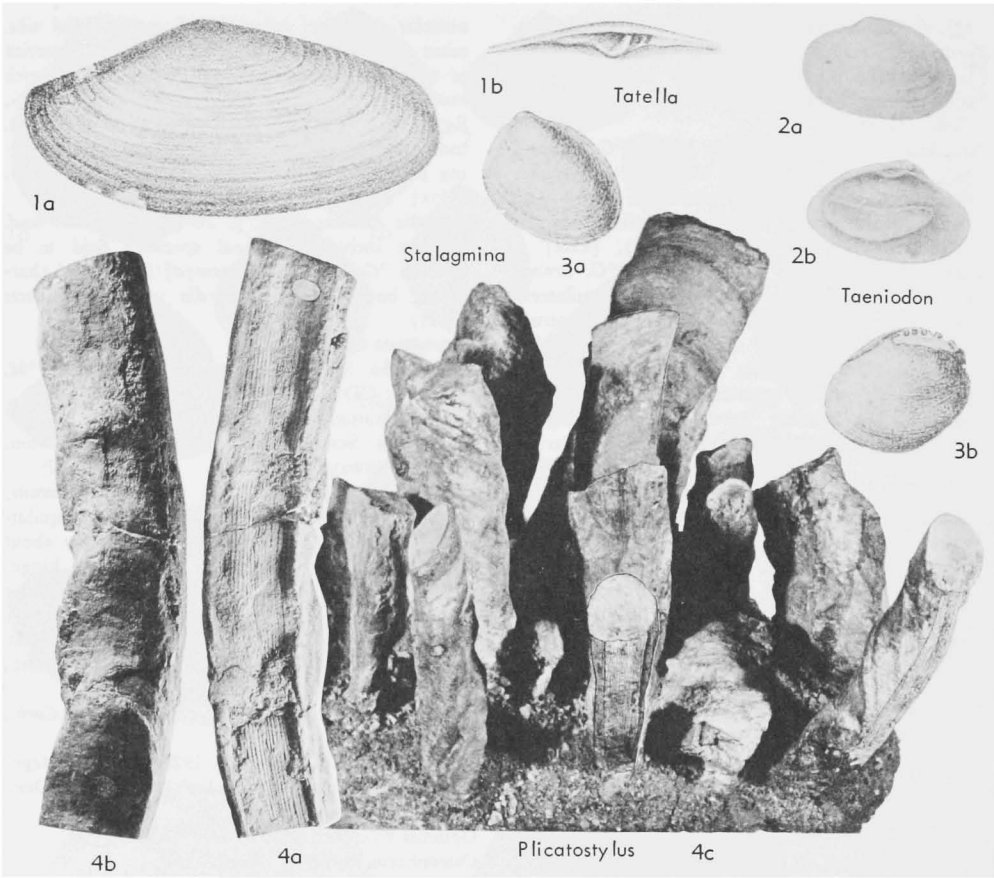

FIG. H2. Class, Order and Family Uncertain (p. *N*866).

Plicatostylus LUPHER & PACKARD, 1930, p. 204 [**P. gregarius;* OD]. Known mainly or solely from attached valve (AV) (=?LV, ?RV) which is large, greatly elongated, acutely conical or columnar, straight or slightly curved, attached at apex; cross section almost semicircular, one side with broad, flat, or slightly concave area (interpreted as ligamental area) extending whole length of AV between 2 riblike projections and bearing numerous low, flat-topped longitudinal ridges varying in width and separated by narrow intervals; convex (probably ventral) side, bearing coarse, upward-arched undulations at distant intervals and growth lines curved in conformity with them, indicating that commissure of valves was very oblique, sloping upward from hinge margin, which presumably was located at upper end of ligamental area; body chamber greatly elongated, subelliptical in cross section, with one side close to ligamental area, other side separated from outer surface of AV by thick wall, which has compact outer layer formed of rather coarse calcite prisms normal to surface, and thick, probably originally vesicular, inner layer of uncertain structure; hinge edentulous, its margin thin; 2 adductor scars present, one located on thick projecting buttress in upper part of body chamber on one side, other limited by low ridge; free valve (FV) imperfectly known or unknown, probably a flat, relatively thin structure. [This colonial reef-building bivalve, with largest illustrated specimen 48 cm. (19 in.) in height, was assigned by LUPHER & PACKARD (1930) to their monotypic Plicatostylidae. By other authors it has been referred to the Caprinidae and with small doubt seems to be a rudist.] *L.Jur.(low. Pleiensbach.)*, N.Am.(Ore.)-S.Am.(Peru).——FIG. H2,*4*. **P. gregarius*, Robertson Formation, USA(Ore.); *4a*, presumed dorsal side of AV showing ?ligamental area, ×0.4; *4b*, opposite (?ventral) side of same specimen showing uparched undulations. ×0.4; *4c*, assemblage of AVs indicating colonial mode of life, ×0.3 (Cox, n). [Cox]

[In the original description of the genus it was stated that the upper valve was curved and cap-shaped, with a prominent umbo and broad ligamental area like that of the lower valve. Dr. R. L. LUPHER has informed me that the specimens originally thought to be upper valves probably are small deformed lower valves and that the upper valve (not yet found complete) seems to have been as here stated.]

Praecardiomya AWAD, 1952, p. 7 [**P. sinaitica;* M]. Rather small, elongate-ovate, beaks at anterior third of length, escutcheon lanceolate; posterior area defined by faint diagonal groove with corresponding internal ridge; integripalliate; LV with triangular chondrophore, RV with corresponding pit; 5 irregular transverse teeth in each valve, forming protuberances from hinge margin on posterior side of beaks. *U.Cret.(Cenoman.),* Sinai. [Cox]

Preroderma KURODA, 1945.

Productea TASCH, *nom. subst.* herein [*pro Productae* TASCH, 1961 *(nom. vet.)*] [**P. dunbari* TASCH, herein *(nom. subst. pro Productae dunbaris* TASCH, 1961, *nom. vet.);* OD]. *L.Perm.(Leonard.),* USA (Kans.). [TASCH]

Psammoconcha TOMMASI, 1896, p. 61 [**P. servini;* M]. Medium-sized, elongate-oval, anterior margin more abruptly curved than posterior; subequilateral, with broad, scarcely projecting umbones; obscure diagonal ridge present in some specimens; internal characters unknown. *L.Trias.,* Eu.(S.Alps). [Cox]

Pseudomya ROEDER, 1882, p. 103 [**P. rarissima;* OD]. Founded on single imperfect elongate, oval, inequilateral LV; muscle scars and pallial line unknown; prominent spoon-shaped chondrophore, extending upwards, and with groove behind it, situated just anterior to beak. *U.Jur.(Oxford.),* Eu. (Alsace). [Cox]

Ptychodes FISCHER DE WALDHEIM, 1848.

Rebusum DE GREGORIO, 1930, p. 27 [**R. drepanense;* M]. Small to medium-sized, smooth, obliquely oval, higher than long, subalate, compressed, recalling some Limidae in outline but apparently lacking cardinal area; internal characters unknown. *L.Jur.(Lias.),* Eu.(Sicily). [Cox].

Rhenanomya LAROCQUE, *nom. subst.* herein [*pro Rhenania* FUCHS, 1915, p. 53 (*non* WAAGEN, 1907)] [**Rhenania tumida* FUCHS, 1915; OD]. Shell ventricose, elongate oval; umbones near anterior end, prosogyrous, strongly incurved; lunule small; hinge curved, prolonged posteriorly; LV with 3, RV with 2 to 3 cardinal teeth; lateral teeth lacking; ligament opisthodetic and external. *L. Dev.,* Eu.(Ger.).——FIG. H1,*9.* **R. tumida* (FUCHS), Coblenz.; *9a,* LV ext. showing outline and position of beaks, ×0.7; *9b,* RV dentition, ×0.7 (Fuchs, 1915). [LAROCQUE]

Rhinchotropis MEEK, 1872.

Rostrotortus TASCH, 1961 [**R. dissimilis;* OD]. ?Estheriid or possibly pathologic bivalve. *Perm. (Leonard.),* USA(Kans.). [NEWELL]

Sanoarca STEPHENSON, 1952.

Sollea DAHMER, 1949.

Spinarcullaea CHAVAN, 1952.

Sponditolites REICHENBACH, 1828.

Stagnestesta TASCH, 1961 [**S. solitaria;* OD]. ?Possibly estheriid. *Perm.(Leonard.),* USA(Kans.). Stunted bivalves from deposits of temporary, variable saline pools. [NEWELL]

Stalagmina DENCKMANN, 1887, p. 89 [**S. koeneni;* M]. Small (8 mm.), obliquely suborbicular, inequilateral; umbones prosogyrate but scarcely protruding; small lunule present; dentition consisting in each valve of elongate posterior lateral and about 3 small teeth of taxodont appearance close to beak; surface smooth. *L.Jur.(up.Lias.-Toarc.),* Eu.(Goslar, Ger.).——FIG. H2,*3.* **S. koeneni; 3a,* LV ext., ×1; *3b,* RV showing impression of teeth, ×1 (Denckmann, 1887). [Cox]

Taeniodon DUNKER, 1848, p. 179 [**T. ellipticus;* M]. Small (20 mm.) equivalve, oval, smooth, moderately inequilateral; LV with curved, upwardly concave, lamellar tooth just posterior to beak, with recess between it and margin for reception of thickened margin of RV; ligament external; muscle scars and pallial line unknown. *L.Jur.(Hettang.),* Eu.(Ger.).——FIG. H2,*2.* **T. ellipticus; 2a,b,* LV ext., int., ×1 (Dunker, 1848).

Tatella ETHERIDGE, 1901, p. 27 [**Corbicella? maranoana* ETHERIDGE, 1892, p. 471; OD]. Medium-sized, elongate, subrectangular or ovate, subequilateral, compressed, gaping slightly at both ends; RV with 2 short subumbonal teeth, LV with 1 blunt tooth recurved between them; no lateral teeth; anterior adductor scars elongate pyriform, oblique, posterior ones rounded; pallial line with small sinus; no ornament except concentric rugae. *L.Cret.,* Australia.——FIG. H2,*1.* **T. maranoana,* Maranoa River, Queensl.; *1a,b,* LV, ext., hinge, ×1 (Jack & Etheridge, 1892). [Cox]

Taxocardia OLSSON & HARBISON, 1953.

Verticipronus HEDLEY, 1904 [**V. mytilus;* OD]. Although assigned to Philobryidae by some authors, it was provisionally assigned to Carditidae and is so listed by POWELL and other Australasian workers. [KEEN]

Zoreia BRUSINA, 1907 [**Z. sanguinea;* M]. *?Pleist.,* Yugosl. Unfigured, minute (2 mm. long); description follows that of a species of *Tapes* in Veneridae, but it is so vague that one cannot be sure the author intended it in that family. [KEEN]

GENERA OF DOUBTFULLY MOLLUSCAN AFFINITIES

(With cross references to *Treatise* Part R)

Anatifopsis BARRANDE, 1872 (*see* p. *R*329).

Aptychopsis WOODWARD, 1872 (*see* p. *R*329).

Discinocaris WOODWARD, 1866 (*see* p. *R*329).

Eoischyrina KOBAYASHI, 1933.

Euchasmella KOBAYASHI, 1933.

Euclusaea GRAY, 1852. Brachiopod?

Fordilla BARRANDE, 1881.
Lebescontia JONES & WOODWARD, 1899 (*see* p. *R*326).
Lingulocaris SALTER, 1866 (*see* p. *R*330).
Modioloides WALCOTT, 1889.
Myocaris SALTER, 1864 (*see* p. *R*331).
Ozomia WALCOTT, 1924.
Paleodora FLEMING, 1957.
Pinnocaris ETHERIDGE, 1878 (*see* p. *R*331).
Pseudoeuchasma KOBAYASHI, 1933.
Pseudotechnophorus KOBAYASHI, 1933.
Ribeirella SCHUBERT & WAAGEN, 1903.
Ribeiria SHARPE, 1853.
Spirodomus BEECHER, 1886, p. 162 [**S. insignis;* OD, M]. *Miss.(Waverly)*, USA(Pa., Warren Co.). Probably not a mollusk. [NEWELL]
Wanwania KOBAYASHI, 1933.
Wanwanella KOBAYASHI, 1933.
Wanwanoidea KOBAYASHI, 1933.

UNRECOGNIZABLE GENERA

Aegilops HALL, 1850, p. 179 [**A. subcarinata;* M]. *M.Ord.(Trenton)*, USA(N.Y.). [Possibly a cyrtodontid (p. *N*248).]
Burriera LASERON, 1910 [**B. dunii;* OD]. *L.Perm. (U. Marine, Wandrawan.)*, Australia(N.S.Wales). [NEWELL]
Dolabra M'COY, 1844. *Carb.* [May belong to Myophoridae.]
Hemisterias RAFINESQUE, 1832, p. 142 [**H. quadriloba;* M]. *?Penn.*, Sherman Cr., Allegheny Mts., USA(Pa.). [NEWELL]
Mactrula RISSO, 1826.
Pleureterites RAFINESQUE, 1832, p. 142 [**P. lateristria;* SD NEWELL, herein]. *?Penn.*, Sherman Cr., Allegheny Mts., USA(Pa.). [NEWELL]
Preavicula WILLIAMS & BREGER, 1916, p. 205 [**Megambonia oblonga* HALL, 1895; OD]. *L.Dev.*, USA(N.Y.). [NEWELL]
Protopecten HIND, 1910 [**P. vimineus, *P. crenulatus*]. Probably a brachiopod. *Sil.(Llandov.)*, Eu.(Eng.). [NEWELL]
Sarka BARRANDE, 1881, p. 150 [**S. infelix;* M]. Possibly a brachiopod. *M.Dev.*, Eu.(Boh.). [NEWELL]
Telistrophis RAFINESQUE, 1832, p. 142 [**T. torsala;* OD, M]. *?Penn.*, Sherman Cr., Allegheny Mts., USA(Pa.). [NEWELL]

Family UNCERTAIN

Paramonopleura KOROBKOV in KOROBKOV & MAKARENKO, 1967 [addition by B. F. PERKINS (see p. *N*783)]. Anterior muscle insertion of AV on shell wall, posterior insertion on prolongation of cardinal platform and separated from 3′ by low ridge; muscle insertions of FV on thickened areas of shell wall. [*Note.*—If the conclusions of KOROBKOV & MAKARENKO are correct, this genus would be the only known Tertiary rudist. It was assigned to the Monopleuridae by KOROBKOV, but without data on larger, more mature shells, such placement is doubtful. The size of the type specimens and their occurrence in "glauconitic sandy-argillaceous deposits with intercalations of shelly detritus" suggest that they may be juveniles reworked from older deposits.] [*Ref.*—KOROBKOV, I. A., & MAKARENKO, D. YE., 1967, *Paramonopleura gen. nov. (Rudistae) iz verkhnego Paleotsena Ukrainy:* Paleont. Zhurnal, no. 4, p. 135-138, 1 fig. [*Paramonopleura gen. nov. (Rudistae) from the upper Paleocene of the Ukraine:* Paleont. Jour., 1968 (July), no. 4, p. 109-112, 1 fig. (transl. Am. Geol. Inst.).]

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ADDENDUM

LIMITATIONS OF BERNARD AND MUNIER-CHALMAS SYSTEM FOR BIVALVE HINGE NOTATION

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[Modified from D. W. Boyd and N. D. Newell, 1968; prepared under NSF Grant GB-6905X]

A method of designating homologous heterodont hinge teeth was devised independently and synthesized late in the 19th century by BERNARD (1895-98) and MUNIER-CHALMAS. It is described by Cox in a previous section (p. *N*53-55) of this *Treatise* Part. Their notation has been widely recommended, but it has not been accepted universally in practice. In many cases their method of naming teeth is difficult to apply because homologies among dissimilar bivalves commonly are not demonstrable readily; the homologous teeth must be recognized and correlated before the notation can be applied properly.

According to these workers, cardinal tooth *1* is an ontogenetically modified part of anterior lateral *AI, 2* of *AII,* and so on. Both *2* and *3* commonly divide to form *2a, 2b,* and *3a, 3b,* respectively. But, if growth series are lacking, how can these teeth be identified? Furthermore, tooth *4b,* although correlated with *AIV,* is not, in our experience, accompanied by *4a,* and *5b* apparently does not have a counterpart in *5a.* Details of these ontogenetic modifications presumably were determined empirically, but they have never been well documented and need to be confirmed.

The recognition of homologies and the tracing of phylogenetic trends in bivalve teeth are complicated by the fact that nonoccluding, or incompletely occluding, ridges and furrows along the hinge plate commonly are excluded from consideration in the dental notation by most investigators. An obsolescent or poorly developed tooth ridge, or the shell margin itself, commonly is not specified in the dental formula. Indeed, many students of heterodont bivalves designate as teeth only those that are completely embraced by a socket, or furrow, of the complementary valve. In this narrow definition, a weakly or incompletely occluding ridge may not be accepted as a hinge tooth. This is not only illogical but fails to provide for the recognition of newly appearing or obsolescent teeth.

Semantic difficulties aside, it is well established that teeth of the heterodonts are "variable" and that new elements may be added and old ones lost during evolution. It has not been demonstrated, however, that these historical events are recapitulatory in ontogenies of living bivalves, as supposed by BERNARD. In fact, it may be that they are rarely recapitulatory.

We believe the system of BERNARD and MUNIER-CHALMAS, with its stress on homologies, is misapplied commonly when used for bivalve taxa in which ontogeny and phylogeny are known poorly.

OBJECTIVE PLAN FOR HINGE ILLUSTRATION AND NOTATION

We propose a flexible, objective method of recording morphological details of the hinge teeth that can be converted readily to a modified version of the BERNARD system whenever homologies are secure. The new system is equally applicable for both heterodont and nonheterodont hinges.

The conventional orientation in illustrating bivalve hinges and the arrangement of dental formulas are extremely confusing. Furthermore, the idea that dental homologies in related bivalves can be ascertained by matching hinge teeth in numerical sequence certainly is not warranted unless supported by independent evidence such as graded growth series or stratigraphic sequences.

Consequently, we find merit in illustrating matched pairs of valves (Fig. BN1) in a manner that facilitates direct comparison with a simplified and objective nota-

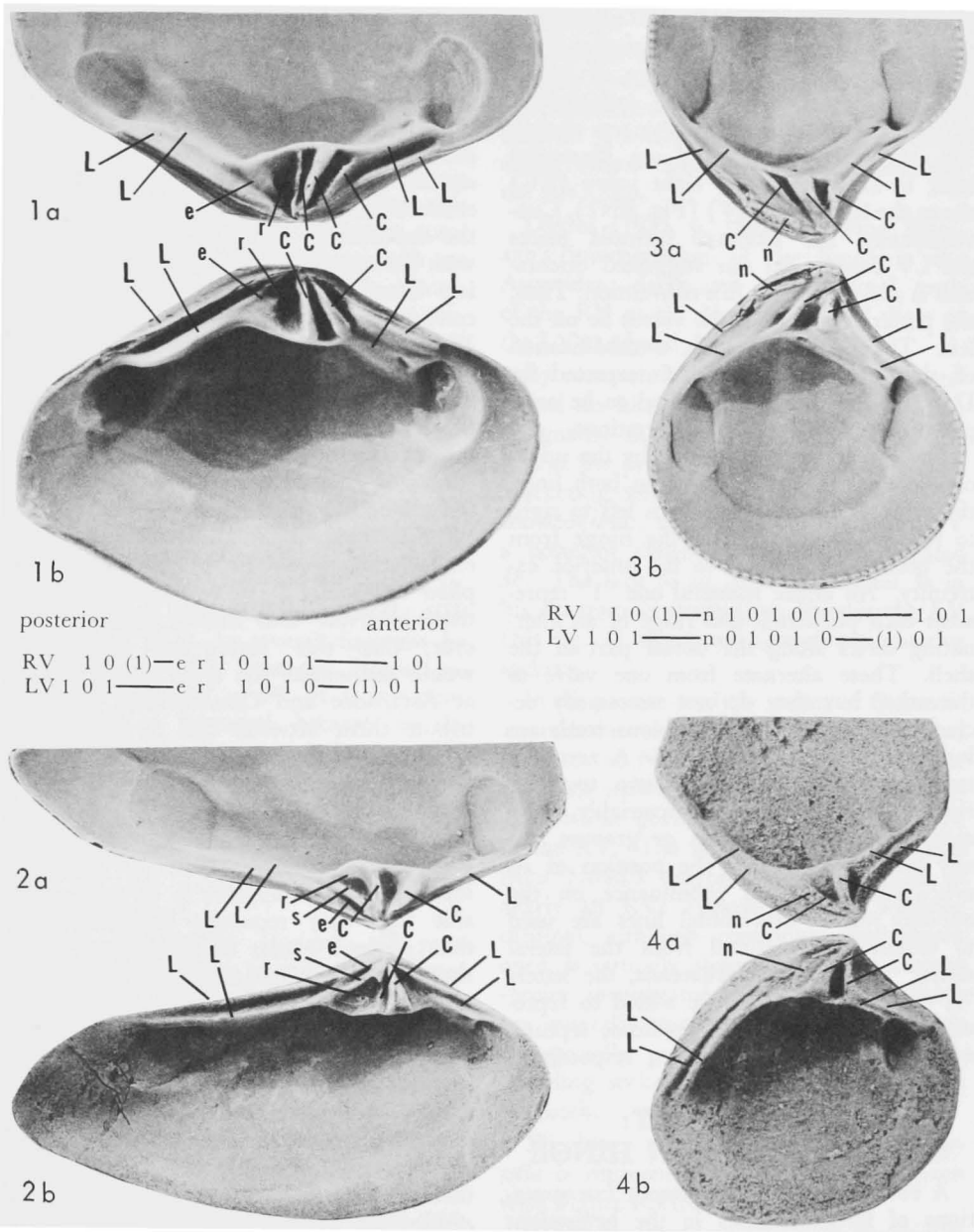

FIG. BN1. Crassatellacean hinges with notation of morphological elements and proposed formulas for them.

1. *Hybolophus speciosus* (ADAMS), Recent crassatellid from Florida; *1a,b,* RV and LV int., ×2, with formulas for hinges.
2. *Oriocrassatella elongata* BOYD & NEWELL, Permian crassatellid from Park City Formation, Wyoming; *2a,b,* RV and LV int., ×2, with formulas for hinges.
3. *Astarte castanea* SAY, Recent astartid from shallow water off Atlantic Highlands, New Jersey; *3a,b,* RV and LV int., ×2, with formulas for hinges.
4. *Astartella aueri* BOYD & NEWELL, Permian astartid from Park City Formation, Wyoming; *4a,b,* RV and LV int., ×3, with formulas for hinges.

[EXPLANATION: *C,* cardinal tooth; *e,* elastic-ligament area; *L,* lateral tooth; *n,* nymph; *r,* resilifer; *s,* septum; *0,* space between adjacent teeth or ridges; *1,* tooth or potential articular ridge; parentheses (), inconspicuous or doubtful tooth; horizontal line, boundary between lateral and cardinal teeth.]

tion. For use with poorly understood groups, our proposed method has the merit of being free from implications of uncertain homologies by avoiding specification of homologues during preliminary studies. The two valves of a shell are illustrated beak to beak, with the right valve (RV) above the left valve (LV) (Fig. BN1). Conventionally, the BERNARD formula places the LV below, and our suggested orientation is a concession to this convention. Thus, the posterior parts of both valves lie on the left. The notation system, a modification of that of STEINMANN as interpreted by DALL (1913), has been devised to be compared directly with such illustrations.

The RV hinge is expressed by the upper of two lines of symbols, and, in both lines, the symbols are arranged from left to right to reflect a traverse along the hinge from the posterior extremity to the anterior extremity. An arabic numeral one "1" represents each projection and ridge of an alternating series along the dorsal part of the shell. These alternate from one valve to the other but they do not necessarily occlude. Inconspicuous or dubious teeth are indicated between parentheses. A zero "0" represents a space between two teeth or ridges. Generally, but not invariably, these spaces function as sockets or grooves. In any case, they indicate the position of an articulating ridge or prominence on the opposite valve. Horizontal lines are used to delimit the cardinal from the lateral series. For the crassatellaceans, the letters "r," "s," "n," and "e" are added to represent the position of the resilium, septum, nymph, and elastic ligament, respectively.

CASE HISTORY: CRASSATELLACEAN HINGE

A review of past and present interpretations of hinge features in the heterodont superfamily Crassatellacea illustrates the limitations of the BERNARD system of hinge notation, as well as the uncertain phyletic significance of grades of hinge complexity.

BERNARD's research on the ontogeny and comparative morphology of the hinges of bivalve mollusks was cut short by his early death, and, to our knowledge, his work has not been subsequently brought under critical review. Essential documentation of his views about dental homologies among living crassatellaceans is lacking, so we are unable to confirm or deny his conclusion. However, we note that BERNARD and many subsequent investigators have recognized certain peculiarities in the dentition of crassatellaceans. Some authors have placed the superfamily with the lucinoids, others with the cyrenoids. DAVIES (1935), following BERNARD (1895) and LAMY (1917), considered the Crassatellacea FÉRUSSAC, 1822 (=Astartacea D'ORBIGNY, 1844), to be of lucinoid derivation, superficially assuming a cyrenoid aspect as a result of evolutionary acquisition of an additional cardinal tooth in the RV.

DAVIES (op. cit.) segregated the Crassatellacea and Carditacea known to him from other lucinoids on the basis of their hinge characteristics and KOROBKOV (1954) applied the ordinal name "Astartedonta" to these bivalves. Our studies indicate, however, that this segregation undesirably would dismember the lines usually classed as Astartidae and Crassatellidae, and distribute them between two of KOROBKOV's orders, the Lucinodonta and the Astartedonta. Consequently, although we acknowledge the utility of "lucinoids" and "cyrenoids" as grades of hinge complexity, there is little to commend them as bases for separate taxa. It appears to us more probable that they represent iterative rather than phyletic grades of complexity. As is shown below, the characteristics of ancestral crassatellaceans do ally them with primitive lucinoids. But post-Paleozoic forms achieve a more advanced evolutionary status superficially similar to, but not quite like, the cyrenoid grade. Furthermore, the hinges of later members of the Crassatellidae and the Astartidae resemble one another more than they do those of their Paleozoic ancestors—an example, apparently, of evolutionary convergence. Thus, some doubt is cast on the integrity of the superfamily Crassatellacea as usually constituted.

CRASSATELLID DENTAL FORMULAS

In the notation suggested above, the hinge of *Hybolophus speciosus,* a living

crassatellid, can be characterized as given in the two-line formulas accompanying Figure BN1,*1a,b*.

BERNARD and later students have supposed that the RV cardinals correspond to *5b, 3b,* and *3a,* and the two LV cardinals, to *4b* and *2*. We cannot find convincing documentation in the literature that this notation is firmly based on studies of ontogenetic development, or that these teeth are homologous with those of other heterodonts conventionally given the same numerals. Similarly, little agreement is found with respect to the lateral teeth. For example, DARRAGH (1965, p. 98) cited only two laterals, *AII* and *PI,* in *Eucrassatella,* although he mentioned *AI* and *PII* (*ibid.,* p. 100, 102), in comments on certain species of that genus. Authors using the BERNARD system have not specified as lateral teeth all the eight ridges indicated as such in our interpretation of *Hybolophus* (Fig. BN1,*1*). LAMY (1917, p. 200) utilized *AI, AII, AIII, PI, PII,* and *PIV*. In several diagrams he designated a strong posterior lateral between *PII* and *PIV* as *PI*. It is not clear whether he so intended, because, in the BERNARD system, the position between *PII* and *PIV* should be occupied by *PIII*. There is precedent, however, in one of BERNARD's diagrams (1895, p. 121) for the misplacement of a lateral tooth where he places *AII* above *AI*. We assume that this position was unintentional.

Recent crassatellids (indeed, all post-Paleozoic ones known to us), possess more cardinals and laterals than does the Paleozoic *Oriocrassatella* (Fig. BN1,*2*). Furthermore, the strong septum that divides the resilium from the ligament in this genus is obscure or lacking in post-Paleozoic crassatellids in which the ligament and the resilium are in contact.

In living crassatellids, as in all the astartids known to us, the anterodorsal margin of the RV overlaps that of the LV. The reverse situation exists in *Oriocrassatella*. The homologies of *Hybolophus* and *Oriocrassatella* are not at all evident and will remain uncertain until intermediate forms, if they exist, are discovered. We favor the hinge analysis of the Permian genus given with Figure BN1,*2a,b*.

ASTARTID DENTAL FORMULAS

Although astartids lack the internal ligament of crassatellids, the dentition of modern representatives of the two families is similar. We interpret the hinge of a Recent shell *(Astarte castanea)* as shown with Figure BN1,*3a,b*.

DAVIES (1935, p. 156), following BERNARD's interpretation of the hinge in the Astartidae, designated the cardinal teeth of the RV as *5b, 3b,* and *3a,* and those of the LV as *4b* and *2*.

By contrast, NICOL (1955, p. 157) interpreted the hinge in *Astarte* as cyrenoid. He designated the large central tooth on the RV as the pivotal tooth *1,* and termed the bracketing teeth of the LV *2b* and *2a*. He showed(*ibid.,* fig. 4, p. 157) on the RV a posterior cardinal which he designated *3b*. The lack of an anterior cardinal *3a* in his diagram is perplexing, because the LV (his fig. 1) shows an appropriate anterior socket.

In the present study, a survey of Cenozoic astartids in the collections of the American Museum of Natural History indicates that the shell shown in Figure BN1,*3,* is characteristic in possessing three cardinal teeth in the RV. The anterior cardinal, omitted from NICOL's diagram, is recognizable in nearly all RVs examined. The posterior cardinal, although commonly well developed, is virtually absent from three Eocene species investigated. Both of these teeth are generally small. In cases in which one is especially poorly developed, the corresponding socket is more conspicuous than the tooth.

The hinge of the Paleozoic genus *Astartella* is represented by the formulas given with Figure BN1,*4a,b*.

It appears that *Astarte* characteristically has the anterior cardinal in the RV, whereas *Astartella* has the anterior cardinal in the LV, as do members of the Myophoriidae and of the Scaphellinidae. The outer anterior lateral of the RV extends to the beak, an unusual and primitive feature in heterodonts.

INTRODUCTION OF NEW TEETH IN CRASSATELLACEAN HINGE

The lucinoid hinge grade appears at least as early as the Middle Ordovician (McAlester, 1965), whereas the cyrenoid hinge was rare or lacking before the Mesozoic. These differences in stratigraphic distribution lend support to the view of Bernard, Davies, and others that the cyrenoid hinge was derived by elaboration of the lucinoid hinge. Bernard concluded that the splitting of the pivotal (central and principal) cardinal tooth in LVs of lucinoids gave rise to two teeth separated by a new socket. The latter receives a new pivotal cardinal tooth of the RV. If this change has been a phyletic as well as an ontogenetic innovation, it may have been heralded by a broadening and bilobation of tooth *2* before actual bifurcation. Bilobation of the pivotal tooth of the LV is a characteristic feature of many late Paleozoic pelecypods (e.g., *Schizodus*) and suggests a possible pattern in a trend toward multiplication of hinge teeth.

Bernard, Davies, and others have supposed that the three cardinal teeth of living crassatellacean RVs correspond to *5b*, *3b*, and *3a*, whereas the two cardinal teeth of LVs were designated as *4b* and *2*. We have given thought to Nicol's (1955) view that the central cardinal on the RV may be cyrenoid *1*, rather than the lucinoid *3b*, and we are unable at present to resolve this problem. The Permian crassatellaceans clearly are similar to lucinoids in possessing two cardinal teeth in each valve, whereas the post-Paleozoic forms generally have a third tooth, commonly identified as *5b*, at the posterior end of the RV series. This tooth is represented in the Paleozoic in *Astartella* but not in *Oriocrassatella*. Although *Astartella* has the cardinal just cited, it has only two, not three, cardinals in the RV. The pivotal tooth of the Paleozoic forms is perceptibly bifid in *Oriocrassatella*. The evolutionary bifurcation of this tooth and the appearance of a new pivotal tooth, *1*, in the opposite valve conceivably could result in hinge development very similar to that which characterizes living crassatellaceans.

According to this interpretation, the crassatellaceans would consist of Paleozoic lucinoids, and post-Paleozoic forms of cyrenoid aspect lacking one tooth typical of the cyrenoid dentition. This suggestion is perhaps more attractive for the crassatellids than for the astartids, because the pivotal tooth in *Astartella* is not bifid.

In any case, the two families require a manipulation of different teeth, in order to derive for both a cyrenoid post-Paleozoic hinge from a Paleozoic lucinoid ancestor. The cyrenoid pivotal tooth would originate within the posterior cardinal socket of the RV in astartids but in the anterior cardinal socket in crassatellids. The two cardinal teeth of the astartid RV would then change numbers in transition from Paleozoic to post-Paleozoic (*5b* to *3b*, and *3b* to *3a*), whereas the enumeration of crassatellid cardinal teeth of the RV (*3a* and *3b*) would remain constant. Finally, the two teeth of the LV would originate from a splitting of the posterior cardinal (*4b*) of *Astartella*, but from the anterior cardinal (*2*) in *Oriocrassatella*.

Even for crassatellids, the preceding idea is suspect, because both Paleozoic and post-Paleozoic LVs have only two cardinals. The hypothesis recognizes an evolutionary trend toward an increase in the number of cardinal teeth and suggests that a shift in hinge symmetry is accomplished by a splitting of the Paleozoic pivotal tooth of the LV to accommodate a new pivotal tooth in the RV. However, this interpretation requires the disappearance of a pre-existing tooth, the LV posterior cardinal. In the interest of simplicity, it appears more likely that steps in the development of the cyrenoid hinge involved only the appearance of new teeth, rather than contemporaneous appearance and disappearance. In our present state of knowledge, it is more reasonable to suppose that the two cardinals of the LV in *Oriocrassatella* are homologous with those in modern crassatellids, than that the posterior one has disappeared while the anterior one evolved into two. Likewise, although it is possible that the two teeth of Paleozoic RVs are homologous with the anterior and posterior elements of the three-toothed post-Paleozoic RVs, it seems

more likely that they are homologous with the anterior and central ones, leaving the posterior rather than the middle one as a post-Paleozoic innovation.

This alternative invites speculation that the posterior tooth in question, commonly designated as *5b,* developed as a wall related to the posterior margin of the resilifer. The border of the resilium in *Oriocrassatella* is reflected in a few valves by an obscure shelf along the anterior margin of the resilifer. This shelf occupies a position analogous to that of the posterior cardinal in post-Paleozoic specimens. Cardinal *5b* in living species is more variable in size and orientation than the other cardinals, and the LV lacks a corresponding socket in some species.

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Italicized names in the following index are considered to be invalid; those printed in roman type, including morphological terms, are accepted as valid. Suprafamilial names are distinguished by the use of full capitals and author's names are set in small capitals with an initial large capital. Page references having chief importance are in boldface type (as **N327**). Some divergences in classification reflect differences of authors concerning validity of nomenclature.