

## SYSTEMATIC DESCRIPTIONS

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

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## Class BIVALVIA Linné, 1758 (Buonanni, 1681)

[ex Vermes Testacea Bivalvia LINNÉ, 1758, p. 645; *nom. correct.* LINNÉ, 1765] [=Acephala CUVIER, 1798; Conchifera LAMARCK, 1818; Pelecypoda GOLDFUSS, 1820; Conchophora GRAY, 1821; Dithyra TURTON, 1822; Lamellibranchia, Lamelli-branchiata DE BLAINVILLE, 1824; Elatobranchiata MENKE, 1828; Cormopoda BURMEISTER, 1837; Tropipoda CATLOW & REEVE, 1845; Aglossa LOVÉN, 1848; Elatocephala BRONN, 1862; Anodontoda HAECKEL, 1868; Lipocephala LANKESTER, 1884]  
[Diagnosis prepared by N. D. NEWELL]

Aquatic, acephalous, passive, and microphagous mollusks characterized by paired lateral shelly valves of conchiolin and calcium carbonate joined at hinge by flexible ligament; shell and ligament secreted by mantle which envelops organs and tissues within bivalved shell; mantle connected with shell submarginally by pallial muscles not present in other mollusks; other shell muscles generally consist of one anterior and one posterior adductor that close valves against opposing stresses within ligament; several small shell muscles activate foot which is variously adapted for creeping, burrowing and secretion of anchorage devices; feeding and respiration are accomplished by more or less symmetrical pair of lateral ctenidia bearing ciliary and mucous systems; fertilization of eggs external, sexes commonly hermaphroditic and protandrous; gut convolute, nephridia paired. *M. Cam.-Rec.*

The origin of the class is shrouded in mystery and the oldest bivalves (Tremadocian and older) give no hint of their derivation. Speculation that they were derived from a monoplacophoran-like ancestor is reasonable but not at all conclusive. Great gaps in the fossil record of many groups probably reflect ineffectual competition with other benthonic organisms, restricted geographic distribution and small population numbers rather than diagenetic destruction of the shells. Gastropods, also with conchiolin-calcareous shells, have a good Cambro-Ordovician record in rocks that rarely show a trace of bivalves.

Extinction of many major groups of competing brachiopods at the end of the Paleozoic Era was followed after a considerable time lapse by a steady evolutionary deployment of bivalves from Late Triassic time until the present. Many living superfamilies are virtually immortal, with known records

and very little morphological change in more than 300 or 400 million years. A fascinating exception were the rudists which underwent rapid radiation and were distributed abundantly and widely at low latitudes during the Cretaceous Period. Certain other groups show evolutionary trends but a more prevalent pattern is for a group to appear and vanish abruptly with very little morphologic change.

The class has been singularly successful and apparently is now near the acme of its diversity, suggesting inherent advantages of conservatism, generalized modes of feeding and reproduction, and life in stable habitats.

## Subclass PALAEOTAXODONTA Korobkov, 1954

[Diagnosis by N. D. NEWELL]

Characters same as those of order Nuculoida DALL, 1889. *Ord.-Rec.*

## Order NUCULOIDA Dall, 1889

[*nom. transl. et correct.* NEWELL, 1965 (ex suborder Nuculacea DALL, 1889)] [Diagnosis by N. D. NEWELL]

Shell taxodont, equivalve, with closed margins, isomyarian; nacreous or crossed lamellar; ligament generally amphidetic; gills protobranchiate; foot grooved and reptant, not byssiferous in adults.<sup>1</sup> *Ord.-Rec.*

## Superfamily CTENODONTACEA Wöhrmann, 1893

[*nom. transl.* McALESTER, herein (ex Ctenodontidae WÖHRMANN, 1893)] [Materials for this superfamily prepared by A. L. McALESTER, Yale University]

Shell equilateral, pallial sinus lacking, resilifer absent, cylindrical external ligament posterior to umbones. *Ord.-Carb.*

<sup>1</sup> The relationships of many poorly understood genera of Recent deep-sea nuculoid bivalves soon will be clarified as a result of anatomical studies nearing completion by H. L. SANDERS, of the Woods Hole Oceanographic Institute, and J. A. ALLEN, of the University of Newcastle upon Tyne, England. Their work suggests that the problematic genus *Pristigloma*, included here in the superfamily Nuculanacea, is more closely related to the Nuculacea. In addition, they have discovered some extremely significant but previously unknown species which exhibit anatomical features and the general shape of nuculoids, but which lack the taxodont dentition found in all other nuculoid bivalves. Pending publication of these important observations, the more traditional assignment of *Pristigloma* and other deep-sea nuculoid genera is retained here.

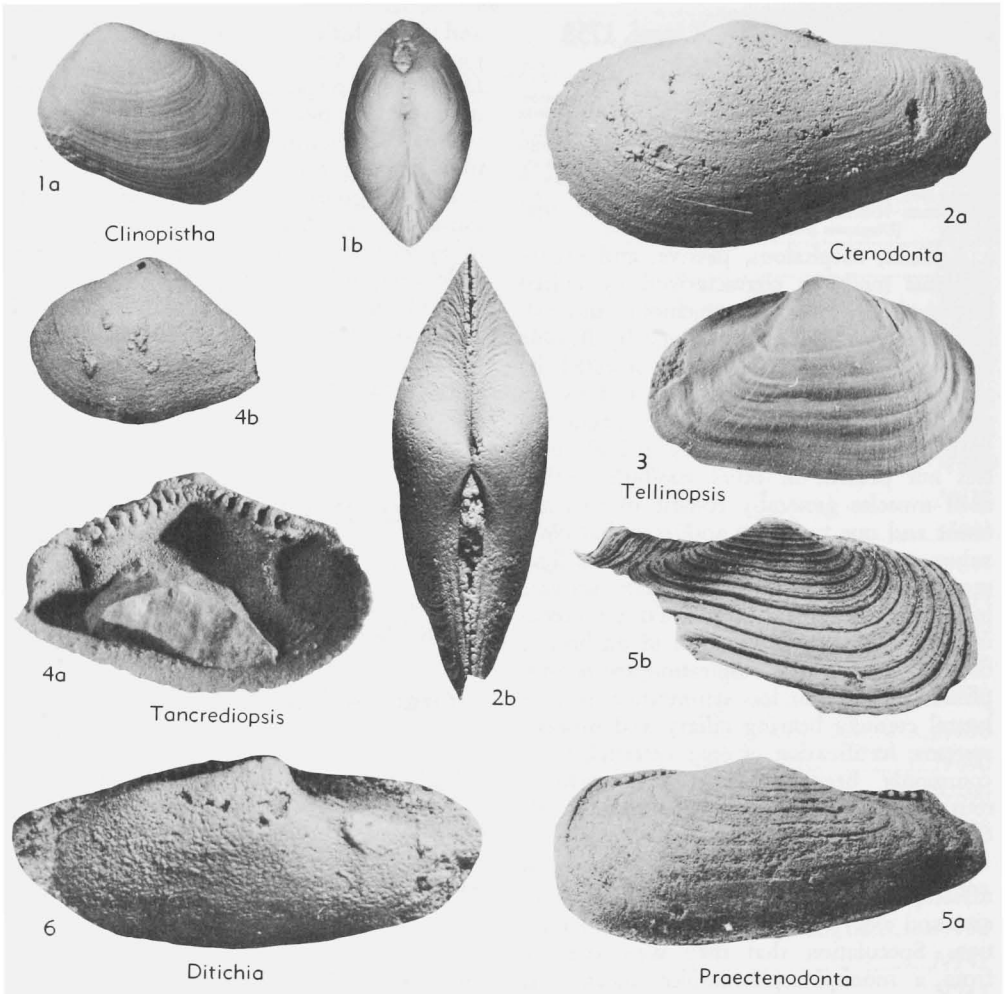


FIG. A1. Ctenodontidae (p. N228-N229).

### Family CTENODONTIDAE Wöhrmann, 1893

Characters of superfamily. *Ord.-Carb.*

**Ctenodonta** SALTER, 1852, p. 64 [*Tellinomya nasuta* HALL, 1847; SD SALTER, 1859] [= *Tellinomya* HALL, 1847, p. 151 (obj.) (non AGASSIZ, 1846)]. Very large, elongate, lacking concentric sculpture. *M.Ord.*, N.Am.—FIG. A1,2. \**C. nasuta* (HALL), Ont.; 2a,b, LV ext., dorsal view of conjoined valves,  $\times 2$  (McAlester, n).

**Clinopistha** MEEK & WORTHEN, 1870, p. 43 [*C. radiata* var. *levis*; OD] [= *Dystactella* HALL & WHITFIELD, 1872, p. 192 (type, *Tellinomya subnasuta*; M)] Like *Ctenodonta* but smaller, more elongate anteriorly. *L.Dev.-Carb.*, N.Am.—FIG. A1,1. \**C. levis*, Carb., USA (Ill.); 1a,b, RV ext.,

dorsal view of conjoined valves,  $\times 2$  (McAlester, n).

**Ditichia** SANDBERGER, 1891, p. 104 [*Leda mira* BEUSHAUSEN, 1884; OD]. Small, elongate, weak adductor muscle scars. *L.Dev.*, Eu. (Ger.)—FIG. A1,6. \**D. mira* (BEUSHAUSEN); LV composite ext.-int. mold,  $\times 4$  (McAlester, n).

**Praectenodonta** PHILIP, 1962, p. 226 [*Palaeoneilo varicostae* CHAPMAN, 1908; OD] [= *Gotodonta* SOOT-RYEN, 1964, p. 502 (type, *Nucula sulcata* HISINGER, 1841; OD)]. Like *Ctenodonta* but with very strong concentric sculpture. *Sil.-L.Dev.*, cosmop.—FIG. A1,5. \**P. varicostae* (CHAPMAN), Sil., Australia; 5a,b, LV composite ext.-int. mold, RV ext.,  $\times 2$  (Philip, 1962).

**Tancrediopsis** BEUSHAUSEN, 1895, p. 70 [*Ctenodonta contracta* SALTER, 1859; SD COSSMANN,

1897]. Like *Ctenodonta*, but with less elongate posterior extremity, some species with fine concentric sculpture. *Ord.*, N.Am.—FIG. A1,4. \**T. contracta* (SALTER), Ont.; 4a,b, LV int., ext.,  $\times 3$ ,  $\times 2$  (556).

**Tellinopsis** HALL & WHITFIELD, 1869, p. 80 [\**Nuculites submarginata* CONRAD, 1842; OD]. Like *Ctenodonta* but less elongate, with fine radial sculpture. *M.Dev.*, E.N.Am.—FIG. A1,3. \**T. submarginata* (CONRAD), USA(N.Y.); RV composite int.-ext. mold showing impression of radial sculpture,  $\times 2$  (McAlester, n).

**Superfamily NUCULACEA Gray, 1824**

[*nom. transl.* DALL, 1889 (ex Nuculidae GRAY, 1824)  
[Diagnosis by A. L. McALESTER]

Truncate posterior extremity, pallial sinus lacking, resilifer present or absent. *Ord.-Rec.*

**Family PRAENUCULIDAE McAlester, new family**

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

Resilifer absent, ligament external. *Ord.-Dev.*

**Praenucula** PFAB, 1934, p. 234 [\**P. dispar expansa*; OD]. Posteriorly truncate, anterior and posterior teeth similar in size and number. *M.Ord.*, Eu. (Czech.).—FIG. A2,6. \**P. expansa*; 6a,b, LV and RV (oblique view), int. molds,  $\times 5$  (McAlester, n).

**Cardiolaria** MUNIER-CHALMAS, 1876, p. 107 [\**C. barrandei*; OD] [=Honeymania McLEARN, 1918, p. 138 (type, *H. planimarginata*; OD)]. Like *Deceptrix*, but more equilateral and rounded. *Ord.-Sil.*, Eu.-N.Am.—FIG. A2,1. \**C. barrandei*, *Ord.*, France; LV int. mold,  $\times 2$  (McAlester, n).

**Deceptrix** FUCHS, 1919, p. 79 [\**D. carinata*; M] [=Praeleda PFAB, 1934, p. 231 (type, *Nucula compar* BARRANDE, 1881, pl. 271; OD)]. Like *Praenucula*, but posterior teeth smaller and more numerous than anterior. *M.Ord.-Dev.*, Eu.—FIG. A2,5. \**D. carinata*, L.Dev., Ger.; LV int. mold,  $\times 2$  (McAlester, n).

**Ledopsis** BEUSHAUSEN, 1884, p. 91 [\**L. rectangularis*; SD McALESTER, 1968] [=Pseudoledopsis MAILLIEUX, 1937, p. 182 (type, *Ledopsis taunica* BEUSHAUSEN, 1895; OD)]. Like *Praenucula*, but with more sharply truncate posterior having strong radial groove. *L.Dev.*, Eu.(Ger.).—FIG. A2,4. \**L. rectangularis*, LV ext.,  $\times 2$  (McAlester, n).

**Palaeoconcha** MILLER, 1889, p. 498 [\**P. jaberis*; OD]. Rounded, small, anterior and posterior teeth similar in size and number. *U.Ord.*, N.Am.—FIG. A2,2. \**P. jaberis*; 2a,b, RV int. mold and int.

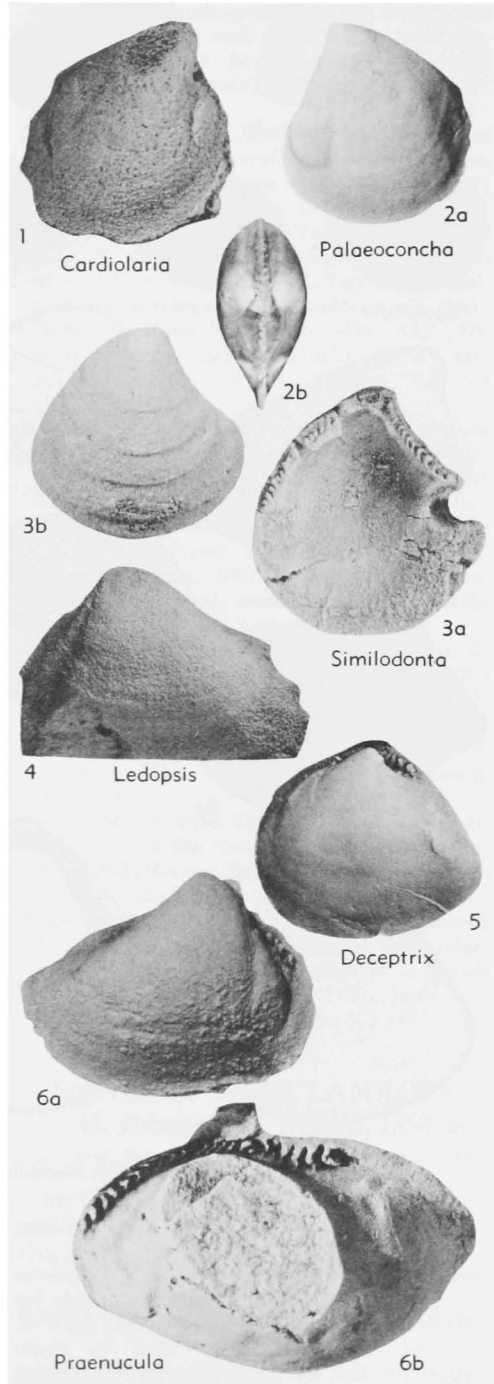


FIG. A2. Praenuculidae (p. N229-N230).

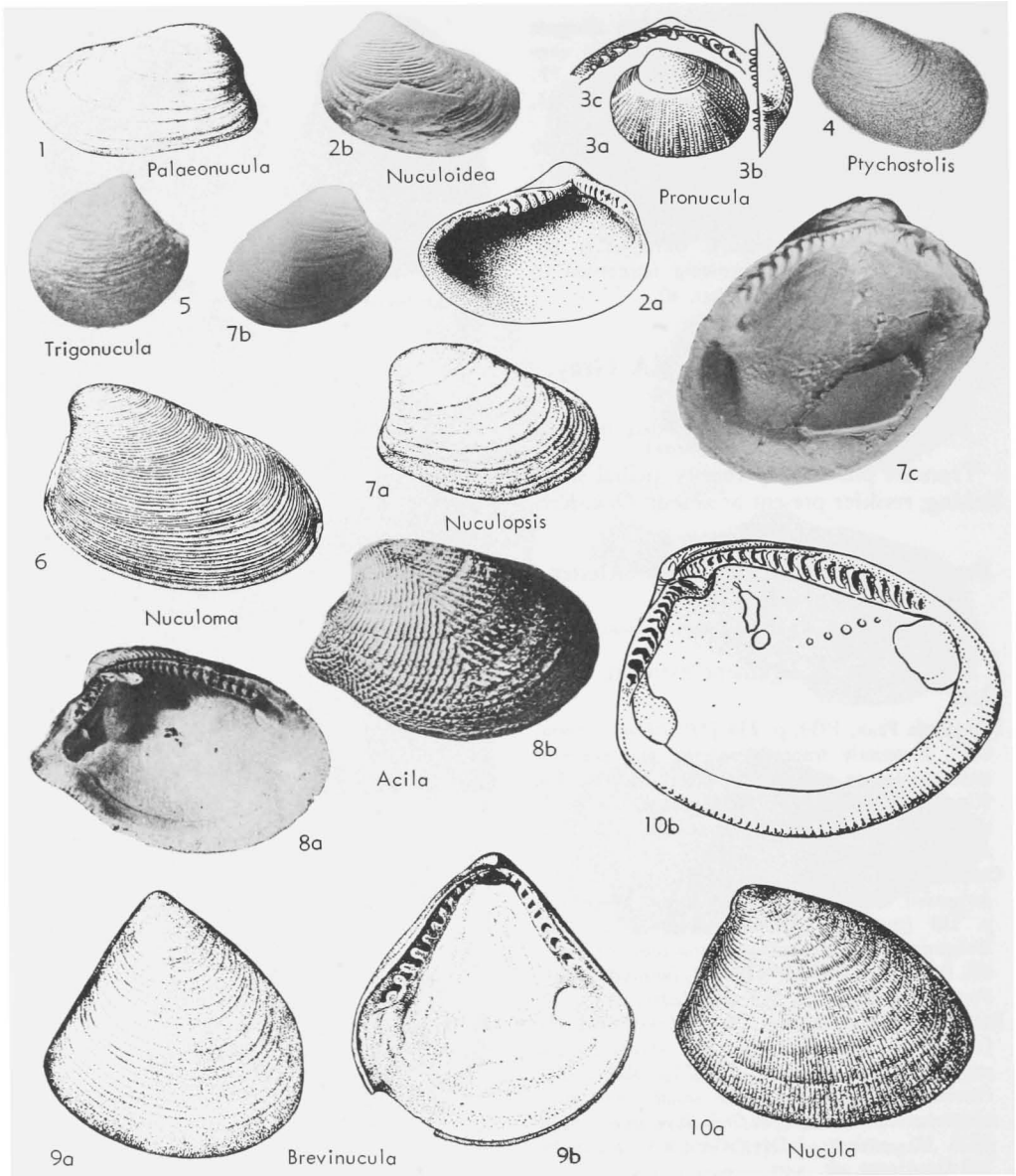


FIG. A3. Nuculidae (p. N230-N231).

mold of conjoined valves, dorsal,  $\times 6$  (McAlester, n).

**Similodonta** SOOT-RYEN, 1964, p. 498 [*Tellinomya similis* ULRICH, 1892; OD]. Like *Palaeoconcha* but much larger, stronger adductor muscle scars. *U. Ord.-Sil.*, N.Am.-Eu.—FIG. A2,3. \**S. similis* (ULRICH); 3a,b, RV int., LV ext.,  $\times 2$  (McAlester, n).

**Family NUCULIDAE Gray, 1824**

[Materials for this family prepared by A. M. KEEN, Stanford University]

Shell material nacreous; beaks opisthogyrate; resilifer present; ligament internal. *Ord.-Rec.*

**Nucula** LAMARCK, 1799, p. 87 [*Arca nucleus*

- LINNÉ, 1758; M] [= *Lembulus* SOWERBY, 1842, p. 170 (*non Lembulus* RISSO, 1826)]. Ovate, normally with polished periostracum. *Cret.-Rec.*, cosmop.
- N. (Nucula).** Sculpture of radial ribs, inner ventral margin crenate. *U.Cret.-Rec.*, cosmop.—FIG. A3,10. \**N. (N.) nucleus* (LINNÉ), *Rec.*, France; 10a,b, RV ext., LV int.,  $\times 5$  (832).
- N. (Gibbonucula)** EAMES, 1951, p. 319 [\**N. (G.) corbuliformis* (*non Nucula corbuliformis* HALL & WHITFIELD, 1869) (= *N. (G.) neocorbuliformis* EAMES, 1955); OD]. Thick-shelled, inflated; surface with coarse concentric and fine radial sculpture; inner ventral margin crenate. *L.Eoc.*, Asia.
- N. (Lamellinucula)** SCHENCK, 1944, p. 97 [\**Nucula tamatawica* ODHNER, 1943; OD]. With strong incised concentric sculpture, weak radial ribs; inner ventral margin crenate. *Eoc.-Rec.*, Eu.-N.Am. S.Am.-Afr.
- N. (Leionucula)** QUENSTEDT, 1930, p. 112 [\**Nucula albensis* D'ORBIGNY, 1844; OD] [= *Nuculopsis* WOODRING, 1925, p. 14 (*non Nuculopsis* GIRTY, 1911) (type, *N. (Nuculopsis) hilli*); *Ennucula* IREDALE, 1931, p. 202 (type, *Nucula obliqua* LAMARCK, 1819; OD)]. Smooth, resiliifer oblique; inner ventral margin smooth. *Cret.-Rec.*, cosmop.
- N. (Linucula)** MARWICK, 1931, p. 49 [\**Nucula ruatakiensis* MARWICK, 1926; OD]. With fine divaricate radial riblets on lunule and escutcheon. *Mio.*, N.Z.
- N. (Pectinucula)** QUENSTEDT, 1930, p. 112 [\**Nucula pectinata* SOWERBY, 1818; OD]. With strong radial ribs. *Cret.*, Eu.-N.Am.
- Acila** ADAMS & ADAMS, 1858, p. 545 [\**Nucula divaricata* HINDS, 1843; SD STOLICZKA, 1871]. Sculpture divaricate. *Cret.-Rec.*, N.Am.-S.Am.-Asia.
- A. (Acila).** With well-defined rostral sinus. *Oligo.-Rec.*, N.Am.-S.Am.-Asia.—FIG. A3,8. \**A. (A.) divaricata* (HINDS), *Rec.*, Korea; 8a,b, LV int., RV ext.,  $\times 1$  (833).
- A. (Truncacila)** GRANT & GALE (*ex* SCHENCK, MS), 1931, p. 115 [\**Nucula castrensis* HINDS, 1843; OD]. Quadrangular to ovate, without rostral sinus. *L.Cret.-Rec.*, Eu.-N.Afr.-N.Am.-S.Am.-Japan.
- Brevinucula** THIELE, 1934, p. 786 [\**Nucula guineensis* THIELE, 1931; M]. Triangular, short. *Mio.-Rec.*, Afr.-N.Am.—FIG. A3,9. \**B. guineensis* (THIELE), *Rec.*, W.Afr.; 9a,b, RV ext., RV int.,  $\times 8$  (832).
- Nuculoidea** WILLIAMS & BREGER, 1916, p. 173 [\**Cucullea opima* HALL, 1843; OD]. Resiliifer triangular, below inner ends of hinge-teeth series; inner ventral margin microscopically crenate. *Ord.-Dev.*, N.Am.—FIG. A3,2. \**N. opima* (HALL), *Dev.*, USA (N.Y.); 2a, RV int.,  $\times 1$  (946); 2b, RV ext.,  $\times 2$  (McAlester, n).
- Nuculoma** COSSMANN, 1907, p. 124 [\**Nucula castor* D'ORBIGNY, 1849; M]. Like *Palaeonucula* but with more strongly opisthogyrate umbones; surface with concentric threads; teeth as in *Nucula*; inner ventral margin smooth. *Jur.*, Eu.-Asia.—FIG. A3,6. \**N. castor* (D'ORBIGNY), France; RV ext.,  $\times 2$  (832).
- Nuculopsis** GIRTY, 1911, p. 123 [\**Nucula ventricosa* HALL, 1858 (*non Nucula ventricosa* FLEMING, 1828) (= *Nuculopsis girtyi* SCHENCK, 1934); OD] [= *Nuculavus* CHERNYSHEV, 1947, p. 5 (type, *N. minuta*; OD); *Nuculanella* TASCH, 1953, p. 395 (type, *N. piedmontia*; OD); *Stagnnucula* CHERNYSHEV, 1947, p. 9 (*nom. nud.*)]. Very inequilateral; inner ventral margin smooth; resiliifer small. *Carb.-Perm.*, Eu.-N.Am.-N.Z.-Asia.—FIG. A3,7. \**N. girtyi* SCHENCK, *Carb.*, USA (Ind.); 7a, RV ext.,  $\times 2$  (832); 7b,c, LV ext., RV int.,  $\times 2$ ,  $\times 4$  (McAlester, n).
- Palaeonucula** QUENSTEDT, 1930, p. 110 [\**Nucula hammeri* DEFRENCE, 1825; OD]. Inflated, smooth; hinge as in *Nucula* but posterior series of teeth shorter; inner ventral margin smooth. *Trias.-Jur.*, Eu.-Asia-N.Am.—FIG. A3,1. \**P. hammeri* (DEFRENCE), *Jur.*, France; LV ext.,  $\times 1$  (832).
- Pronucula** HEDLEY, 1902, p. 290 [\**P. decorosa*; OD]. Hinge arched, elements separated, resiliifer vertical. *U.Oligo.-Rec.*, Australasia.
- P. (Pronucula).** Inner ventral margin crenate. *U. Oligo.-Rec.*, Australasia.—FIG. A3,3. \**P. (P.) decorosa*, *Rec.*; 3a,b, RV ext., RV dorsal,  $\times 7$ ; 3c, RV hinge, enl. (832).
- P. (Austronucula)** POWELL, 1939, p. 220 [\**A. schencki*; OD]. Inner ventral margin smooth. *Rec.*, N.Z.
- Ptychostolis** TULLBERG, 1881, p. 14 [\**P. nordenskiöldi*; M]. Shell like *Nucula* but with strong lunule. *Jur.*, USSR (Novaya Zemlya).—FIG. A3,4. \**P. nordenskiöldi*, RV ext.,  $\times 1$  (919).
- Trigonucula** ICHIKAWA, 1949, p. 267 [\**T. sakawana*; OD]. Trigonal, escutcheon defined by sharp ridge; sculpture of concentric striae; hinge as in *Nucula* but resiliifer not as oblique. *U.Trias.*, Japan.—FIG. A3,5. \**T. sakawana*; LV ext.,  $\times 3$  (422).

## Superfamily NUCULANACEA

### H. Adams & A. Adams, 1858

[*nom. transl.* PURI, herein (*ex* Nuculanidae ADAMS & ADAMS, 1858)] [Diagnosis by A. L. McALESTER]

Shell elongate posteriorly, with or without resiliifer, pallial sinus usually present. *Ord.-Rec.*

### Family MALLETIIDAE Adams & Adams, 1858

[*nom. correct.* McALESTER, herein (*pro* Malletidae BELLARDI, 1875, *nom. transl. ex* Mallettinae ADAMS & ADAMS, 1858)] [Materials for this family prepared by A. L. McALESTER, Yale University]

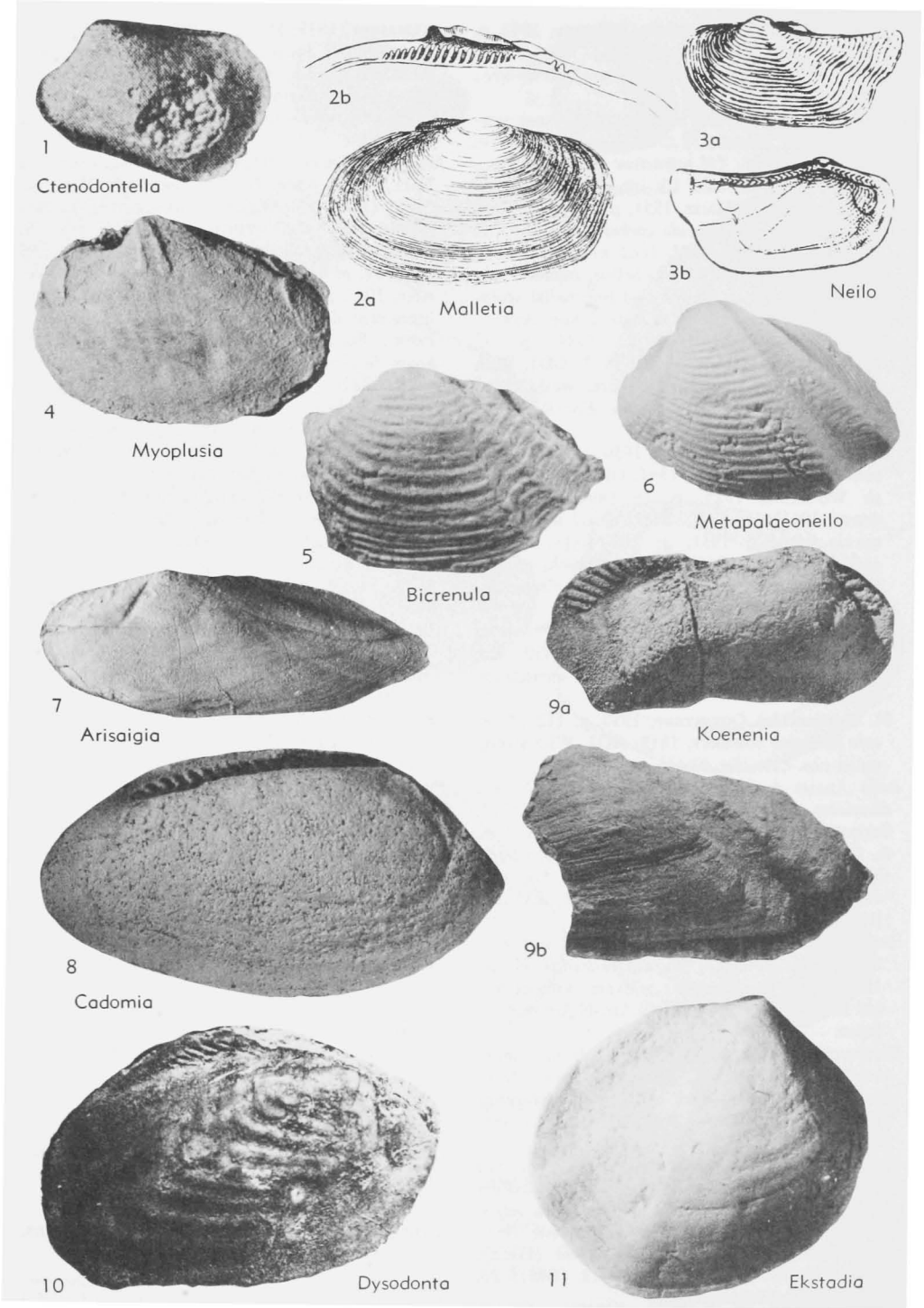


FIG. A4. Malletiidae (p. N233).

No resilifer, ligament predominantly external. *Ord.-Rec.*

- Malletia** DES MOULINS, 1832, p. 85 [*\*M. chilensis*; M] [= *Solenella* SOWERBY, 1832, p. 197 (type, *S. norrisii*; M); *Ctenoconcha* GRAY, 1840, p. 139; *Nucularia* CONRAD, 1869, p. 44 (type, *N. papyria*; M); *Pseudomalletia* FISCHER, 1886, p. 987 (type, *Yoldia obtusa* SARS, 1872; SD DALL, 1898)]. Thin shell, weak concentric sculpture, elongate, blunt posterior, strong pallial sinus. *Mesoz.-Rec.*, cosmop.
- M. (Malletia)**. Compressed, not rostrate. *Mesoz.-Rec.*, cosmop.—FIG. A4,2. *\*M. (M.) chilensis*, *Rec.*, Chile; *2a*, RV ext.,  $\times 1$ ; *2b*, LV hinge, enl. (Sowerby, 1842).
- M. (Malletiella)** SOOT-RYEN, 1957, p. 1 [*\*Malletia pacifica* DALL, 1897; OD]. Compressed, rostrate. *Rec.*, E.Pac.
- M. (Minormalletia)** DALL, 1908, p. 385 [*\*M. (M.) arciformis*; SD FINLAY, 1926]. Inflated, not rostrate. *Rec.*, E.Pac.
- Arisaigia** McLEARN, 1918, p. 139 [*\*A. postornata*; OD]. Elongate, radial sculpture on posterior, with posterior radial groove and internal septum. *Sil.*, N.Am.(Nova Scotia).—FIG. A4,7. *\*A. postornata*; LV composite ext.-int. mold,  $\times 2$  (McAlester, n).
- Bicrenula** WILLIAMS & BREGER, 1916, p. 163 [*\*Palaeoneilo bisulcata* HALL & WHITFIELD, 1869; SD McALESTER, 1968]. Two posterior radial grooves, strong concentric sculpture. *Dev.*, E.N. Am.—FIG. A4,5. *\*B. bisulcata* (HALL & WHITFIELD), U.Dev., USA(N.Y.); LV composite ext.-int. mold,  $\times 4$  (McAlester, n).
- Cadomia** TROMELIN, 1877, p. 48 [*\*C. typha*; M]. Very large, lacking posterior radial groove, weak concentric sculpture. *Ord.*, Eu.(Fr.).—FIG. A4,8. *\*C. typha*; RV composite ext.-int. mold,  $\times 1.5$  (McAlester, n).
- Ctenodontella** KHALFIN, 1940, p. 262 [*\*C. macrodiformis*; OD]. Elongate, expanding to greatest height posteriorly. *L.Dev.*, USSR(Sib.).—FIG. A4,1. *\*C. macrodiformis*; LV composite ext.-int. mold,  $\times 4$  (Khalfin, 1940).
- Dysodonta** MANSUY, 1913, p. 9 [*\*D. deprati*; M]. Expanding to greatest height posteriorly, strong concentric sculpture, large blade-shaped posterior teeth. *Sil.*, SE.Asia(N.Vietnam).—FIG. A4,10. *\*D. deprati*; RV composite ext.-int. mold,  $\times 1$  (Mansuy, 1913).
- Ekstadia** SOOT-RYEN, 1964, p. 501 [*\*E. tricarinata*; OD]. Rounded, weak surface sculpture, two weak posterior radial grooves. *Sil.*, Eu.(Swed.).—FIG. A4,11. *\*E. tricarinata*; RV ext.,  $\times 6$  (Soot-Ryen, 1964).
- Koenenia** BEUSHAUSEN, 1884, p. 72 [*\*Cucullaea lasii* ROEMER, 1843; M]. Very large, posteriorly elongate, strong posterior radial groove. *L.Dev.*, Eu.(Ger.).—FIG. A4,9. *\*K. lasii* (ROEMER); *9a,b*, RV int. mold showing dentition and ant. muscle scar, LV cast of post. part ext. mold,  $\times 1$  (McAlester, n).
- Metapalaeoneilo** LAMCKE, 1934, p. 186 [*\*Palaeoneilo (M.) baltica*; M]. Equilateral, strong posterior radial groove, strong concentric sculpture, internal septum present. *Sil.*, Eu.(N.Ger.) (Baltic boulders).—FIG. A4,6. *\*M. baltica* (LAMCKE); LV ext.,  $\times 3$  (McAlester, n).
- Myoplusia** NEUMAYR, 1884, p. 416 [*\*Leda bilunata* BARRANDE, 1881; SD McALESTER, 1968]. [= *Pseudocyrtodonta* PFAB, 1934, p. 236 (type, *Leda ala* BARRANDE, 1881; OD)]. Like *Palaeoneilo*, but with much larger and stronger umbonal pedal muscle scars. *M.Ord.*, Eu.(Czech.).—FIG. A4,4. *\*M. bilunata* (BARRANDE); LV int. mold,  $\times 5$  (McAlester, n).
- Neilo** ADAMS, 1852, p. 93 [*\*N. cumingii*; M]. Thick shell, strong concentric sculpture, elongate, blunt posterior, strong pallial sinus. *Tert.-Rec.*, cosmop.—FIG. A4,3. *\*N. cumingii*, *Rec.*, N.Z.; *3a,b*, LV ext. and int.,  $\times 1.5$  (Adams, 1852).
- Nuculites** CONRAD, 1841, p. 49 [*\*N. oblongatus*; SD MILLER, 1889] [= *Cleidophorus* HALL, 1847, p. 300 (type, *Nuculites planulata* CONRAD, 1841; M); *Cucullella* M'COY, 1851, p. 50 (type, *Cucullaea antiqua* SOWERBY, 1839; SD BEUSHAUSEN, 1895); *Pyrenomoëus* HALL, 1852, p. 87 (type, *P. cuneatus*; M)]. Like *Palaeoneilo*, but with internal septum. *Ord.-Dev.*, cosmop.—FIG. A5,7. *\*N. oblongatus*, M.Dev., N.Y.; RV composite ext.-int. mold,  $\times 1.5$  (McAlester, n).
- Palaeoneilo** HALL & WHITFIELD, 1869, p. 6 [*nom. conserv.* ICZN (Opinion 215), 1954] [*\*Nuculites constricta* CONRAD, 1842; SD HALL, 1885] [= *Anthraconneilo* GIRTY, 1911, p. 131 (type, *A. taffiana*; OD); *Anthraconneilopsis* TASCH, 1953, p. 391 (type, *A. kansana*; OD); *Filius* BARRANDE, 1881, p. 162 (obj. syn. of *Synek* BARRANDE); *Goniodon* HERRICK, 1888, p. 84 (type, *G. ohioensis*; M); *Olegija* CHERNYSHEV, 1948, p. 3 (type, *O. eugenii*; OD); *Straba* PRANTL & RŮŽIČKA, 1954, p. 3 (type, *S. bohemica*; OD); *Strabiella* PRANTL & RŮŽIČKA, 1954, p. 4 (type, *Straba (S.) holynensis*; OD); *Strabina* PRANTL & RŮŽIČKA, 1954, p. 4 (type, *Straba (S.) formosa*; OD); *Synek* BARRANDE, 1881, p. 162 (type, *S. antiquus*; OD)]. Faint posterior radial groove, concentric sculpture, no internal septum. *Ord.-Mesoz.*, cosmop.—FIG. A5,9. *\*P. constricta* (CONRAD), M.Dev., N.Y.; composite ext.-int. molds of both valves (LV below),  $\times 1.5$  (McAlester, n).
- Phaenodesmia** BITTNER, 1894, p. 188 [*\*P. klipsteiniana*; SD DIENER, 1923]. Like *Palaeoneilo*, but with more tapered posterior. *Trias.*, Eu.—FIG. A5,2. *\*P. klipsteiniana*; *2a,b*, LV ext., dorsal view of both valves,  $\times 1$  (58).
- Prosoleptus** BEUSHAUSEN, 1895, p. 70 [*\*Nucula lineata* GOLDFUSS, 1840; OD]. Like *Palaeoneilo*,



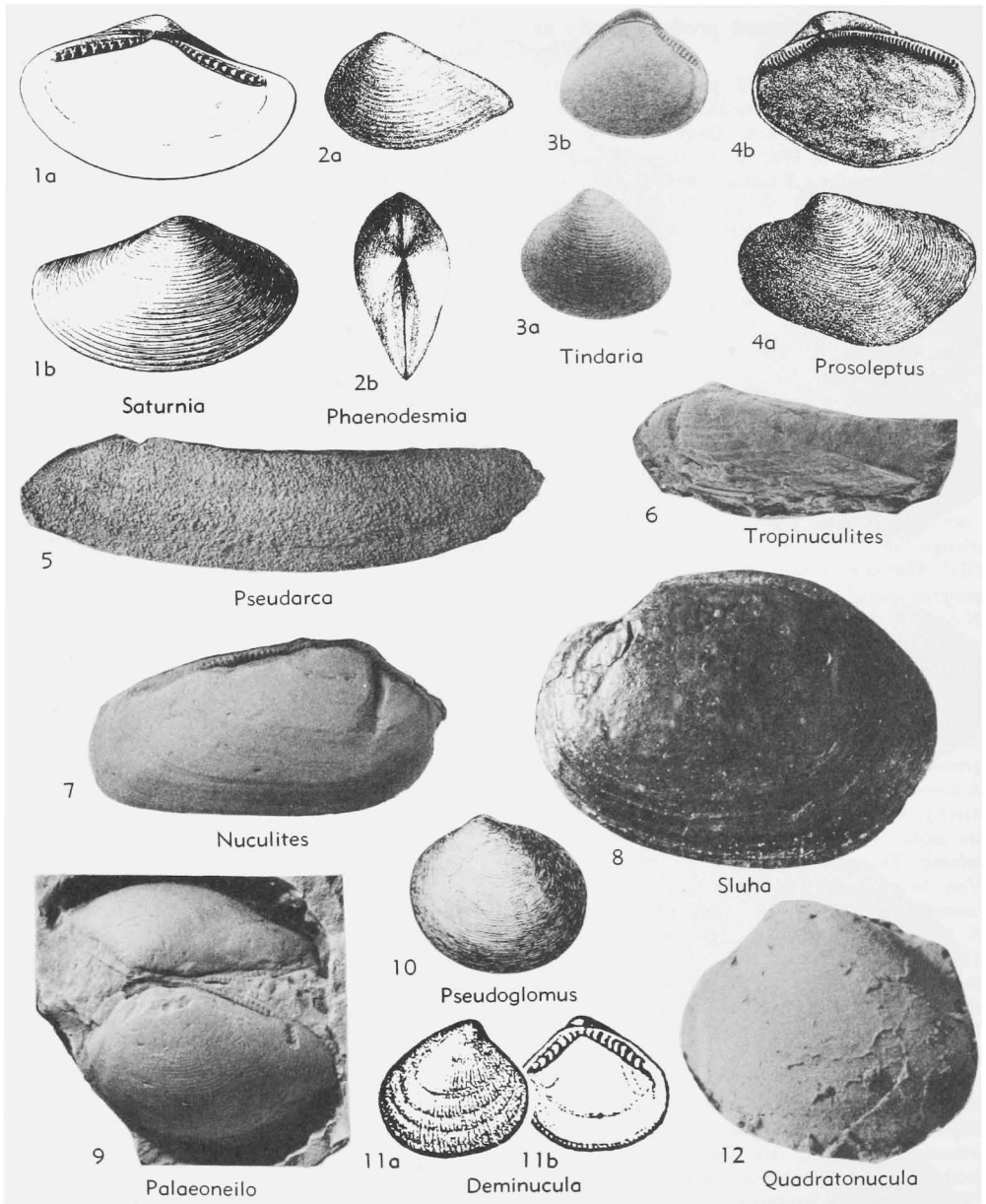


FIG. A5. Malletiidae (p. N233-N235).

but with ventral protrusion. *Trias.*, Eu.—A5,4. \**P. lineata* (GOLDFUSS); 4a,b, LV ext., RV int.,  $\times 1.5$  (58).

**Pseudarca** TROMELIN & LEBESCONTE, 1875, p. 5 [\**P. tyra*; OD] [= *Adranaria* MUNIER-CHALMAS, 1876, p. 105 (type, *A. tromelini*; OD); *Siliquarca* TROMELIN & LEBESCONTE, 1875, p. 5 (obj.)].

Extremely elongate posterior. *Ord.-Dev.*, Eu.—FIG. A5,5. \**P. tyra*, Ord., France; LV composite ext.-int. mold,  $\times 1.5$  (McAlester, n).

**Pseudoglozmus** DALL, 1898, p. 582 [*Yoldia pompholyx* DALL, 1890; OD] [= *Protonucula* COTTON, 1930, p. 223 (type, *P. verconis*; OD)]. Thin shell, weak concentric sculpture, constricted



or rounded posterior. *Rec.*, cosmop. (deep oceans).

**P. (Pseudoglomus).** Rounded, few teeth, slight pallial sinus. *Rec.*, cosmop. (deep oceans).—FIG. A5,10. \*P. (*P.*) *pompholyx* (DALL), Cuba; LV ext.,  $\times 6$  (Dall, 1890).

**P. (Clencharia)** CLARKE, 1961, p. 373 [\**Tindaria* (*C.*) *diaphana*; OD]. Elongate, many teeth, strong pallial sinus. *Rec.*, S.Afr.

**Quadratonucula** DICKINS, 1963, p. 32 [\**Q. australiensis*; OD]. Rounded, wide posterior, no surface sculpture. *Perm.*, Australia.—FIG. A5,12. \**Q. australiensis*; LV ext.,  $\times 6$  (263).

**Saturnia** SEGUENZA, 1877, p. 1178 [\**Nucula pusio* PHILIPPI, 1844; M] [= *Austrotindaria* FLEMING, 1948, p. 72 (type, *A. wrightii*; OD); *Neilonella* DALL, 1881, p. 126 (type, *Leda* (*N.*) *corpulenta*; OD)]. Thick shell, strong concentric sculpture, constricted posterior, strong to weak pallial sinus. *Rec.*, cosmop. (deep oceans).

**S. (Saturnia).** Not rostrate. *Rec.*, cosmop. (deep oceans).—FIG. A5,1. *S.* (*S.*) *corpulenta* (DALL), Cuba; *1a,b*, RV int., ext.,  $\times 4$  (216).

**S. (Spinula)** DALL, 1908, p. 377 [\**Leda* (*Spinula*) *calcar*; OD] [= *Bathyspinula* FILATOVA, 1958, p. 212 (*nom. nud.*)]. Strongly rostrate. *Rec.*, cosmop. (deep oceans).

**S. (Tindariopsis)** VERRILL & BUSH, 1897, p. 59 [\**Malletia* (*Tindaria*) *agathida* DALL, 1889; OD]. Moderately rostrate. *Rec.*, cosmop. (deep oceans).

**Sluha** BARRANDE, 1881, p. 159 [\**S. expansus*; OD] [= *Praearca* NEUMAYR, 1891, p. 755 (type, *Arca kosoviensis* BARRANDE; SD McALESTER, 1968); *Servitor* BARRANDE, 1881, p. 159 (obj.)]. Like *Palaeoneilo*, but rounded, compressed, wider posteriorly. *U.Ord.*, Eu. (Czech.).—FIG. A5,8. \**S. expansus*; LV composite ext.-int. mold,  $\times 2$  (McAlester, n).

**Tindaria** BELLARDI, 1875, p. 28 [\**T. arata*; M]. Thick shell, strong concentric sculpture, rounded, weak pallial sinus. *Tert.-Rec.*, cosmop.

**T. (Tindaria).** Concentric sculpture only. *Tert.-Rec.*, cosmop.—FIG. A5,3. \**T.* (*T.*) *arata*, L. Plio., Italy; *3a,b*, LV ext., int.,  $\times 2$  (35).

**T. (Deminucula)** IREDALE, 1931, p. 202 [\**Nucula praetenta* IREDALE, 1924; OD]. Radial and concentric sculpture. *Rec.*, Australia.—FIG. A5,11. \**T.* (*D.*) *praetenta* (IREDALE); *11a,b*, LV ext., int.,  $\times 4$  (832).

**Tropinuculites** McLEARN, 1918, p. 140 [\**Nuculites* (*Orthonota*) *carinata* HALL, 1860; OD]. Very elongate posterior, with internal septum. *Sil.*, N. Am. (Can.).—FIG. A5,6. \**T. carinata* (HALL), Nova Scotia; LV composite int.-ext. mold,  $\times 1.5$  (McAlester, n).

### Family NUCULANIDAE Adams & Adams, 1858

[= *Ledidae* ADAMS & ADAMS, 1858 (obj.)] [Materials for this family prepared by H. S. PURI, Florida Geological Survey]

Resilifer present, ligament partially internal. *Dev.-Rec.*

**Nuculana** LINK, 1807, p. 155 [\**Arca rostrata* CHEMNITZ, 1774; OD (= *Arca pernula* MÜLLER, 1771)] [= *Eptoleda* IREDALE, 1939, p. 239 (type, *Leda darwini* SMITH, 1884; OD); *Exocholedea* IREDALE, 1939, p. 241 (*nom. nud.*); *Kamaleda* IREDALE, 1939, p. 241 (*nom. nud.*); *Leda* SCHUMACHER, 1817, p. 173 (obj.); *Ledaspinga* MARWICK, 1931, p. 53 (type, *L. simulea*; OD); *Monopleura* PHILIPPI, 1887, p. 198 (type, *M. ambigua*; OD); *Perrisonota* CONRAD, 1869, p. 98 (type, *P. protexta*; M); *Spineilo* FINLAY & MARWICK, 1937, p. 17 (type, *Malletia elongata* MARSHALL, 1917; OD); *Zygonoledea* IREDALE, 1939, p. 239 (type, *Z. corbuloides minutalis*; OD)]. Ligament pit narrow, oblique; posterior end produced; with concentric sculpture. *Trias.-Rec.*, cosmop.

**N. (Nuculana).** Elongate, rostrate, strong concentric sculpture. *Trias.-Rec.*, cosmop.—FIG. A6,8. \**N.* (*N.*) *pernula* (MÜLLER), Eu.; *8a,b*, LV ext., dorsal view of conjoined valves,  $\times 1.5$  (Sars, 1878); *8c*, RV hinge,  $\times 5.5$  (938).

**N. (Borissia)** SLODKEVICH, 1938 [\**N.* (*B.*) *alferovi*; OD]. Outline as in *Nuculana*, but less inequilateral; with low broad concentric ribs covering median portion of valve. *Mio.?*, USSR (Kamchetka).—FIG. A6,2. \**N.* (*B.*) *alferovi*; *2a,b*, dorsal views of conjoined valves; *2c*, LV ext.,  $\times 3$  (848).

**N. (Costanuculana)** HABE, 1951, p. 25 [\**N. husamaru* NOMURA, 1940; OD]. Shell medium, thick; surface with conspicuous circular furrow on earlier half; later one-third flat and smooth. Hinge teeth, large, few. *Rec.*, Japan.—FIG. A6,6. \**N.* (*C.*) *husamaru* (NOMURA); *6a,b*, LV ext., int.,  $\times 2$  (365).

**N. (Costelloledea)** HERTLEIN & STRONG, 1940, p. 370 [\**N. costellata* SOWERBY, 1832; OD]. Shell elongate, with strong concentric sculpture. *Rec.*, N. Am.—FIG. A6,12. \**N.* (*C.*) *costellata* (SOWERBY), Calif.; LV ext.,  $\times 3$  (403).

**N. (Jupiteria)** BELLARDI, 1875, p. 20 [\**N. concava* BRONN, 1831; SD DALL, 1898] [= *Teretiledea* IREDALE, 1929, p. 158 (type, *Nuculana oculata* IREDALE, 1925; OD)]. Small, corbuloid, strongly inflated, rostrum blunt and barely ridged; sinus shallow. *U.Cret.-Rec.*, N.Z.-N. Am.-Eu.—FIG. A6,11. *N.* (*J.*) *oculata* (IREDALE), *Rec.*, Australia; LV ext.,  $\times 3$  (432).

**N. (Ledella)** VERRILL & BUSH, 1897, p. 54 [*nom. subst. pro Junonia* SEGUENZA, 1877, p. 1175 (*non Junonia* HUEBNER, 1819)] [\**Leda messanensis* SEGUENZA, 1877; SD VERRILL & BUSH, 1897] [= *Comitiledea* IREDALE, 1924, p. 181 (type, *Leda miliacea* HEDLEY, 1902; OD); *Magaleda* IREDALE, 1929, p. 158 (type, *Leda inopinata* SMITH, 1885; OD)]. Short, with uncarinate rostrum. *Oligo.*, N.Z.-E. Indies; *Mio.-Plio.*, Italy; *Rec.*, cosmop.—FIG. A6,7. \**N.* (*L.*) *messanen-*

sis (SEGUENZA), Rec., N.Am.; LV hinge, X8 (Verrill & Bush, 1897).

N. (*Lembulus*) RISSO, 1826, p. 319 [*\*Lembulus rossianus*; SD GRAY, 1847]. Like *Saccella* but with wider and deeper posterior groove; with

diagonal sculpture. *Eoc.-Rec.*, cosmop.—FIG. A6,3. *\*N. (L.) rossianus* (Risso), Rec., Medit.; RV ext., X1 (789).

N. (*Politoleda*) HERTLEIN & STRONG, 1940, p. 370 [*\*Nucula polita* SOWERBY, 1832; OD]. Shell

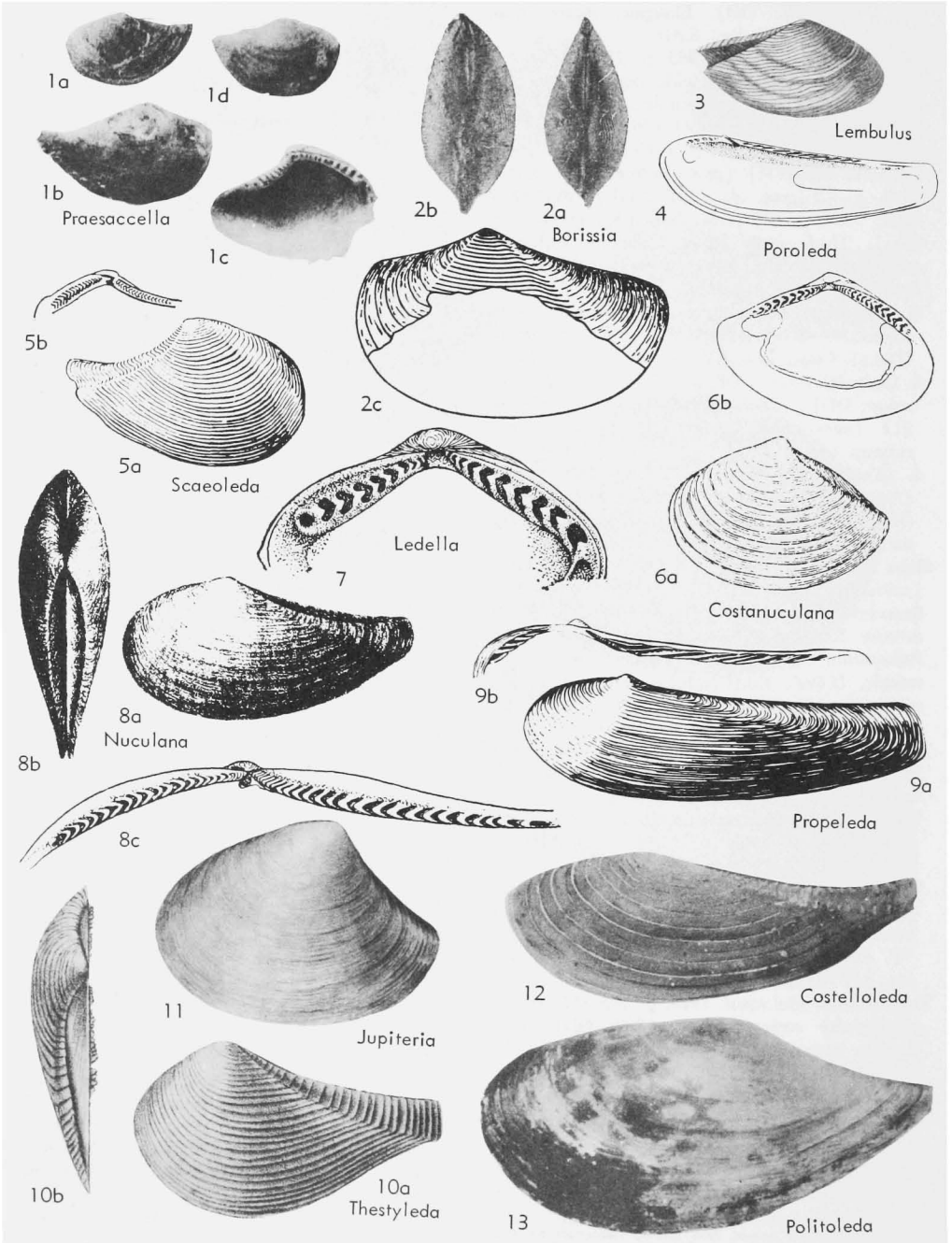


FIG. A6. Nuculanidae (p. N235-N237).

- elongate, posteriorly pointed; sculpture of very fine concentric growth lines and fine, wavy incised lines on lower half, posteriorly nearly parallel to posterior dorsal margin. *Rec.*, trop. Am.—FIG. A6,13. \**N. (P.) polita* (SOWERBY); LV ext.,  $\times 3$  (403).
- N. (Poroleda)** TATE, 1893, p. 186 [*\*Scaphula? lanceolata* HUTTON, 1885; SD COTTON & GODFREY, 1938]. Shell like *Nuculana* but with an oblique cartilage pit and nearly straight hinge line with longitudinal imbricating teeth. *Eoc.-Rec.*, N.Z.—FIG. A6,4. \**N. (P.) lanceolata* (HUTTON), *Rec.*; RV int.,  $\times 2$  (398).
- N. (Praesacella)** COX, 1940, p. 32 [*\*N. (P.) juriana*, OD]. Shell as in *Sacella* but with entire pallial line, larger and less numerous hinge teeth. *Jur.*, India-Eu. (France-Port.)—FIG. A6, 1. \**N. (P.) juriana* (Cox), India; 1a, LV ext.,  $\times 2.2$ , 1b-d, RV ext., LV int., RV ext.,  $\times 4$  (183).
- N. (Propeleda)** IREDALE, 1924, p. 181 [*\*Leda ensicula* ANGAS, 1877; OD] [= *Lamellileda* COTTON, 1930 (type, *L. typica*; OD)]. Shell sickle-shaped, chondrophore backwardly sloping, hinge thin. *Rec.*, Australia.—FIG. A6,9. \**N. (P.) ensicula* (ANGAS), 9a,b, LV ext., RV hinge,  $\times 5$  (166).
- N. (Robaia)** HABE, 1958, p. 248 [*\*Leda robai* KURODA, 1929; OD]. No concentric sculpture, moderately rostrate. *Rec.*, Japan.
- N. (Rollieria)** COSSMANN, 1920, p. 82 [nom. subst. pro *Nuculopsis* ROLLIER, 1912, p. 64 (non *Nuculopsis* GIRTY, 1911); = *Isoleda* ROLLIER, 1923, p. 67, nom. subst. pro *Nuculopsis* ROLLIER, 1912, and *Isonuculana* COX, 1925, p. 124, nom. subst. pro *Isoleda* ROLLIER, 1923] [*\*Nucula palmae* SOWERBY, 1824; SD ROLLIER, 1923]. Shell thin, ovate, smooth, without dorsal areas or umbonal ridges; anterior and posterior rows of hinge form very obtuse angle. Pallial line with small sinus. *Jur.*, Eu.-India.
- N. (Sacella)** WOODRING, 1925, p. 15 [nom. subst. pro *Ledina* SACCO, Dec. 1898, p. 26 (non *Ledina* DALL, April 1898)] [*\*Arca fragilis* CHEMNITZ, 1784; OD]. Rostrate, rostrum pointed; sculpture of strong concentric rugae; posterior and anterior series of teeth equal; pallial sinus U-shaped. *Tert.-Rec.*, cosmop.
- N. (Scaoleda)** IREDALE, 1929, p. 158 [*\*Nucula crassa* HINDS, 1843; OD]. Shell large, stout, strongly lirate, long-beaked. *Rec.*, S.Pac. (Tasmania-Low Isles).—FIG. A6,5. \**N. (S.) crassa* (HINDS), Australia; 5a,b, RV ext., hinge,  $\times 1.3$  (572).
- N. (Thestyleda)** IREDALE, 1929, p. 158 [*\*Leda ramsayi* SMITH, 1885; OD]. Rostrate with strong concentric sculpture that curves at rostral sinus. Posterior truncate; often with a keel at inflection of concentric ribs; chondrophore large. *Plio-*
- Rec.*, W.Am.—FIG. A6,10. \**N. (T.) ramsayi* (SMITH); 10a,b, LV ext., dorsal,  $\times 6$  (852).
- Adrana** ADAMS & ADAMS, 1858, p. 547 [*\*Nucula lanceolata* LAMARCK, 1819; SD STOLICZKA, 1871]. Shell thin, compressed, narrow-lanceolate or long-elliptical, nearly equilateral, sculpture oblique. *Eoc.-Rec.*, cosmop.—FIG. A7,2. *A. taylori* (HANLEY), *Rec.*; RV ext.,  $\times 2$  (383).
- Costatoleda** ROTH VON TELEGD, 1914 (1915), p. 61 [*\*Leda (C.) psammobiaeformis* ROTH VON TELEGD, 1914; OD]. Shell sculptured like *Hilgardia* but without a well-pronounced rostrum. *Oligo.*, Eu. (Hungary).—FIG. A7,4. \**C. psammobiaeformis*; 4a,b, LV ext., dorsal view of conjoined valves,  $\times 1$  (800).
- Dacryomya** AGASSIZ, 1840, p. 500 [*\*Nucula lacryma* SOWERBY, 1824; SD HERRMANNSEN, 1846, p. 368] [= *Dacryomya* GRESSLEY, 1838 (nom. nud.)]. With chondrophore; inflated, with truncate rostrum, dorsally concave; umbones prominent, opisthogyrous; escutcheon deep, bounded by sharp carinae which divide pallial line or not. *M.Jur.*, Eu.—FIG. A7,1. \**D. lacryma* (SOWERBY), Eng.; 1a-c, RV ext., LV ext., LV int.,  $\times 2$  (870).
- Ezonuculana** NAGAO, 1938, p. 121 [*\*Nuculana mactraeformis* NAGAO; OD]. Not naereous, sculpture concentric, with chondrophore; pallial sinus small to obsolete. *Cret.*, Japan.—FIG. A7,5. \**E. mactraeformis* (NAGAO), *Cret.*, Japan; 5a,b, LV int., RV ext.,  $\times 2$  (655).
- Hilgardia** HARRIS & PALMER, 1946, p. 59 [*\*Leda multilineata* CONRAD, 1855; OD]. With radial ribs intersecting concentric sculpture as crenulations and nodes. *Eoc.*, N.Am.—FIG. A7,7. \**H. multilineata* (CONRAD); 7a, dorsal view of conjoined valves,  $\times 3.5$ ; 7b, RV int.,  $\times 3$ ; 7c, LV ext.,  $\times 2.75$  (389).
- Ledina** DALL, Apr. 1898, p. 580 [non *Ledina* SACCO, Dec. 1898] [*\*Leda eborea* CONRAD, 1860 (non CONRAD, 1846) (= \**L. smirna* DALL, 1898); OD]. Strong, solid arcuate below, ends evenly rounded, valves smooth, equilateral. ?*Eoc.*, N.Am.—FIG. A7,3. \**L. smirna* DALL; LV ext.,  $\times 1$  (387).
- Lithorhadia** STEWART, 1930, p. 37 [*\*Leda acala* DALL, 1898; OD]. Shape of *Nuculana* but hinge of *Calorhadia*. *Eoc.*, cosmop.—FIG. A7,8. \**L. acala* (DALL), N.Am.; LV ext.,  $\times 3$  (223).
- Mesosacella** CHAVAN, 1946, p. 197 [*\*Nucula foersteri* MÜLLER, 1847; OD]. No ligamental fossettes, ligament external, behind beaks, a depressed widening below beaks foreshadowing the fossette. Outline and sculpture of *Sacella*. *Cret.*, Eu.—FIG. A7,6. \**M. foersteri* (MÜLLER); 6a,b, dorsal view of both valves, RV ext.,  $\times 2$ ,  $\times 3$  (650).
- Paleyoldia** LINTZ, 1958, p. 108 [*\*Yoldia glabra* BEEDE & ROGERS, 1899; OD]. Compressed, elongate anterior, strong concentric sculpture. *Penn.*, USA (Tex.-Okla.Kans.).—FIG. A8,2. \**P. glabra* (BEEDE & ROGERS), Tex.; LV ext.,  $\times 2$  (McAlester, n).

**Phaseolus** MONTEROSATO, 1875, p. 4 [*\*P. ovatus*; OD] [= *Silicula* JEFFREYS, 1879, p. 573 (obj.)]. Shell small, teeth few, lamelliform, oblique. [Deep-water.] *Rec.*, Atl.-Medit.

**Phestia** CHERNYSHEV, 1951, p. 9 [*\*Leda inflatiformis* CHERNYSHEV, 1939; OD] [= *Culunana* LINTZ, 1958, p. 106 (type, *Leda bellistriata* STEVENS, 1858; OD)]; *Girtyana* ELIAS, 1956, p. 127

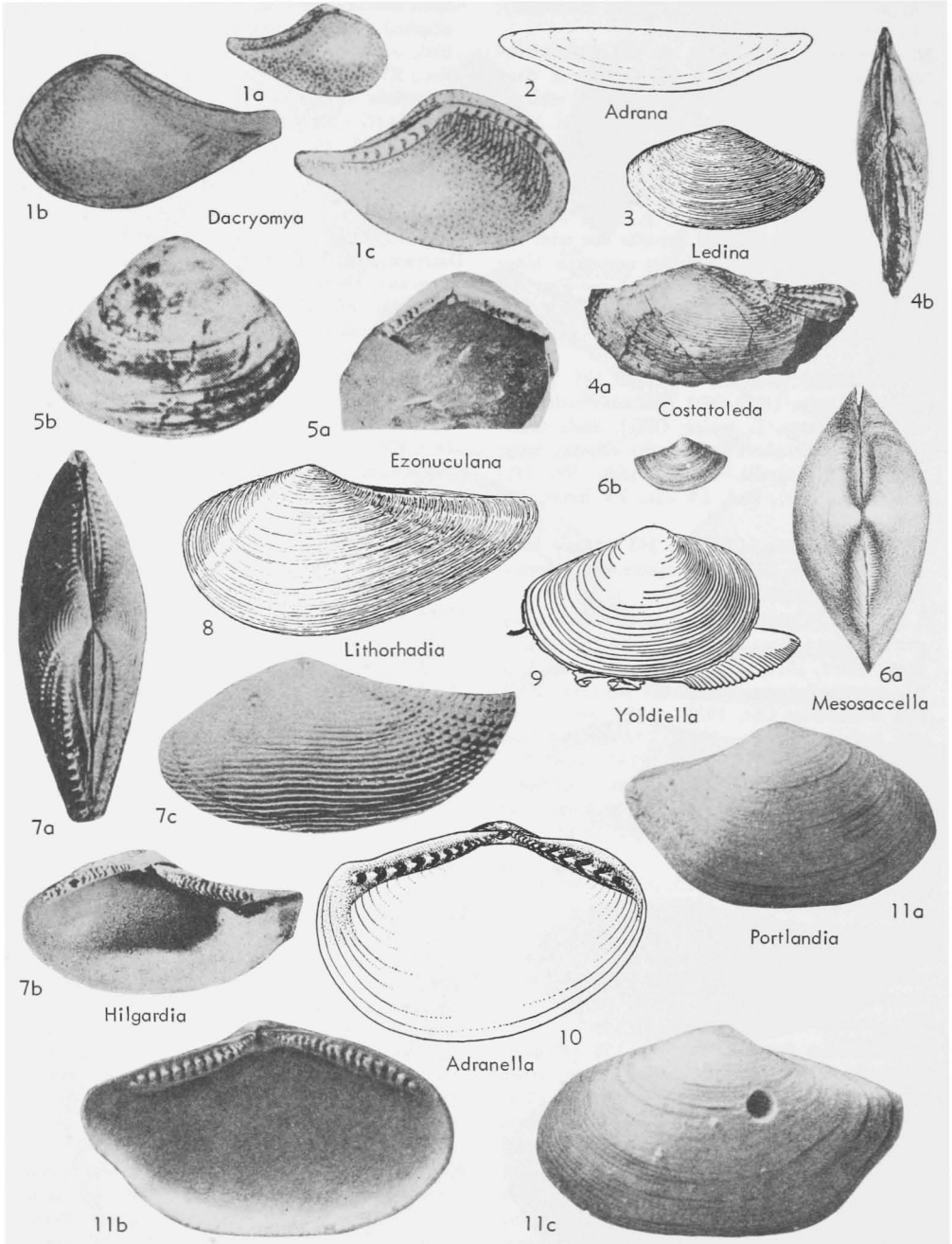


FIG. A7. Nuculanidae (p. N237, N239),



FIG. A8. Nuculanidae (p. N238-N239).

(type, *G. honessi*; OD); *Nuculochlamys* PAUL, 1941, p. 38 (*nom. nud.*); *Polidevcia* CHERNYSHEV, 1951, p. 25 (type, *Leda karagandensis* CHERNYSHEV, 1941; OD)]. Like *Nuculana*, but with prominent internal ridges. *Dev.-L.Trias.*, cosmop.

—FIG. A8,3. \**P. inflatiformis* (CHERNYSHEV), U. Carb., USSR; LV ext.,  $\times 2$  (McAlester, n).

**Portlandia** MÖRCH, 1857, p. 93 (ICZN, 1966 (Opinion 769, name no. 1705)] [\**Nucula arctica* GRAY, 1824; SD ICZN, 1966 (Opinion 769, name no. 2132)] [= *Pseudoportlandia* WOODRING, 1925, p. 20 (type, *Leda clara* GUPPY, 1873; OD); *Portlandella* STEWART, 1930, p. 61 (type, *Leda rosa* HANNA, 1927; OD)]. Inflated, somewhat rostrate. *Tert.-Rec.*, cosmop.

**P. (Portlandia)**. Posterior end set off by indistinct furrow; pallial sinus deep. *Tert.-Rec.*, cosmop. —FIG. A9,4. \**P. (P.) arctica* (GRAY), *Rec.*, N.Atl.; RV ext.,  $\times 2$  (Mossevitch, 1928). —FIG. A7,11. *P. (P.) clara* (GUPPY), Mio., Jamaica; 11a-c, RV ext., LV int., ext.,  $\times 4$  (1005).

**P. (Adranella)** VERRILL & BUSH, 1898, p. 858 [\**Yoldia (A.) casta* VERRILL & BUSH, 1898; OD]. Oblong-ovate, compressed, with posterior end broadly rounded, rostrum nearly obsolete. *Rec.*, Carib. —FIG. A7,10. \**P. (A.) casta* (VERRILL & BUSH); LV int.,  $\times 11$  (938).

**P. (Hataiyoldia)** KAMADA, 1962, p. 55 [\**Yoldia tokunagai* YOKOYAMA, 1925; OD]. Like *P. (Portlandia)* but with zigzag surface sculpture. Mio., Japan.

**P. (Yoldiella)** VERRILL & BUSH, 1897, p. 55 [\**Yoldia lucida* LOVÉN, 1846; OD]. Small; ligament external; pallial sinus indistinct; mostly in deep water. *Rec.*, E.Am.-W.Am. —FIG. A7,9. \**P. (Y.) lucida* (LOVÉN), N.Am.; RV view entire animal,  $\times 5.5$  (937).

**Pristigлома** DALL, 1900, p. 44 [*nom. subst. pro Glomus* JEFFREYS, 1876, p. 433 (*non* GISTEL, 1848)] [\**Glomus nitens* JEFFREYS, 1876; M].

Like *Sarepta*, but with more unequal, V-shaped teeth. [Deep oceans]. *Rec.*, cosmop.

**Ryderia** WILTON, 1830, p. 72 [\**Leda renevieri* OPPEL; SD COX, 1936]. Pallial sinus very wide, shallow; shell-shaped like *Nuculana*. Rostrum very long and narrow. *Jur.*, Eu. —FIG. A9,3. \**R. renevieri* (OPPEL), Eng.; 3a-c, LV ext., dorsal view of both valves, LV ext.,  $\times 1$  (992).

**Sarepta** ADAMS, 1860, p. 303 [\**S. speciosa*; OD] [= *Ovaleda* IREDALE, 1925, p. 248 (type, *Sarepta tellineaformis* HEDLEY, 1902)]. Rounded, not rostrate, very short hinge. *Rec.*, Indo-Pac. —FIG. A9,1. \**S. speciosa*, Japan; 1a,b, LV ext., int.,  $\times 3.0$  (Adams, 1868).

**Veteranella** PATTE, 1926, p. 158 [\**Nuculana (V.) strenua*; OD]. Similar to *Nuculana* but characterized by chevron-shaped ornamentation. *Perm.-Trias.*, Indo-Pac.

**V. (Veteranella)**. Small, oval, posterior not constricted. *U.Trias.*, Indo-China.

**V. (Glyptoleda)** FLETCHER, 1945, p. 298 [\**G. reidi*; OD]. Large, elongate, posterior constricted. *Perm.*, Australia. —FIG. A8,1. \**V. (G.) reidi*; LV ext.,  $\times 2$  (McAlester, n).

**V. (Nucundata)** WATERHOUSE, 1965, p. 641 [\**N. undata*; OD]. Similar to *V. (Glyptoleda)* but with less prominent chevron-shaped ornamentation. *Perm.*, N.Z.

**Yoldia** MÖLLER, 1842, p. 18 [\**Y. hyperborea* TORELL, 1859 (*pro Y. arctica* MÖLLER, 1842, *non Nucula arctica* GRAY, 1824); SD ICZN, 1966 (Opinion 769)] [= *Microyoldia* VERRILL & BUSH, 1897, p. 56 (type, *Y. regularis* VERRILL, 1884; OD); *Tepidoleda* IREDALE, 1939, p. 240 (type, *T. lata orion*; OD)]. Elongate-ovate, thin-shelled gaping in most; hinge series subequal; resilium pit large; pallial sinus deep and wide. *Cret.-Rec.*, cosmop.

**Y. (Yoldia)**. Smooth, compressed, pedal gape wide, siphonal gape moderate. *Cret.-Rec.*, cosmop. —

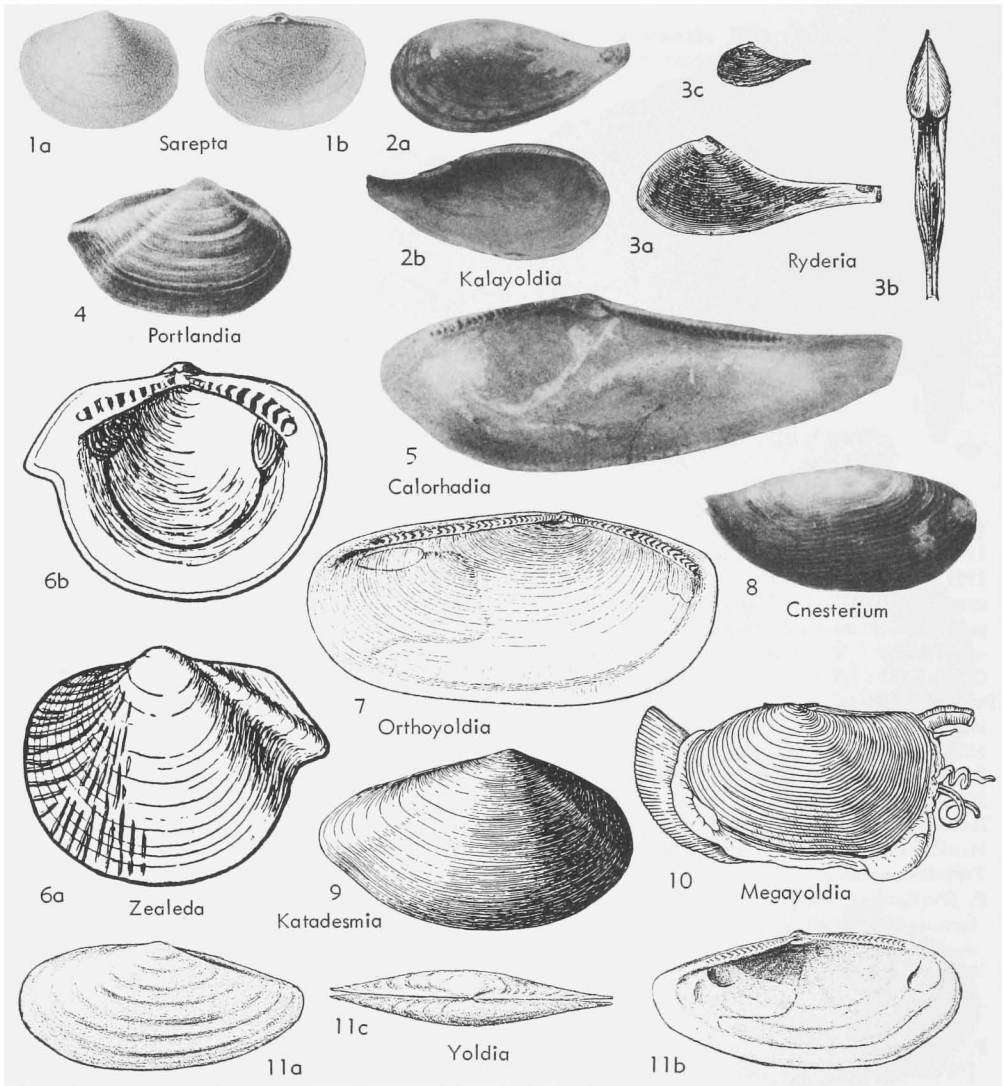


FIG. A9. Nuculanidae (p. N239-N241).

FIG. A9,11. \*Y. (*Y.*) *hyperborea* (TORELL), Rec., N.Atl.; 11a-c, LV ext., int., both valves dorsal,  $\times 1$  (829).

Y. (*Aequiyoldia*) SOOT-RYEN, 1951, p. 6 [\*Y. *subaequilateralis* SMITH, 1875; OD]. Equilateral, slightly rostrate; chondrophore triangular, broad, mantle margins fringed above siphons. Rec., Antarctic (South Shetland I.).

Y. (*Calorhadia*) STEWART, 1930, p. 37 [\**Leda pharcida* DALL, 1898; OD]. With sunken lunule; ligamental pit wide. Eoc., Am.—FIG. A9,5. \*Y. (*C.*) *pharcida* (DALL), N.Am.; RV int.,  $\times 1.5$  (892).

Y. (*Cnesterium*) DALL, 1898, p. 595 [\*Y. *scissurata* DALL, 1897 (pro *Nucula arctica* BRODERIP & SOWERBY, 1829, non GRAY, 1824); OD] [= *Scissula* DALL, 1908, p. 256 (non DALL, 1900) (obj.)]. With oblique secondary incised sculpture especially on anterior end. Rec., E.Pac.—FIG. A9,8. \*Y. (*C.*) *scissurata*, W.Am.; RV ext.,  $\times 1$  (345).

Y. (*Kalayoldia*) GRANT & GALE, 1931, p. 128 [\*Y. *cooperi* GABB, 1865; OD]. Posterior part of valves short, narrowed, recurved. Mio.-Rec., W.Am.—FIG. A9,2. \*Y. (*K.*) *cooperi*, Rec.; 2a,b, LV ext., int.,  $\times 0.5$  (Grant & Gale, 1931).

**Y. (Katadesmia)** DALL, 1908, p. 379 [\*Y. (*K.*) *vincula* DALL, 1908; OD]. With well-defined functional opisthodontic ligament. *Rec.*, C.Am.—FIG. A9,9. \*Y. (*K.*) *vincula*; RV ext.,  $\times 3$  (Dall, 1908).

**Y. (Megayoldia)** VERRILL & BUSH, 1897, p. 55 [\**Nucula thraciaeformis* STORER, 1838; OD] [= *Multidentata* KRISHTOFOVICH, 1964 (type, *Y. multidentata* KHOMENKO, 1937; OD)]. Broad, compressed, rostrum indefinite, with posteroventral marginal lobe; chondrophore large, concave, striate within; pallial sinus large; ligament external, strongly developed. *Oligo.-Rec.*, cosmop.—FIG. A9,10. \*Y. (*M.*) *thraciaeformis* (STORER), *Rec.*, N.Am.; LV, with animal,  $\times 0.67$  (Verrill & Bush, 1897).

**Y. (Orthoyoldia)** VERRILL & BUSH, 1897, p. 55 [\*Y. *scapania* DALL, 1889; OD]. Oblong, blunt or rounded at both ends, without distinct rostrum, no carina; pallial sinus broad; teeth numerous in both series. *Eoc.-Rec.*, Carib.-W.N.Am.—FIG. A9,7. \*Y. (*O.*) *scapania* DALL, *Rec.*, Brazil; LV int.,  $\times 3$  (Dall, 1889).

**Zaleda** MARWICK, 1924, p. 25 [\**Z. hamata*; OD]. With radial ribs that become divaricate anteriorly; no pallial sinus. *Oligo.-Rec.*, N.Z.—FIG. A9,6. \**Z. hamata*, Plio., N.Z.; 6a,b, LV ext., int.,  $\times 10$  (Marwick, 1924).

### Family ISOARCIDAE Keen, new family

[Materials for this family prepared by MYRA KEEN]

Cordate, inequilateral; shell material nacreous; ligament external. *M.Jur.-U.Cret.*

**Isoarca** MÜNSTER, 1842 [\**Isocardia subspirata* MÜNSTER, 1837; SD WOODWARD, 1854] [= *Prionia* DESOR & GRESSLY, 1859 (*non* HUEBNER, 1819)]. Sculpture decussate to concentrically striate; hinge teeth angled at ends of anterior and posterior series, hinge arched (673). *M.Jur.(Bajoc.)-U.Cret. (Senon.)*, Eu.—FIG. A10,1a. *I. texata* (MÜNSTER), U.Jur., Ger.; RV int.,  $\times 1$  (GOLDFUSS).—FIG. A10,1b,c. \**I. subspirata* (MÜNSTER), U.Jur., Ger.; 1b,c, LV and dorsal views of int. molds, both valves  $\times 1$  (341).

### Subclass CRYPTODONTA Neumayr, 1884

[*nom. transl. et correct.* NEWELL, 1965 (*ex* Cryptodonten NEUMAYR, 1884; unspecified familial group name)] [Diagnosis by N. D. NEWELL]

Generally equivalve, thin-shelled dimyarian bivalves; hinge plate absent or narrow; ligament external, amphidetic to opisthodontic, generally without nymphs; hinge margin edentulous or taxodont. ?*U.Cam.*, *L.Ord.-Rec.*

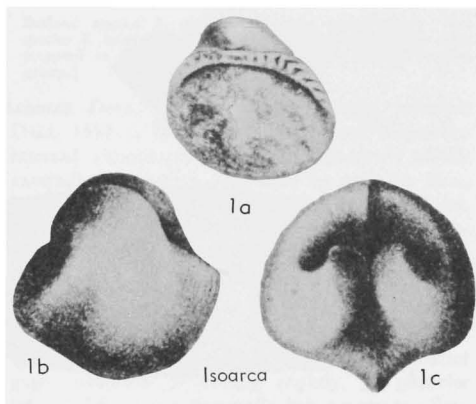


FIG. A10. Isoarcidae (p. N241).

A provisional arrangement for diverse, poorly understood, mainly Paleozoic forms.

### Order SOLEMYOIDA Dall, 1889

[*nom. transl. et correct.* NEWELL, 1965 (*ex* suborder Solenomyacea DALL, 1889)] [Diagnosis by N. D. NEWELL]

Edentulous, anisomyarian, anterior adductor muscle being larger than posterior; shell gaping, with anterior end longer than posterior; shell microstructure homogeneous, aragonitic; gills protobranchiate. *Dev.-Rec.*

### Superfamily SOLEMYACEA H. Adams & A. Adams, 1857 (1840)

[*nom. transl.* DALL, 1895 (*ex* Solemyidae ADAMS & ADAMS, 1857)] [Materials for this superfamily prepared by L. R. COX]

Equivalve; oblong or oval, moderately to strongly inequilateral, with umbones toward posterior end; weakly to rather strongly inflated; no anterodorsal area (lunule), escutcheon present in some forms; hinge edentulous; ligament wholly or mainly posterior to beaks, internal or external; dimyarian, pallial line obscure in many forms; ostracum thin, porcelaneous internally; surface smooth or with weak radial ornament; periostracum thick in living forms, projecting (except dorsally) well beyond margins of calcareous part of valves. *Dev.-Rec.*

This superfamily consists only of the family Solemyidae. Its living representatives are protobranchiate, so that in PELSENER's classification, based on gill structure, the group was placed in the same



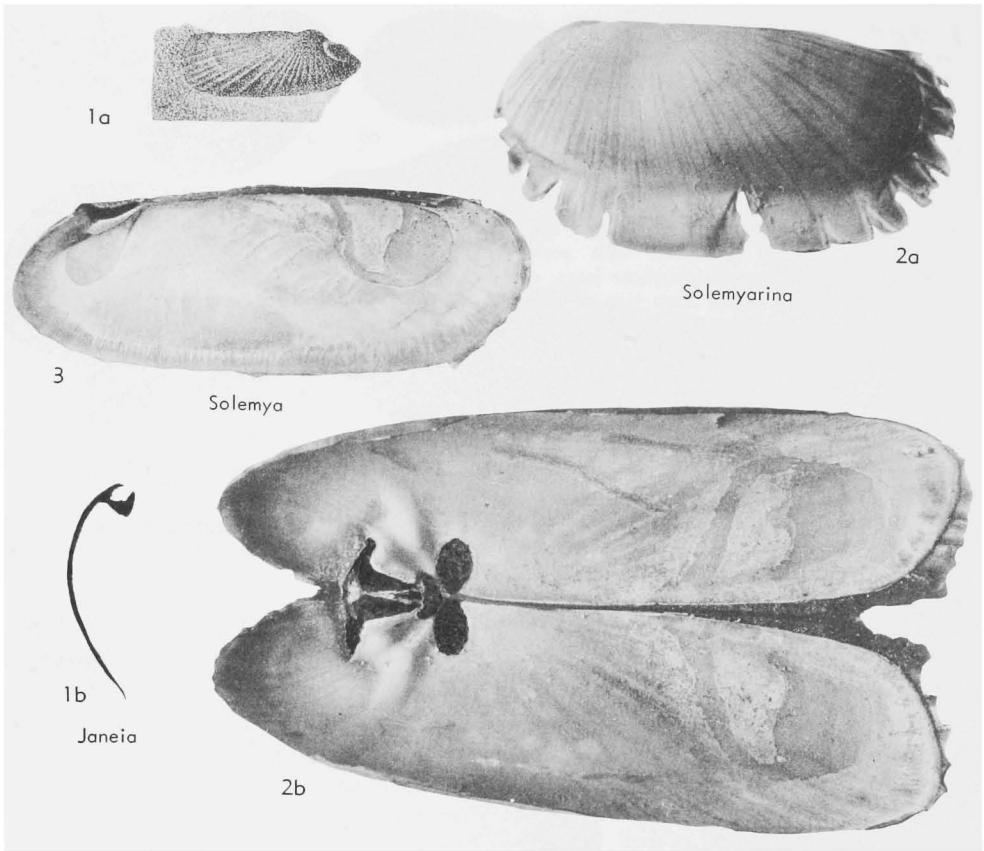


FIG. B1. Solemyidae (p. N243).

order as the Nuculacea. The foot is large and adapted for burrowing. When the valves are drawn together their uncalcified (periostracal) fringe can be tucked in between their margins by the action of special muscles. The animal lives buried in the muddy or sandy substratum.

#### Family SOLEMYIDAE Adams & Adams, 1857 (1840)

[Solemyidae ADAMS & ADAMS, 1857 (*pro* Solenomyidae GRAY, 1840)] [=Solenomyidae VON MARTENS, 1867; Solemyacidae DALL, 1900; Solenomyacidae DALL, 1908] [In accordance with Code Art. 40a,b, this family ranks from 1840 for purposes of priority]

Characters of superfamily. *Dev.-Rec.*

**Solemya** LAMARCK, 1818, p. 488 [\**S. mediterranea* (= \**Tellina togata* POLI, 1795, p. 42); SD CHILDREN, 1823] [= *Solenimya* BOWDICH, 1822 (*nom. van.*); *Solenomya* CHILDREN, 1823 (*nom. van.*); *Stephanopus* SCACCHI, 1833 (*obj.*); *Solenymia* SWAINSON, 1840 (*nom. van.*); *Solenymya* SCHAU-FUSS, 1869 (*nom. van.*)]. Elongate-oval or sub-

rectangular, compressed; umbones level with hinge margin, placed well toward posterior end of shell; valve margins with narrow anterior and posterior gapes; ligament wholly or mainly posterior to beaks and located between margin and thick internal chondrophore sloping obliquely downward from beak; posterior adductor scar rather small, anterior scar larger, continued from its posteroventral corner by scar forming narrow band ascending obliquely to and broadening out along dorsal margin, and marking attachment of muscles of integument of visceral mass and (dorsally) of foot;<sup>1</sup> pallial line entire, usually obscure; ornament consisting of irregularly arranged, depressed radial ribs; periostracum polished, consisting of radial sectors alternating in thickness and varying in width according to ribbing of shell; periostracum extends well beyond margins of calcareous part of valves, forming frill which on death of animal cracks along thinner sectors,

<sup>1</sup> The compiler is grateful to Professor G. OWEN, of Belfast, for confirming the interpretation here given of this characteristic internal scar of *Solemya*.



producing series of rectangular or tongue-like projections separated by fissures (usual condition of Recent museum specimens). [Few fossil forms can be assigned definitely to subgenera, as these are distinguished by internal shell features.] *Dev.-Rec.*, cosmop.

**S. (*Solemya*)**. Ligament posterior to umbones, only very thin descending strip adhering to shell interior in front of chondrophore, which lacks supporting buttresses. *Rec.*, *Medit.-W.Atl.* Fossil distribution uncertain.—FIG. B1,3. \*S. (*S.*) *togata* (POLI), *Medit.*; LV int., showing ligament (black) with supporting chondrophore, muscle scars, and broken edge of periostracum (along anterodorsal margin),  $\times 2$  (Cox, n).

**S. (*Janeia*)** KING, 1850, p. 177 [*\*Solemya primaeva* PHILLIPS, 1836, p. 209; OD] [= *Janeira* TRYON, 1884 (*nom. null.*)]. Resembling *S. (Solemya)* in external features and in presence of internal chondrophore; with internal ridge originating at anterior end of chondrophore and diverging from it at acute angle, passing below posterior adductor scar. *Dev.-Perm.*, cosmop.—FIG. B1,1a. \*S. (*J.*) *primaeva* PHILLIPS, *L.Carb.*, Eng.; LV ext.,  $\times 1$  (407).—FIG. B1,1b. S. (*J.*) *truncata* (GOLDFUSS), *M.Dev.*, Ger.; dorsoventral sec. posterior to umbo, showing internal chondrophore,  $\times 2$  (W. Quenstedt, 1930).

[The impression of the internal ridge is seen on molds of the type species, which also bear indications of the chondrophore. The latter is well seen in transverse sections of the Devonian species *S. (J.) truncata* (GOLDFUSS) (Fig. B1,1b). It is not possible to say if *Janeia* differed from the subgenera enumerated next in any features of importance.]

**S. (*Petrasma*)** DALL, 1908, p. 2 [*\*Solemya borealis* TOTTEN, 1834, p. 366; OD]. Ligament wholly posterior to umbones; chondrophore with 1 or 2 internal ridges below it. *Phio.*, Japan; *Rec.*, E. Pac.-Japan-W.Atl.-Carib.

**S. (*Solemyarina*)** IREDALE, 1931, p. 202 [*\*Solemya velesiana*; OD] [= *Zesolemya* IREDALE, 1938 (type, *Solemya parkinsonii* SMITH (*ex* GRAY, MS); *Solemyaria* HABE, 1951 (*nom. null.*)). Most of ligament located between chondrophore and dorsal margin, but small part extending anteriorly beyond chondrophore, partly along margin beyond umbo and partly as thin patch reaching downward on interior of valve; internal ridge diverges from chondrophore at acute angle, bounding posterior adductor. *Oligo.*, USA (Ore.-Wash.); *Rec.*, Australia-N.Z.—FIG. B1,2. *S. (S.) australis* LAMARCK, *Rec.*, Australia; 2a, RV ext., with frill of cracked periostracum,  $\times 1$ ; 2b, opened valves, int., showing chondrophore, rib diverging from it, and int. ligament (darkened) with thin oval ant. extension, but fore-shortened dorsoventrally,  $\times 2$  (both Cox, n).

[The type species of *Solemyarina* has not been figured, but its internal characters have been briefly described by IREDALE (1938, *Brit. Museum [Nat. History], Great Barrier Reef Exped. Sci. Rept.* v. 5, no. 6, p. 233). The characters distinguishing it from the better-known New

Zealand species *S. parkinsonii* seem unimportant. The species *S. australis* LAMARCK, which some authorities have accepted as type species of *Solemya*, also belongs to this group.]

**Acharax** DALL, 1908, p. 2 [*\*Solemya johnsoni* DALL, 1891, p. 189; OD]. Like *Solemya* externally; internal chondrophores absent, ligament wholly external, opisthodontic, supported by nymphs. *Mio.*, USA-Japan; *Rec.*, E. Pac.-W. Pac.-Ind. O.-W. Atl. [Probably also fossil from *Dev.* onward, if considered to include all *Solemya*-like forms with external ligament and without internal rib.]

**Adulomya** KURODA, 1931, p. 27 [*\*A. uchimuraensis*; M]. Relatively large (up to 19 cm. long), elongate, slightly arched, with narrow anterior gape; umbones protruding slightly, at posterior 6th or 7th of length; no radial ornament; ligament external; internal rib running from below beak to posteroventral corner, passing below posterior adductor scar. *Mio.*, Japan.

## Order PRAECARDIOIDA Newell, 1965

[Diagnosis by N. D. NEWELL]

Circular to oval or elongate, shells thin; isomyarian; ligament external, amphidetic or opisthodontic; hinge plate weak or lacking; edentulous, or with interlocking taxodont denticles resembling provinculum of living forms; terminal margins gaping in some forms; pallial line generally entire but with small sinus demonstrated in a few forms. ?*U.Cam.*, *L.Ord.-L.Miss.*

## Superfamily PRAECARDIACEA Hörnes, 1884

[*nom. transl.* NEWELL, 1965 (*ex* Praecardiidae HÖRNES, 1884)] [Materials for this superfamily prepared by N. D. NEWELL and AURÈLE LAROCQUE]

Ovate, orthogyre, or prosogyre with prominent beaks; ligament amphidetic or lacking, without nymphs; lunule and escutcheon poorly defined or lacking; musculature unknown. ?*U.Cam.*, *L.Ord.-L.Miss.*

## Family PRAECARDIIDAE Hörnes, 1884

Shell approximately equivalve; with or without marginal gape; cardinal area broad and flattened to narrow; surface rarely smooth, more commonly radially costate. ?*U.Cam.*, *L.Ord.-L.Miss.*

The so-called taxodont dentition in this group may represent a neotenuous retention of the provinculum. In some shells the den-

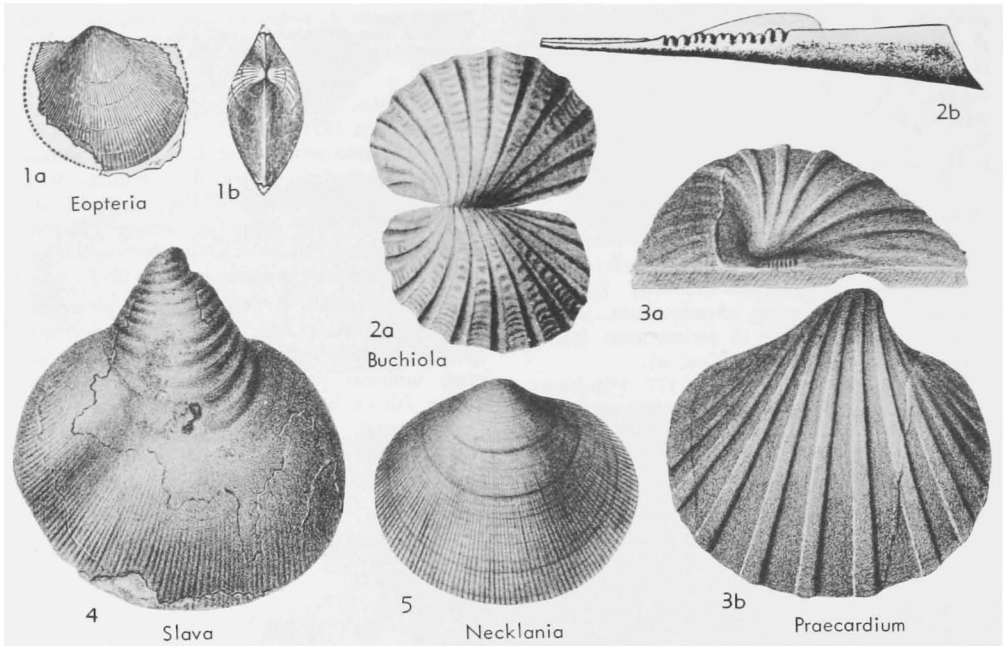


FIG. B2. Praecardiidae (Praecardiinae) (p. N244-N245).

tion behind and in front of the beaks consists clearly of the interlocking ends of radial ribs.

#### Subfamily PRAECARDIINAE Hörnes, 1884

[*nom. transl.* NEWELL & LAROCQUE, herein (*ex* Praecardiidae HÖRNES, 1884)]

Equivalve, cardinal area obscure to prominent, few taxodont teeth below beaks. ?*U. Cam.*, *L.Ord.-Dev.*

**Praecardium** BARRANDE, 1881, p. 141 [*\*P. primulum*; SD RŮŽIČKA & PRANTL, 1960] [= *Silurocardium* LEYMERIE, 1878, pl. B, fig. 4-6 (*nom. oblit.*) (type, *S. barrandei*; SD NEWELL & LAROCQUE, herein); *Gibboleura* BARRANDE, 1881, p. 81 (type, *G. recumbens*; SD RŮŽIČKA & PRANTL, 1960); *Paracardium* BARRANDE, 1881, p. 137 (type, *P. subharmonicum*; SD NEWELL & LAROCQUE, herein); *Panenka* BARRANDE, 1881, p. 128 (type, *P. robustula*; SD RŮŽIČKA & PRANTL, 1960); *Puella* BARRANDE, 1881, p. 128; *Nevesta*, *Sponsa* BARRANDE, 1881, p. 133 (obj.); *Pantata* BARRANDE, 1881, p. 135 (type, *P. regens*; SD RŮŽIČKA & PRANTL, 1960); *Pater* BARRANDE, 1881, p. 135 (obj.); ?*Paraptyx* CLARKE, 1904, p. 261 (type, *P. ontario*; OD); *Kralovna* BARRANDE, 1881, p. 93 (type, *K. bohemia*; OD); *Regina* BARRANDE, 1881, p. 93 (obj.); ?*Praelima* BARRANDE, 1881, p. 144 (type, *P. proaeva*; RŮŽIČKA & PRANTL, 1960;

?*Praelucina* BARRANDE, 1881, p. 145 (type, *P. protendens*; SD RŮŽIČKA & PRANTL, 1960); *Pararca* HALL, 1885, p. 429 (type, *P. venusta*; SD S. A. MILLER, 1889); ?*Pleurodonta* CONRATH, 1887, p. 49 (type, *P. bohemia*; OD); *Barcinia* SUÑER & COMA, 1959 (type, *Kralovna almerae* BARRANDE, 1881; OD); *Joachymcardium* RŮŽIČKA & PRANTL, 1960, p. 50 (type, *Cardium cunctatum* BARRANDE, 1881; OD)]. Ovoid, evenly ventricose, with distinct but narrow cardinal area; radial costae fine to coarse, rounded, generally but not invariably uniform in size; hinge in best-known species with small, numerous, vertical teeth under beaks, *Sil.*(E<sub>2</sub>), *Eu.*(Boh.-France-Ger.)-*Dev.*, *N. Am.*(N.Y.-Mich.-Ont.).—FIG. B2,3. *\*P. primulum*, *Sil.*(E<sub>2</sub>), Boh.; 3a,b, RV cardinal and side views, ×1 (27).

**Buchiola** BARRANDE, 1881, p. 61 [*\*Venericardium retrostriatum* VON BUCH, 1832; M] [= *Glyptocardia* HALL, 1885, p. 35 (obj.)]. Differs from *Praecardium* chiefly in being less inflated and in the small number of broad, flat radial costae which are crossed by regularly spaced, up-arched, growth lamellae. *Sil.*, *Eu.*; *U.Dev.*, *Eu.-N.Am.*.—FIG. B2,2. *\*B. retrostriata* (VON BUCH), *U.Dev.*(Naples), *N.Am.*(N.Y.); 2a, bivalved individual, ext., ×6; 2b, hinge with denticulations, approx. ×12 (136). **Eopteria** BILLINGS, 1865, p. 221 [*\*E. typica*; OD]. Valves evenly convex, beaks incurved, nearly orthogyre; ventral margin semicircular; hinge about

as long as shell length, with subquadrate extremities; valves with slight anterior gape; area obscure or lacking; ornamented with fine costellae. ?*U. Cam.* (erratic in *L.Ord.* Levis Sh.), Quebec; *L.Ord.* (*Beekmantown.*), Quebec-Newf.—FIG. B2, 1. *E. richardsoni* (BILLINGS), *L.Ord.* (Quebec Gr.), St. Antoine, Que.; 1a, LV ext.; 1b, dorsal view both valves; both  $\times 1$  (52).

*Necklania* RŮŽIČKA & PŘIBYL, 1953, p. 57 [*pro Dalila* BARRANDE, 1881, p. 76 (non THOMSON, 1856)] [*\*Dalila obtusa* BARRANDE, 1881; SD RŮŽIČKA & PRANTL, 1960]. Oval, equivalve, equilateral; umbones generally orthogyre, median, low; beaks short, blunt; surface ornament with numerous radial costae. *U.Sil.* (*F<sub>1</sub>*), Boh.—FIG. B2, 5. *\*N. obtusa* (BARRANDE); RV ext.,  $\times 0.5$  (27).

*Slava* BARRANDE, 1881, p. 154 [*\*S. bohémica*; SD RŮŽIČKA & PRANTL, 1960] [= *Gloria* BARRANDE, 1881 (obj.); *Tiaraconcha* FRECH, 1891 (obj.)]. Beaks and umbones prominent; surface divided into 2 distinct growth stages by sharply dissimilar convexity and ornamentation; umbones ventricose, ornamented by regular concentric furrows; marginal area of shell less convex, ornamented by fine costellae; hinge short, taxodont, without distinct area. *Sil.*, E.Eu.—FIG. B2, 4. *\*S. bohémica*, *Sil.* (*E<sub>2</sub>*), Boh.; RV ext.,  $\times 1$  (27).

**Subfamily CARDIOLINAE Fischer, 1886**

[*nom. transl.* NEWELL & LAROCQUE, herein (ex *Cardiolidae* FISCHER, 1886)]

Equivalve; cardinal area prominent; essentially edentulous. *L.Sil.*-*L.Miss.*

*Cardiola* BRODERIP in MURCHISON, 1839, p. 617 [*\*C. interrupta* SOWERBY, 1839, in MURCHISON; SD S. A. MILLER, 1889] [= ?*Cardiopsis* MEEK & WORTHEN, 1861, p. 144 (type, *Cardiomorpha radiata* MEEK & WORTHEN, 1860) (non DE KONINCK, 1884) (= *Megambonia lyoni* HALL, 1860); ?*Salweyia* REED, 1931, p. 298 (type, *S. subobliquata*; OD)]. Ventricose, beaks and umbones prominent, hinge with triangular, flat, divergent cardinal area; surface with coarse radial costae. *U.Sil.* (*L.Ludlov.*)-*Dev.*, Eu.-N.Am.; *L. Miss.*, USA.

**C. (*Cardiola*)**. Ovoid, without posterior wing. *U. Sil.* (*L.Ludlov.*)-*Dev.*, Eu.-N.Am.; *L.Miss.*, USA.—FIG. B3, 4. *\*C. (C.) interrupta* (SOWERBY), *Sil.* (*E<sub>2</sub>*), Boh.; 4a, LV hinge view; 4b, same, side view, both  $\times 1$  (27).

**C. (*Cardiopsis*)** HERITSCH, 1929, p. 46 [*\*Cardiopsis typica* STACHE in HERITSCH, 1929; OD]. Differs from *Cardiola*, s.s. in possessing flattened and extended posterior wing. *Sil.*, E.Alps.

?*Euthydesma* HALL, 1885, p. 32 [*\*Astarte subtextilis* HALL, 1843; M]. Similar to *Cardiomorpha* but with short and regularly rounded anterior end; surface marked by very fine radial costellae producing cancellated appearance. *Sil.* (*M.*

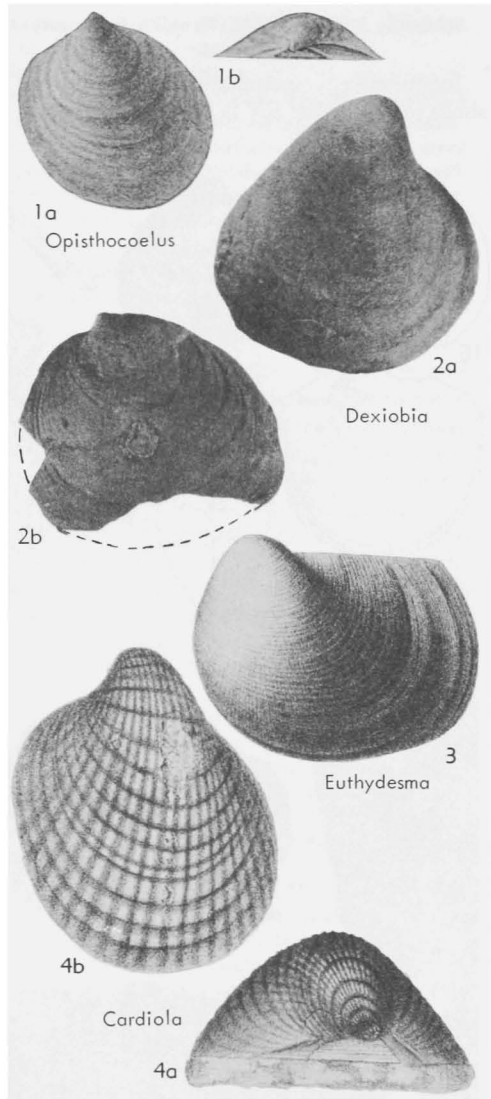


FIG. B3. Prae-cardioidae (Cardiolinae) (1, 3-4), Dexiobiinae (2) (p. N245-N247).

*Llandov.*), Scot.-*Dev.* (*Portage*), USA (N.Y.).—FIG. B3, 3. *\*E. subtextilis* (HALL), *Dev.* (*Portage*), USA (N.Y.); LV ext.,  $\times 1$  (370).

*Opisthocoeclus* BEUSHAUSEN, 1895, p. 338 [*\*O. concentricus*; SD NEWELL & LAROCQUE, herein] [= ?*Ontaria* CLARKE, p. 279 (type, *Ungulina suborbicularis* HALL, 1843)]. Ovoid, surface smooth or faintly costellate; interior unknown. *U.Sil.*-*U. Dev.*, Ger.-Belg.—FIG. B3, 1. *\*O. concentricus*, *U.Dev.*, Budesheim, Ger.; 1a, RV ext.; 1b, same, hinge view; both  $\times 2$  (47).

Subfamily DEXIOBIINAE Newell & LaRocque,  
new subfamily

Inequivalve, inequilateral, amphidetic  
shells in which the RV is subtriangular with

large umbo and markedly more convex than  
LV; beaks prosogyre, separated by an  
edentulous, undefined area. ?*Sil.*, *L.Miss.*

*Dexiobia* WINCHELL, 1863, p. 10 [*\*Cardiomorpha*

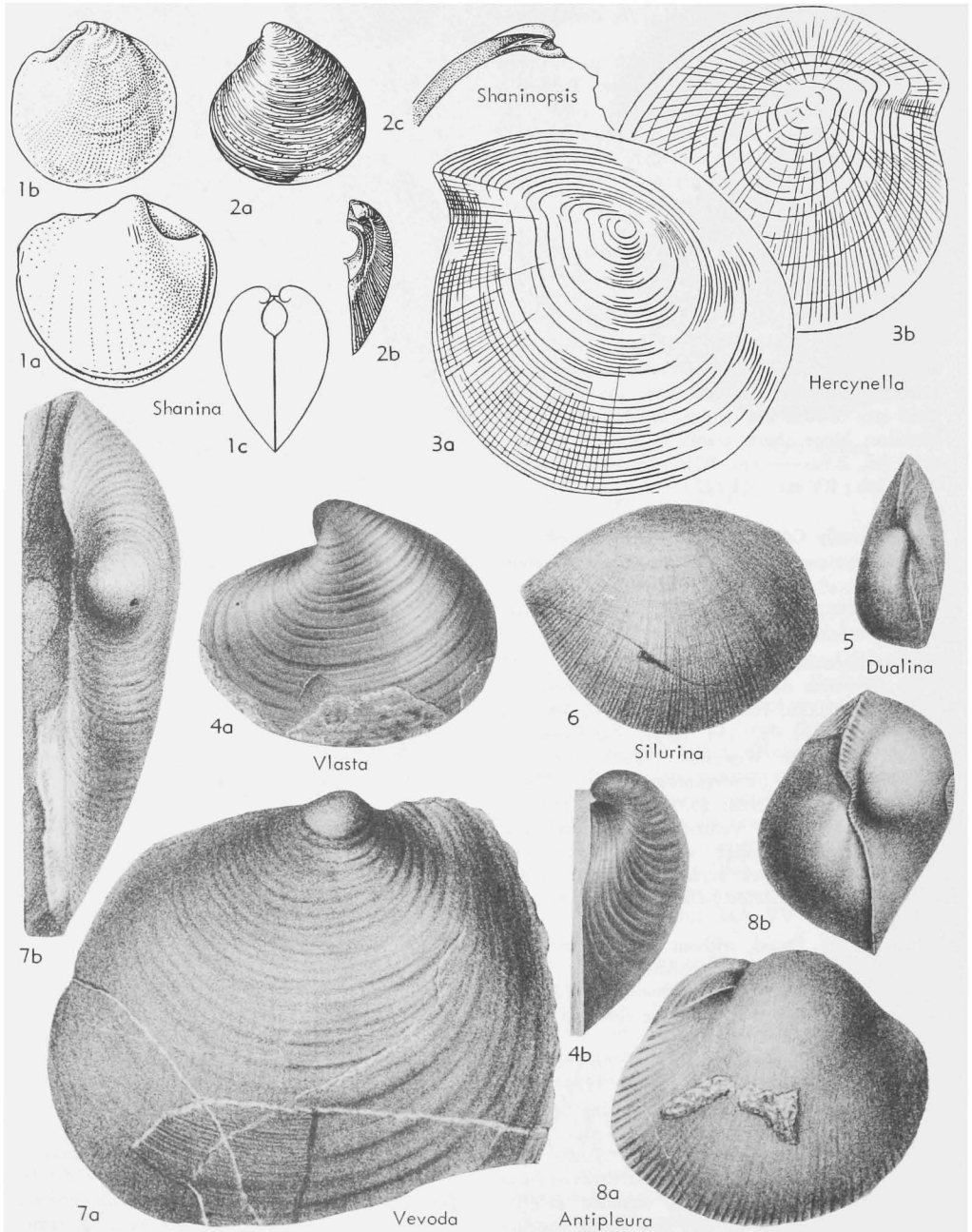


FIG. B4. Antipleuridae (Antipleurinae) (3,5-6,8), (Vlastinae) (1-2,4,7) (p. N247-N248).

*ovata* HALL, 1858; SD MILLER, 1889 (non D'ORBIGNY, 1850) [= \**Dexiobia whitei* WINCHELL, 1863] [= *Oracardia* HERRICK, 1888, p. 41 (type, *O. cornuta*; SD LaROcQUE & NEWELL, herein)]. Surface ornamentation of fine radial costellae and irregular concentric wrinkles. *Sil.*(E<sub>2</sub>)?, Boh.; *L. Miss.*(Kinderhook.), C.USA.—FIG. B3,2. \**D. whitei* (WINCHELL), *L. Miss.*(Kinderhook.), USA (Iowa); 2*a*, RV ext.; 2*b*, LV ext., both ×4 (Driscoll & Hall, 1963).

**Family ANTIPLEURIDAE Neumayr, 1891**

[*nom. transl.* DALL, 1895 (ex Antipleuriden NEUMAYR, 1891, p. 724)] [Materials for this family prepared by N. D. NEWELL & AURÈLE LaROcQUE]

Shell equivalve or very inequivalve, ligament probably amphidetic or lacking, without nymphs or differentiated area between beaks; lunule lacking; margin denticulate as interlocking terminations of surface costellae. *M.Ord.-Dev.*

**Subfamily ANTIPLEURINAE Neumayr, 1891**

[*nom. transl. et correct.* NEWELL & LaROcQUE, herein (ex Antipleuriden NEUMAYR, 1891); unspecified familial name]

Shell very inequivalve, commonly costellate. *Sil.-Dev.*

*Antipleura* BARRANDE, 1881, p. 18 [\**A. bohémica*; M]. Inflated, subcircular, beaks prosogyre; posterior part of shell commonly set off by carina; surface ornamented by uniform costellae. *M.Sil.*(E<sub>2</sub>), Boh.

**A.** (*Antipleura*). Beaks about equal in size, large, that of RV lying slightly ahead of LV. *M.Sil.*(E<sub>2</sub>), Boh.—FIG. B4,8. \**A. (A.) bohémica*; 8*a*, right side view of int. mold; 8*b*, dorsal view int. mold, showing crenulated shell margin, offset beaks and sinuous hinge; both ×1 (27).

**A.** (*Dualina*) BARRANDE, 1881, p. 77 [\**D. comitans*; SD RŮŽIČKA & PRANTL, 1860] [= *Sestra* BARRANDE, 1881, p. 151 (type, *S. novella*; OD); *Soror* BARRANDE, 1881, p. 151 (obj.)]. Similar to *Antipleura*, *s.s.*, but LV appreciably more convex with strongly prosogyre, overhanging beak. *M.Sil.*(E<sub>2</sub>), Boh.—FIG. B4,5. \**A. (D.) comitans*; dorsal view, ×1 (27).

*Hercynella* KAYSER, 1878, p. 101 [\**H. beyrichi*; SD COSSMANN, 1895]. Thin, patelloid, with central, subcentral, or submarginal apex at which originates more or less prominent fold extending to front margin of shell; sculpture consisting of radial costellae around shell margin; internal characters unknown. [First considered to be a gastropod, *Hercynella* is now classed as a bivalve because of its resemblance to and association with species of *Silurina*.] *M.Sil.-U.Dev.*, Eu.-USA-Morocco-Australia.—FIG. B4,3. *H. nobilis* (BARRANDE), *M.Sil.*(E<sub>2</sub>), Boh.; 3*a,b*, LV ext., RV ext., enl. (Termier & Termier, 1950).

*Silurina* BARRANDE, 1881, p. 153 [\**S. percalva*; SD RŮŽIČKA & PRANTL, 1960]. Subcircular, with a nasute auricle at the anterodorsal part of the shell; surface with fine costellae; umbones in some species well below dorsal margin; surface with fine costellae. *Sil.*(E<sub>2</sub>)-*Dev.*(F<sub>1</sub>), Boh.—FIG. B4,6. \**S. percalva*, *Sil.*(E<sub>2</sub>); LV ext., ×1 (27).

**Subfamily VLASTINAE Neumayr, 1891**

[*nom. transl. et correct.* DALL, 1895 (ex Vlastiden NEUMAYR, 1891)]

Shell thin, ovate, equivalve, beaks elevated, either prosogyre or opisthogyre and incurved; gaping slightly terminally in some genera; hinge margin edentulous or weakly taxodont, arched; flattened cardinal areas and ligament nymphs lacking; valves meeting along hinge line at obtuse angle beneath beaks; surface generally smooth, in some forms marked by concentric furrows with, or without, weak radial costae. *M.Ord.-Dev.*

*Vlasta* BARRANDE, 1881, p. 167 [\**V. bohémica*; SD RŮŽIČKA & PRANTL, 1960] [= *Jahnia* RŮŽIČKA & PRANTL, 1960, p. 50 (type, *Isocardia bohémica* BARRANDE, 1881)]. Thin, ovoid to subcircular, tumid, with prominent umbones; gaping at both ends; beaks commonly but not invariably opisthogyre; dentition absent or rudimentary; radial ornamentation very weak or absent. *U.Ord.*(*Richmond*), Can.(Ont.); *M.Sil.*(E<sub>2</sub>), Boh.—FIG. B4,4. \**V. bohémica*, *Sil.*(E<sub>2</sub>), Boh.; 4*a,b*, RV side and rear views, both ×0.5 (27).

*Shanina* REED, 1915, p. 18 [\**S. vlastoides*; M]. Suborbicular, gently convex; beaks subcentral; hinge line thickened behind beaks, sloping downward in front; valves gaping slightly in front of beaks; hinge unknown; interior with faint radiating lines; outer surface with growth lines only. *M.Ord.*, India.—FIG. B4,1. \**S. vlastoides*, *M.Ord.*(U.Naugkangyi beds), N.Shan. States, India; 1*a*, RV int. mold, ×1.5; 1*b*, LV int. mold, ×1; 1*c*, restored outline anterior, ×1 (778).

*Shaninopsis* ISBERG, 1934, p. 336 [\**S. prona*; OD]. Similar to *Shanina*, but without internal radial ribs. *U.Ord.*(*U.Leptaena* Ls.), Swed.—FIG. B4,2. \**S. prona*, *U.Ord.*, Swed.(Kallholn-Dalarna); 2*a,b*, LV ext. and ant. views of holotype, showing gape, ×1; 2*c*, hinge of same; all ×1.5 (439).

*Vevoda* BARRANDE, 1881, p. 166 [\**V. expectans*; SD RŮŽIČKA & PRANTL, 1960] [= *Dux* BARRANDE, 1881 (obj.), p. 166; *Sluzka* BARRANDE, 1881, p. 160 (type, *S. pulchella*; SD RŮŽIČKA & PRANTL, 1960; OD); *Praeostrea* BARRANDE, 1881, p. 147 (type, *P. bohémica*; M)]. Subcircular to subelliptical, gaping slightly in front; cardinal line strongly arched; beaks relatively small, prosogyre,

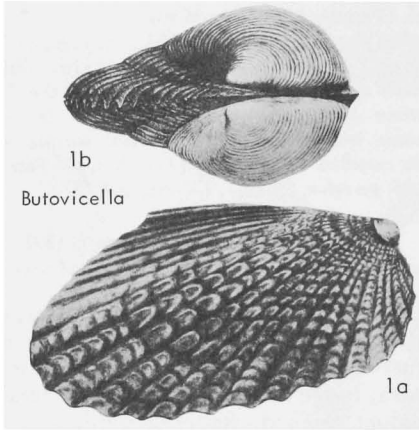


FIG. B5. Butovicellidae (p. N248).

swollen, distinct from remainder of shell; surface with both concentric and radial ornamentation, latter weaker. *Sil.*(E<sub>2</sub>)-*Dev.*(F<sub>1</sub>), Boh.—FIG. B4,7. \**V. expectans*, *Sil.*(E<sub>2</sub>), Boh.; 7a, RV ext. showing form, ornamentation, and prominent prodissoconch; 7b, same, hinge view; both  $\times 1$  (27).

### Family BUTOVICELLIDAE Kříž, 1965

[Materials for this family prepared by N. D. NEWELL]

#### Characters of *Butovicella*. *Sil.*

*Butovicella* Kříž, 1965, p. 207 [\**Cardiola migrans* BARRANDE, 1881; M]. Shells small, thin, elongate-ovoid, strongly inequilateral, equivalve, moderately inflated; nepioconch opisthogyre, adult shell prosogyre; sculpture of nodose strong radial ribs; ligament opisthodontic; interior unknown. *Sil.*, Eu.—FIG. B5,1. \**B. migrans* (BARRANDE), Kopanina F., *P. nilssoni* Zone, Boh.; 1a, RV ext.,  $\times 5$ ; 1b, both valves, dorsal, cardinal,  $\times 20$  (Kříž, 1965).

## Subclass PTERIOMORPHIA Beurlen, 1944

[*nom. transl.* NEWELL, 1965 (ex order Pteriomorpha BEURLEN, 1944)] [Diagnosis by N. D. NEWELL]

Cyrtodonts, arks, anisomyarians, and monomyarians of authors; mainly epifaunal, sedentary forms with free mantle margins, characterized as whole by byssal fixation or cementation generally and tendency for foot and anterior adductor to become reduced or lost in many most specialized genera; some groups secondarily free; duplivincular liga-

ment, unknown in other bivalves, characterizes less specialized Arcacea and several Paleozoic groups (Ambonychiacea, Pterinoplectinidae, Pterineidae). [Some superfamilies display convergent and parallel trends in many characters; consequently, a simple morphological diagnosis is not possible.] *L.Ord.-Rec.*

## Order ARCOIDA Stoliczka, 1871

[*nom. correct.* NEWELL, 1965 (ex order Arcacea STOLICZKA, 1871)] [Materials for this order prepared by N. D. NEWELL with additions as indicated]

Arks and their near relatives; sedentary, with free or byssate adults; characteristically isomyarian and equivalved with circular to trapezoidal shells; interior shell microstructure crossed-lamellar; gills filibranchiate in living forms; in most groups dorsal margin bears narrow to broad, flat cardinal areas that rise above hinge axis. *L.Ord.-Rec.*

## Superfamily CYRTODONTACEA Ulrich, 1894

[*nom. transl.* NEWELL, 1965 (ex Cyrtodontidae ULRICH, 1894)] [Diagnosis by N. D. NEWELL]

Ovoid, lacking radial ornamentation, slightly prosocline, commonly with prominent umbones and elongate, duplivincular ligament mainly behind beaks; generally with groups of anterior and posterior teeth separated by edentulous area of hinge plate; posterior laterals, where present, parallel to shell margin and mainly behind ligament; anterior teeth commonly arcuate over anterior adductor. *M.Ord.-Dev.*

## Family CYRTODONTIDAE Ulrich, 1894

[Materials on this family prepared by AURÈLE LAROCQUE with additions as indicated]

#### Characters of superfamily. *M.Ord.-Dev.*

*Cyrtodonta* BILLINGS, 1858 [\**C. rugosa*; SD WILLIAMS & BREGER, 1916] [= *Palaearca* HALL, 1859 (type, *P. ventricosa*; SD LAROCQUE, herein); *Angellum* MILLER, 1878 (type, *A. cuneatum*; OD)]. Cardinal teeth 3, commonly only 2, rarely 4, directed backward, horizontal or nearly so, and not essentially radial. *M.Ord.*(*St. Peter*)-*Sil.*(*Clinton*), N.Am.; *L.Sil.*(*Llandoverly*), Eu.—FIG. C1,4. \**C. rugosa*, *M.Ord.*(Trenton-Blackriv.), near Ottawa, Ont., Can.; 4a,b, RV ext., showing ornamentation and RV int.,  $\times 1$  (51).

?*Cypricardites* CONRAD, 1841, p. 51 [\**C. curtus*; SD S. A. MILLER, 1889]. This genus is presently un-



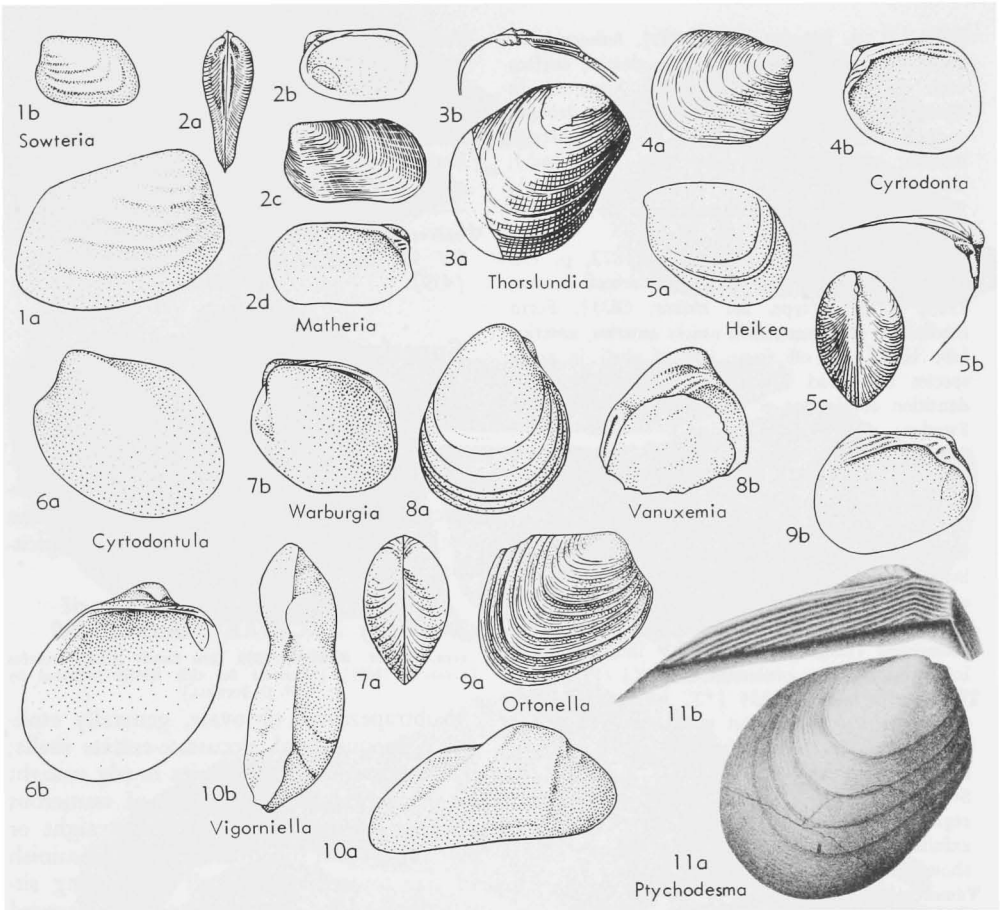


FIG. C1. Cyrtodontidae (p. N249-N250).

recognizable from available evidence. *U.Ord.*, USA.

**Cyrtodontula** TOMLIN, 1931 [*\*Whitella obliquata* ULRICH, 1890; OD] [= *Rhynchotropis* MEEK, 1872 (type, *R. sterlingensis*; M); *Whitella* ULRICH, 1890 (non SPINOLA, 1850); ?*Bodmania* MILLER & FABER, 1894 (type, *B. insultum*; OD)]. Obliquely quadrangular or suboval, more or less ventricose; umbonal ridge and umbones prominent, escutcheon distinct; surface with fine concentric lines and random stronger concentric ridges; 2 to 5 rather oblique folds or teeth in front of beaks, a few posterior lateral teeth. *Ord.* (*Blackriv.-Richmond.*), N.Am.; ?*Sil.* (*Niagar.*), USA (Ind.).—FIG. C1, 6. *\*C. obliquata* (ULRICH), *U.Ord.* (Cincinnati), USA (Ohio) (6a), *Ord.*, USA (Minn.) (6b); 6a, LV int. mold,  $\times 1$ ; 6b, LV int. showing dentition and muscle scars,  $\times 1$  (929).

?**Heikea** ISBERG, 1934, p. 276 [*\*H. selecta*; OD]. Similar in form to *Vanuxemia* but inequivalve,

RV umbo projecting over that of LV; LV with 1 small cardinal tooth; RV with 1 cardinal socket; without lateral teeth. *M.Ord.-Sil.*, N.Am.-Eu.—FIG. C1, 5. *\*H. selecta*, *Sil.* (*U. Leptaena* Ls.), Sweden; 5a, LV ext.,  $\times 2$ ; 5b, LV hinge,  $\times 3$ ; 5c, both valves dorsal,  $\times 2$  (439). [LA ROCQUE & NEWELL]

?**Matheria** BILLINGS, 1858 [*\*M. tenera*; OD]. Ob-long quadrate or suboval; beaks small, anterior; surface with concentric growth lines; LV with 2 small, divergent cardinal teeth beneath beak; RV with 1 cardinal tooth, no lamellar teeth; ligament external; pallial line simple, obscurely defined. [May belong in Astartidae; see Crassatellacea.] *Ord.* (*Trenton.*)-*Sil.* (*Niagar.*), N.Am. (Que.-Minn.-Wis.-Ill.).—FIG. C1, 2. *\*M. tenera*, *Ord.* (*Trenton.*), Blue Point, Que. (Lake St. John); 2a, both valves dorsal; 2b, RV int.; 2c, LV ext.; 2d; LV int.; all  $\times 1$  (51).

**Ortonella** ULRICH, 1893 (1894) [*\*Cypricardites*

*hainesi* S. A. MILLER, 1874; OD]. Subquadrate, beaks anterior, umbonal ridge moderate; surface with concentric lines of growth; hinge as in *Cyrtodonta* but cardinal teeth relatively stronger and immediately under beaks; 2 short posterior lamellar teeth in each valve. *Ord.*(*Richmond.*), USA(Ind.).—FIG. C1,9. \**O. hainesi* (MILLER); 9a, LV ext. showing ornamentation; 9b, LV int. showing dentition; both  $\times 1$  (929).

?*Ptychodesma* HALL & WHITFIELD, 1872, p. 192 [\**P. knappanum*; M] [=? *Macrodesma* ISBERG, 1934, p. 277 (type, *M. striata*; OD)]. Form modioloid, umbones small, nearly anterior, anterior lobe broad, set off from rest of shell in some species by broad sulcus; ligament area broad; dentition obsolescent or poorly known. *U.Ord.*-*Sil.*, Sweden; *Dev.*, USA(Ky.-Ind.).—FIG. C1,11. \**P. knappanum*, M.Dev., USA(Ind.); 11a, RV ext.,  $\times 1$ ; 11b, LV hinge,  $\times 2$  (379). [NEWELL]  
*Sowteria* WHITEAVES, 1908 [\**Whitiella canadensis* RAYMOND, 1905; OD]. Subtrapezoidal, beaks anterior, test and dentition unknown; surface of internal molds with strong concentric ridges on anterior 0.7 of shell; postumbonal slope smooth. *Ord.*(*Chazy.*), Can.(Ont.).—FIG. C1,1. \**S. canadensis* (RAYMOND); 1a,b, RV int. mold, LV int. mold, showing ornamentation,  $\times 1$  (976).

*Thorslundia* ISBERG, 1934 [\**T. bellistriata*; OD]. Similar to *Cyrtodonta* but with posterior part of hinge plate thickened; surface with radial and concentric ornamentation. *U.Ord.*(*U.Leptaena Ls.*), Sweden.—FIG. C1,3. \**T. bellistriata*, Dalarna region (Kallholn); 3a, RV ext. view of partially exfoliated holotype,  $\times 1$ ; 3b, RV hinge (holotype) showing dentition,  $\times 2$  (439).

*Vanuxemia* BILLINGS, 1858, p. 186 [\**V. inconstans*; SD S. A. MILLER, 1889]. Ventricose, oblique, ovate to subcircular; anterior end reduced, posterior broadly rounded; hinge as in *Cyrtodonta*, anterior adductor sharply defined, situated on anterior prolongation of hinge plate. *M.Ord.*-*U.Ord.*, N.Am.; *U.Ord.*(*U.Leptaena Ls.*), Sweden.—FIG. C1,8. \**V. inconstans*, M.Ord., E.Can.; 8a,b, LV ext., int.,  $\times 1$  (51). [LAROCQUE & NEWELL]

*Vigorniella* REED, 1934 [\**V. regia*; OD]. Inequivalve, beaks anterior; RV swollen, deep, larger than LV, twisted, carinated, with high incurved beak, depressed posterior area, and broad median transverse sulcus; LV shallow, more or less flattened or concave, with much lower and smaller beak and weaker median sulcus; no external ligamental area. Interior both valves with short, stout, vertical clavicular ridge immediately in front of beaks. *Sil.*(*Downton.*, Stage 1,9), Eng.—FIG. C1,10. \**V. regia*; 10a, RV ext.,  $\times 4$ ; 10b, dorsal view of complete specimen,  $\times 6$  (781).

*Warburgia* ISBERG, 1934 [\**W. lata*; OD]. Equivalve, thick, hexagonal to oval, beaks anterior; no lunule or area; ligamental area weak; surface concentrically striate. Hinge plate thick; cardinal teeth (number unknown) radially arranged under beak; 1 or 2 short posterior lamellar teeth parallel to hinge margin. *U.Ord.*(*U.Leptaena Ls.*), Sweden.—FIG. C1,7. \**W. lata*; 7a, dorsal view of both valves showing thickness of shell; 7b, RV int. with LV int. mold showing ant. muscle scar,  $\times 1$  (439).

## Superfamily ARCACEA Lamarck, 1809

[*nom. transl.* GILL, 1871 (ex family group arcacées LAMARCK, 1809) [Diagnosis by N. D. NEWELL]

Generally trapezoidal, radially ornamented; ligament elongate, generally duplivincular or striate, not confined to median resilifer; periostracum commonly conspicuous. *L.Ord.*-*Rec.*

### Family ARCIDAE Lamarck, 1809

[*nom. correct.* BRODERIP, 1839 (pro family group arcacées LAMARCK, 1809) [Materials for this family prepared by N. D. NEWELL]

Subtrapezoidal or ovate, generally inequivalve, inequilateral, decussate-costate shells; hinge taxodont, dental series nearly straight or slightly arched, consisting of numerous small, more or less transverse, straight or chevron-shaped subequal teeth that diminish in size toward middle, all teeth being situated near hinge axis and radially disposed with respect to point well below beaks; ligament duplivincular, prosodetic, amphidetic, or opisthodetic; without myophoric ridges or shelves. ?*Trias.*, *Jur.*-*Rec.*

#### Subfamily ARCINAE Lamarck, 1809

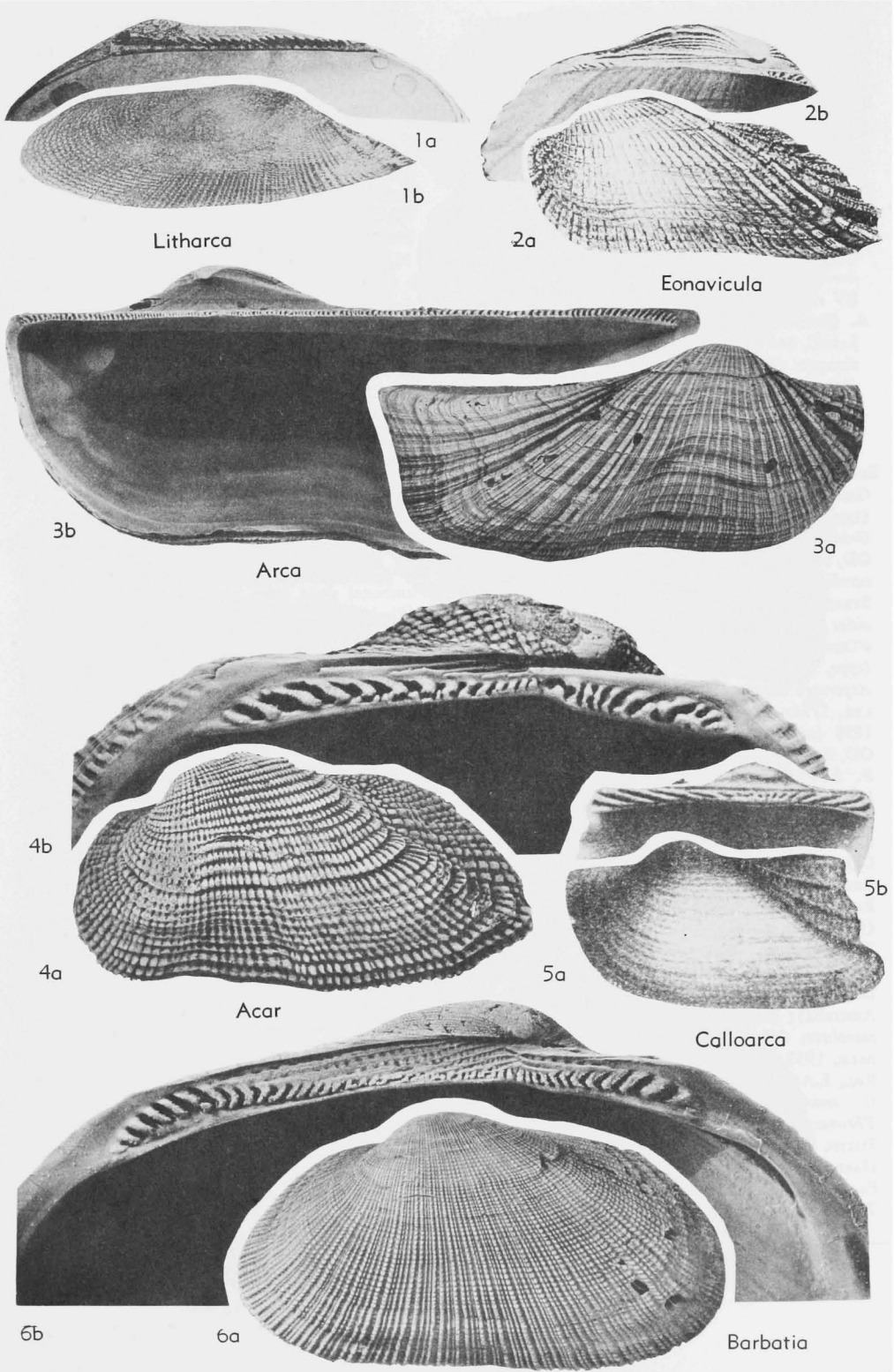
[*nom. transl. et correct.* STOLICZKA, 1871 (ex family group arcacées LAMARCK, 1809)]

Nestling or rock-boring forms characteristically with byssal gape and commonly corresponding shallow sinus at ventral margin for emergence of byssus; ventral border not crenulate. ?*Trias.*, *Jur.*-*Rec.*

*Arca* LINNÉ, 1758 [\**A. noae*; SD SCHMIDT, 1818 (ICZN Opinion 189)] [= *Daphne* POLI, 1791 (= *Daphnoderma* POLI, 1795, type, *A. noae*; SD NEWELL, herein); *Navicula* DE BLAINVILLE, 1825 (obj.); *Byssarca* SWAINSON, 1832 (obj.); *Cibota*

FIG. C2. Arcidae (Arcinae) (p. N252, N254) (facing page).





MÖRCH, 1853 (type, *A. noae*; SD NEWELL, herein); *Arcoptera* HEILPRIN, 1887 (type, *A. aviculaeformis*); *Mesocibota* IREDALE, 1939 (type, *M. luana*). Elongate, subtrapezoidal to subrectangular, very inequilateral, commonly expanded or auriculate posteriorly, posterior umbonal carina prominent; cardinal area broad, covered throughout by ligament; dental series long and nearly straight; surface sculpture radial, fine. *M.Jur.-Rec.*

**A. (Arca).** Teeth small, numerous, transverse across middle of shell, becoming longer and convergent terminally. *U.Cret.-Rec.*, cosmop. in warm waters. —FIG. C2,3. \**A. (A.) noae*, Rec., Medit.; *3a*, RV ext.,  $\times 0.85$ ; *3b*, RV int.,  $\times 1.3$  (Newell, n).

**A. (Eonavicula)** ARKELL, 1929 [\**A. quadrisulcata* J. DE C. SOWERBY, 1824; OD]. Median teeth more elongate than in *A. (Arca)* converging strongly downward toward point below beaks. *M.Jur.-Rec.*, W.Eu. —FIG. C2,2. *A. (E.) trichordis* (DE LORIO), U.Jur., Switz.; *2a,b*, LV ext., int.,  $\times 1.3$  (20).

**Barbatia** GRAY, 1842 [\**A. barbata* LINNÉ, 1758; SD GRAY, 1857] [= *Modioliformia* DESHAYES, 1860 (type, *Arca obliquaria* NYST, 1847; OD, Eoc., Fr.); *Granoarca* CONRAD, 1862 (type, *Arca propatula*?; OD, Mio., USA); *Plagiarca* CONRAD, 1875 (type, *B. carolinensis*; OD, U.Cret., N.Car.); ?*Soldania* STEPHANI & PANTANELLI, 1878 (type, *Arca mytiloides* BROCCHI, 1814; OD, Plio., Italy) (*non* D'ORBIGNY, 1826); *Savignyarca* JOUSSEAUME, 1891 (type, *S. savignyarca*; OD, Rec., GulfAden); *Asperarca* SACCO, 1898 (type, *Acar nodulosa* MÜLLER, 1776; OD, Rec., Denm.); *Obliquarca* SACCO, 1898 (type, *Arca modioliformis* DESHAYES, 1831; OD, Eoc., Italy); *Pugilarca* MARWICK, 1928 (type, *B. barneaformis*; OD, Oligo., N.Z.); *Destacar* IREDALE, 1936 (type, *Arca metella* HEDLEY, 1924; OD, Rec., S.Australia); *Abarbatia* DALL, BARTSCH & REHDER, 1938, p. 29 (type, *Barbatia oahua*; OD, Rec., Hawaii); ?*Hawaiarca* DALL, BARTSCH & REHDER, 1928, p. 27 (type, *H. rectangula*; OD, Rec., Hawaii); ?*Nipponarca* HABE, 1951, p. 34 (type, *Arca bistrigata* DUNKER; OD, Rec., W.Pac.); *Barbarca* DALL, BARTSCH & REHDER, 1938 (type, *Calloarca hua*; OD, Rec., Hawaii); *Barbatirus* IREDALE, 1939 (type, *B. mimulus*; OD, Rec., E. Australia); *Mimarcaria* IREDALE, 1939 (type, *M. saviolum*; OD, Rec., E.Australia); *Miratacar* IREDALE, 1939 (type, *Arca wendti* LAMY, 1907; OD, Rec., E.Australia); *Opularca* IREDALE, 1939 (type, *O. tenella egenora*; OD, Rec., E.Australia); *Thronacar* IREDALE, 1939 (type, *B. corpulenta* SMITH, 18??; OD, Rec., N.Australia); *Jacksonarca* HARRIS & PALMER, 1946 (type, *B. seraperta*; OD, Eoc., Miss.); *Tucetonella* HABE, 1961, p. 112 (type, *Tucetona planacosta*; OD, proposed as a subgenus

of *Tucetona*). Small, elongate, ovoid, inequilateral, generally equivalve, but rarely RV is slightly smaller than LV; terminations rounded or subangular and slightly expanded; ornamentation costellate, commonly fine. ?*Trias.*, *Jur.-Rec.*, cosmop.

**B. (Barbatia).** Umbonal carina low, rounded, cardinal area low, ligamental grooves closely spaced, costellae numerous, in some forms obsolescent. ?*Trias.*, *Jur.-Rec.*, cosmop. —FIG. C2,6. \**B. (B.) barbata* (LINNÉ), Rec., Medit.; *6a,b*, LV ext., int.,  $\times 1$ ,  $\times 2$  (Newell, n).

**B. (Acar)** GRAY, 1857 [\**Arca gradata* BRODERIP & SOWERBY, 1829; SD WOODRING, 1925] [= *Vitracar* IREDALE, 1939 (type, *V. laterosa*)]. Posterior umbonal carina prominent, extended posteriorly in emargination of shell; cardinal area very narrow, ligament mainly opisthodontic; ornamentation uniform, decussate; adductor scars somewhat elevated. *Paleoc.(Dan.)-Rec.*, Eu.-N.Am.-S.Am. —FIG. C2,4. \**B. (A.) gradata* (BRODERIP & SOWERBY), Rec., W.Colom.; *4a*, RV ext.,  $\times 2.6$ ; *4b*, RV int.,  $\times 5.2$  (Newell, n).

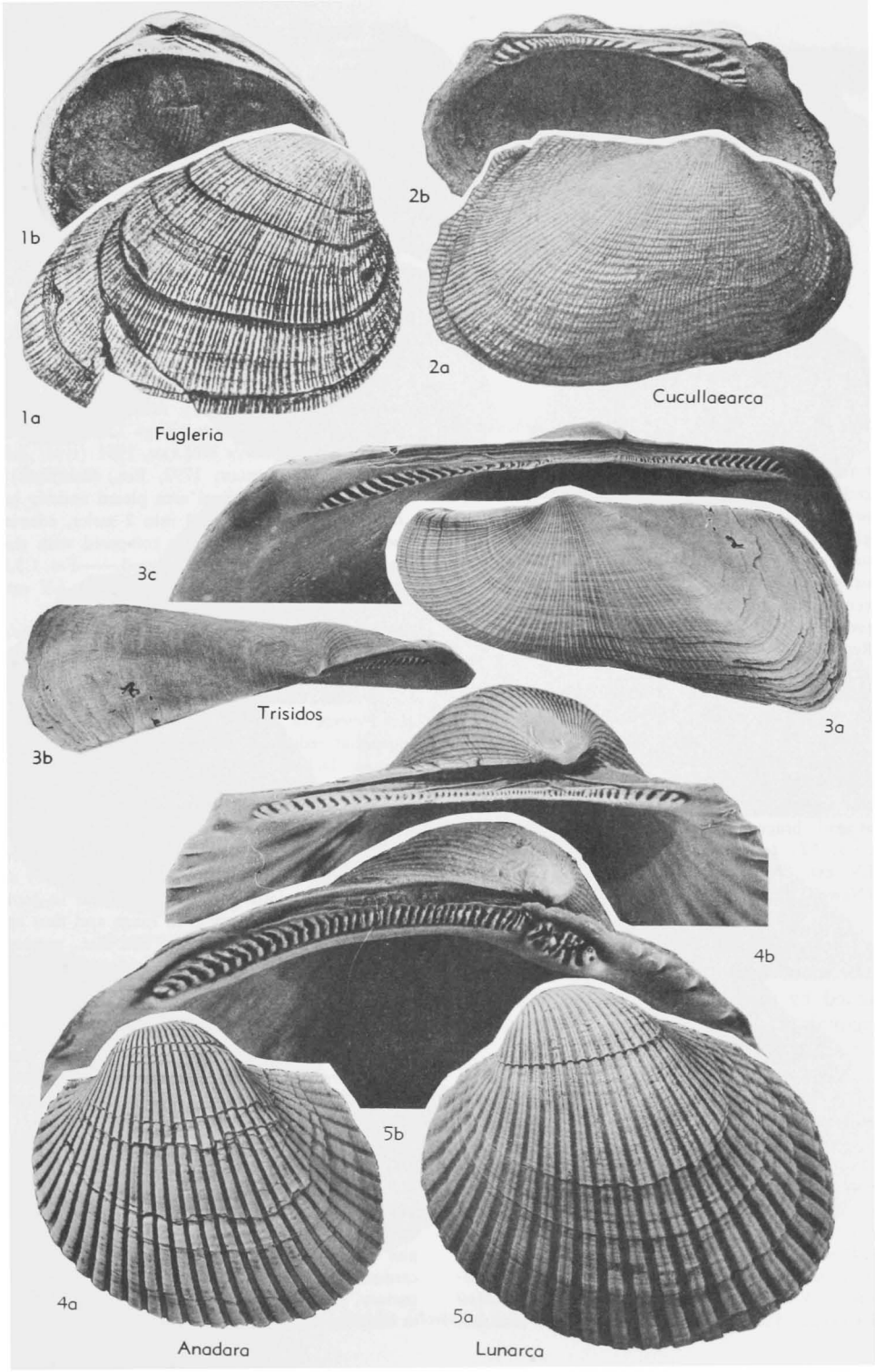
**B. (Calloarca)** GRAY, 1857 [\**Byssoarca alternata* SOWERBY, 1833; OD]. Similar to *Acar* but costellae very unequal in size, those of posterior umbonal slope large, elevated. *Mio.-Rec.*, N.Am. (Fla.)-C.Am.-NW.S.Am. —FIG. C2,5. \**B. (C.) alternata* (SOWERBY), Rec., Panama; *5a,b*, LV ext., int.,  $\times 1.3$  (688).

**B. (Cucullaearca)** CONRAD, 1865 [\**Byssoarca lima* CONRAD, 1847; SD STOLICZKA, 1871] [= *Polyneuma* CONRAD, 1875 (type, *B. lintea*, U.Cret., N.Car.)]. Elongate to obliquely subquadrate, subequivalve but generally much distorted, ventral margin deeply sinuated by large byssal gape; cardinal area high, amphidetic; sculpture formed by fine to coarse subequal costae; hinge long, straight, teeth in continuous series in young but in adults divided in middle by long gap, distal teeth conspicuously larger and oblique. *U.Cret.-Rec.*, cosmop. in warm seas. —FIG. C3,2. *B. (C.) lintea* (CONRAD), U.Cret., SE.USA; *2a,b*, RV ext., int.,  $\times 2.25$  (887). —FIG. C4,1. \**B. (C.) lima* (CONRAD), Oligo., USA (Miss.); LV ext.,  $\times 0.8$  (Conrad, 1840).

**B. (Fugleria)** REINHART, 1937 [\**B. (F.) pseudoillota*; OD]. Ovoid, posterior carina low, rounded; cardinal area and ligament as in *Acar*; ornamentation consisting of uniform costellae. *Plio.*, N.Am.(Fla.-Calif.); Rec., C.Am. —FIG. C3,1. \**B. (F.) pseudoillota*, Plio., Calif., *1a,b*, RV ext., int.,  $\times 1.7$  (Reinhart, 1937).

**B. (Taeniarca)** OLSSON, 1965, p. 25 [\**B. toaeniata* DALL, 1898; OD]. *Mio.-Plio.*, Ecuador.

FIG. C3. Arcidae (Arcinae) (1-3), (Anadarinae) (4-5) (p. N252, N254) (facing page).



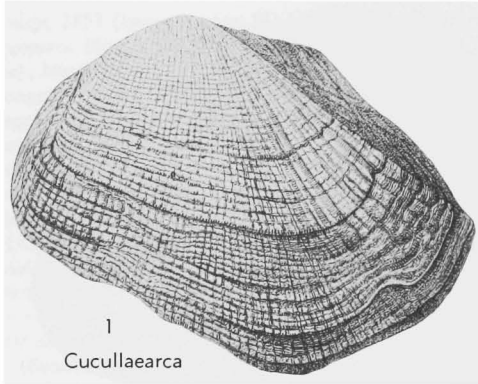


FIG. C4. Arcidae (Arcinae) (p. N254).

**Litharca** GRAY, 1892 [\**Byssarca lithodomus* SOWERBY, 1833; SD GRAY, 1847]. Elongate, cuneiform, subequivalve, strongly inequilateral, posterior end acuminate, carinated, beaks opisthogyre, approximately 0.75 of length behind anterior margin; cardinal area low, ligament prosodetic; sculpture characteristically worn by rock-boring, consisting of fine costellae and concentric threads; ventral margin not corrugated. *Rec.*, Panaman. prov.—FIG. C2,1. \**L. lithodomus* (SOWERBY), *Rec.*, Ecuador; 1a, RV int.,  $\times 5.7$ ; 1b, RV ext.,  $\times 1.1$  (688).

**Trisidos** RÖDING, 1798 [\**Arca tortuosa* LINNÉ, 1758; OD] [= *Trisis* OKEN, 1815 (obj.); *Parallelopedum* MÖRCH, 1850 (obj.); *Epirisis* IREDALE, 1939 (type, *Arca semitoria* LAMARCK, 1819, *Rec.*, E. Australia)]. Similar to *Arca* (*Arca*) but with narrow cardinal area and exhibiting marked torsion around hinge axis. *Eoc.-Rec.*, IndoPac.—FIG. C3,3. \**T. tortuosa* (LINNÉ), *Rec.*, Philip., 3a,b, LV ext., dorsal,  $\times 0.75$ ; 3c, LV hinge,  $\times 1.1$  (Newell, n).

#### Subfamily ANADARINAE Reinhart, 1935

Without byssal gape, adults free or attached by thin byssus; subtrapezoidal, sub-trigonal or ovoid, beaks prosogyre; dental series arched (688, 784). *U.Cret.-Rec.*

**Anadara** GRAY, 1847 [\**Arca antiquata* LINNÉ, 1758; OD] [= *Anomalocardia* MÖRCH, 1853 (type, *A. granosa* LINNÉ, 1758, *Rec.*) (non *Anomalocardia* SCHUMACHER, 1817); *Cara* GRAY, 1857 (type, *Arca aviculoides* REEVE, 1844, = *Arca formosa* SOWERBY, 1833, *Rec.*, Panama); *Rasia* GRAY, 1857 (type, *Arca formosa* SOWERBY, 1833, *Rec.*, Panama); *Nemoarca* CONRAD, 1869 (type, *N. cretacea*, U.Cret., N.J.); *Pectinatarca* SACCO, 1898 (type, *Arca pectinata* BROCCHI, 1814, Mio., Italy); *Diluvarca* WOODRING, 1925 (type, *Arca diluvii* LAMARCK, 1805, Mio., Eu.); *Tegillarca* IREDALE,

1939 (type, *T. granosa bessalis*, *Rec.*, E. Australia); *Esmerarca* OLSSON, 1961 (type, *Arca reinharti* LOWE, 1935, *Rec.*, Panama)]. Rotund, moderately heavy, ornamented with strong costae which correspond to interlocking crenulations of shell margins; equivalve in shape and sculpture; cardinal area narrow, elongate; dental series only slightly arched. *U.Cret.-Rec.*, cosmop.

**A. (Anadara)**. Subtrapezoidal; ligament amphidetic; dental series continuous, consisting of similar and uniformly graded teeth. *U.Cret.*, USA (N.J.); *Oligo.-Rec.*, cosmop.—FIG. C3,4. \**A. (A.) antiquata* (LINNÉ), *Rec.*, Madag.; 4a, LV ext.,  $\times 1.1$ ; 4b, LV hinge,  $\times 2.25$  (Newell, n).

**A. (Lunarca)** GRAY, 1857 [\**L. costata*; OD] [= *Argina* GRAY, 1842 (type, *Arca pexata* SAY, 1821, = *A. campechensis* GMELIN, 1792) (non *Argina* HÜBNER, 1816); *Mabellarca* IREDALE, 1939 (type, *Arca dautzenbergi* LAMY, *Rec.*, E. Australia); *Arginarca* McLEAN, 1951 (type, *Arca campechensis* GMELIN, 1792, *Rec.*, Gulf Mex.)]. Elongate, ovoid, cardinal area placed entirely behind beaks; teeth divided into 2 series, anterior being short and irregular as compared with posterior series. *Eoc.-Rec.*, widespread.—FIG. C3,5. \**A. (L.) costata*, *Rec.*, USA (Ala.); 5a, LV ext.,  $\times 1.1$ ; 5b, LV hinge,  $\times 2.25$  (Newell, n).

**Bathyarca** KOBELT, 1891 [\**Arca pectunculoides* SCACCHI, 1833; OD] [= *Microcucullaea* IREDALE, 1929 (type, *B. perversidens* HEDLEY, 1907, *Rec.*, S. Australia); *Indacar* IREDALE, 1939, p. 261 (type, *Acar pteroessa* SMITH, M)]. Ovoid small shells somewhat reduced anteriorly, posterior carina obscure or lacking, umbones situated less than 0.3 back of anterior margin, ornamented with radial costellae and concentric growth lines, ligament area narrow; teeth short, oblique, converging toward point below beaks, divided into anterior and posterior series of slightly longer teeth separated by an elongate edentulous gap, posterior teeth in some forms becoming subparallel to hinge and thus approaching Grammatodontinae. *Eoc.-Rec.*, cosmop.—FIG. C5,2. \**B. pectunculoides* (SCACCHI), *Rec.*; RV ext.,  $\times 6$  (Kobelt, 1891).

**Bentharca** VERRILL & BUSH, 1898 [\**Macrodon asperula* DALL, 1881; OD]. Similar to *Bathyarca* but extremities quadrate and anterior end of shell is more reduced; teeth not divided or serrated. *Rec.*, Gulf Mex.—FIG. C5,1. \**B. asperula* (DALL); 1a,b, LV hinge, RV ext.,  $\times 4$  (216).

**Larkinia** REINHART, 1935 [\**Anadara larkinii* NELSON, 1870; OD] [= *Grandiarcia* OLSSON, 1961 (type, *Arca grandis* BRODERIP & SOWERBY, 1829, *Rec.*, Panama)]. Subtrigonal, nearly as high as long, heavy, with prominent, elevated umbones and small beaks, somewhat truncate posteriorly; cardinal area high, ligament amphidetic; costae narrow, steep-sided, smooth or beaded with coarse or scabrous nodes. ?*Oligo.*, Mio.-*Rec.*, E.Pac.-Carib.

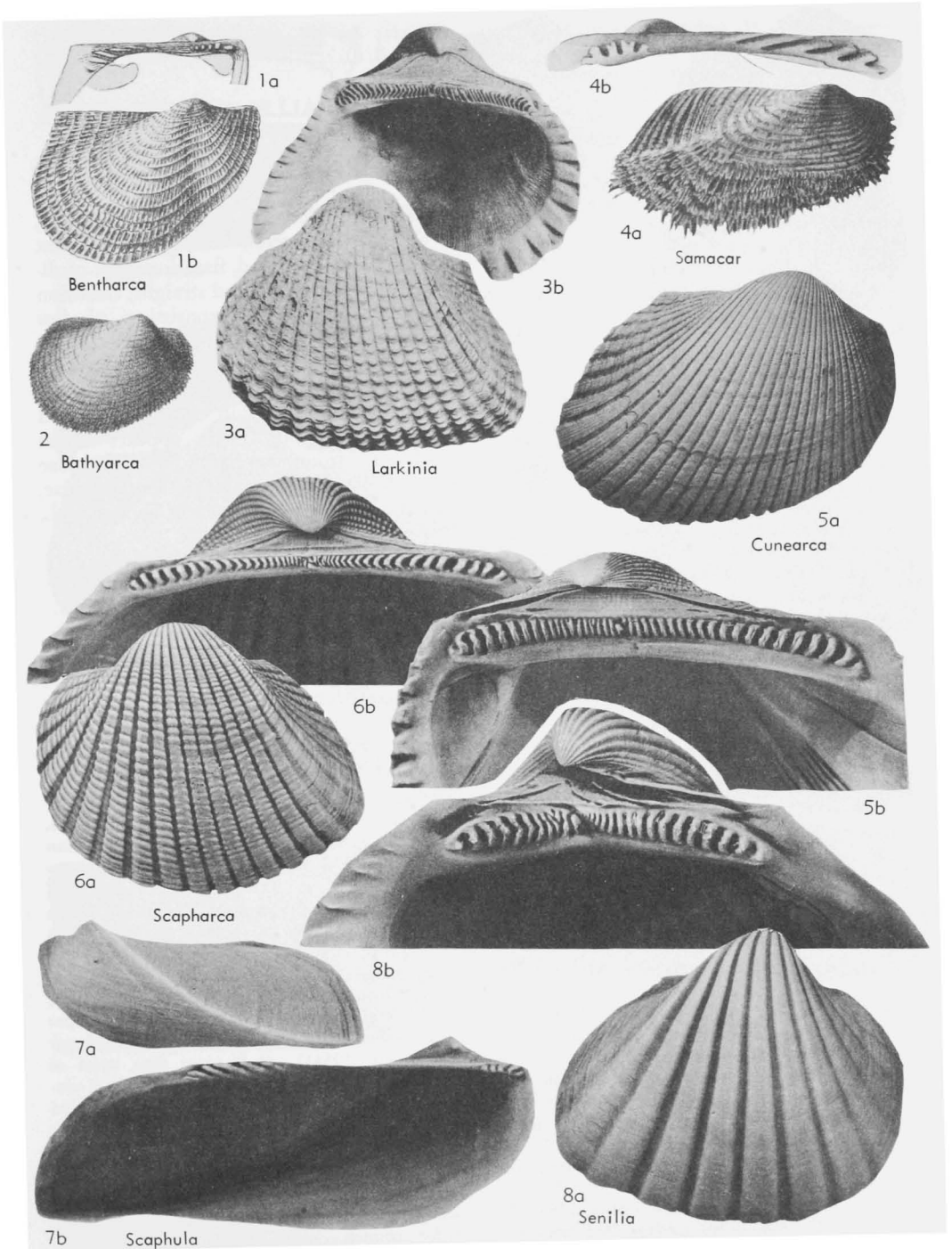


FIG. C5. Arcidae (Arcinae) (p. N254, N256).

—FIG. C5.3. \**L. larkinii* (NELSON), Mio., Peru; 3*a,b*, LV ext., int.,  $\times 0.7$  (Olsson, 1932).

**Samacarc** IREDALE, 1936 [\**Arca strabo* HEDLEY, 1914 (1915); OD]. Beaks about 0.25 of length back of anterior margin, anterior end rounded, narrow, posterior broad and obliquely truncated; ornamented with low, broad, concentric ridges crossed by faint costellae; hinge with medial edentulous area, anterior teeth short, bifid, and posterior teeth somewhat longer, serrate, obliquely inclined, radial with respect to a point well below beaks. ?*Pleist.-Rec.*, Australia.—FIG. C5.4. \**S. strabo* (HEDLEY), Rec.; 4*a*, RV ext.,  $\times 4$ ; 4*b*, RV hinge,  $\times 8$  (399).

**Scapharca** GRAY, 1847 [\**Arca inaequalvis* BRUGUIÈRE, 1789; OD] [= *Caloosarca* OLSSON, 1961 (type, *Andarca rustica* TUOMEY & HOLMES, 1857, Plio., SE.USA); *Sectiarca* OLSSON, 1961 (type, *Anadara* (*S.*) *floridana* CONRAD, 1869, Rec., Panama)]. Shell relatively thin, moderately convex; valves discordant, LV being larger, its margin overlapping that of RV; dentition as in *Anadara*. *Oligo.-Rec.*, cosmop.

**S. (Scapharca)**. Elongate, moderately convex, umbones flattened or slightly sulcate; sculpture similar in 2 valves, consisting of smooth or nodose, simple or bifurcating costae, rectangular in cross section and separated by flattened interspaces; cardinal area narrow, elongate; ligament commonly reduced or lacking in front of beaks. *Oligo.-Rec.*, cosmop.—FIG. C5.6. \**S. (S.) inaequalvis* (BRUGUIÈRE), Rec., Malaya; 6*a*, LV ext.,  $\times 1$ ; 6*b*, RV int.,  $\times 2$  (Newell, n).

**S. (Cuncarca)** DALL, 1898 [\**Arca incongrua* SAY, 1822; SD LAMY, 1907] [= *Imparilarca* IREDALE, 1929 (type, *I. hubbardi*, Rec., Queensl.); *Potiarca* IREDALE, 1939 (type, *P. pilula*, Rec., E.Australia)]. Subtrigonal, inflated, with full umbones and small, submedial beaks over high, triangular cardinal area covered completely by amphidetic ligament; sculpture discrepant, costae of LV being larger and more coarsely nodose. *Oligo.-Rec.*, cosmop.—FIG. C5.5. \**S. (C.) incongrua* (SAY), Rec., USA(Fla.); 5*a*, RV ext.,  $\times 1$ ; 5*b*, RV int.,  $\times 2$  (Newell, n).

?**Scaphula** BENSON, 1834 [\**S. celox*; SD BENSON, 1836]. Subtrapezoidal, elongate, very small smooth shells lacking radial ornamentation over most of surface; posterior umbonal carina high and narrow; teeth numerous, subequal, converging obliquely downward. [Fresh- and brackish-water habitat.] *Rec.*, Burma-India.—FIG. C5.7. \**S. celox*, India; 7*a*, LV ext.,  $\times 4$ ; 7*b*, LV int.,  $\times 6$  (Newell, n).

**Senilia** GRAY, 1842 [\**Arca senilis* LINNÉ, 1758; SD GRAY, 1847]. Similar to *Larkinia* but with extremely prosogyrate beaks, bearing few very broad radial ribs, having more trigonal form, and with oblique interruption in dentition beneath beaks. *Rec.*, W.Afr.—FIG. C5.8. \**S. senilis* (LINNÉ),

Angola; 8*a*, RV ext.,  $\times 1$ ; 8*b*, RV int.,  $\times 2$  (Newell, n).

## Family PARALLELODONTIDAE Dall, 1898

[*nom. subst.* DALL (*pro* Macrodontidae DALL, 1895, invalid name based on junior homonym)] [Materials for this family prepared by N. D. NEWELL]

Inflated, elongate, nearly equivalve, strongly inequilateral, orthogyre; ligament duplivincular on broad, flat, divergent cardinal areas; hinge long and straight; dentition strongly inequilateral, consisting of few posterior laterals and numerous, generally short, oblique, horizontal, or falcate anterior and medial cardinals. [The phylogeny of this group is difficult to determine and poorly understood. There appears to be gradation from ancestral Cyrtodontidae through Parallelodontidae to Cucullaeidae, and the limits are not clearly defined.] *L. Ord.-Rec.*

### Subfamily PARALLELODONTINAE Dall, 1898

[*nom. transl.* NEWELL, herein (*ex* Parallelodontidae DALL, 1898)]

Byssal gape and corresponding ventral sinus present; valve margins not denticulate; hinge teeth converging toward point slightly above anterior end and ahead of beaks; anterior ends of posterior laterals intersecting dorsal margin of shell. *L. Ord.-U. Jur.*

**Parallelodon** MEEK & WORTHEN, 1866 [*pro* *Macrodon* (LYCETT) BUCKMAN, 1845 (*non* SCHINZ, 1822, *nec* MÜLLER, 1842) = *Macrodus* BEUSHAUSEN 1895 (obj.) (*non* GRAY, 1864)] [\**Macrodon rugosus* BUCKMAN, 1845] [= *Prorhynchus* HALL, 1884, p. xlviii (type, *Palaeoanatina quadratum* HALL, 1883; OD); *Beushausenia* COSSMANN, 1897 (obj.) (*non* MAILLIEUX, 1913, = *Mailleuxia* COSSMANN, 1920); ?*Sufia* PRANTL & RUZIČKA, 1955 (type, *S. paradoxa*; OD); ?*Mnataia* PRANTL & RUZIČKA, 1955 (type, *M. pribyli*; OD); *Palaeocucullaea* TOKUYAMA, 1960 (type, *Parallelodon monobensis* NAKAZAWA, 1956)]. Shell more than twice as long as high, some species posteriorly alate; umbones approximately 0.25 of shell length behind anterior extremity; smooth or ornamented with radial ribs; ligament areas broad, with several chevron grooves converging toward beaks; with or without anterior myophoric buttress; hinge long and straight (Driscoll, 1961). *L. Ord. (Tremadoc.-U. Jur.*, cosmop.—FIG. C6.1*a*. \**P. rugosus* (BUCKMAN), M. Jur., Eng.; RV int.,  $\times 0.4$ .—FIG. C6.1*b*. *P. bipartitum* (ROEMER), U. Jur., Belg.; LV ext.,  $\times 1$  (20). [= *Glyptarca* HICKS, 1873, p. 48 (type, *G. primaeva*; SD NEWELL, herein).]



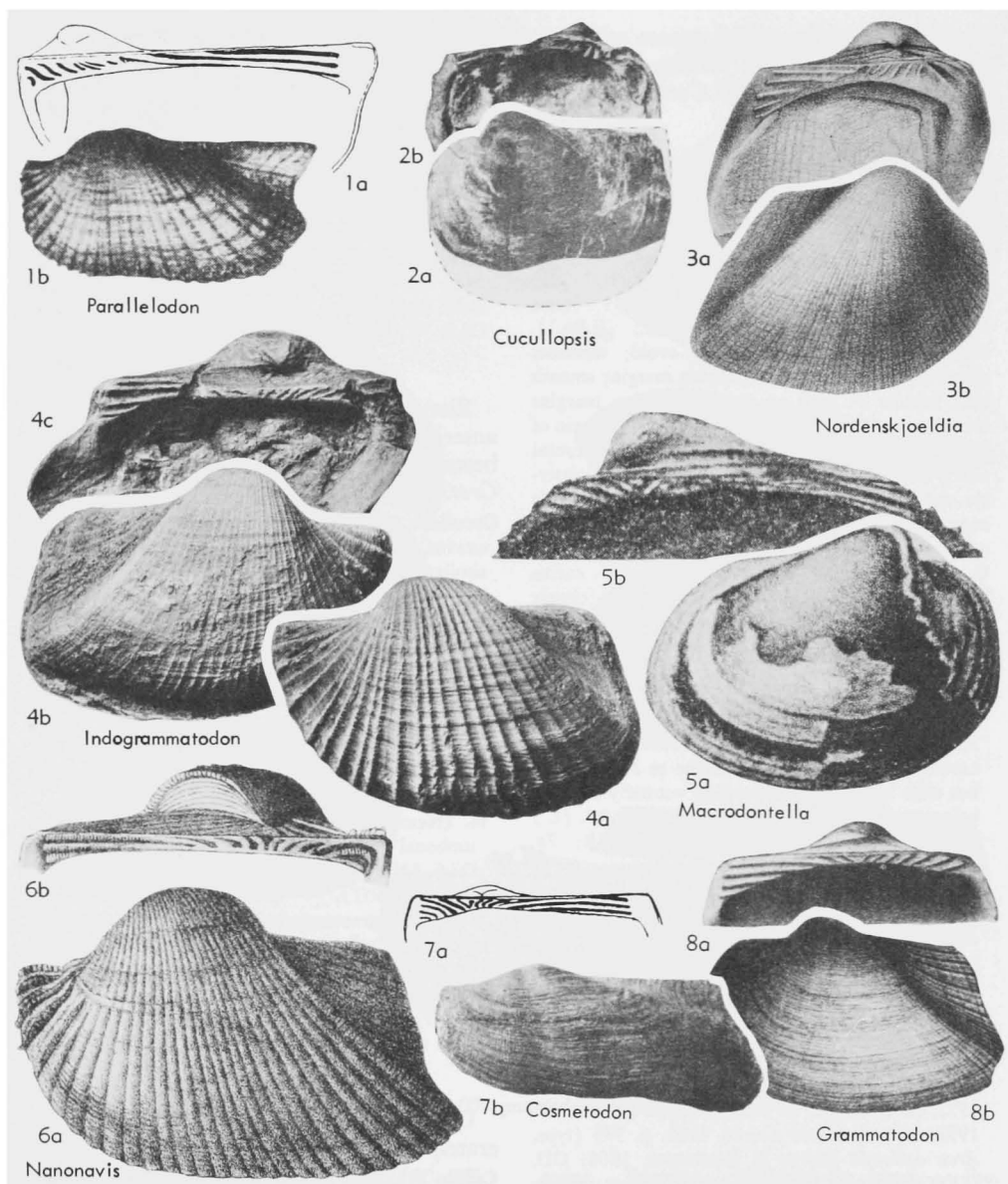


FIG. C6. Parallelodontidae (Parallelodontinae) (1,5), (Grammatodontinae) (2-4,6-8) (p. N256-N258).

?*Carbonarca* MEEK & WORTHEN, 1870 [\**C. gibbosa*; OD]. Penn., USA (Ill.).

?*Curvirostrum* BUCKMAN, 1882 [\**C. striatum*; OD]. M.Jur. (*Bajoc.*), Eng.

*Macrodontella* ASSMANN, 1916 [\**M. lamellosa*; OD]. Ovoid, without posterior umbonal carina, surface unornamented; ligament area narrow. Trias., Ger. —FIG. C6,5. \**M. lamellosa*, M.Trias., E.Ger., 5a, RV ext.,  $\times 2$ ; 5b, RV int.,  $\times 4$  (Assmann, 1916).

**Subfamily GRAMMATODONTINAE Branson, 1942**

[*nom. transl.* NEWELL, herein (ex Grammatodontidae BRANSON, 1942)]

Valve margins closed, without denticulations; hinge teeth converging downward toward point well below beaks so that anterior ends of posterior pseudolaterals intersect ventral margin of hinge plate; shell

relatively shorter in several genera with umbones placed relatively farther back than in *Parallelodontinae*. ?*U.Carb.*, *U.Trias.-Rec.*

#### GRAMMATODON GROUP

Shell trapezoidal, anterior teeth short and not horizontal. ?*U.Carb.*, *Jur.-Cret.*

**Grammatodon** MEEK & HAYDEN, 1861 [*\*Arca (Cucullaea) inornata* MEEK & HAYDEN, 1859; OD] [= *Pseudomacrodon* STOLL, 1934 (type, *Macrodon pictum*, Callov.-Oxford., E.Eu.)]. Length less than twice height, ovoid; umbones about 0.3 or more back of anterior margin; smooth over middle of shell or costellate; valve margins closed; myophoric buttress lacking; inner margin of hinge plate straight or slightly curved, with several nearly parallel and horizontal posterior pseudolaterals and series of small, generally oblique cardinals converging toward point below beaks. *Jur.-Cret.*, cosmop.

**G. (Grammatodon)**. Posterior umbonal carina commonly well defined and costellae closely spaced. *Jur.-Cret.*, cosmop.—FIG. C6,8. *G. (G.) concinnus* (PHILLIPS), U.Jur., Eu.; *8a,b*, LV int., ext.,  $\times 2$  (20).

**G. (Cosmetodon)** BRANSON, 1942 [*\*Arca keyserlingii* D'ORBIGNY, 1850; OD] [= *Beushausenia* ARKELL, 1930 (non COSSMANN, 1897, nec MAILLIEUX, 1913)]. Externally similar to *Parallelodon* but with hinge teeth converging ventrally to point below umbones. *Jur.*, Eu.—FIG. C6,7. *\*G. (C.) keyserlingii* (D'ORBIGNY), Oxford, USSR; *7a*, RV int.,  $\times 0.5$ ; *7b*, LV ext.,  $\times 1$  (20).

**G. (Indogrammatodon)** COX, 1937 [*\*Cucullaea virgata* J. DE C. SOWERBY, 1840; OD]. Posterior umbonal ridge poorly defined; costae narrow, widely spaced, coarser on LV. *Jur.*, India-Afr.-SW.Pac.—FIG. C6,4. *\*G. (I) virgatus* (SOWERBY), M.Jur., India; *4a,b*, LV ext., RV ext.,  $\times 2$ ; *4c*, LV int.,  $\times 2$  (180).

**G. (Nanonavis)** STEWART, 1930 [*\*Arca carinata* J. SOWERBY, 1813; OD] [= *Spinularca* CHAVAN, 1952, p. 10 (type, *S. cristata* BIGOT in CHAVAN, 1952, M); *Aptolinter* CASEY, 1961, p. 575 (type, *Arca aptiensis* PICTET & CAMPICHE, 1866; OD, L.Apt., W.Eu.)]. Trapezoidal, with low, closely spaced costae; umbonal carina sharp, delimiting deeply concave posterodorsal area; hinge plate narrow; teeth serrate, medial and anterior teeth falcate, tangential with dorsal and anterior margins. *Cret.*, USA (Calif.)-Eng.-Japan.—FIG. C6, 6. *\*G. (N.) carinata* (SOWERBY), Alb., Eng.; *6a,b*, LV ext., hinge,  $\times 2$  (Woods, 1899).

**G. (Nordenskoeldia)** WILCKENS, 1910 [*\*Arca disparilis* D'ORBIGNY, 1846 (non REEVE, 1844) (= *\*G. subdisparilis* NICOL, 1954); OD]. Ovoid, with low, closely spaced costae; umbonal carina sharp; teeth not serrate, hinge plate narrow, an-

terior teeth straight, oblique, becoming anteriorly parallel with anterodorsal margin. *U.Cret.*, India-Madag.—FIG. C6,3. *\*G. (N.) subdisparilis* (NICOL), India; *3a,b*, LV int., RV ext.,  $\times 1.5$  (Stoliczka, 1891).

?**Cuculopsis** CHAO, 1927 [*\*C. quadrata*; OD]. Shell thick, subquadrate, with height nearly equal to length, umbones prominent and placed well forward, umbonal carina weak and rounded, surface unornamented; several similar, oblique teeth in front and 2 subparallel pseudolaterals behind; ligament area narrow. *U.Carb. (Ural.)*, China.—FIG. C6,2. *\*C. quadrata*; *2a,b*, LV ext., int.,  $\times 1$  (95).

#### CUCULLARIA GROUP

Elongate, radially ribbed shells in which anterior teeth, shorter than posterior teeth, become subparallel with hinge margin. *U. Cret.-Eoc.*

**Cucullaria** CONRAD, 1869 [*\*Arca heterodonta* DESHAYES, 1860; OD]. Ovoid, costate, externally similar to *Barbatia* but with anterior and posterior laterals separated by few small cardinal teeth below beaks. *Eoc.*, France.—FIG. C7,3. *\*C. heterodonta* (DESHAYES); *3a,b*, RV ext., hinge,  $\times 0.7$  (259).

**Nemodon** CONRAD, 1869 [*\*Arca (Macrodon) eufalensis* GABB, 1860; OD] [= *Gilbertwhitea* CRICKMAY, 1930 (type, *Arca simillina* WHITEAVES, 1879, Jur., B.C.)]. Length about twice height. *U.Cret.*, N.Am.-Asia-Madag.

**N. (Nemodon)**. Costellae closely spaced; posterior umbonal carina distinct. *U.Cret.*, N.Am.—FIG. C7,6. *\*N. (N.) eufalensis* (GABB); *6a,b*, LV ext., int.,  $\times 2$  (951).

**N. (Pleurogrammatodon)** ICHIKAWA & MAEDA, 1958 [*\*P. splendens*; OD]. Inflated, with prominent umbones, costae widely spaced; posterior carina lacking. *U.Cret.*, Japan-Madag.-W.Can.—FIG. C7,5. *\*N. (P.) splendens*, Japan; *5a,b*, both valves dorsal, LV int.,  $\times 0.5$  (424).

#### CATELLA GROUP

Ovoid or trapezoidal, small and moderately short. *U.Trias.-Rec.*

**Catella** HEALEY, 1908 [*\*Grammatodon (C.) latyclava*; OD] [= *Cryptochasma* CASEY, 1961, p. 567 (type, *Cucullaea ovale*; OD; U.Apt., Eng.)]. Trapezoidal, pteroid, inflated, umbones situated about 0.3 of shell length behind anterior extremity, which is reduced, pointed, and separated from rest of shell by median sulcus; dentition similar to *Grammatodon*. *U.Trias.-Jur.*, Eurasia.

**C. (Catella)**. Ornamented with concentric rugae or growth lamellae. *U.Trias. (Rhaet.)*, Burma; *Jur.*, Sweden.—FIG. C7,2. *\*C. (C.) latyclava*, Rhaet., Burma; *2a,b*, LV ext., hinge,  $\times 1$  (Healey, 1908).



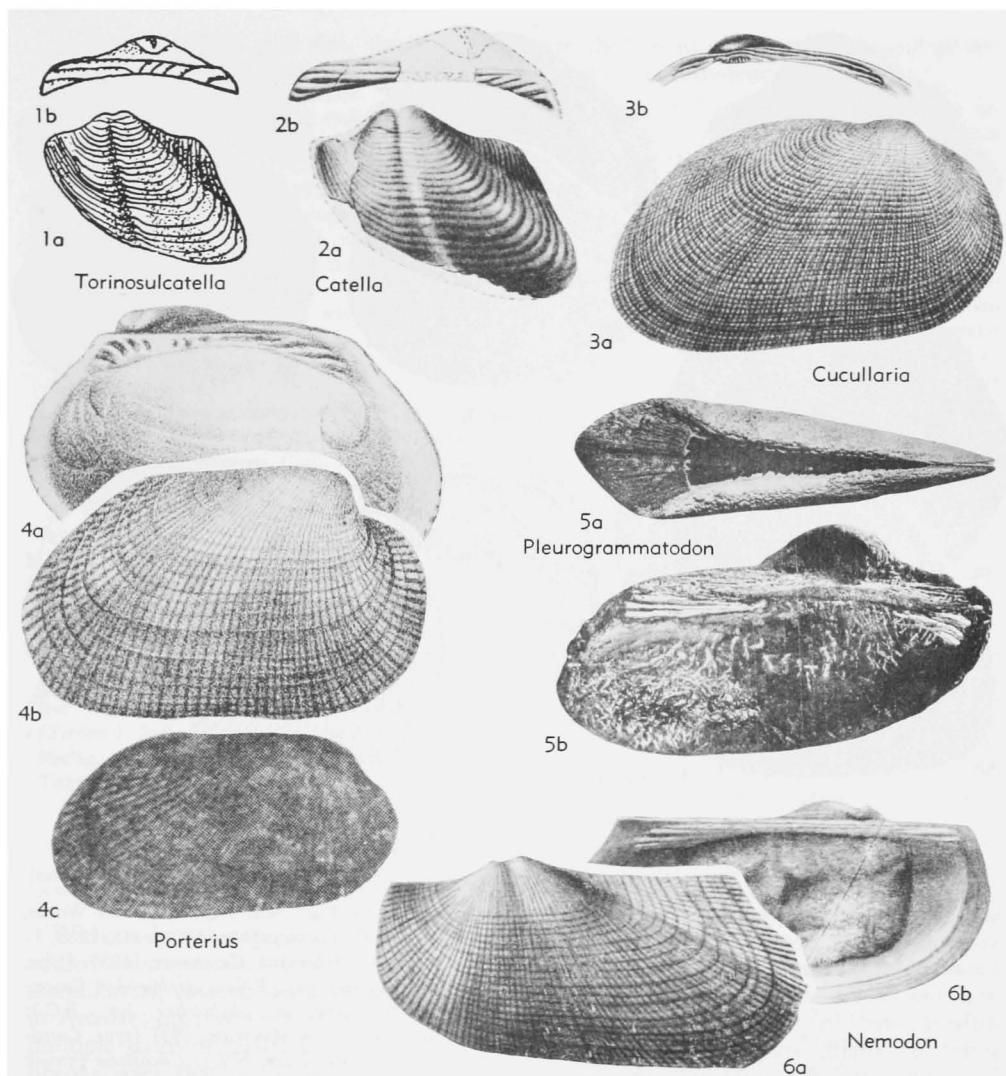


FIG. C7. Parallelodontidae (Grammatodontinae) (p. N258-N259).

**C. (*Torinosulcatella*)** TAMURA, 1959 [*\*C. (T.) kobayashii*; OD]. Ornamented with fine radial costellae. *U. Jur.*, Japan.—FIG. C7, 1. *\*C. (T.) kobayashii*; 1a, b, LV ext., hinge,  $\times 2$  (901).

**Paragrammatodon** NOMURA & NIINO, 1940 [*\*Pseudogrammatodon pacificus* NOMURA & ZINBO, 1934; OD]. Similar to *Porterius* but ornamented with prominent concentric ridges and obsolescent costae. *Rec.*, Japan.

**Porterius** CLARK, 1925 [*\*Barbatia andersoni* VAN WINKLE, 1918; OD] [= *Pseudogrammatodon* ARKELL, 1930]. Ovoid, costellate, externally similar to *Barbatia* but with posterior lateral teeth and cardinals that converge ventrally as with *Gramma-*

*todon*. *Eoc.-Rec.*, NW.USA-Eu.-Japan.—FIG. C7, 4a, b. *P. adversidentatus* (DESHAYES), *Eoc.*, France; 4a, b, RV int., ext.,  $\times 3$  (259).—FIG. C7, 4c. *\*P. andersoni* (VAN WINKLE), *Oligo.*, USA (Wash.); RV ext.,  $\times 1.5$  (Van Winkle, 1918).

#### Family CUCULLAEIDAE Stewart, 1930

[*nom. transl.* NEWELL, herein (ex Cucullacinae STEWART, 1930)] [Materials for this family prepared by N. D. NEWELL]

Ovoid, subtrigonal to subquadrate, smooth or radially costate, heavy shells with nearly median umbones and closed margins; valves of some shells with slight differences in

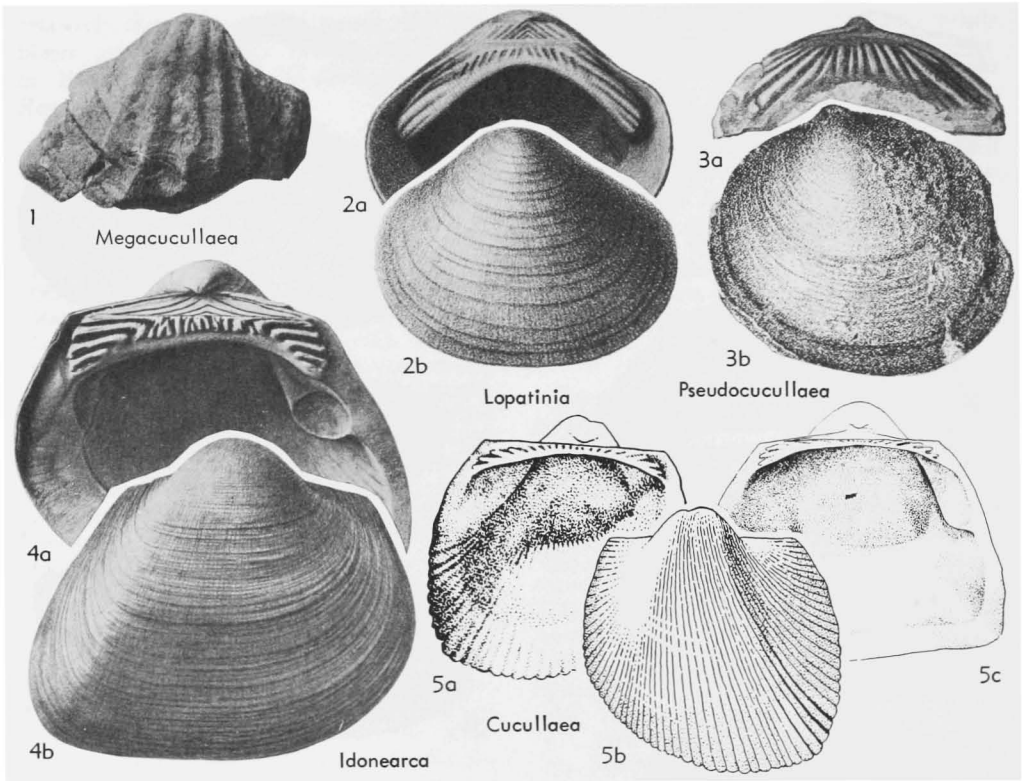


FIG. C8. Cucullacidae (p. N260-N261).

ornamentation, LV projecting slightly beyond RV along rear and ventral margins; ligament amphidetic, duplivincular, broad, with few chevron-shaped grooves; teeth well differentiated in adults into intermediate series of small, transverse denticles and long, symmetrically arranged anterior and posterior, commonly crenulated pseudolaterals; teeth of young individuals of some genera converging downward toward point below beaks, at maturity diverging downward, away from beaks; posterior myophoric flange or shell characteristically developed. [Several genera have been based on the form and distribution of the lateral teeth but the phylogenetic significance of these variations is uncertain.] *L.Jur.-Cret., Rec.*

**Cucullaea** LAMARCK, 1801 [*\*C. auriculifera* (= *Arca cucullata* RÖDING, 1798, *Arca cucullus* GMELIN, 1791, *\*Arca labiata* SOLANDER, 1786); SD CHILDREN, 1823] [= *Cucullana* LICHTENSTEIN, 1818 (type, *Arca (C.) cucullus* GMELIN, 1791, *Rec.*, W. Pac.); *Latiarca* CONRAD, 1862 (type, *C. gigantea*

CONRAD, 1830, *Eoc.*, Md.); *Dicranodonta* WOODS, 1899 (type, *C. donningtonensis* KEEPING, 1883, *L. Cret.*, Eng.); *Ashcroftia* CRICKMAY, 1930 (type, *A. inversidentata*, *Jur.*, B.C.); *Archaeodon* CRICKMAY, 1930 (type, *A. phylarchus*, *Jur.*, B.C.); *Cucullastis* FINLAY & MARWICK, 1937 (type, *Cucullaea (C.) barbara*, Dan., N.Z.); *Cucullona* FINLAY & MARWICK, 1937 (type, *Cucullaea (C.) inarata*, Dan., N.Z.)]. Subtrigonal, subtrapezoidal to ovoid, heavy shells with rounded posterior umbonal carina, posterior margin obliquely truncated, surface radially ornamented with strong costae; middle series of teeth and crenulations of inner shell margin becoming obsolete in mature and old individuals; pseudolaterals diverging downward in adults. *L.Jur. (Lias.)-Cret.*, Eu.-USA; *Rec.*, IndoPac.

**C. (Cucullaea)**. Subtrigonal to subtrapezoidal short shells, ornamented with moderate to coarse, closely-spaced costae; laterals diverging downward in adults. *Rec.*, IndoPac.—FIG. C8.5. *\*C. (C.) labiata* (SOLANDER), W.Pac.; 5a,b, LV int., ext.,  $\times 3$ ; 5c, RV int.,  $\times 0.5$  (674).

**C. (Idonearca)** CONRAD, 1862 [*\*C. tippiana* CONRAD, 1858 (= *C. capax* CONRAD, 1858; *\*C. vulgaris* MORTON, 1830); SD DALL, 1898]. Sub-

trapezoidal, elongate, with fine, closely spaced radial costellae and subhorizontal lateral teeth. *Jur.-Cret.*, Eu.-USA.—FIG. C8.4. \**C. (L.) vulgaris* (MORTON), *Cret.*, USA; 4*a,b*, RV int., ext.,  $\times 0.7$  (951).

**Lopatinia** SCHMIDT, 1872 [\**L. petschorae* KEYSERLING, 1846; SD MAURY, 1930]. Ovoid, nearly equilateral, with rounded dorsal margin, middle series of teeth gradational with marginal laterals, all diverging downward away from beaks. *Cret.*, USSR-Afr.-S.Am.

**L. (Lopatinia)**. Ornamented with fine costellae. *Cret.*, USSR.—FIG. C8.2. *L. (L.) jennisaeae* (LAHUSEN), Sib.; 2*a,b*, RV int., LV ext.,  $\times 1$  (Schmidt, 1872).

**L. (Pseudocucullaea)** SOLGER, 1903 [\**P. lens*; OD] [=*Eusebia* MAURY, 1930 (non DUPONCHEL, 1845) (type, *E. stantoni*, *Cret.*, Brazil)]. Surface unornamented. *Cret.*, W.Afr.-S.Am.—FIG. C8.3. \**L. (P.) lens*, W.Afr.; 3*a,b*, RV hinge, LV ext.,  $\times 1.5$  (Solger, 1903).

**Megacucullaea** RENNIE, 1936 [\**Cucullaea kraussi* TATE, 1867 (= *C. cancellata* KRAUSS, 1850, non *C. cancellata* PHILLIPS, 1829); OD] [= ?*Noramyia* CASEY, 1961, p. 575 (type, *Arca forbesii* PICTET & CAMPICHE, 1866; OD, L.Apt., Eng.)]. Surface ornamented with fine costellae superimposed on few widely spaced radial plications. *U.Jur. (Tithon.)*, India; *L.Cret. (Neocom.)*, E.Afr.-S.Afr.-Madag.—FIG. C8.1. \**M. kraussi* (TATE), Tithon., India; RV ext.,  $\times 0.5$  (183).

### Family NOETIIDAE Stewart, 1930

[*nom. transl.* NEWELL, herein (ex Noetiinae STEWART, 1930)] [=Noetiidae MACNEIL, 1937] [Materials for this family prepared by N. D. NEWELL]

Without byssal gape and mostly free in adults; subtrapezoidal to ovoid, equivalve, inequilateral, costate; dentition generally as in Arcidae; ligament vertically striated with multiple strips of elastic layer imbedded in fibrous layer that is in contact with shell; prosodetic, amphidetic or opisthodetic; myophoric ridge or shelf at inner margin of one or both adductor scars. [Widespread in shallow seas.] *L. Cret.-Rec.*

#### Subfamily NOETIINAE Stewart, 1930

Ovoid to trigonal, commonly inequilateral with well-developed posterior umbonal ridge and corresponding posterior emargination of shell; ornamentation commonly of primary and intercalated secondary costae, of which latter form principal ribs in adults, inner margin crenulate; ligament elongate and broad, characteristically coextensive with half or more of cardinal area; opistho-

gyre shells tend to be prosodetic and prosogyre shells opisthodetic. *L.Cret.-Rec.*

**Noetia** GRAY, 1857 [\**N. triangularis* (= *Arca reversa* SOWERBY, 1833); OD] [= *Noetiella* THIELE & JAEKEL, 1931 (type, *N. congoensis*, Rec., E. Atl.)]. Rhomboidal to subtrigonal, heavy shells, produced posteroventrally, beaks opisthogyre, high when situated just anterior to mid-point of hinge, becoming lower when posterior; ornamented with subequal costae, inner margin crenulated posteroventrally; ligament covering most or all of anterior part of cardinal area and part of posterior part of area within cardinal area; teeth radial, chevron-shaped anteriorly and in some species posteriorly, anterior series becoming relatively longer than posterior series in forms with posterior beaks. *L.Cret.-Rec.*, cosmop.

**N. (Noetia)**. Umbonal ridge carinate; radial ribs coarse, simple, not bifurcate over umbonal slope; posterior margin subangular, commonly truncate. *U.Eoc.*, IndoPac.; *L.Mio.-Rec.*, E.Pac.-Carib.—FIG. C9.3. \**N. (N.) reversa* (SOWERBY), Rec., Panama; 3*a,b*, RV int., both valves, RV view,  $\times 1$  (Maury, 1922).

**N. (Eontia)** MACNEIL, 1938 [\**Arca ponderosa* SAY, 1822; OD]. Similar to *Noetia* but generally more ovoid and inflated and with coarse bifurcating costae; anterior and posterior dental series subequal; ligament amphidetic. *L.Mio.-Rec.*, W. Eu.-W.Atl.-Carib.-E.Pac.—FIG. C9.7. \**N. (E.) ponderosa* (SAY), Rec., USA (Fla.); 7*a,b*, LV ext., int.,  $\times 1$  (MacNeil, 1938).

**N. (Incanopsis)** OLSSON, 1944 [\**I. acariformis*; OD] [= *Palestinarca* VOKES, 1946 (type, *Trigonarca palestina* WHITFIELD, 1891, Apt., Lebanon)]. Umbonal ridge carinate; radial ribs numerous, fine, not bifurcate; posterior margin obliquely truncate. *Cret. (Apt.-Senon.)*, N.Peru-Lebanon.—FIG. C9.2. \**N. (I.) acariformis*, U.Cret., N. Peru; 2*a,b*, LV ext., int.,  $\times 2$  (Olsson, 1944).

**Arginopsis** MACNEIL, 1938 [\**Scapharca sullanensis* WOODS, 1822; OD] [= *Samanoetia* MACNEIL, 1940 (pro *Arginella* MACNEIL, 1938) (type, *Arca samanensis* OLSSON, 1929, U.Eoc., Peru) (non *Arginella* FORSIUS, 1926)]. Subovate to subcircular in lateral profile, evenly inflated, umbonal ridge rounded, obscure; beaks strongly prosogyre, situated anteriorly; ornamented with many regular costae; ligament opisthodetic, completely covering posterior part of cardinal area; anterior series of teeth short, chevron-shaped. *U.Eoc.*, Peru.—FIG. C9.6. \**A. sullanensis* (WOODS); 6*a,b*, both valves dorsal, RV ext.,  $\times 1$  (MacNeil, 1938).

**Noetiopsis** MACNEIL, 1938 [\**N. woodringi*; OD]. Trigonal, subcarinate, similar to *Noetia*, but with prosogyre beaks situated well forward of mid-point of hinge; ligament opisthodetic. *Eoc.*, Panama.—FIG. C9.5. \**N. woodringi*, LV ext.,  $\times 1$  (MacNeil, 1938).

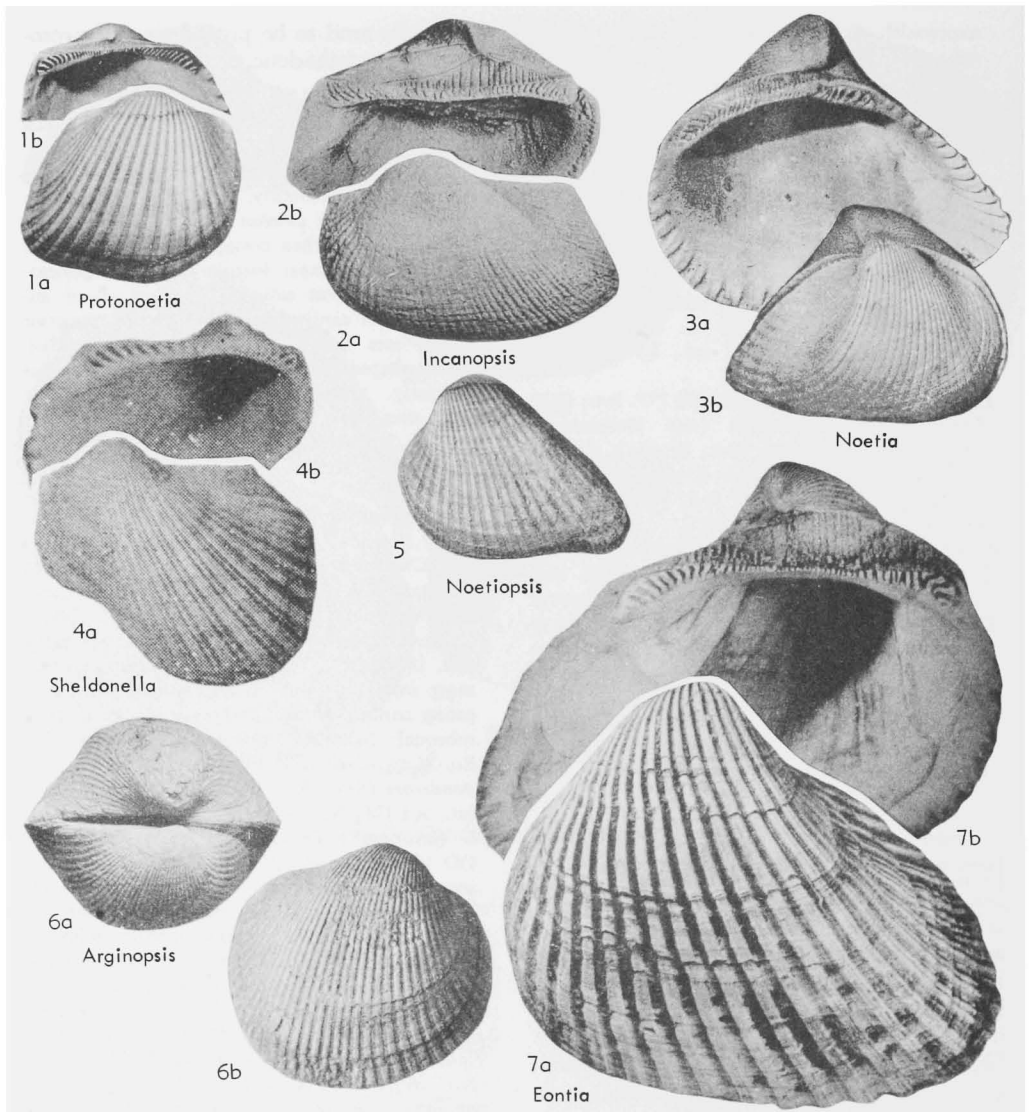


FIG. C9. Noetiidae (Noetiinae) (p. N261-N262).

**Protonoetia** MACNEIL, 1938 [*Anadara nigeriensis* NEWTON, 1922; OD]. Subquadrate, inflated, subangular posteroventrally, umbonal ridge subcarinate, beaks nearly central and orthogyre; ornamented with subequal, undivided costae; ligament amphidetic; terminal anterior and posterior teeth chevron-shaped. *M.Eoc.*, W.Afr.(Nigeria).—FIG. C9,1. \**P. nigeriensis* (NEWTON); 1a,b, RV ext., int.,  $\times 1$  (MacNeil, 1938).

**Sheldonella** MAURY, 1917 [\**Noetia* (*S.*) *maoica*; OD] [= *Barbatiella* LAMY, 1917 (type, *B. barbatiella*, = *Arca venusta* DUNKER, 1852, = *A. lateralis* REEVE, 1844, Rec., IndoPac.); *Didimacra*

IREDALE, 1939 (type, *D. repenta*, Rec., E.Australia); *Paranoetia* THIELE, 1934 (type, *Arca lateralis* REEVE, 1844, Rec., IndoPac.)]. Elongate, barbati-form, umbonal ridge rounded, beaks moderately high, prosogyre to opisthogyre, situated anteriorly; secondary costae becoming bifurcate marginally in adults. *M.Mio.*, Domin.Repub.; Rec., IndoPac.—FIG. C9,4. \**S. maoica*, *M.Mio.*, Domin.Repub.; 4a,b, LV ext., int.,  $\times 3$  (MacNeil, 1938).

#### Subfamily STRIARCINAE MacNeil, 1938

Generally small, ovoid, subequilateral, with submedian umbones, beaks prosogyre

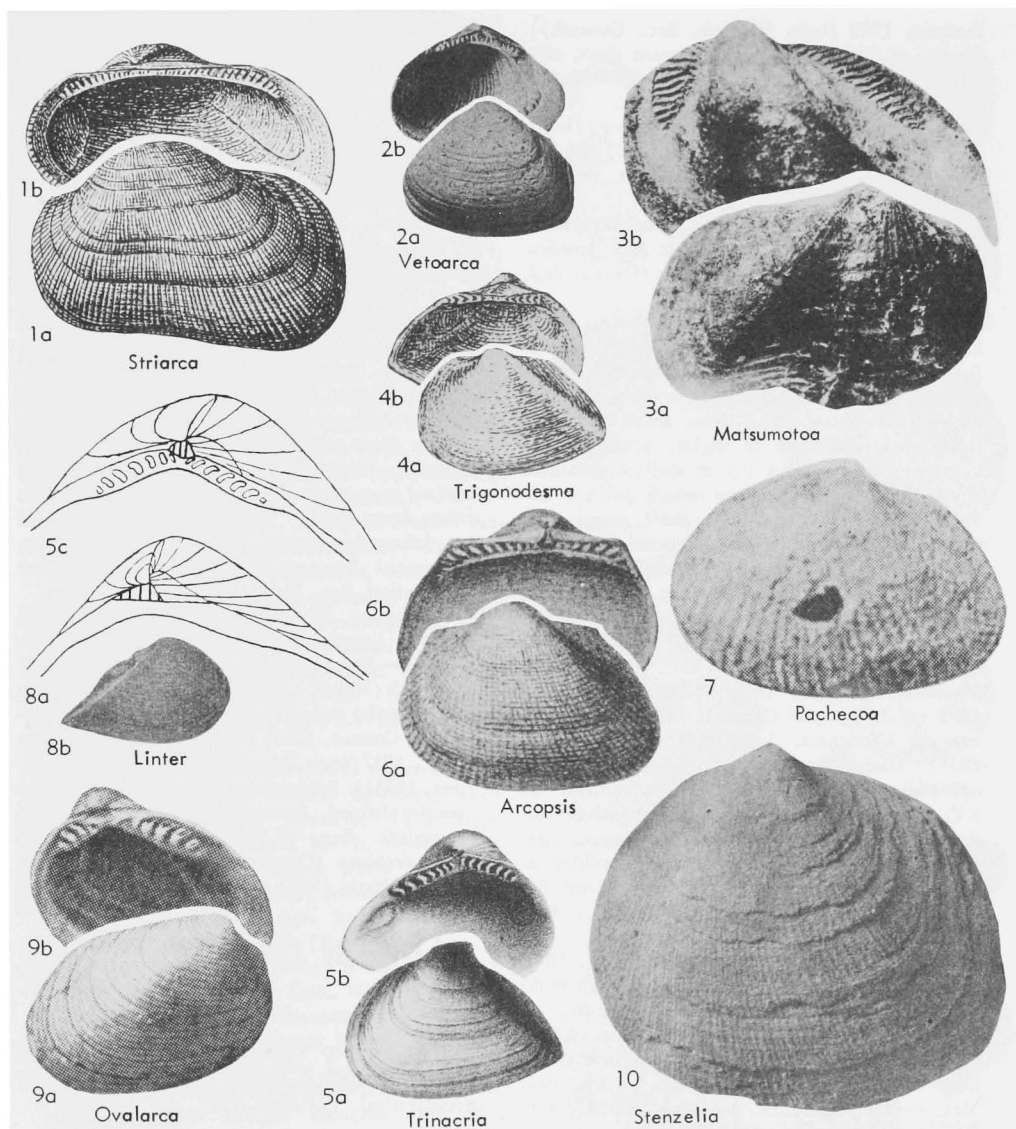


FIG. C10. Noetiidae (Striarciinae) (1-4,6,9), (Trinacriinae) (5,7,8,10) (p. N263-N264).

to slightly opisthogyre; costellate; ligament amphidetic, short to long, bordered by ligament-free cardinal area. *U.Cret.-Rec.*

**Striarca** CONRAD, 1862 [*Arca centenaria* SAY, 1824; OD] [= *Breviarca* CONRAD, 1872 (type, *Arca safordi* GABB, 1860; SD STEWART, 1930, *U.Cret.*, Tenn.); *Estellacar* IREDALE, 1939 (type, *E. saga*, Rec., Queensl.); *Galactella* COSSMANN & PEYROT, 1912 (type, *Arca lactea* LINNÉ, 1758, Rec., Medit.)]. *Barbatia*-like costellate shells with relatively long ligament; inner margin of anterior and posterior adductor scars bordered with raised myo-

phoric flange. *U.Cret.-Rec.* USA-Eu.-Australia.—  
FIG. C10.1. \**S. centenaria* (SAY), Mio., USA (Md.); 1a,b, LV ext., RV int., ×2 (Glenn, 1904).

**Arcopsis** KOENEN, 1885 [*Arca limopsis* KOENEN, 18??; SD REINHART, 1935] [= *Fossularca* COSSMANN, 1887 (type, *Arca quadrilatera* LAMARCK, 1805, *Eoc.*, France); *Gabinarca* IREDALE, 1939 (type, *G. pellita*, Rec., Queensl.); *Mulinarca* IREDALE, 1939 (type, *Barbatia aceraea* MELVILL & STANDEN, 1899, Rec., Queensl.); *Scapularca* COSSMANN & PEYROT, 1912 (type, *Arca scapulina* LAMARCK, 1805, *Eoc.*, France); *Spinearca* IREDALE, 1939 (type, *S. deliciosa*, Rec., Queensl.); *Verilarca*

- IREDALE, 1939 (type, *V. bivia*, Rec., Queensl.). Similar to *Striarca* but with ligament short, confined to shallow, triangular resiliifer below beaks. *Paleog.(Dan.)-Rec.*, Eu.-N.Am.-IndoPac.
- A. (Arcopsis).** Surface costellate. *Paleog.(Dan.)-Rec.*, cosmop.—FIG. C10,6. \**A. (A.) limopsis* (KOENEN), Dan., Denm., 6*a,b*, LV ext., int.,  $\times 4$  (Koenen, 1885).
- A. (Ovalarca)** WOODRING, 1925 [\**Barbatia ovalina* DALL, 1898; OD]. Surface smooth. *Mio.*, Jamaica.—FIG. C10,9. \**A. (O.) ovalina* (DALL); 9*a,b*, RV ext., int.,  $\times 12$  (1005).
- Matsumotoa** OKADA, 1958 [\**M. japonica*; OD]. Elongate, ovoid, with rounded anterior and obliquely rounded posterior margin, ventral margin medially sinuate; umbonal ridge carinate, bounded anteriorly by broad radial sulcus across middle of shell; beaks orthogyre to slightly prosogyre, situated at about anterior 0.3 of shell; ornamented anteriorly by distinct costae which become obsolescent over posterior area, inner margin not crenulate; dentition cucullaeid, central teeth very short, ventrally convergent, terminal teeth long and slender, subparallel with hinge line; ligament vertically striate. *U.Cret.*, Japan.—FIG. C10,3. \**M. japonica*; 3*a,b*, RV ext., int.,  $\times 1.25$  (Okada, 1958).
- Trigonodesma** WOOD, 1864 [\**Arca lissa* BAYAN, 1873 (= *A. laevigata* CAILLAT, 1873, non SPENGLER in CHEMNITZ, 1784); SD WINCKWORTH, 1934]. Umbonal carina well developed, weakly opisthogyrate, radial sculpture predominant on RV, concentric on LV; posterior muscle scar bordered anteriorly by low myophoric flange; ligament confined to small, triangular resiliifer at center of flattened cardinal area. *Eoc.*, N.Am.-Eu.—FIG. C10,4. \**T. lissa* (BAYAN), Eng.; 4*a,b*, LV ext., int.,  $\times 6$  (Wood, 1864).
- Vetoarca** STEPHENSON, 1947 [\**V. hindsana*; OD]. Beaks prominent, orthogyre, subcentral; shell without radial ornamentation; adductor muscles attached to slightly raised platforms; inner surface within pallial line strongly ribbed; ligament confined to small, triangular resiliifer. *U.Cret.*, Gulf Mex.—FIG. C10,2. \**V. hindsana*; 2*a,b*, LV ext., RV int.,  $\times 2$  (Stephenson, 1947).

#### Subfamily TRINACRIINAE MacNeil, 1937

Small, trigonal to ovoid, with or without weak, subequal, radial ornamentation, strongly inequilateral to subequilateral; ligament restricted to narrow resiliifer bounded by small cardinal area, prosodetic, opisthogyre; largest teeth commonly chevron-shaped. [These forms are convergent with the Limopsidae from which they differ in being opisthogyre and in possessing a striated ligament.] *U.Cret.-Eoc.*

**Trinacria** MAYER, 1868 [\**Trigonocoelia crassa* DESHAYES, 1860; SD GARDNER, 1926]. Opisthogyre, amphidetic to opisthodetic, cardinal area small, indistinct, entirely behind beaks, umbonal ridge broadly rounded; numerous weak costellae; dental series usually interrupted at ligament. *Eoc.*, Eu.-N.Am.—FIG. C10,5*a,b*. \**T. crassa* (DESHAYES), Paris Basin; 5*a,b*, LV ext., int.,  $\times 4$  (259).—FIG. C10,5*c*. *T. media* (DESHAYES), Paris Basin; LV hinge,  $\times 4$  (570).

**Linter** STEPHENSON, 1937 [\**L. acutata*; OD]. Similar to *Trinacria* but more elongate and with sharp umbonal carina. *U.Cret.*, N.Am.—FIG. C10,8. \**L. acutata*, USA (Tex.); 8*a*, RV hinge,  $\times 4$  (570); 8*b*, RV ext.,  $\times 4$  (Stephenson, 1937).

**Pachecoa** HARRIS, 1919 [\**Trinacria (P.) cainei*; OD] [= *Halonanus* STEWART, 1930 (type, *Noetia pulchra* GABB, 1860, Eoc., Tex.)]. Opisthogyre, prosodetic or amphidetic, umbonal ridge weak; cardinal area small, situated entirely behind beaks; differs from *Noetia* in that sculpture consists of few bifurcating costae, inner margin crenulate, and initial ligament groove is oblique, rather than vertical. *Eoc.*, N.Am.

**P. (Pachecoa).** Elongate-ovoid, cardinal area well defined, ligament elongate, prosodetic. *Eoc.*, SE. USA.—FIG. C10,7. \**P. (P.) cainei*, S.Car.; LV ext.,  $\times 5$  (Harris, 1919).

**P. (Stenzelia)** MACNEIL, 1954 [\**Pectunculus perplanus* CONRAD, 1865; OD] [= *Trinacriella* MACNEIL, 1937 (non DEL GUERICO, 1913; nec PARONA, 1933)]. Subquadrate to ovoid, cardinal area poorly defined, ligament short, amphidetic to prosodetic. *Eoc.*, SE.USA.—FIG. C10,10. \**P. (S.) perplana* (CONRAD), USA (Ala.); LV ext.,  $\times 3.5$  (Harris, 1919).

## Superfamily LIMOPSACEA Dall, 1895

[Diagnosis by N. D. NEWELL]

Orbicular to obliquely ovoid, generally without umbonal ridge; smooth or radially ornamented. *L.Perm.-Rec.*

### Family LIMOPSIDAE<sup>1</sup> Dall, 1895

[Materials for this family prepared by N. D. NEWELL]

Small, orbicular to subtrigonal, orthogyre or prosogyre, equilateral to strongly inequilateral, with closed margins; ligament not striated, short, mainly restricted to central

<sup>1</sup> Note to R. C. MOORE from Professor L. W. GRENSTED at request of W. E. CHINA, ICZN: "The generic ending *-opsis* makes its genitive  $\delta\psi\epsilon\omega\varsigma$ , *opseos*, and this (as the accent shows) is treated as a dissyllable. The stem therefore is not *-opse* (or Ionic, *-opsis*) but *-ops*. Poeciopsinae and Macropsidae are therefore quite correct."



triangular resilifer, which may be bordered by smooth uncovered cardinal area; dentition taxodont, radial with respect to point well below beaks, divided into two more or less symmetrical series. [Exhibits some parallelism with Glycymerididae. Convergent with some of the Philobryidae.] *U. Trias.-Rec.*

**Limopsis** SASSI, 1827 [\**Arca aurita* BROCCHI, 1814; OD] [= *Trigonocoelia* NYST & GALEOTTI, 1835 (obj.); SD HERRMANNSEN, 1894]; *Lunopsis* D'ORBIGNY, 1850 (type, *Pectunculus hoeninghausii* MÜLLER, 1847, *nom. null.*, Cret., Aachen); *Cnisma* MAYER, 1868 (type, *Pectunculus nuculatus* LAMARCK, 1807; M); *Limopsilla* THIELE, 1923, p. 289 (type, *Limopsis pumilio* SMITH, 1904; OD); ?*Lissarca* THIELE, 1923, p. 290 (type, *L. australis*; OD); *Loringella* IREDALE, 1929 (type, *L. lorongi* ANGAS, 1873; OD) (Rec., E.Australia); *Phrynelima* IREDALE, 1929 (type, *Loringella brazieri* IREDALE, 1929; OD) (Rec., E.Australia); *Glycilima* IREDALE, 1931 (type, *G. paradoxa*, *nom. nud.*). Irregular, nearly equilateral, commonly with slight forward obliquity. *M.Jur.-Rec.*, cosmop.

**L. (Limopsis).** Surface without radial ornamentation, inner margins not crenulate. *M.Jur.-Rec.*, cosmop.—FIG. C11,1. \**L. (L.) aurita* (BROCCHI), Plio., Italy; 1a,b, LV int., ext., ×1 (222).

**L. (Pectunculina)** D'ORBIGNY, 1843 (*emend. SACCO*, 1898) [\**Pectunculus scalaris* SOWERBY, 1825; OD] [= *Cosmetopsis* ROVERTO, 1898 (type, *Limopsis retifera* SEMPER, 18??); *Aspalima* IREDALE, 1929 (type, *Limopsis erecta* HEDLEY & PETTERD, Rec., S.Australia); *Senectidens* IREDALE, 1931 (type, *S. dannevegi*, Rec., E.Australia); *Versipella* IREDALE, 1931 (*V. soboles*, Rec., E.Australia); *Limopsista* FINLAY & MARWICK, 1937 (type, *Limopsis microps*, Dan., N.Z.); *Circlimopa* IREDALE, 1939 (type, *C. woodwardi mutanda*, Rec., S.Australia); *Oblimopa* IREDALE, 1939 (*O. macgillivrayi actaviva*, Rec., E.Australia)]. Similar to *L. (Limopsis)*, but sculptured with radial costellae; inner margin crenulate. *Cret.-Rec.*, cosmop.—FIG. C11,7. \**L. (P.) scalaris* (SOWERBY), Eoc., Eng.; 7a,b, RV ext., LV int., ×2 (Wood, 1864).

**Empleconia** DALL, 1908 [\**Limopsis vaginata* DALL, 1891; OD]. Ovoid, strongly oblique, without radial ornamentation; posterior dorsal margin deeply infolded, forming deep, narrow cleft between closed valves. *Rec.*, Bering S., N.Pac.—FIG. C11, 4. \**E. vaginata* (DALL); 4a, LV ext., ×1.5; 4b, RV int., ×1 (Dall, 1895).

**Hoferia** BITTNER, 1894 [\**Lucina duplicata* MÜNSTER, 1838; OD] [= *Arcoptera* BITTNER, 1895 (*non* HEILPRIN, 1887) ( type, *A. elegantula*, *U. Trias.*, Alps); *Bittnerella* DALL, 1898; *Elegantarca* TOMLIN, 1930 (*nom. subst. pro Arcoptera* BITTNER,

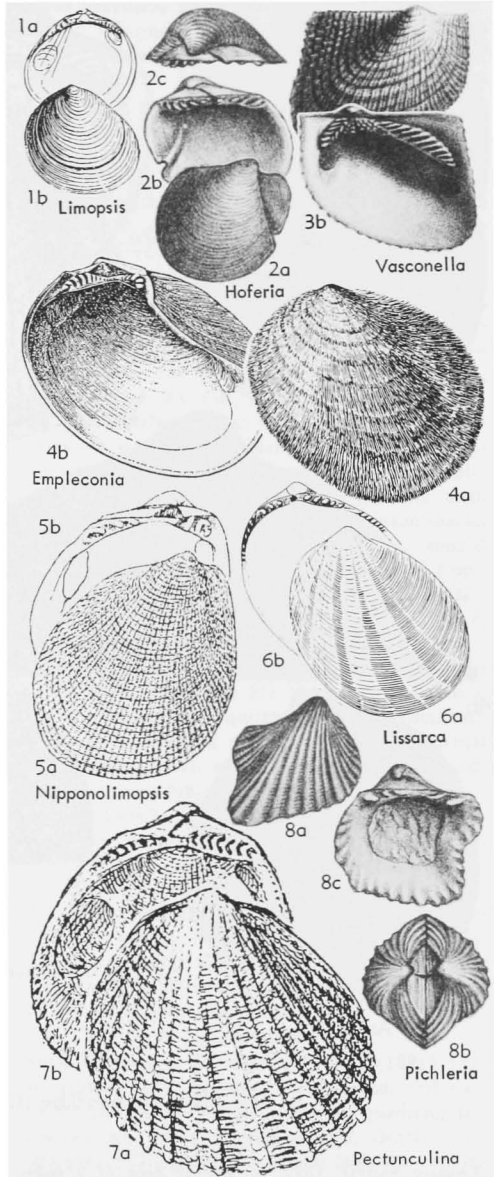


FIG. C11. Limopsidae (p. N265-N267).

1895)]. Ovoid to rhomboid, very inequilateral, umbones and broad cardinal area prominent; without radial sculpture; rounded anterior auricle set off from body of shell by narrow sulcus and byssal notch. *U.Trias.*, Alps.—FIG. C11,2. \**H. duplicata* (MÜNSTER); 2a-c, RV ext., int., dorsal, ×2 (58).



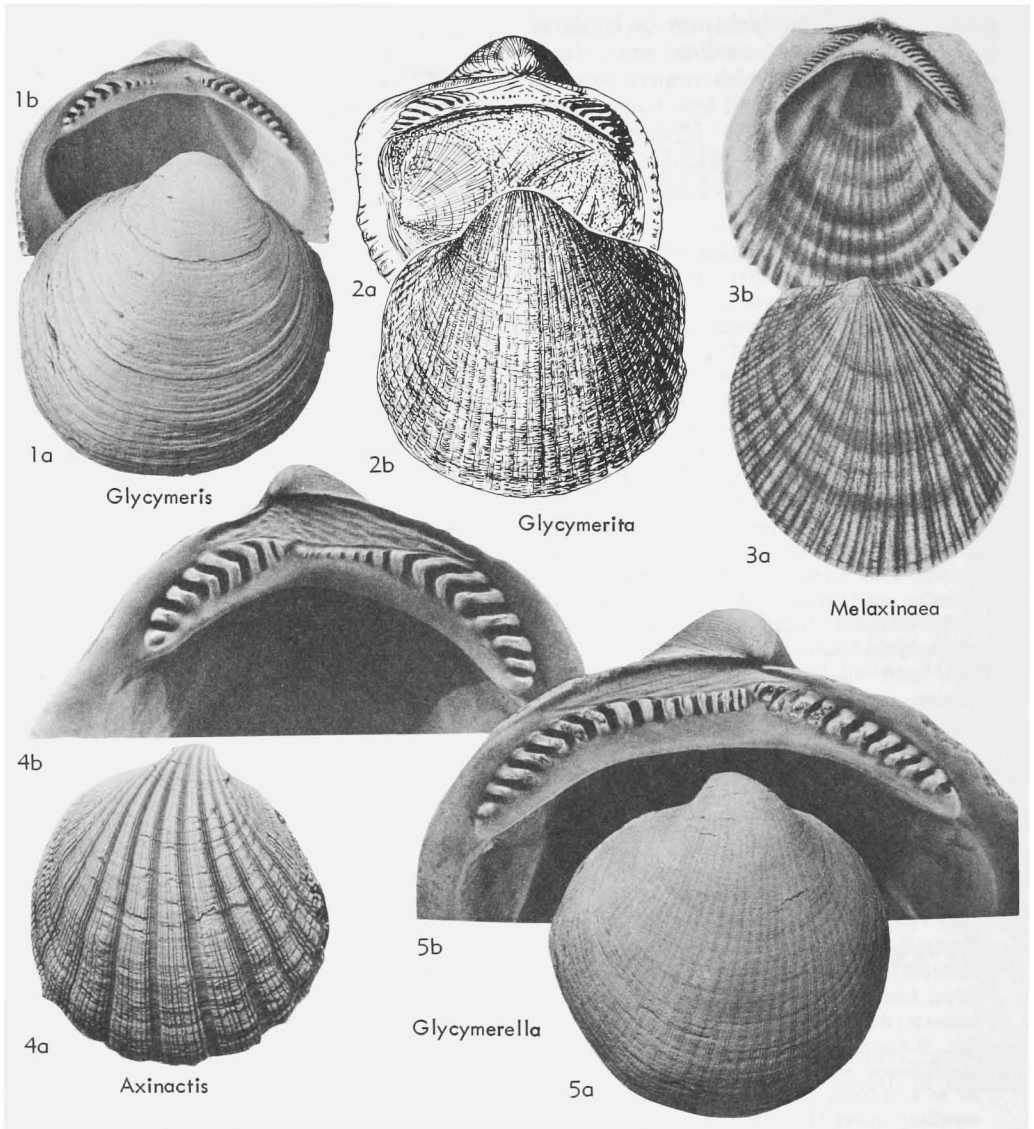


FIG. C12. Glycymerididae (Glycymeridinae) (p. N267-N268).

**Lissarca** SMITH, 1877, p. 168 [*\*Arca* (L.) *rubrofusca*; M] [= *Austrosarepta* HEDLEY, 1899 (type, *A. picta*; M)]. Shell prosocline, hinge strongly arched, teeth few, with edentulous hiatus in middle, ventral margin crenulate; radial ornamentation obsolescent. *Plio.-Rec.*, SW.Pac.-Antarctic.—FIG. C11,6. *L. rubricata* (TATE), S.Australia; 6a,b, LV ext., RV int.,  $\times 10$  (167).

**Nipponolimopsis** HABE, 1951 [*\*Limopsis nipponica* YOKOYAMA; OD]. Acuminate-ovoid, inequilateral, with cancellate ornamentation; anterior dental series and adductor somewhat reduced. *Rec.*, Japan.—FIG. C11,5. *\*N. nipponica* (YOKOYAMA); 5a,b, RV ext., LV int.,  $\times 3$  (365).

?**Nucunella** D'ORBIGNY, 1850, p. 389 [*\*Stalagmium nystii* GALEOTTI, 1843; SD STOLICZKA, 1871]. *Tert.*, Belg.

**Pichleria** BITTNER, 1894 [*\*Cucullaea auingeri* LAUBE, 1865; OD]. Subquadrate, strongly inequilateral, with prominent beaks and broad cardinal area; ornamented by widely spaced costae corresponding to crenulations of margin; rounded posterodorsal auricle set off from body of shell by broad sulcus. *U.Trias.*, Alps.—FIG. C11,8. *\*P. auingeri* (LAUBE); 8a-c, RV ext., shell dorsal, RV int.,  $\times 3$  (58).

?**Vasconella** BOUSSAC, 1911, p. 42 [*\*Stalagmium aviculooides* D'ARCHIAC, 1850; OD] [= *Boussacia*

COSSMANN, 1911 (obj.). Rhomboidal, strongly inequilateral, with reduced anterior extremity but without anterior sulcus; ornamented by fine intercalating costellae; teeth in 2 series converging ventrally and separated by small triangular, ?duplivincular ligament. *Eoc.*, W.Eu.—FIG. C11,3. \**V. aviculoides* (D'ARCHIAC), *Eoc.*, France (Biarritz); *3a,b*, RV, ext., int.,  $\times 1$  (d'Archiac, 1850).

**Family GLYCYMERIDIDAE Newton, 1922**

[*nom. correct.* WARMKE & ABBOTT, 1961 (*pro* Glycymeridae NEWTON, 1922) [=Axinaeinae ADAMS & ADAMS, 1858; Pectunculidae GRAY, 1847 (invalid name, Code Art. 11e, based on *Pectunculus* LAMARCK, 1799, *non* HUDDSFORD, 1770)] [Materials for this family prepared by N. D. NEWELL]

Adults free, not byssate, subtrigonal to subcircular, equivalve, more or less equilateral, heavy shells with submedian, orthogyre, slightly prosogyre or opisthogyre beaks, generally slightly truncate or subangular behind, margins without gape; cardinal area broad, ligament duplivincular, amphidetic or prosodetic, cardinal area with one or more chevron grooves; hinge plate broad, dental series strongly arched, consisting of robust taxodont teeth in anterior and posterior sets that diminish gradually in size toward middle and extremities, teeth transverse or chevron-shaped with angulation pointing toward middle of hinge, radial with respect to point well below beaks, larger teeth commonly crenulate; myophoric buttress or platform commonly developed at front of posterior adductor. *L.Cret.-Rec.*

**Subfamily GLYCYMERIDINAE Newton, 1922**

[*nom. transl. et correct.* NEWELL, herein (*ex* Glycymeridae NEWTON, 1922)]

Orbicular, with or without obscure posterior umbonal carina; smooth or with radial ornamentation, border crenulate. *Cret.-Rec.*

*Glycymeris* DA COSTA, 1778 [*non Glycimeris* LAMARCK, 1799 (=Panopea MÉNARD, 1807)] [\**Arca orbicularis* DA COSTA, 1778 (=Arca glycymeris LINNÉ, 1758); T] [=Axinaea POLI, 1791 (type, *Arca pilosa* LINNÉ, 1767, *Rec.*, Atl.); *Axinaeoderma* POLI, 1795 (type, *Arca pilosa* LINNÉ, 1767, *Rec.*, Atl.); *Tuceta* RÖDING, 1798 (type, *Arca glycymeris* LINNÉ, 1758, *Eu.*); *Pectunculus* LAMARCK, 1799 (*non* HUDDSFORD, 1770) (obj.); *Pectunculopsis* EBERT, 1890 (obj.); *Pseudaxinea* MONTEROSATO, 1892 (type, *Pectunculus violacescens* LAMARCK, 1819, *Rec.*, *Medit.*); *Grandaxinaea* IREDALE, 1931 (type, *Glycymeris magnificens* IREDALE, 1929, *Rec.*, SW.Pac.); *Veletuceta* IREDALE, 1931 (type, *Glycymeris glammeus* REEVE, 1843, *Rec.*,

Australia); *Tucetona* IREDALE, 1931 (type, *Pectunculus flabellatus* TENNISON-WOOD, 1878, *Rec.*, S.W. Pac.); *Glycymerula* FINLAY & MARWICK, 1937 (type, *Axinaea modesta* ANGAS, 1879, *Rec.*, N.Z.); *Manaia* FINLAY & MARWICK, 1937; *Tucetilla* IREDALE, 1939 (type, *Glycymeris capricornis* HEDLEY, 1906, *Rec.*, W.Pac.); *Tucetopsis* IREDALE, 1939 (type, *Cardium amboinensis* GMELIN, 1791, *Rec.*, W.Pac.)]. Subcircular to subquadrate, beaks orthogyre to opisthogyre, ligament amphidetic, surface smooth or costate, ventral margins internally fluted. *L.Cret.-Rec.*, cosmop.

**G. (Glycymeris).** Subcircular, subequilateral, with small umbones and beaks; teeth relatively short, transverse, becoming obsolescent medially; surface smooth or costate. *L.Tert.-Rec.*, cosmop.—FIG. C12,1. \**G. (G.) glycymeris* (LINNÉ), *Rec.*, *Medit.*; *1a,b*, RV ext., LV int.,  $\times 1$  (Newell, n).

**G. (Glycymerita)** FINLAY & MARWICK, 1937 [\**Glycymeris concava* MARSHALL, 1917; OD]. Subquadrate, posterior subtruncate, with prominently projecting umbones, anterior and posterior teeth moderately elongate, curved or chevron-shaped with convexity directed toward beaks, medial teeth small, transverse, exterior costate. *L.Cret.-Tert.*, Eu.-N.Z.-Calif.—FIG. C12,2. \**G. (G.) concava* (MARSHALL), *Paleog.*(Dan.), N.Z.; *2a,b*, LV int., ext.,  $\times 0.7$  (304).

*Axinactis* MÖRCH, 1861 [\**Pectunculus inaequalis* G. B. SOWERBY, 1833; SD HERTLEIN & STRONG, 1943]. Orbicular, inequilateral, beaks prominent, opisthogyre; ligament prosodetic; hinge and dental series asymmetrical, somewhat abbreviated behind. *Mio.-Rec.*, trop.Am.

**A. (Axinactis).** Costae relatively few, large, bearing fine costellae. *Rec.*, Panama.—FIG. C12,4. \**A. (A.) inaequalis* (SOWERBY); *4a*, RV ext.,  $\times 1$ ; *4b*, RV int.,  $\times 2$  (Newell, n).

**A. (Glycymerella)** WOODRING, 1925 [\**Arca decussata* LINNÉ, 1758 (=Pectunpennaceus LAMARCK, 1819)]. Costae numerous, low, bearing fine costellae. *Mio.-Rec.*, trop.W.Atl.—FIG. C12, 5. \**A. (G.) decussata* (LINNÉ), *Rec.*; *5a*, RV ext.,  $\times 1$ ; *5b*, LV int.,  $\times 2$  (Newell, n).

*Felicia* MABILLE & ROCHEBRUNE, 1889 (1891) [\**F. jousseaumi*; M]. Oblique, with anterior end narrowly rounded, posterior slightly quadrangular; exterior and inner margin smooth; dental series straight. [This genus is said to lack the resilifer of Limopsidae. The size of the holotype (length, 39 mm.) suggests a glycymeridid something like *Peruarca*. Unfortunately, the type species, as far as can be ascertained, has not been illustrated.] *Rec.*, S.Am.(Beagle Channel, Cape Horn).

*Melaxinaea* IREDALE, 1930 [\**M. labyrinthica*; OD]. Subcircular, compressed, equilateral, with low umbones and inconspicuous orthogyre beaks, ornamented with scabrose costae that become smoother and more numerous distally by intercalation in successive ranks; ligament short and narrow,

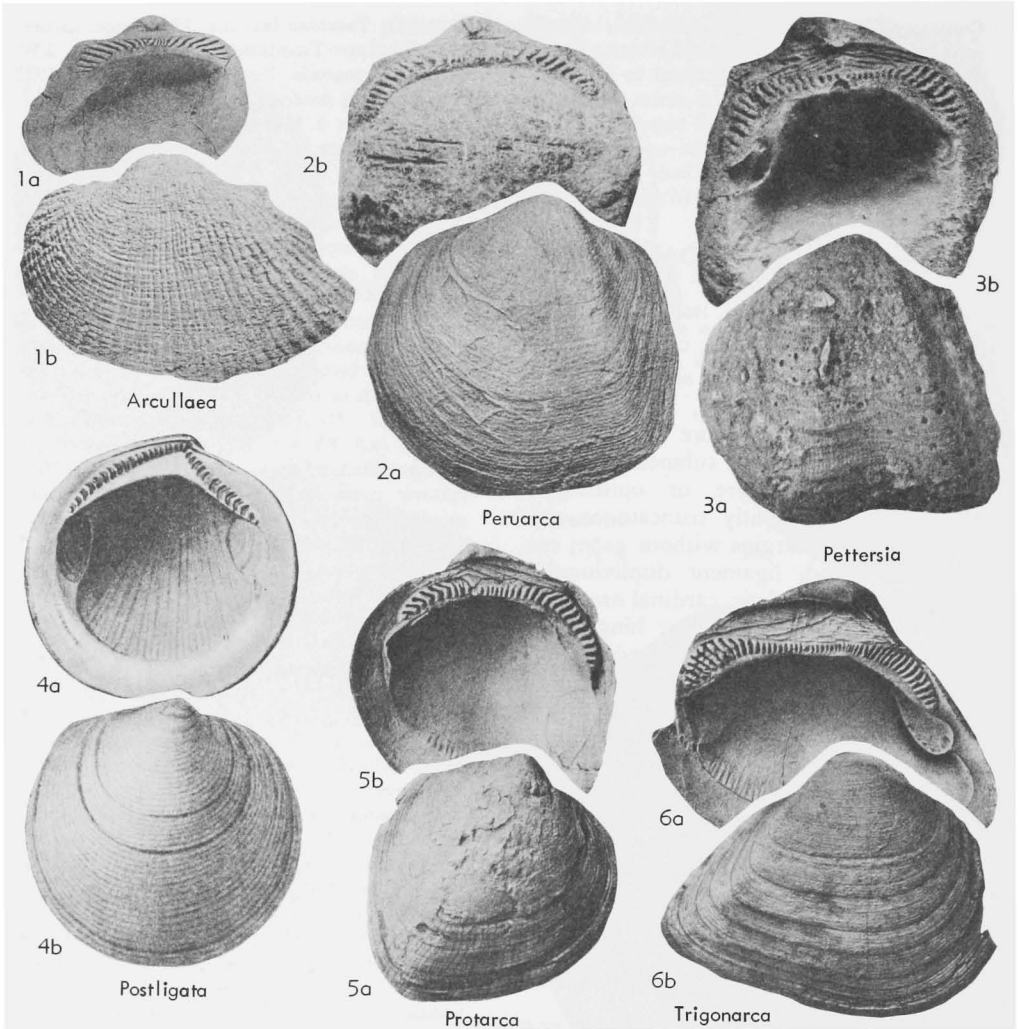


FIG. C13. Glycymerididae (Arcullaeinae) (p. N268-N269).

amphidetic; teeth similar, chevron-shaped, in 2 series that diverge under beaks at approximately right angle, separated in adult. *Rec.*, W.Pac.—FIG. C12,3. \**M. labyrinthica*; 3a,b, LV ext., int.,  $\times 1$  (Iredale, 1930).

**Subfamily ARCULLAEINAE** Newell,  
new subfamily

Ovoid to subtrigonal, rarely subcircular, inequilateral, beaks central to slightly anterior, with or without rounded posterior umbonal carina; exterior smooth or with more or less obsolescent radial ribs, inner margin not crenulate. [This group is externally similar to Cucullaeidae from which it probably was derived but the hinge more

closely resembles Glycymerididae.] *L.Cret.-U.Cret.*

**Arcullaea** VOKES, 1946 [*\*A. olea*; OD]. Elongate-ovoid, somewhat obliquely truncate behind, radially sculptured with fine costellae which disappear over middle of RV. *L.Cret.*, Lebanon.—FIG. C13,1. \**A. olea*; 1a, LV int.,  $\times 1$ ; 1b, LV ext.,  $\times 3$  (1945).

**Peruarca** OLSSON, 1944 [*\*P. pectunculoides*; OD]. Subcircular, truncate behind, posterior umbonal carina well defined, surface without radial costae. *U.Cret.*, Peru.—FIG. C13,2. \**P. pectunculoides*; 2a,b, LV ext., RV int.,  $\times 0.8$  (Olsson, 1944).

**Pettersia** NICOL, 1953 [*\*Cardium? abnormalis* OLSSON, 1944; OD]. Subtrigonal, rounded, slightly higher than long, with prominent posterior umbonal ridge and broad median sulcus corre-

sponding to ventral sinus, umbones prominent; exterior ornamented with fine costellae. *U.Cret.*, S.Am.(Peru-Colom.).—FIG. C13,3. \**P. abnormalis* (OLSSON), Peru; 3a,b, LV ext., RV int.,  $\times 1$  (Nicol, 1953).

**Postligata** GARDNER, 1916 [\**Glycymeris* (P.) *wordeni*; OD]. Subcircular, compressed, with low umbones and inconspicuous prosogyre beaks, without radial ornamentation; ligament opisthodontic, elongate, narrow; 2 arcuate series of similar, chevron-shaped teeth forming approximate right angle under beaks, both slightly concave toward front of shell. *U.Cret.*, USA (Md.).—FIG. C13,4. \**P. wordeni*; 4a,b, LV int., RV ext.,  $\times 4$  (334).

**Protarca** STEPHENSON, 1923 [\**P. obliqua*; OD]. Ovoid, with forward obliquity, vertically truncate behind, prosogyrate; surface ornamented with irregular low costae; ligament and dental arch shortened anteriorly. *U.Cret.*, USA (N.Car.).—FIG. C13,5. \**P. obliqua*; 5a,b, RV ext., int.,  $\times 0.5$  (887).

**Trigonarca** CONRAD, 1862 [\**Cucullaea macoensis* CONRAD, 1860; OD]. Subtrigonal, obliquely truncated behind, opisthogyrate, without radial ornamentation; ligament and dental arch shortened and reduced posteriorly. *U.Cret.*, N.Am.-Eu.-S.Afr.-India.—FIG. C13,6. \**T. macoensis* (CONRAD), USA (Ala.); 6a,b, RV int., LV ext.,  $\times 0.5$  (887).

### ?Family MANZANELLIDAE Chronic, 1952

[=*Nuculinidae* CHRONIC, 1952; *Nucnellidae* VOKES, 1956]  
[Materials for this family prepared by MYRA KEEN and N. D. NEWELL]

Small to minute shells, unornamented, nuculoid in shape, with umbones behind mid-point of dorsal margin; not nacreous; ligament opisthodontic and external; dentition consisting of series of taxodont cardinals below and behind beaks and 1 strongly buttressed anterior lateral in each valve; pallial line entire. [A degree of uncertainty relates to the orientation of these animals, since some authors regard the shells as prosodetic, with posterior lateral teeth.] *Perm.-Rec.*

**Manzanella** GIRTY, 1909 [\**M. elliptica*; OD]. Subquadrate, nearly equilateral, prosogyrate; ligamental furrow elongate; anterior lateral and anterior adductor buttressed from within cavity of valves. *Perm.*(*San Andres-Kaibab-?Yeso*), SW. USA.—FIG. C14,3. \**M. elliptica*, ?Yeso F., N. Mex.; 3a,b, LV int., RV int.,  $\times 2$  (338).

**Huxleyia** A. ADAMS, 1860 (Apr.) [\**H. sulcata*; M] [= *Cyrilla* A. ADAMS, 1860 (June) (obj.; *pro Huxleyia*); *Diabolica* JOUSSEAUME, 1897 (type, *D. diabolica*; T); *Cyrillista* IREDALE, 1929 (type, *Nuculina concentrica* VERO, 1907; OD)]. Liga-

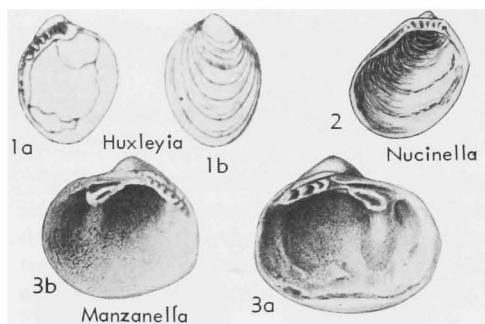


FIG. C14. Manzanellidae (p. N269).

mental fossette large and round, impinging on cardinal area; lateral tooth smaller than in *Nucinella*. *Rec.*, Japan-S. Australia-E. Afr.-W. Am.—FIG. C14,1. \**H. sulcata*, Japan; 1a,b, LV int., ext.,  $\times 5$  (365).

**Nucinella** WOOD, 1851 [\**Pleurodon ovalis* WOOD, 1840; SD STOLICZKA, 1870] [= *Pleurodon* WOOD, 1840 (*non* HARLAN, 1831); *Nuculina* D'ORBIGNY, 1844 (*non* PORRO, 1837); *Cyrillona* IREDALE, 1929 (type, *Cyrilla dalli* HEDLEY, 1902; OD); *Neopleurodon* HERTLEIN & STRONG, 1940 (type, *Pleurodon subdolos* STRONG & HERTLEIN, 1937; OD)]. Obliquely ovate, inequilateral, opisthogyrate; ligamental furrow short, narrow; with or without angulate expansions of hinge margins. *Jur.*(*Hettang.*)-*Rec.*, Eu.-S.Afr.-E.Afr.-Australia-N. Z.-W.N.Am.-W.Mex.-Carib.—FIG. C14,2. \**N. ovalis* (WOOD), Plio., Eng.; LV int.,  $\times 6$  (Wood, 1851).

### ?Family PHILOBRYIDAE Bernard, 1897

[*nom. trans.* SUTER, 1913 (*ex* Philobryinae BERNARD, 1897)]  
[Materials for this family prepared by MYRA KEEN]

Small, equivalve, very inequilateral; umbones projecting or with flat cap formed by prodissoconch; shell not nacreous. Ligament internal or only partly external, median or directed backward; short thin byssus between anterior margins of valves; hinge with strong vertical crenulations, with or without marginal teeth or ridges; anterior adductor muscle obsolete in some. *Eoc.-Rec.*

**Philobrya** CARPENTER, 1872 [*pro Bryophila* CARPENTER, 1864 (*non* TREITSCHKE, 1825)] [\**B. setosa* CARPENTER, 1864; M] [= *Philippiella* MARTENS & PFEFFER, 1886 (type, *P. quadrata*; SD DELL, 1964); *Stempellaria* CLASING, 1918 (type, *Avicula magellanica* STEPELL, 1899; M); *Stempellia* ODHNER, 1921 (*non* LÉGER & HESSE, 1910)]. Mytiliform, surface smooth or nearly so. *Pleist.-Rec.*, N.Am.-S.Pac.-S.Atl.

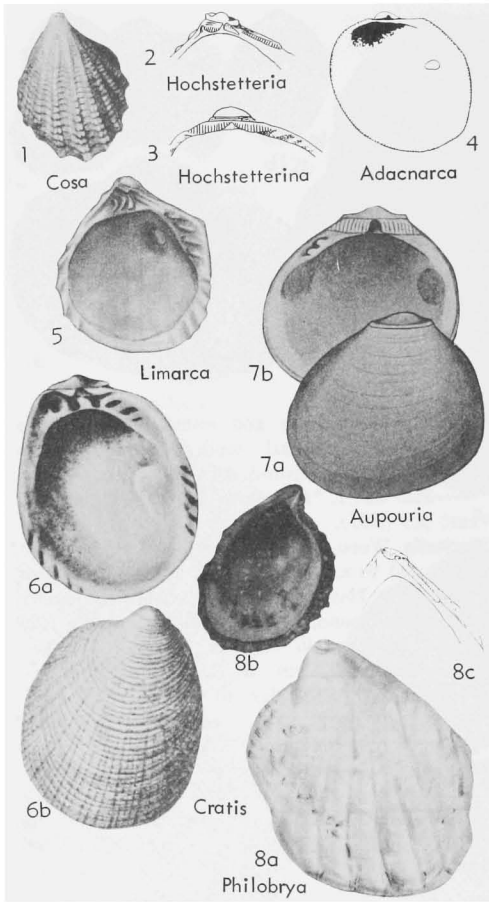


FIG. C15. Philobryidae (p. N270).

- P. (Philobrya).** With flaky periostracum that may or may not be radially marked; hinge area nearly smooth; interior of shell shiny, minutely punctate. *Pleist.-Rec.*, W. N. Am.-S. Afr.-S. Atl.—FIG. C15,8. \**P. (P.) setosa* (CARPENTER), *Rec.*, USA (Calif.); 8a, LV ext.,  $\times 5$  (42); 8b, RV int.,  $\times 4$  (Keen, n); 8c, detail of RV hinge,  $\times 16$  (42).
- P. (Adacnarca)** PELSENEER, 1903 [\**A. nitens*; M]. Rounded, thin, weakly radially striate; hinge margin finely toothed; anterior adductor muscle scar very small. *Rec.*, Antarctic.—FIG. C15,4. \**P. (A.) nitens* (PELSENEER); LV int.,  $\times 4$  (Pelseeneer, 1903).
- P. (Hochstetteria)** VÉLAIN, 1877 [\**H. aviculoides*; SD KOBELT, 1881] [= *Cosatova* IREDALE, 1939 (type, *P. recapitula* HEDLEY, 1906; OD)]. Embryonal shell prominent; hinge crenulations well marked; ligamental fossette short, triangular. *Rec.*, Medit.-S. Atl.-Australasia.—FIG. C15,2.

\**P. (H.) aviculoides* (VÉLAIN), St. Paul I.; RV hinge,  $\times 16$  (42).

**P. (Hochstetterina)** THIELE, 1934 [\**Hochstetteria crenella* VÉLAIN, 1877; M] [= *Hochstetteria* AUCTT.]. Shell margin slightly dentate; hinge cross-striate, teeth wanting. *Rec.*, S. Atl.-S. Pac.—FIG. C15,3. \**P. (H.) crenella* (VÉLAIN), N.Z. (Stewart I.); RV hinge,  $\times 20$  (42).

**P. (Micromytilus)** COTTON, 1931 [\**Myrina crenatilis* TATE, 1892; SD COTTON & GODFREY, 1940]. Umbo not terminal; hinge teeth series separated by oblique resilifer. *Rec.*, Australia.

**P. (Neocardia)** SOWERBY, 1892 [\**N. angulata*; M]. Quadrate, hinge with 1 or 2 marginal crenulations at posterior end; sculpture cancellate. *Rec.*, S. Afr.

**P. (Notomytilus)** HEDLEY, 1916 [\**Philippiella ruber* HEDLEY, 1904; OD]. Umbo terminal; hinge plate curved, the somewhat overlapping series of anterior and posterior teeth separated by long, narrow cartilage. *Rec.*, S. Australia.

**Aupouria** POWELL, 1937 [\**A. parvula*; OD]. Minute, solid, smooth, hinge with U-shaped resilium and 2 small crenulate teeth anteriorly. *Plio.-Rec.*, N.Z.—FIG. C15,7. \**A. parvula*, *Rec.*; 7a, b, LV ext., RV int.,  $\times 15$  (Powell, 1937).

**Cosa** FINLAY, 1927 [\**Hochstetteria costata* BERNARD, 1896; OD]. With well-developed radial ribs. *Eoc.-Rec.*, S. Australia-N.Z.—FIG. C15,1. \**C. costata* (BERNARD), *Rec.*, N.Z. (Stewart I.); LV ext.,  $\times 6$  (42).

**Cratis** HEDLEY, 1914 (1915) [\**C. progressa*; OD] [= *Denticosa* IREDALE, 1930 (type, *Philobrya cuboides* VERCO, 1907); OD]. Young stages resembling *Philobrya*, with crenulate hinge and prodissocoench cap; mature shell resembling *Limopsis*, cuboid, reticulately sculptured; cardinal teeth relatively heavy, divaricate. *L.Mio.-Rec.*, N.Z.-Australia.—FIG. C15,6. \**C. progressa*, *Rec.*, New S. Wales; 6a, b, RV int., ext.,  $\times 7$  (399).

**Limarca** TATE, 1886 [\**L. angustifrons*; M]. Inequilateral, cartilage pit lanceolate, directed backward; hinge with anterior denticles and long, striate posterior teeth. *U.Eoc.*, S. Australia.—FIG. C15,5. \**L. angustifrons*; RV int.,  $\times 4$  (Ludbrook, MS).

## Order MYTILOIDA Férussac, 1822

[*nom. correct.* NEWELL, 1965 (ex order Mytilacés FÉRUSSAC, 1822)] [Diagnosis by N. D. NEWELL]

Equivalve and very inequilateral; generally byssate and epifaunal throughout life or secondarily burrowing; heteromyarian; ligament opisthodontic and parivincular, greatly extended posteriorly by secondary fusion of mantle edges behind primary ligament; without well-developed siphons, with essentially free mantle margins; shell pris-

mato-nacreous; gills filibranchiate or eulamellibranchiate; pallial line entire. *Dev.-Rec.*

The Pinnidae, secondarily members of the infauna, are usually arbitrarily classed as Pteriacea. They are morphologically isolated but also have much in common with the Mytilacea and there is no paleontological evidence that the Pinnidae were derived from inequivalve ancestors.

## Superfamily MYTILACEA Rafinesque, 1815

[*nom. transl. et correct.* TRYON, 1884 (ex Mytilidia RAFINESQUE, 1815)] [Materials for this superfamily prepared by TRON SOOT-RYEN with other contributions as indicated]

Equivalve, inequilateral, beaks prosogyre, near anterior end, outer layer of shell consists of fine radially oriented needles, inner layer commonly pearly; ligament opisthodontic, elongate, deep-set, supported by nymphae and connected with valves by calcified resilial ridge which continues to dorsal margin; anterior margin growing over posterior margin below beaks, or radially sculptured lunule is bent inward; hinge margins smooth or with dysodont teeth before, or before and behind ligament; surface usually divided in anterior, median and posterior areas with varying sculpture or color. Anterior adductor small, absent in some, posterior adductor confluent with posterior retractors. Prodissoconch with provinculum, which persists in some species, some with short internal resilium; pallial line simple or with shallow posterior concavity; periostracum usually strong, commonly hirsute; byssiferous. [Marine, brackish or freshwater.] *Dev.-Rec.*

### Family MYTILIDAE Rafinesque, 1815

[*nom. correct.* NEWELL, 1965 (pro Mytilidia RAFINESQUE, 1815)]

Characters of superfamily. *Dev.-Rec.*

Fossil records seem to indicate that *Modiolus*- and *Lithophaga*-like species probably originated in the Silurian or Devonian, as such forms occur early in the Paleozoic strata. *Mytilus*-like species may have evolved from the *Brachidontes* group during the Jurassic. The *Musculus-Crenella* group may possibly be polyphyletic. To bring apparently related forms together the genera are grouped in subfamilies mainly established by ADAMS & ADAMS. The con-

tents of these, however, differ somewhat from what was included in them originally.

### Subfamily MYTILINAE Rafinesque, 1815

[*nom. transl.* SOOT-RYEN, herein (ex Mytilidia RAFINESQUE, 1815)]

Typically mytiliform with anterior beaks, anterior margin usually twisted, with dysodont teeth or interlocking folds, dysodont teeth commonly behind ligament. Smooth or with radial sculpture. [Free-living.] *?Perm., Trias.-Rec.*

*Mytilus* LINNÉ, 1758, p. 704 [*\*M. edulis*; SD GRAY, 1847, p. 198] [= *Mytilus* MEUSCHEN, 1789 (*nom. null.*); *Mytilarius* FRORIEP, 1806; *Mytiligenus* RENIER, 1807; *Eumytilus* IHERING, 1900]. Wedge-shaped, elongate, beaks terminal, lunule with radiating folds forming dysodont teeth on anterior margin, anterior retractor scar elongate, behind umbo; anterior adductor small but distinct; margins not crenulated, surface smooth or with radial ribs which are not bent dorsalward. *U.Jur.-Rec.*, cosmop.

**M. (Mytilus).** Resilial ridge pitted; smooth or with radial ribs, margins smooth. [Temperate and boreal seas.] *Plio.-Rec.*, N.Am.-N.Eu.-S.Am.-S.Australia-N.Z.-Kerguelin Is.—FIG. C16.2. *\*M. edulis*, Rec., France; 2a, RV ext.,  $\times 1$  (89a); 2b, muscle scars,  $\times 1$  (860).

**M. (Crenomytilus)** SOOT-RYEN, 1955, p. 23 [*\*M. grayanus* DUNKER, 1853; OD] [= *Mytiloconcha* AUCT. (*non* CONRAD, 1862)]. Resilial ridge compact, margins minutely serrated. *Oligo.-Plio.*, NW.N.Am., Rec., Japan-Philippines.

**M. (Pernomytilus)** ROLLIER, 1914, p. 356 [*\*M. pernoides* ROEMER, 1836; OD]. Thin, concentrically striated or folded, internal characters unknown. *U.Jur.*, Eu.(Ger.).

**Antetrichomya** IREDALE, 1951, p. 348 [*\*A. problematica*; OD]. Margins crenulated, hinge with large elongate narrow tooth; sculptured by about 20 thickened ribs posteriorly, diverging to more than 40 ventral ribs nearly obsolete medially. *Tert.*, Australia.

**Arcomytilus** AGASSIZ in J. SOWERBY, 1842, p. 318 [*\*Mytilus pectinatus* J. SOWERBY, 1821 (*non* *Modiola pectinata* LAMARCK, 1819), = *Mytilus subpectinatus* D'ORBIGNY, 1850; OD]. Wedge-shaped, posteriorly broadly truncate or subtruncate between 2 obtuse ridges. Surface with distinct concentric growth stops and radial striae bending toward dorsal margin and finer unilateral branching striae toward ventral margin which is finely crenulate. *L. Jur. (Lias.)-Eoc.*, Eu.-Afr.—FIG. C16.4. *\*A. pectinatus* (SOWERBY), Kimmeridg., Eng.(Weymouth); RV ext.,  $\times 1$  (Sowerby, 1821).

**Aulcomya** MÖRCH, 1853, p. 53 [*\*Mytilus magellanicus* CHEMNITZ, 1785 (= *Mytilus ater* MOLINA, 1782); SD IHERING, 1900, p. 87]. Mytiliform, anterior adductor absent in larger specimens, an-



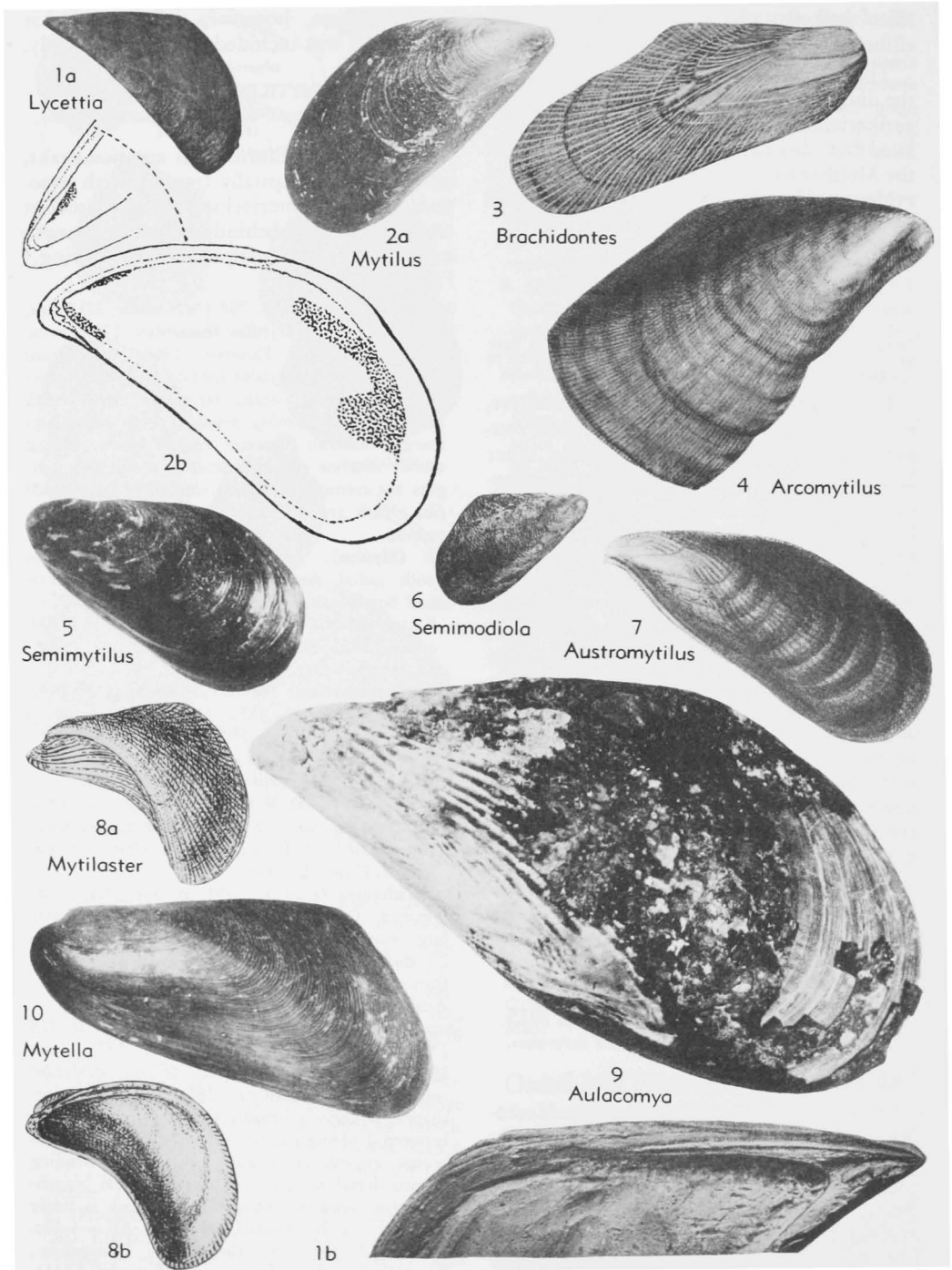


FIG. C16. Mytilidae (Mytilinae) (p. N271, N273-N274).



terior retractor scars elongate, posterior retractors broadly united with adductor; resilial ridge compact; lunule of LV turned inward, forming broad toothlike fold corresponding to depression in RV; surface with more or less distinct radial ribs, margins smooth. *Mio.-Rec.*, S.Am.-S.Afr.-N.Z.—FIG. C16,9. \**A. ater* (MOLINA), *Rec.*, Peru; LV ext.,  $\times 1$  (860).

**Brachidontes** SWAINSON, 1840, p. 384 [\**Modiola sulcata* LAMARCK, 1819 (*non* 1805) (= *Mytilus citrinus* RÖDING, 1798, = *Arca modiolus* LINNÉ, 1767); M] [= *Brachyodontes* AUCTT.]. Mytiliform, beaks terminal or nearly so, radially sculptured with bifurcating ribs, ligament relatively short, hinge with dysodont teeth before and after ligament. *Jur.-Rec.*, cosmop.

**B. (Brachidontes)**. Umbones subterminal, radial sculpture on ventral part simple or regularly bifurcating. *Jur.-Rec.*, cosmop.—FIG. C16,3.

\**B. (B.) modiolus* (LINNÉ), *Rec.*, USA (Fla.); RV ext.,  $\times 1.4$  (728).

**B. (Austromytilus)** LASERON, 1956, p. 265 [\**Mytilus rostratus* DUNKER, 1857; OD]. Hinge usually with 1 tooth in RV and 2 teeth in LV. *Plio.-Rec.*, Australia.—FIG. C16,7. \**B. (A.) rostratus* (DUNKER), *Rec.*, Tasmania, LV ext.,  $\times 1$  (783).

**B. (Hormomya)** MÖRCH, 1853, p. 53 [\**Mytilus exustus* LINNÉ, 1758; SD JUKES-BROWNE, 1905, p. 223]. Umbones usually terminal, radial sculpture on ventral part unilaterally bifurcate. *Mio.-Rec.*, N.Am.-Afr.-Pac.O.

?**Coxesia** MENDES, 1952, p. 109 [\**C. mezzalirae*; OD]. Shell smooth, sickle-shaped, with pointed terminal umbones, small umbonal septum lies behind beaks; hinge with mytilid type of ligament nymphs; edentulous. *Perm.(Corumbatai)*, S.Am. (S.Brazil).—FIG. C17,1. \**C. mezzalirae*; 1a,b, LV ext., int.,  $\times 2$  (Mendes, 1952). [NEWELL]

**Ischadium** JUKES-BROWNE, 1905, p. 223 [\**Mytilus siamensis* SAY, 1822 (= *Mytilus recurvus* RAFINESQUE, 1820); OD]. Mytiliform, radial bifurcate sculpture covering whole surface, lunule and anterior margin bent inward, forming 1 or 2 toothlike ridges; resilial ridge compact, ligament relatively short, margins crenulated, anterior adductor absent. *Rec.*, NE.N.Am.

**Limnoperna** ROCHEBRUNE, 1882, p. 102 [\**Dreissena siamensis* MORELET, 1866; OD]. Modioliform, small, of variable outline, commonly carinated, beaks slightly behind anterior end, hinge with dysodont teeth before and after ligament, other margins smooth. [Fresh and brackish water.] *Rec.*, E.Asia.

**Lycettia** COX, 1937 [\**Mytilus lunularis* LYCETT, 1857; OD] [= *Cuneolus* STEPHENSON, 1941 (type, *Dreissena tippiana* CONRAD, 1858)]. Smooth, falcate, nacreous shells with acute, terminal beaks and sharp carina extending from beaks to postero-ventral extremity; without anterior lobation; umbonal cavity covered by small plate or deck which

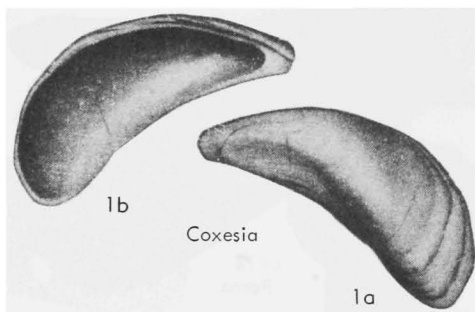


FIG. C17. Mytilidae (Mytilinae) (p. N273).

bears elongate radial tooth and furrow on each valve, tooth of RV overlying that of LV; well-defined ligament nymph extending along hinge from near beak to mid-length of flattened area bearing growth rugae. [This genus is strongly convergent with *Dreissenidae*, from which it differs in nacreous structure of the shell.] *Jur.*, Eng.-India-NE.Afr.; *U.Cret.*, USA (Tex.).—FIG. C16, 1. \**L. lunularis* (LYCETT), Inf. Oolite, Eng.; 1a, LV ext.,  $\times 1$ ; 1b, LV int.,  $\times 2$  (182). [NEWELL]

**Mauricia** HARRIS, 1919, p. 32 [\**Modiola houstonia* HARRIS, 1895; OD]. Modioliform, thin, concentric growth lines below well-defined umbonal ridge, with broad concentric undulations above it, anterior end radially striated. *Eoc.-Mio.*, N.Am. (USA)-Eu.

**Mytella** SOOT-RYEN, 1955, p. 47 [\**Modiola guyanensis* LAMARCK, 1819; OD]. Mytiliform to modi-oliform or elongate, beaks subterminal, anterior margin with or without teeth, resilial ridge pitted, 2 anterior retractor scars; smooth or concentrically striated, rarely finely striated radially. *Mio.-Rec.*, W.N.Am.-S.Am.—FIG. C16,10. \**M. guyanensis* (LAMARCK), *Rec.*, Gulf Calif.; LV ext.,  $\times 1$  (860).

**Mytilaster** MONTEROSATO, 1883, p. 89 [\**Mytilus lineatus* GMELIN, 1780; OD] [= *Mytilidonta* COEN, 1935 (type, *M. paulae*)]. Mytiliform, with varying sculpture from mere concentric growth lines to wavy or divaricate; dysodont teeth after ligament. *Rec.*, *Medit.*—FIG. C16,8. \**M. lineatus* (GMELIN); 8a,b, LV ext., RV int.,  $\times 1.5$  (89a).

?**Peregrinamor** SHOJI, 1938 [\**P. ohshimi*; OD]. *Rec.*, S. Japan. [NEWELL]

**Perna** RETZIUS, 1788, p. 20 [\**P. magellanica* (= *Mya perna* LINNÉ, 1758); SD SOOT-RYEN, 1955, p. 29] [*non Perna* BRUGIÈRE, 1792; ADAMS & ADAMS, 1858] [= *Chloromya* MÖRCH, 1853; *Mytiloconcha* CONRAD, 1862]. Like *Mytilus* but without anterior adductor except in young specimens; lunule bent inward, forming 1 or 2 toothlike ridges, surface and margins smooth. *Eoc.-Rec.*, cosmop.

**P. (Perna)**. Resilial ridge pitted, posterior retractor scars widely separated. *Eoc.-Rec.*, cosmop.(tropic-

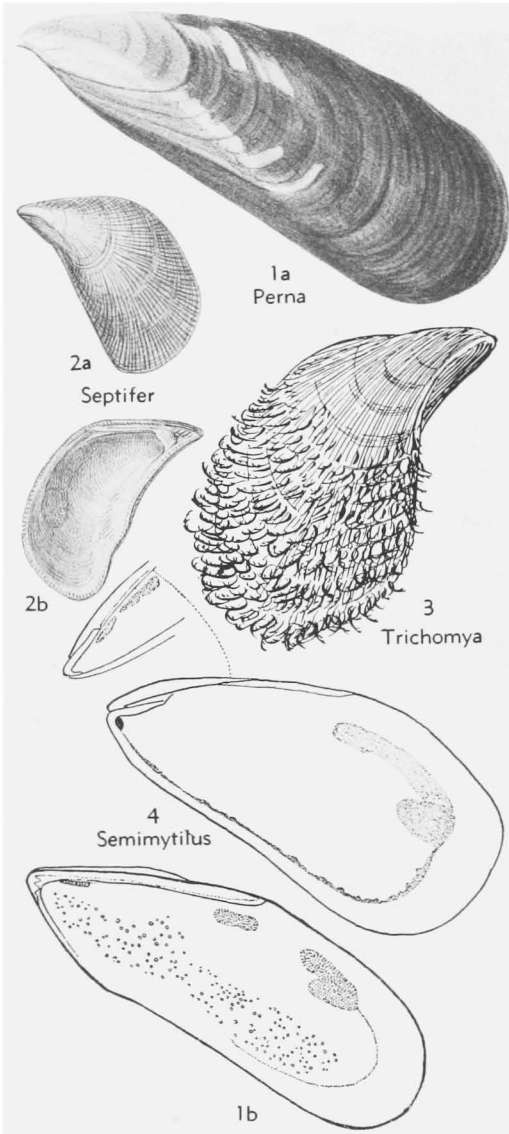


FIG. C18. Mytilidae (Mytilinae) (p. N274).

subtropic seas).—FIG. C18,1. \**P. (P.) perna* (LINNÉ), Rec., S.Am.; 1a, LV ext.,  $\times 0.8$  (783); 1b, muscle scars and usual internal pittings,  $\times 0.4$  (860).

**P. (Choromytilus)** SOOT-RYEN, 1952, p. 30 [*Mytilus chorus* MOLINA, 1782; OD]. Resilial ridge compact, posterior retractor scars continuous. *Mio.-Rec.*, Pac.-W.Am.-S.Afr.

**Semimodiola** COSSMANN, 1887, p. 154 [*Modiola hastata* DESHAYES, 1830; OD]. Modioliiform to mytiliform, recurved, keeled; radial striae divaricating and obsolete in middle, margins deeply

crenulated. *U.Eoc.*, Eu.—FIG. C16,6. \**S. hastata* (DESHAYES), Bognor, Eng., RV ext.,  $\times 1$  (Wood, 1871).

**Semimytilus** SOOT-RYEN, 1955, p. 25 [*Mytilus algosus* GOULD, 1850; M]. Mytiliform, with nearly terminal beaks, lunule small, circumscribed by fine line, anterior margin without teeth, resilial ridge compact, anterior retractor elongate and separated in middle; surface and margins smooth. *Rec.*, SW.N.Am.-S.Am.—FIG. C16,5; C18,4. \**S. algosus* (GOULD), Peru; C16,5, LV ext.,  $\times 1.5$ ; C18,4, muscle scars,  $\times 1.7$  (860).

**Septifer** RECLUZ, 1848, p. 275 [*Mytilus bilocularis* LINNÉ, 1758; SD STOLICZKA, 1871, p. 366]. Externally similar to *Brachidontes* (*Brachidontes*), anterior adductor placed on internal septum beneath beaks. *Trias.-Rec.*, cosmop. (tropic, subtropic seas).

**S. (Septifer)**. Radial sculpture strong, margins crenulated. *Trias.-Rec.*, cosmop.—FIG. C18,2. \**S. bilocularis* (LINNÉ), Rec., IndoPac., 2a,b, LV ext., int.,  $\times 0.8$  (7).

**S. (Mytilisepta)** HABE, 1951, p. 53 [*Tichogonia virgata* WIEGMANN, 1837; OD]. Radial sculpture weak, margins with fine crenulations only. *L. Tert.-Rec.*, Japan.

**Trichomya** IHERING, 1900, p. 87 [*Mytilus hirsutus* LAMARCK, 1819; OD] [= *Dentimodiolus* IREDALE, 1939 (p. 414) (type, *Dentimodiolus sculptus* IREDALE, 1939)]. Mytiliform with fine radial sculpture, periostracum with serrate hairs. *M.Tert.-Rec.*, W.Pac.—FIG. C18,3. \**T. hirsuta* (LAMARCK), Rec., S.Australia; RV ext.,  $\times 0.5$  (169).

#### Subfamily CRENELLINAE Adams & Adams, 1857

Round to modioliiform, beaks more or less behind anterior end, anterior hinge margin thickened and vertically striated or with dysodont teeth, dorsal hinge margin usually finely vertically striated. Surface with radial sculpture commonly absent on median area or rarely smooth. [Free-living, nestling, rarely boring.] *U.Trias.-Rec.*

**Crenella** BROWN, 1827, pl. 31, fig. 12-14 [*Mytilus decussatus* MONTAGU, 1808; M] [= *Stalagmium* CONRAD, 1833 (type, *Crenella margaritifera* CONRAD, 1833 [?1834]); *Hippagus* LEA, 1833, p. 72 (type, *Hippagus isocardioides* LEA, 1833; M); ?*Myoparo* LEA, 1833 (type, *Mytilus costatus* VON MÜNSTER, 1840); *Nuculocardia* D'ORBIGNY, 1845 (type, *N. divaricata*); ?*Crenellodon* EDWARDS in NEWTON, 1891 (type, *Modiola pulcherrina* ROEMER, 1836)]. Small, round to ovate, rather solid, beaks anterior; hinge thickened and striated, ligament short, sunken, radiating sculpture usually unilaterally bifurcate anteriorly and posteriorly, bifurcate or simple in middle, margins crenulated. ?*Cret.*, *Rec.*, cosmop.—FIG. C19,8. \**C. decussata* (MONTAGU), Rec., N.Nor.; RV ext.,  $\times 10$  (860).

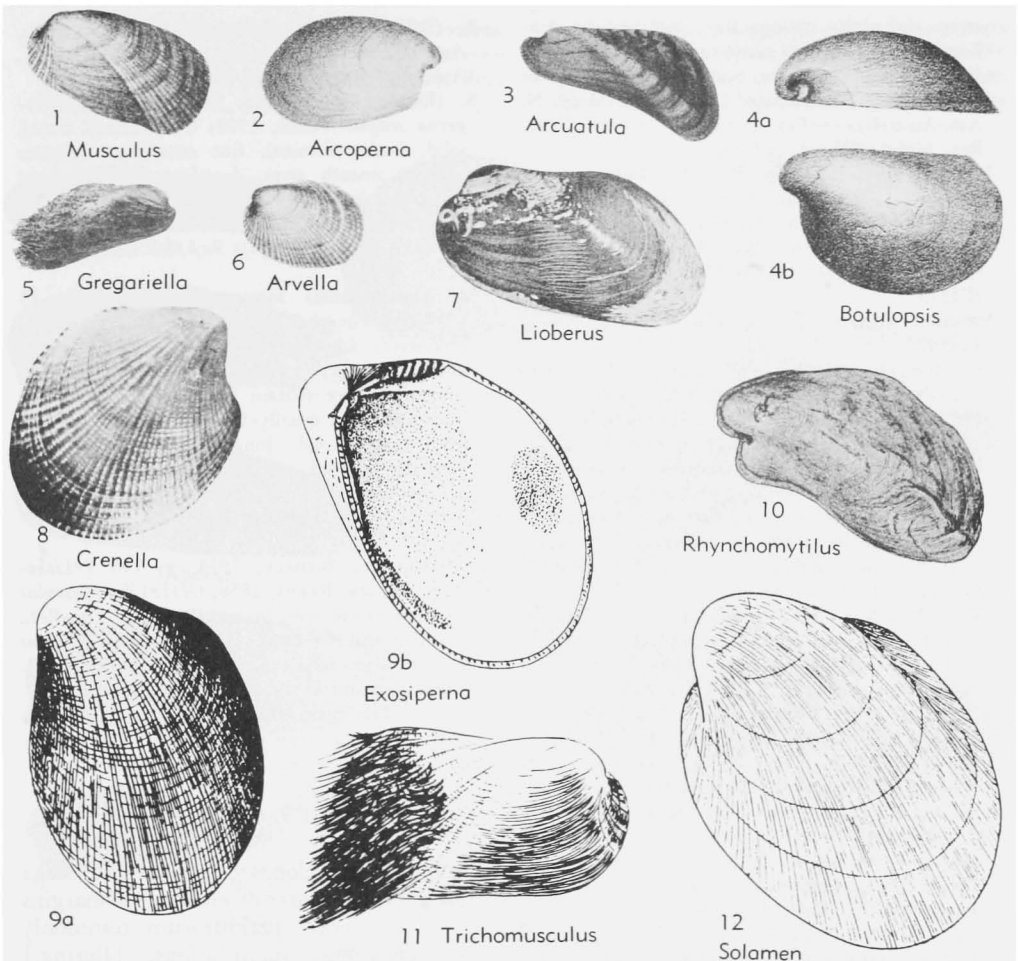


FIG. C19. Mytilidae (Crenellinae) (p. N274-N276).

**Arcoperna** CONRAD, 1865, p. 140 [*\*A. filosa*; M]. Oval or oblong, inflated, thin-shelled, beaks terminal; surface with numerous fine striae separated by smooth area near anterior end; hinge with obsolete crenulations or smooth; ligament internal; margins finely crenulated. *Cret.-Eoc.*, ?*Rec.*, N.Eu.-NE.Am.-Afr.—FIG. C19,2. *\*A. filosa*, Eoc., Enterprise F., USA (Miss.); RV ext.,  $\times 1$  (151).

**Arcuatula** JOUSSEAUME in LAMY, 1919, p. 173 (non SOOT-RYEN, 1955) [*\*Modiola arcuatula* HANLEY, 1843; OD] [= *Lamya* SOOT-RYEN, 1958]. Modioliform, relatively thin-shelled, hinge with dysodont teeth continued behind ligament, which is long, deep-set on weak nymphae, lunule smooth or radially ribbed, anterior adductor large. *Rec.*, S.Afr.-IndoPac.—FIG. C19,3. *\*A. arcuatula* (HANLEY), Philip.; LV ext.,  $\times 1$  (783).

**Arvella** BARTSCH in SCARLATO, 1960, p. 67 [*\*My-*

*tilus jaba* MÜLLER, 1776; OD]. Like *Musculus* (*Musculus*) but with regular radiating ribs over whole surface, dorsally more or less parallel to margin. *Rec.*, NE.Am.-Greenl.-NE.Asia.—FIG. C19,6. *\*A. jaba* (MÜLLER), W.Greenl.; LV ext.,  $\times 1$  (450).

**Botulopsis** REIS, 1926, p. 124 [*\*Botula cassiana* BITTNER, 1895; M]. Elongate-ovate, gibbose, dorsal margin straight, beaks terminal, strongly prosogyrous; lunule cordate bounded by well-defined ridge, apparently edentulous. *U.Trias.*, Eu.—FIG. C19,4. *\*B. cassiana* (BITTNER), S.Tirol. (St. Cassian); 4a,b, LV lat., ext.,  $\times 1$  (58).

**Gregariella** MONTEROSATO, 1883, p. 90 [*\*Modiolus sulcatus* RISSO, 1826 (= *\*Modiola opifex* SAY, 1825); M] [= *Botulina* DALL, 1889; *Tibialectus* IREDALE, 1939, p. 424 (type, *T. otteri*)]. Elongate, inflated, beaks incurved, umbonal keel angulated; radially striated anteriorly and posteriorly where

- striae end along oblique line, median part concentrically striated, periostracum hairy along umbonal keel; anterior and posterior dysodont teeth, margins crenulated. *Mio.-Rec.*, *Medit.-N. Am.-Australia*.—FIG. C19,5. \**G. opifex* (SAY), *Rec.*, *Medit.*; RV ext.,  $\times 1$  (89a).
- Lioberus** DALL, 1898, p. 805 [\**Modiola castanea* SAY, 1822; OD]. Beaks near anterior end, smooth or with obsolete radial sculpture, edentulous, periostracum smooth. *Rec.*, *SE.N.Am.*.—FIG. C19,7. \**L. castaneus* (SAY), USA (Fla.), LV ext.,  $\times 2.3$  (728).
- Musculus** RÖDING, 1798, p. 156 [\**Mytilus discors* LINNÉ, 1767; SD IREDALE, 1915, p. 485] [= *Modiolaria* BECK, 1838; *Lanistes* SWAINSON, 1840 (*non* DE MONTFORT, 1810); *Modiolarca* GRAY, 1843; *Lanistina* GRAY, 1847; *Planimodiola* COSSMANN, 1887 (type, *Modiola sulcata* LAMARCK, 1805)]. Modioliform, with broadly rounded umbonal keel, posterodorsal part usually separated from remainder of valve by furrow, radiate sculpture separated in middle by concentrically striated area; margins crenulated, dysodont teeth in front and behind ligament. *Jur.-Rec.*, cosmop.
- M. (Musculus)**. Shell rather flat, with broadly rounded umbonal keel, posterior retractors continuous, united with posterior adductor. *Jur.-Rec.*, cosmop.—FIG. C19,1. \**M. (M.) discors* (LINNÉ), *Rec.*, *Denm.*; LV ext.,  $\times 2$  (450).
- M. (Propetilus)** IREDALE, 1937, p. 235 [\**Musculus nobilis* IREDALE, 1937; OD]. Small, posterior angle pronounced, sculpture very fine, hinge with numerous strong denticles. *Rec.*, *S.Pac.*
- M. (Ryenella)** FLEMING, 1959, p. 172 [\**Mytilus impactus* HERMANN, 1782; OD] [= *Modiolarca* GRAY, 1843; *Lanistina* SOOT-RYEN, 1955 (*non* GRAY, 1847)]. Inflated, posterior retractors elongate, fastened along dorsal margin with single branch above posterior adductor. *Mio.-Rec.*, cosmop.
- M. (Undatimusculus)** EAMES, 1951, p. 369 [\**Musculus (U.) rakhiensis* EAMES, 1951; OD]. Like *Musculus (Musculus)* but umbonal region with coarse concentric folds. *L.Eoc.*, *Pak.*
- Rhynchomytilus** ROLLIER, 1914, p. 355 [\**Mytilus studeri* OPPEL & WAAGEN, 1866; OD]. Reniform, gibbose, beaks anterior, inflated and widely projecting beyond rounded and expanded anteroventral corner; fine concentric and radial lines; hinge line smooth or crenulated. *U.Jur.*, *Eu.*.—FIG. C19,10. \**R. studeri* (OPPEL & WAAGEN), *L.Argov.*, *Birmensdorf*; LV ext.,  $\times 1$  (795b).
- Solamen** IREDALE, 1924, p. 198 [\**S. rex*; M]. Round to ovate, beaks nearly terminal, sculpture consisting of numerous fine striae separated by smooth areas near anterior end and also commonly dorsally; hinge usually with weak dysodont teeth anteriorly and above and behind ligament, which is short, semi-internal; margins crenulated. *Rec.*, *N.Am.-Pac.-Eu.-S.Afr.-Australia* (New S.Wales).
- S. (Solamen)**. Thin-shelled, hinge weak. *Rec.*, *Australia-W.N.Am.*.—FIG. C19,12. \**S. (S.) rex*, *Australia* (New S.Wales); LV ext.,  $\times 2$  (532).
- S. (Exosiperna)** IREDALE, 1929, p. 166 [\**Arco-perna scapha* VERCO, 1908; OD]. Small, ovate, solid, beaks terminal, fine cancellate sculpture without smooth areas, dysodont teeth in front and above ligament, which is deeply sunk, margins crenulated. *Rec.*, *S.Australia*.—FIG. C19,9. \**S. (E.) scapha* (VERCO); *9a,b*, LV ext., RV int.,  $\times 10$  (169).
- S. (Rhomboidella)** MONTEROSATO, 1884, p. 13 [\**Modiola rhombea* BERKELEY, 1827 (= *Modiola pridaux* (i) LEACH, 1815); M]. Small, inflated umbones large, anterior, prodissoconch large, smooth; surface striated by radial diverging and bifurcating ribs usually with narrow smooth area near anterior end; hinge with thickened and vertically striated anterior margin below umbo and vertical striations behind short ligament, margins finely crenulated. *Rec.*, *Eu.-NE.N.Am.-S.Afr.-Ind.O.*
- Trichomusculus** IREDALE, 1924, p. 196 [\**Lithodomus barbatus* REEVE, 1858; OD]. Like *Musculus* but periostracum with branched hairs. *U.Eoc.-Rec.*, *N.Z.-Australia*.—FIG. C19,11. \**T. barbatus* (REEVE), *Rec.*, *S.Australia*; RV ext.,  $\times 3.5$  (169).
- Vilasina** BARTSCH in SCARLATO, 1960, p. 69 [\**V. pillula*; OD]. Like *Musculus* but with few weak radial striae anteriorly, otherwise finely concentrically striated. *Rec.*, *NE.Asia-NW.N.Am.*

#### Subfamily LITHOPHAGINAE Adams & Adams, 1857

More or less elongate, cylindrical, beaks slightly behind anterior end, hinge margins generally smooth, periostracum commonly with calcareous incrustations. [Boring.] ?*Carb.*, *U.Perm.-Rec.*

**Lithophaga** RÖDING, 1798, p. 156 [\**L. mytiloides* (= *Mytilus lithophagus* LINNÉ, 1780); M] [= *Lithophagus* MEGERLE VON MÜHLFELD, 1811; *Lithodomus* CUVIER, 1816; *Lithoglyphus* STURM, 1821]. Cylindrical, usually tapering posteriorly, beaks near anterior end; smooth or with vertical striae; periostracum strong, commonly covered by calcareous incrustations; ligament deep-set; hinge edentulous; margins smooth. [Boring.] ?*Carb.*, *L. Mio.-Rec.*, cosmop.

**L. (Lithophaga)**. Shell with vertical striations, no calcareous incrustations. ?*Carb.*, *Rec.*, cosmop.—FIG. C20,7. \**L. (L.) lithophaga* (LINNÉ), *Rec.*, *France*; RV ext.,  $\times 1$  (89a).

**L. (Diberus)** DALL, 1898, p. 799 [\**Modiola plumula* HANLEY, 1843; OD] [= *Exodiberus* IREDALE, 1939 (type, *Lithophaga calcifer* IREDALE, 1939; OD); *Salebrolabis* IREDALE, 1939 (type, *Lithophaga divaricalix* IREDALE, 1939; OD)]. Two or more posterior sulci with plumelike in-

crustation distinctly projecting beyond valves.  
*L.Mio.*, USA (Fla.); *Rec.*, W.N.Am.-IndoPac.—  
 FIG. C20,5. \**L. (D.) plumula* (HANLEY), *Rec.*,  
 Costa Rica; LV ext.,  $\times 1.2$  (860).

L. (*Labis*) DALL, 1916, p. 405 [\**Modiola attenuata*  
 DESHAYES, 1836; M] [= *Doliolabis* IREDALE, 1939,  
 p. 417 (type, *Lithophaga laevigatus instigans*  
 IREDALE, 1939; OD)]. Calcareous incrustations

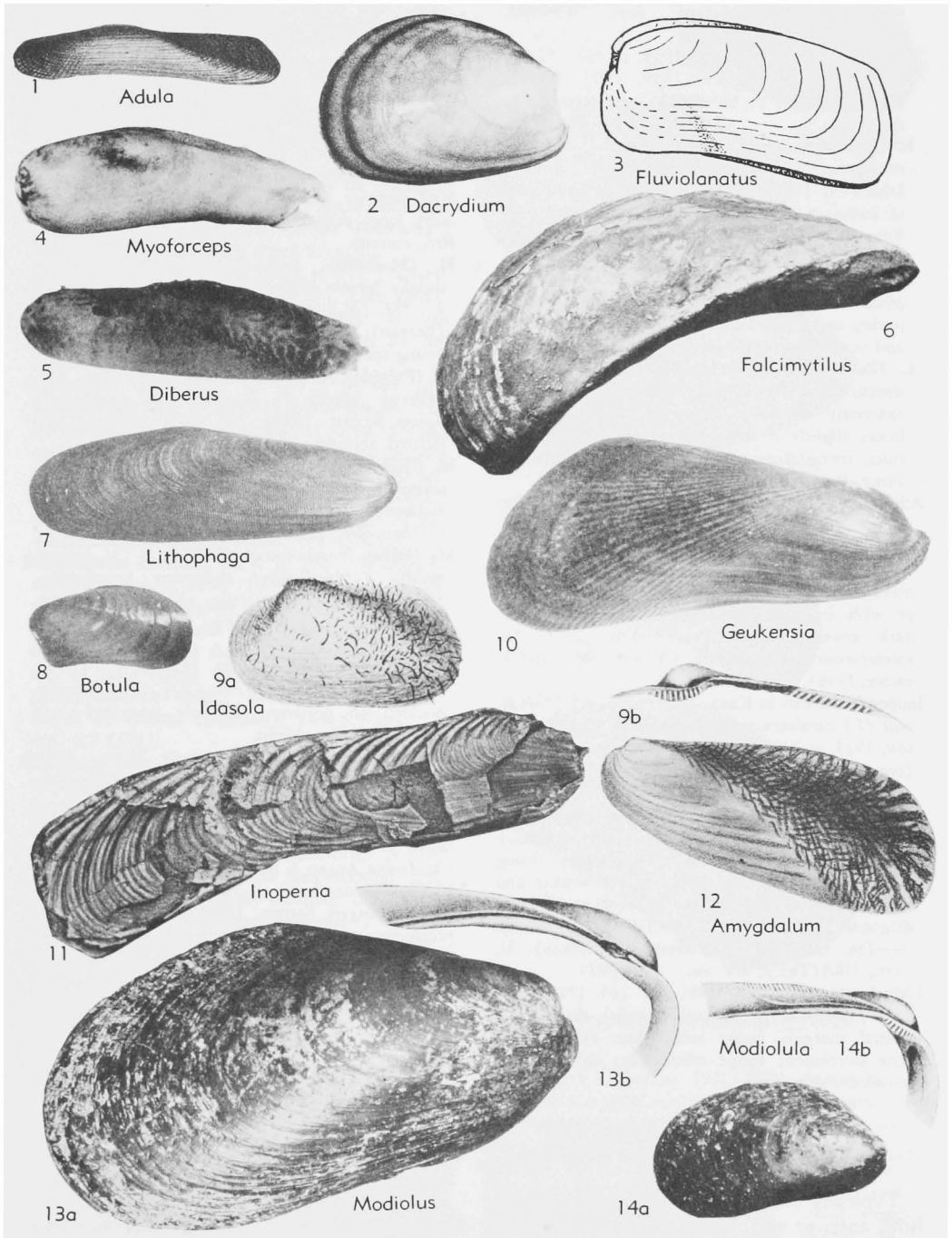


FIG. C20. Mytilidae (Lithophaginae), (1,4,5,7,11), (Modiolinae) (2-3, 6, 8-10, 12-14), (p. N276-N280).

- smooth, long, ending in median spine. *Rec.*, W.N.Am.-Australia.
- L. (*Leiosolenus*)** CARPENTER, 1856, p. 130 [*\*Leiosolenus spatiosus* CARPENTER, 1856; M]. Calcareous incrustation thin and equally diffused without projecting parts. *Rec.*, W.N.Am.-Australia.
- L. (*Myapalmula*)** IREDALE, 1939, p. 417 [*\*Lithophaga dichroa* IREDALE, 1939; OD]. Smooth, with very little or no chalky incrustation. *Rec.*, Australia.
- L. (*Myoforceps*)** FISCHER, 1886, p. 969 [*\*Modiola caudigera* LAMARCK, 1819 (= *\*Mytilus aristatus* DILLWYN, 1817); M]. Projecting posterior parts of incrustation crossed. *L.Mio.-Rec.*, cosmop.—FIG. C20,4. *\*L. (M.) aristata* (DILLWYN), *Rec.*, C.Am.; LV ext.,  $\times 2$  (860).
- L. (*Stumpiella*)** SOOT-RYEN, 1955, p. 93 [*\*Lithophagus calyculatus* CARPENTER, 1856; M]. Projecting incrustation closed behind but with dorsal and ventral openings. *Rec.*, tropic W.N.Am.
- L. (*Zelithophaga*)** FINLAY, 1927, p. 451 [*\*Lithodomus trunculus* GRAY, 1843; OD]. Shell highest anteriorly, tapering backward, umbones high, beaks slightly behind anterior end, no posterior sulci, incrustation without regular sculpture. *L. Pleist.-Rec.*, N.Z.
- Adula** ADAMS & ADAMS, 1857, p. 517 [*\*Mytilus soleniformis* D'ORBIGNY, 1846; M]. Elongate, cylindrical, beaks behind anterior margin, antero-dorsal margin thickened, dorsal margin with minute dysodont teeth or smooth, surface smooth or with irregular wrinkles, posterodorsally with dark covering. *Rec.*, Pac.—FIG. C20,1. *\*A. soleniformis* (D'ORBIGNY); LV ext.,  $\times 1$  (D'ORBIGNY, 1846).
- Inoperna** CONRAD IN KERR, 1875. App. A5 [*\*Modiolus (L.) carolinensis* CONRAD, 1875; SD STEPHENSON, 1923, p. 239] [= *Pharomytilus* ROLLIER, 1914 (type, *Mytilus plicatus* SOWERBY, 1819)]. Narrow, elongate, with nearly parallel dorsal and ventral margins, surface divided by diagonal ridge, part ventral to ridge smooth, that dorsal to it bearing folds which are parallel to growth stages, strong near dorsal margin but split up into weaker and more numerous ones halfway between margin and diagonal ridge. *L.Jur.(U.Lias.)-U.Cret.*, cosmop.—FIG. C20,11. *\*I. carolinensis* (CONRAD), *U. Cret.*, USA(Tex.); RV ext.,  $\times 1$  (881).
- Lithodolina** WAAGEN, 1881, p. 264 [*\*L. typha*; OD]. Elongate, thin, with parallel dorsal and ventral margins, beaks subanterior, anterior end little developed; hinge edentulous; ligament internal. *U.Perm.*, India.
- Subfamily MODIOLINAE Keen, 1958**
- [*nom. transl.* SOOT-RYEN, herein (*ex tribus Modiolini* KEEN, 1958)]
- Typically modioliform, beaks slightly behind anterior end; hinge margin smooth or finely striated vertically; shell surface usually lacking radial sculpture, periostracum commonly hairy. [Free-living, often nesting.] *Dev.-Rec.*
- Modiolus** LAMARCK, 1799, p. 87 [*nom. conserv. (pro Volsella* SCOPOLI, 1777, ICZN pend.)] [*\*Mytilus modiolus* LINNÉ, 1758; SD GRAY, 1847, p. 198] [= *Modiola* LAMARCK, 1801; *Perna* ADAMS & ADAMS, 1858; *Eumodiolus* IHERING, 1900; *Nudiola* MONTEROSATO, 1917, p. 5 (type, *Modiola adriatica* LAMARCK, 1819)]. More or less inflated, rounded anteriorly, umbones obtuse, distinctly behind anterior end; hinge line smooth, ligament fairly long; periostracum commonly hirsute. *Dev.-Rec.*, cosmop.
- M. (*Modiolus*)**. Inflated, smooth, periostracum usually hirsute. *Dev.-Rec.*, cosmop.—FIG. C20, 13. *\*M. (M.) modiolus* (LINNÉ), *Rec.*, Norway (Bergen); 13a, RV ext.,  $\times 1$ ; 13b, LV hinge of young specimen,  $\times 7$  (450).
- M. (*Fulgida*)** JOUSSEAUME IN LAMY, 1919, p. 318 [*\*Perna fulgida* H. ADAMS, 1870 (= *Modiola lignea* REEVE, 1858); M]. Solid, concentrically striated, shining. *Rec.*, RedS.-Ind.O.
- M. (*Gibbomodiola*)** SACCO, 1898, p. 41 [*\*G. taur-arcuata*; OD]. Elongately ovate, transversely arcuately gibbous, posteriorly broadly expanded. *U.Oligo.-Rec.*, Medit.
- M. (*Jolya*)** BOURGUIGNAT, 1877, p. 9 [*\*J. letourneauxi* (= *Modiolatus stultorum* JOUSSEAUME, 1893); M]. Concentrically plicated anteriorly, hinge with elongate anterior ridge. [Estuarine.] *Rec.*, NW.Afr.
- M. (*Modiolatus*)** JOUSSEAUME, 1893, p. 192 [*\*Mytilus plicatus* GMELIN, 1791; OD]. Concentrically plicated on posterior obliquely truncated end. *Rec.*, Ind.O.-Pac.-Medit.
- M. (*Modiolusia*)** YAMAMOTO & HABE, 1958 [*\*Modiola elongata* SWAINSON, 1821; OD]. *Rec.*, Japan.
- Adipicola** DAUTZENBERG, 1927, p. 274 [*\*Modiolarca? pelagica* FORBES IN WOODWARD, 1854; M] [= *Myrina* ADAMS & ADAMS, 1857 (*non* FABRICIUS, 1808); *Miridas* IREDALE, 1939, p. 425 (type, *Myrina coppingeri* SMITH, 1885)]. Elongate, beaks protruding, prosogyre, in front of middle, anterior margin rounded, ventral margin straight, hinge with toothlike process below umbo and more or less obsolete vertical striations in front and behind umbo. *Rec.*, Eu.-S.Afr.-Australia.
- Amygdalum** MEGERLE VON MÜHLFELD, 1811, p. 69 [*\*A. dendriticum*; M] [= *Modiella* MONTEROSATO, 1884 (type, *Modiola polia* VERRILL & SMITH, 1880)]. Modioliform, thin, resilial ridge and nymphae very weak; edentulous; surface and margins smooth. [Deep-water.] *Rec.*, cosmop.—FIG. C20,12. *\*A. dendriticum*, W.Indies; LV ext.,  $\times 2$  (783).
- Botula** MÖRCH, 1853, p. 55 [*\*Mytilus fuscus* GME-



LIN, 1791; SD DALL, BARTSCH, & REHDER, 1938, p. 59] [= *Botulopa* IREDALE, 1939, p. 414 (type, *B. silicula infra*)]. Elongate ovate, inflated, beaks terminal, prominent, somewhat coiled; ligament relatively short, dorsal margin with fine vertical striae, other margins smooth. [Warm seas.] *Eoc.-Rec.*—FIG. C20,8. \**B. fusca* (GMELIN), *Rec.*, Venez.; LV ext.,  $\times 2$  (860).

**Dacrydium** TORELL, 1859, p. 138 [\**Mytilus vitrea* HOLBÖLL in MÖLLER, 1842; M]. Hyaline smooth, beaks anterior; hinge crenulated anteriorly and with vertical striations posteriorly; internal resilium. *Plio.-Rec.*, cosmop.

**D. (Dacrydium)**. Anterior adductor on thickened support; no grooved teeth. *Rec.*, Arctic-Antarctic. —FIG. C20,2. \**D. (D.) vitreum* (HOLBÖLL), N.Norway; RV ext.,  $\times 6$  (Soot-Ryen, n).

**D. (Quendreda)** IREDALE, 1936, p. 271 [\**Dacrydium fabale* HEDLEY, 1904; OD]. Like *Dacrydium* but with single grooved tooth on each side of resilium, no thickened support for anterior adductor. *Plio.-Rec.*, Pac.

**Falcimylus** COX, 1937, p. 343 [\**Mytilus (F.) suprajurensis* COX, 1937; OD]. Sickle-shaped, with bluntly pointed terminal beaks and blunt, strongly curved carina which runs from beak to posteroventral corner; edentulous; anterior adductor scar small, situated in umbonal angle. *Jur.*, Eu-India. —FIG. C20,6. \**F. suprajurensis* (COX), U.Jur. (Kimmeridg.), Eng.; RV ext.,  $\times 1$  (182).

**Fluviolanatus** IREDALE, 1924, p. 196 [\**Modiolarca subtorta* DUNKER, 1856 (1857); OD]. Irregularly subquadrangular, slightly twisted, inequivalve, RV overlapping LV, beaks near anterior end; hinge edentulous, ligament short, internal; concentrically and in some species radially striate. [Coastal lagoons, brackish water.] *Rec.*, Australia.—FIG. C20,3. *F. amarus* (LASERON), New S.Wales; LV ext.,  $\times 3$  (532).

**Geukensia** POEL, 1959, p. 26 [*nom. subst. (pro Arcuatula* SOOT-RYEN, 1955, *non* JOUSSEAU in LAMY, 1919; *nec* GUGENBERGER, 1934)] [\**Modiola plicatula* LAMARCK, 1819 (= *Modiola demissa* DILLWYN, 1817); OD]. Modioliform, radially ribbed, weaker striations on anteroventral area, margins crenulated but no toothlike crenulations in front or behind deep-set ligament; 2 anterior retractors in and in front of umbonal cavity. *Rec.*, N.Am.—FIG. C20,10. \**G. demissa* (DILLWYN), *Rec.*, USA (Calif.); RV ext.,  $\times 0.7$  (860).

**Idasola** IREDALE, 1915, p. 340 [*pro Idas* JEFFREYS, 1876 (*non* MULSANT & VERREAUX, 1875)] [\**Idas argenteus* JEFFREYS, 1876; M]. Small, thin-shelled, argenteous, with rounded anterior and posterior margins, beaks in front of middle; hinge with vertical striations on thickened anterior margin below umbo and behind the ligament; periostracum thin, with hairlets. *Rec.*, Atl.—FIG. C20,9. \**I. argentea* (JEFFREYS), off Iceland; 9a, LV ext.,  $\times 6.5$ ; 9b, RV hinge,  $\times 20$  (450).

**Lecompteus** POEL, 1959, p. 13 [\**Mytilus ornatus*

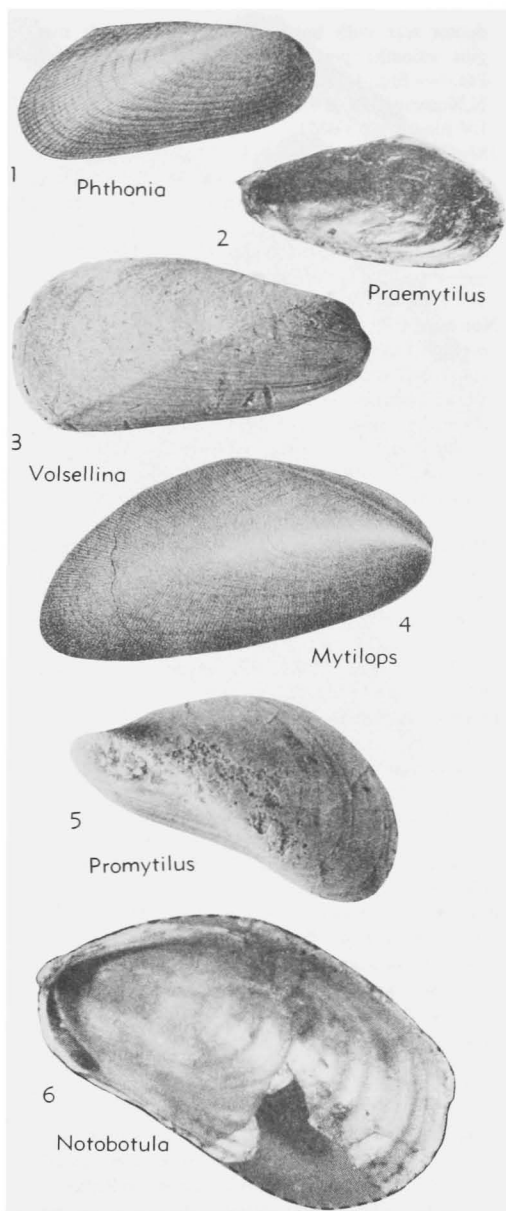


FIG. C21. Mytilidae (Modiolinae) (p. N280).

MÜNSTER in GOLDFUSS, 1837; OD]. Modioliform to mytiliform with complex sculpture of radiating and concentric elements commonly in chevrons. *Jur.-Cret.*, Eu-Afr-Asia.

**Modiolula** SACCO, 1898, p. 41 [\**Modiola phaseolina* PHILIPPI, 1844; OD]. Modioliform, hinge with dysodont teeth below umbo and vertical striae above and behind short ligament; anterior ad-



- ductor scar with buttress-like ridge behind; margins smooth; periostracum hairy. *Rec.*, Eu.-NE. Pac.—FIG. C20,14. \**M. phaseolina* (PHILIPPI), N.Norway; 14a, RV ext.,  $\times 1$  (Soot-Ryen, n); 14b, LV hinge,  $\times 8$  (450).
- ?*Mytilos* HALL, 1883, p. 11 [\**Modiola precedens* HALL, 1870; SD S. A. MILLER, 1889]. Similar to *Promytilus* in form but ornamented by outward curving fine costellae that intersect shell margin approximately at right angles. *U.Dev.*, USA(N.Y.). —FIG. C21,4. \**M. precedens* (HALL); RV ext.,  $\times 1$  (378). [NEWELL]
- Notobotula* FLEMING, 1959, p. 170 [\**Botula* (*N. molina*) FLEMING, 1959; OD]. Anterior adductor scar very elongate close above curve of antero-ventral margin, raised on thickened step bordered above by buttress-like ridge; hinge margins vertically striated. *L.Pleist.*, N.Z.—FIG. C21,6. \**N. molina* (FLEMING); RV int.,  $\times 3$  (309).
- ?*Phthonia* HALL, 1870, p. 70 [\**Cypricardites sectifrons* CONRAD, 1842; SD S. A. MILLER, 1889]. Modioliform, with beaks slightly behind anterior extremity; ventral margin nearly straight, diverging only slightly with respect to hinge margin; interior unknown; ornamented by straight or nearly straight costae or costellae. *M.Dev.*, USA (N.Y.).—FIG. C21,1. \**P. sectifrons* (CONRAD); RV ext.,  $\times 1$  (378). [NEWELL]
- Praemytilus* ANDERSON & COX, 1948, p. 105 [\**Mytilus* (*P.*) *strathairdensis*; OD]. Narrowly and obliquely ovate, with rather broad, edentulous, anterior marginal reflection and deep, elongate anterior adductor scar adjoining it. *M.Jur.* (*Bathon.*), W.Scot.—FIG. C21,2. \**P. strathairdensis* (ANDERSON & COX), Esheria Sh., Scot. (Strathaird); LV ext.,  $\times 1.2$  (16).
- Promytilus* NEWELL, 1942, p. 37 [\**P. annosus*; OD] [= *Pachoya* LUTKEVICH & LOBANOVA, 1956 (type, *P. sicaria*; OD)]. Shell thin, elongate, beaks terminal, anterior lobe small but set off from rest of shell by broad sulcus from beaks to ventral sinuosity; umbonal ridge rounded; hinge line smooth. *Miss.-Perm.*, N.Am.—FIG. C21,5. \**P. annosus*, South Bend Ls. (U. Missourian), Kans.; holotype, LV ext.,  $\times 2$  (666). [NEWELL]
- Stavelia* GRAY, 1858, p. 90 [\**Mytilus tortus* DUNKER, 1856; OD]. Broad modioliform, commonly distorted, with nearly anterior beaks; edentulous; ligament rather short; periostracum strongly hirsute. *Rec.*, Pac.
- Terua* DALL, BARTSCH, & REHDER, 1938, p. 57 [\**T. pacifica*; OD]. Arcuate, thin, beaks in anterior 4th; hinge edentulous, ligament subinternal, half length of shell, with fine vertical striations behind; margins and surface smooth. *Rec.*, Hawaii.
- Volsellina* NEWELL, 1942, p. 42 [\**Pleurophorus subellipticus* MEEK, 1867; OD]. Thin, elongate, flattened, beaks subterminal, anterior lobe extending slightly ahead of beaks, anterior sulcus obscure, umbonal ridge narrow; edentulous. *Penn.-Perm.*, N.Am.—FIG. C21,3. \**V. subelliptica* (MEEK), U.Penn. (Willard Sh.), Neb.; RV ext.,  $\times 2$  (666).

### Family MYSIDIELLIDAE Cox, 1964

[Materials for this family prepared by L. R. Cox]

Shell medium-sized, ovate or trapezoidal, equivalve or slightly inequivalve, RV larger than LV; dorsal margin straight or arcuate, umbones more or less anterior; no differentiated posterior wing; anterior auricle present or absent; byssal gape probably present in all genera; hinge edentulous; ligament internal, elongated, extending posteriorly in groove from near beak; probably monomyarian; shell structure unknown. *L. Trias.-U. Trias.*

*Mysidiella* COX, 1964, p. 44 [*pro Mysidia* BITTNER, 1891, p. 113 (*non* WESTWOOD, 1840)] [\**Mysidia orientalis* BITTNER, 1891; OD]. Equivalve, ovate, higher than long, well inflated, with rather prominently protruding, prosogyrous, anterior umbones; no anterior auricles; anterior marginal region reflected below each beak to form deep, narrow lunule, dorsal margin of which is much thickened; lunular margins probably with narrow gape; elongate ligamental ridge below and extending to posterior extremity of dorsal margin; surface smooth except for faint radial striations. *M. Trias.* (*Ladin.*)—*U. Trias.* (*Rhaet.*), Eu. (S. Alps-N. Alps-Hung.-Greece)—Anatolia.—FIG. C22,1. \**M. orientalis* (BITTNER), U. Trias. (Nor.), Anatolia; 1a-c, RV ext. and hinge, LV hinge, both  $\times 0.7$  (Bittner, 1891-92).

*Protopsis* KITTL, 1904, p. 718 [\**Opis* (*Protopsis*) *triptycha*; M] [= *Joannina* WAAGEN, 1906, p. 390 (type, *J. joannae*; M)]. Subequivalve, trapezoidal, with strongly prosogyrous umbones; strongly inflated diagonally, some species with diagonal keel; with relatively large, sharply pointed anterior auricle not differentiated from body of shell, its margin with byssal gape; ligament in elongate longitudinal groove; surface smooth or with radial ridge on posterodorsal area. *L. Trias.* (*Werfen.*)—*U. Trias.* (*Carn.*), Eu. (S. Alps-Balkans)—Timor.—FIG. C22,3. *P. joannae* (WAAGEN), U. Trias. (Carn.), S. Alps; 3a,b, LV ext. and hinge,  $\times 1$  (950).

*Tommasina* COX, 1964, p. 44 [*pro Mytiliconcha* TOMMASI, 1911, p. 35 (*non* CONRAD, 1862)] [\**Mytiliconcha orobica* TOMMASI, 1911; OD] [= *Mytiloconcha* DIENER, 1923 (*non* CONRAD, 1862)]. Probably slightly inequivalve, trapezoidal, longer than high, with anterior, strongly prosogyrous umbones, that of RV protruding prominently, of LV less so; anterior auricle lacking; sharp carina crossing shell diagonally from umbo in each valve; dorsal margin arcuate; ligamental

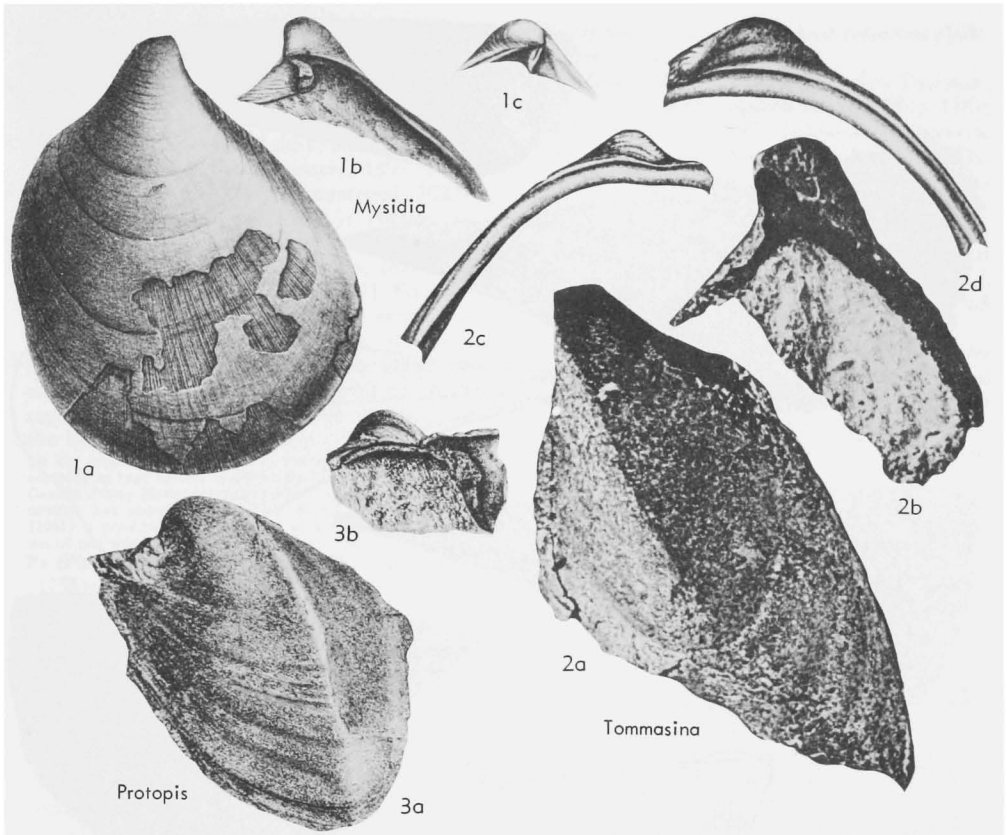


FIG. C22. Mysiidiellidae (p. N280-N281).

groove probably as in *Protopsis*, but not yet clearly observed; surface smooth. *U.Trias.*(*Carn.*), Eu.(S. Alps).—FIG. C22,2. \**T. orobica* (TOMMASI); 2a,b, RV ext. and hinge; 2c,d, LV and RV hinges (reconstr.), all  $\times 1$  (Tommasi, 1911).

### Superfamily PINNACEA Leach, 1819

[*nom. transl.* NEWELL, 1965 (ex Pinnidae LEACH, 1819)]  
[Materials for this superfamily prepared by L. R. COX and  
L. G. HERTLEIN]

Medium-sized to large, cuneiform, mytiliform or ham-shaped, mostly inequivalve, a few forms distorted and inequivalve; beaks at or near anterior end of long hinge margin; ventral margins with long narrow gape near anterior end for protrusion of bunch of long silky byssal threads; posterior margins gaping in dead shell, living animal capable of closing gape by action of adductor muscles owing to flexible nature of

ostracum; dimyarian, with anterior adductor relatively small and placed in anterior angle of shell, and posterior adductor large, situated at or slightly anterior to mid-length; hinge edentulous; ligament linear, subinternal, extending along whole length of hinge margin, its posterior part formed by "fusion layer"<sup>1</sup>; some specimens (in *Streptopinna*) with valves completely fused along posterodorsal margin; ostracum with outer layer of prismatic calcite, very thick in some forms, and thin inner nacreous layer absent from part of shell beyond posterior adductors. *L.Carb.-Rec.*

### Family PINNIDAE Leach, 1819

Characters of superfamily. *L.Carb.-Rec.*

<sup>1</sup> See C. M. YONGE, 1953, Roy. Soc. London, Phil. Trans., B, v. 237, p. 343.

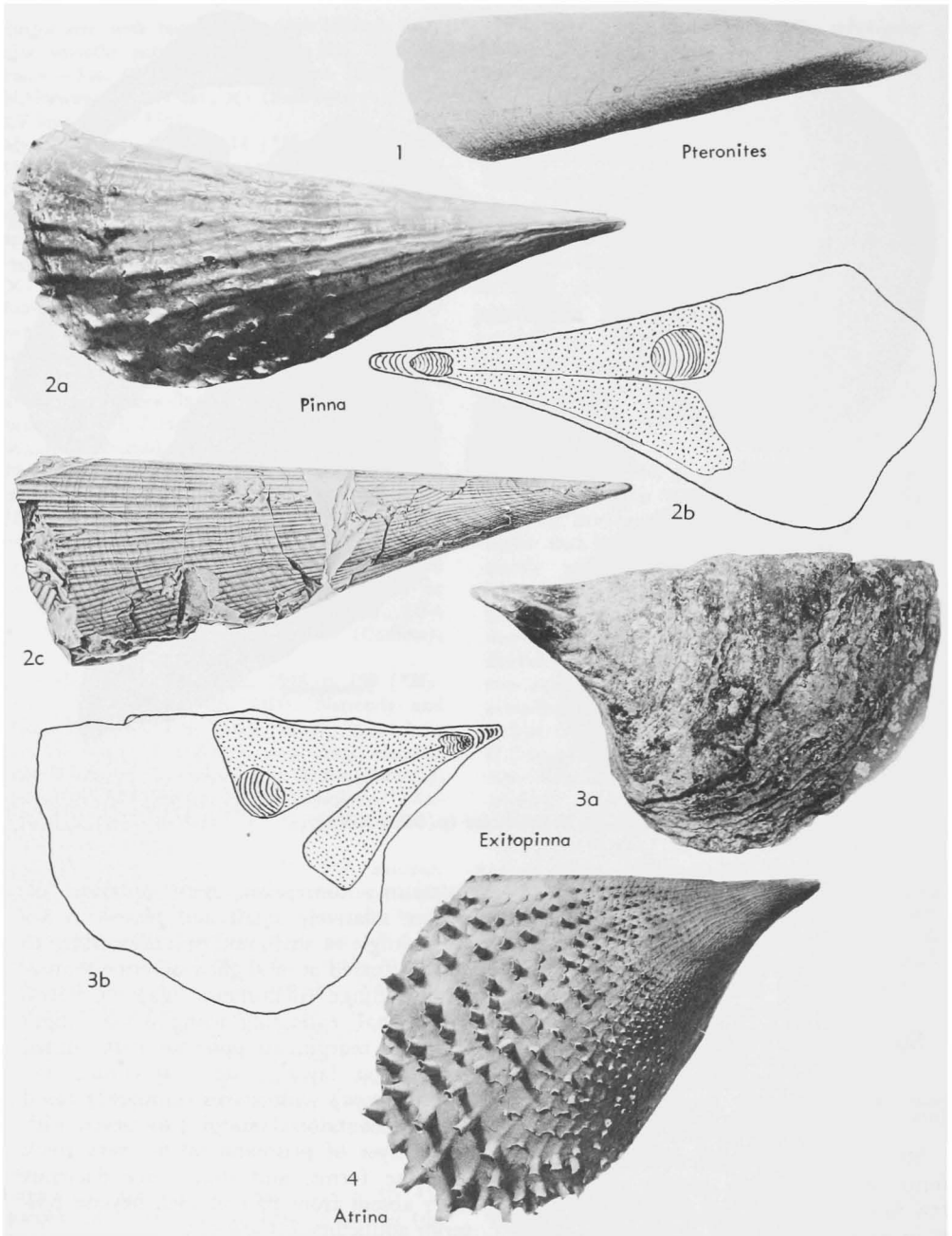


FIG. C23. Pinnidae (p. N283).

Most Pinnidae live with the pointed anterior end of the shell buried in soft sediment and the hinge margin and commissure of the valves more or less vertical; the wide posterior end of the shell is exposed.

The animal is anchored by the byssus to underlying stones or other objects. The anterior end of the shell may be worn constantly by corrosion and sealed off by a succession of thin partitions, the anterior

adductor at the same time migrating in a posterior direction.

**Pinna** LINNÉ, 1758, p. 707 [\**P. rudis*; SD CHILDREN, 1823, p. 34] [= *Chimaeroderma* POLI, 1795, p. 259 (type, *Pinna rudis* LINNÉ; SD COX, herein); *Pinnarius* DUMÉRIEL in FROPIER, 1806 (obj.); *Pinnigenus* RENIER, 1807 (suppressed ICZN); *Pinnula* RAFINESQUE, 1815 (obj.); *Pinnites* VON SCHLOTHEIM, 1820 (obj.); *Pennaria* MÖRCH, 1853 (non OKEN, 1815); *Pinna* SEGUENZA, 1877 (nom. null.); *Pina* KOCH, 1922 (nom. null.)]. Equivalve, wedge- to ham-shaped; umbones at extreme anterior end; valves carinate medially, at least in earlier growth stages; mostly with radial ribs, some forms with growth undulations on ventral region; nacre of interior divided medially into two lobes. *L.Carb.-Rec.*, cosmop.

[It has been maintained that *P. muricata* LINNÉ should be accepted as type species of *Pinna* by Linnean tautonymy, as *Concha Pinna* HASSELIQUIST was cited by LINNÉ in its synonymy; but according to Article 68,d,i of the new Code (1961) a pre-Linnean name cited in synonymy should consist of one word only if this rule of typification is to apply.]

**P. (Pinna)** [= *Chimaera* POLI, 1791 (non LINNÉ, 1758)]; *Sulcatopinna* HYATT, 1892, p. 341 (type, *P. flexicostata* M'COY, 1844 [= *P. costata* PHILLIPS]); *Sulcatipinna* GIRTY, 1915 (nom. van.); *Quantulopinna* IREDALE, 1939, p. 310 (type, *Q. delsa*); *Subitopinna* IREDALE, 1939, p. 312 (type, *P. menkei* REEVE, 1858)]. Wedge-shaped, ventral margin straight to concave; median ridge well defined; sculpture of radial ribs or rows of scales. *L.Carb.-Rec.*, fossil forms cosmop., living ones worldwide in tropical or subtropical seas.—FIG. C23,2a. \**P. (P.) rudis*, Rec., Barbados; RV ext.,  $\times 0.3$  (Cox, n).—FIG. C23,2b. *P. (P.) atropurpurea* G. B. SOWERBY, Rec., S.India; RV interior showing extent of 2 lobes of nacre (stippled), adductor scars, and partitions separating series of loculi at anterior end,  $\times 0.3$  (995).—FIG. C23,2c. *P. (P.) costata* PHILLIPS, L. Carb., Belg.; RV ext.,  $\times 0.25$  (de Koninck, 1885).—FIG. C23,3. *P. (P.) deltodes* MENKE, Rec., W. Australia; 3a, LV ext., 3b, LV int., showing muscle scars and extent of lobes of nacre (stippled),  $\times 0.3$  (Cox, n). [= *Exitopinna* IREDALE, 1939 (type, *E. deltodes ultra* IREDALE, 1939; OD).]

[ROSEWATER (1961, Indo-Pacific Mollusca, v. 1, no. 4, p. 197, pl. 150) has shown that the type specimen of IREDALE's *Exitopinna* is a stunted, repeatedly broken shell of *Pinna bicolor* GMELIN, 1791 (= *P. rudis* LINNÉ). Therefore, *Exitopinna* is considered to be a junior synonym of *Pinna* (*Pinna*).]

**P. (Cyrtopinna)** MÖRCH, 1853, p. 51 [\**P. incurva* GMELIN, 1791, p. 3366; M]. Long, narrow, slightly curved, very thin; median ridge well defined; radial ribbing weak. *Jur.-Rec.*, fossil forms cosmop., Rec., IndoPac.

**P. (Plesiopinna)** AMANO, 1956, p. 70 [\**Plesiopinna atriniformis*; OD]. Wedge-shaped, with median ridge when young, later ham-shaped and irregular; radial ribbing weak. Reported to resemble

*Exitopinna* but may be based on deformed shells. *U.Cret.*, Japan.

**Atrina** GRAY, 1842, p. 83 [\**Pinna nigra* DILLWYN, 1817, p. 325 (= *P. vexillum* BORN, 1778, p. 118); SM GRAY, 1847, p. 199] [= *Servatrina* IREDALE, 1939, p. 317 (type, *Pinna assimilis* REEVE, 1858)]. Equivalve, ham-shaped, posterior end rounded, no median ridge; smooth or with radial rows of ribs or scales; internal nacre not divided into 2 lobes. *M.Jur.-Rec.*, fossil forms cosmop., Rec. in tropical and warm temperate seas.—FIG. C23,4. \**A. vexillum* (BORN), Rec., Philip.Is.; RV ext.,  $\times 0.3$  (Cox, n).

**Curvula** RAFINESQUE, 1819, p. 427 [= *Curvulites* RAFINESQUE, 1831, p. 4]. Genus without nominal species founded on fossil bivalves of uncertain age from interior of USA. Compared with *Pinna* in description but probably not member of Pinnidae. Subsequently ignored.

**Oxisma** RAFINESQUE, 1819, p. 427 [\**O. bifida*; M] [= *Oxysma* HERRMANNSEN, 1847 (nom. van.); *Otysma* PAETEL, 1875 (nom. null.)]. Unrecognizable from description and subsequently ignored. [Compared with *Pinna* in description but probably not member of Pinnidae. Possibly not a fossil.] [Cox]

**Pteronites** M'COY in GRIFFITH, 1844, p. 81 [\**P. angustatus*; SD STOLICZKA, 1871, p. 388 (specific name wrongly cited as "angustus")] [= *Aviculopinna* MEEK, 1864, p. 212 (type, *Solen pinnaeformis* GEINITZ, 1848); *Pterinites* STOLICZKA, 1871 (nom. null.); *Aviculipinna* GIRTY, 1904 (nom. van.)]. Elongate, cuneiform; umbones set back a short distance from pointed anterior extremity, not protruding above cardinal margin; valves without median carina; radial ornament obscure or lacking; internal characters unknown. *L.Carb.-Perm.*, Eu.-USSR (Sib.)-N.Am.-S.Am.—FIG. C23,1. *P. pinnaeformis* (GEINITZ), U.Perm. (Zechstein), Ger.; RV ext.,  $\times 0.75$  (Geinitz, 1861).

**Stegoconcha** J. BÖHM, 1907, p. 148 [\**Pinna granulata* J. SOWERBY, 1822, p. 65; SD COX, 1940, p. 133]. Equivalve, large, mytiliform, gibbose, most inflated along rounded ridge passing from umbo to posteroventral corner; height exceeding length; ornament of radial ribs or threads, commonly broken up into granules, and confined to or most conspicuous on dorsal side of ridge; shell moderately thick. *M.Jur.-U.Jur.*, Eu.-Asia-E.Afr.—FIG. C24,3. *S. gmuelleri* (KRENKEL), U.Jur. (U. Kimmeridg.), Tanganyika; RV ext.,  $\times 0.5$  (Cox, n).

**Streptopinna** VON MARTENS, 1880, p. 318 [\**Pinna saccata* LINNÉ, 1758, p. 707; M]. Inequivalve, irregularly twisted or bent, highly variable in form, mytiliform, pteriiform, or elongate-rectangular, but with terminal, pointed umbones; valves commonly fused along posterior part of dorsal margin; ornament of broad radial ribs on dorsal

half of valves. *Rec.*, IndoPac.—FIG. C24,2. \**S. saccata* (LINNÉ), Muscat, Arabia; 2a,b, RV ext. views of 2 specimens, showing variability,  $\times 0.5$  (Cox, n).

*Trichites* VOLTZ in THURMANN, 1833, p. 13 [\**T. saussuri*; M] [The earliest publication of *Trichites* (a very old name used by PLOT in 1677) as an available generic name has been attributed by

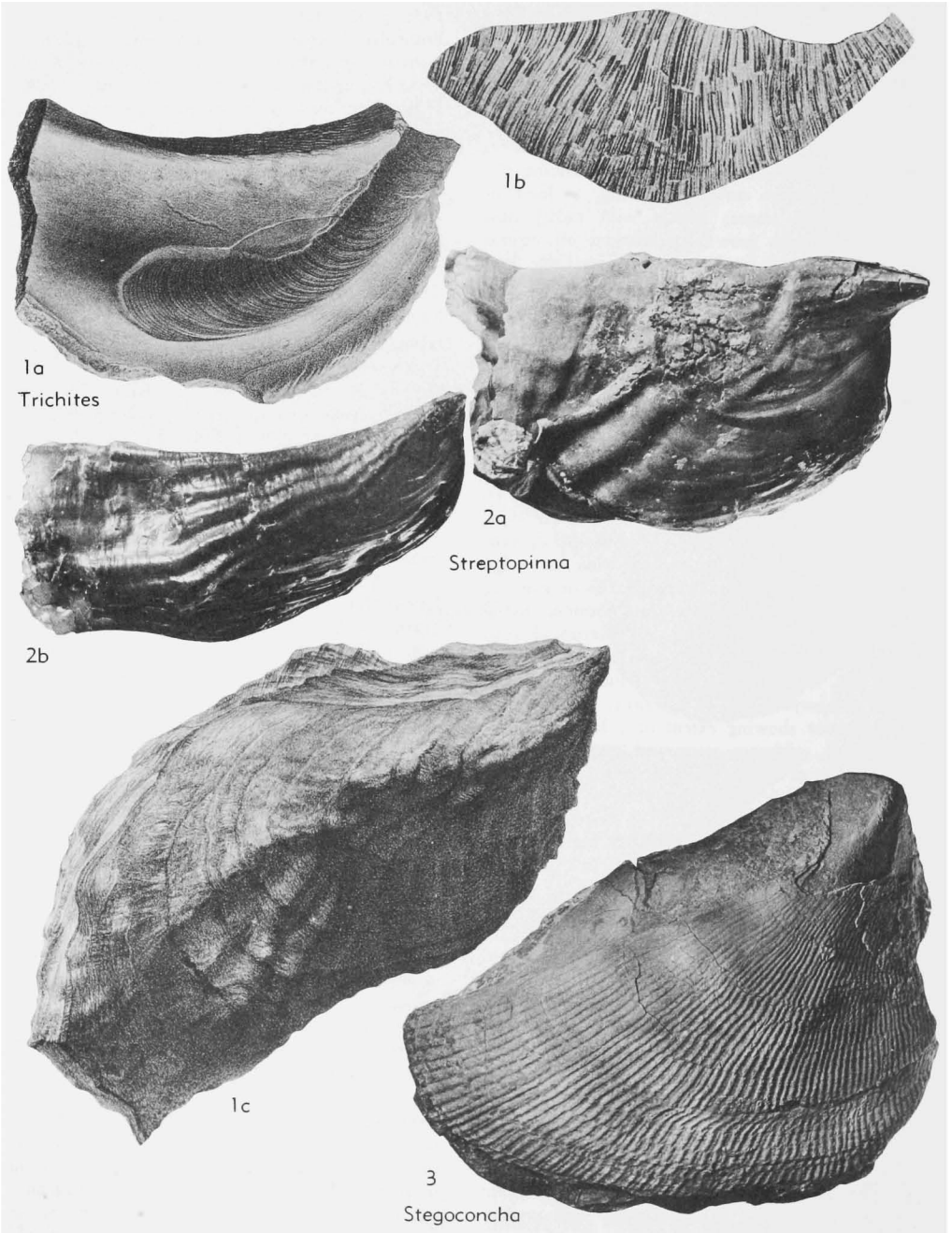


FIG. C24. Pinnidae (p. N283-N285).

some authors to DESHAYES (1832), who, however, published it in the French vernacular form *trichite*, plural *trichites*.] [= *Pinnogena* BRONN, 1836 (no valid nominal species); *Pinnigena* DESHAYES, 1839 (obj.); *Pinuigena* COSSMANN, 1915 (*nom. null.*)]. Commonly large, irregularly trapeziform or falciform, more or less inequivalve; margins with irregular undulations, closed or with narrow byssal gape; posterior adductor scar deep, much extended in radial direction; surface uneven, some specimens with broad, depressed, bifurcating ribs or with irregular nodosities; shell very thick, composed of fibrous calcite, and commonly found only as fragments. *M.Jur.* (*Bajoc.*)-*L. Cret.*, Eu.-Asia-N. Afr.-E. Afr.—FIG. C24,1a. *T. seebachi* BÖHM, U.Jur.(L.Tithon.), Ger.(Kelheim); RV showing extended adductor scar,  $\times 0.3$  (Böhm, 1882).—FIG. C24,1b, *T. sp.*, U.Jur.(L.Tithon.), Ger.(Kelheim); fragment of test,  $\times 0.7$  (Böhm, 1882).—FIG. C24,1c. \**T. saussuri*, U.Jur.(L.Kimmeridg.), Yonne, Fr.; LV,  $\times 0.5$  (Bayle, 1878).

## Order PTERIOIDA Newell, 1965

[Diagnosis by N. D. NEWELL]

Generally inequivalve and pleurothetic; inequilateral or secondarily nearly equilateral; heteromyarian or monomyarian; ligament opisthodontic or amphidetic, alivincular, multivincular or duplivincular, generally extended by secondary fusion layer; prismatoneacrous, crossed-lamellar or foliate; pallial line not sinuopalliate. *Ord.-Rec.*

## Suborder PTERIINA Newell, 1965

[Diagnosis by N. D. NEWELL]

Adults fixed by byssus through notch in RV, or cemented by RV; byssate throughout much or all of ontogeny; shell microstructure variable; gills filibranch or eulamellibranch. *Ord.-Rec.*

## Superfamily AMBONYCHIACEA

S. A. Miller, 1877

[*nom. transl.* NEWELL, 1965 (*ex* Ambonychiidae S. A. MILLER, 1877)] [Diagnosis by N. D. NEWELL]

Strongly inequilateral, triangular, quadrate or trapezoidal, heavy to thin shells with beaks at or near anterior end of hinge; byssal sinus commonly evident; ligament mainly opisthodontic, duplivincular; musculature heteromyarian or monomyarian in adults with posterior adductor placed near or below and behind center of valves; pallial line integripalliate, discontinuous as series

of small insertion pits; inner ostracum lamellar aragonite, probably nacreous; outer ostracum prismatic calcite. [Morphologically these shells are intermediate in some respects between the Pterineidae or Cyrtodontidae and the Mytilidae. The last-named family also resembles Modiomorphidae and may have been derived from them rather than from the Ambonychiacea.] ?*L.Ord.*, *M.Ord.-L.Jur.*, ?*U.Jur.*

## Family AMBONYCHIIDAE

S. A. Miller, 1877

[Materials for this family prepared by N. D. NEWELL & AURÈLE LAROCQUE in consultation with JOHN POJETA, JR., Washington, D.C., except as otherwise indicated]

Equivalve, generally prosogyre; hinge teeth few, variable, or apparently absent. [Many genera have been proposed for poorly preserved and poorly prepared specimens. Internal characters of very few of the genera are adequately known. Consequently, external details of form and ornamentation have been stressed.] *M.Ord.*(*Chazy.*)-*U.Dev.*, ?*L.Miss.*

*Ambonychia* HALL, 1847, p. 163 [\**A. radiata*; SD STOLICZKA, 1871, p. 387] [= *Byssonychia* ULRICH, 1894 (obj.), p. 498; *Eridonychia* ULRICH, 1893 (1895), p. 639 (type, *E. apicalis*; OD)]. Proscloine to slightly opisthocline, orbicular to ovoid shells without anterior lobation; ornamented equally on both valves by simple radial costae; byssal gape generally prominent below beaks; dentition pseudoheterodont, composed of 2 or 3 small radial cardinal teeth in each valve below beaks and few posterior lateral elements located at posterior extremity of hinge margin. *M.Ord.-U.Ord.*, E.N.Am.-Eu.—FIG. C25,7. \**A. radiata*; *M.Ord.*, USA(N.Y.); 7a, RV ext.,  $\times 1$ ; 7b, LV int.,  $\times 3$  (745).

*Allonychia* ULRICH, 1893 (1895), p. 640 [\**Megambonia jamesi* MEEK, 1872; OD]. With prominent anterior lobe; ornamented with simple, coarse, radial costae; without posterior wing or discernible byssal gape; hinge unknown. *M.Ord.-U.Ord.*, USA(Ohio Valley).—FIG. C26,6. \**A. jamesi* (MEEK), U.Ord., Ohio; RV int. mold,  $\times 1$  (929).

*Ambonychiopsis* ISBERG, 1934, p. 84 [\**A. osmundbergensis*; OD] [= *Ambonychia* AUCTT.]. Beaks terminal; surface with fine radial costellae, cancellate in many shells; without byssal opening; hinge unknown. *M.Ord.*(*Chazy.*)-*M.Sil.*(*Niag.*), N.Am.-Eu.—FIG. C25,8. \**A. osmundbergensis*, U.Ord.(Boda Ls.), Sweden; 8a,b, RV ext., dorsal,  $\times 2$  (439).

*Amphicoelia* HALL, 1865 [\**A. leidyi*; M]. Without anterior lobe but with prominent anteroventral

salient forming obtuse angle with umbonal ridge; beaks terminal; cardinal margin long; ornamentation of costellae or costae, growth varices or con-

centric undulations; without visible byssal gape; byssal sinus prominent; shell medium to large in size; dentition unknown. *M.Sil.-U.Sil.*, USA.—

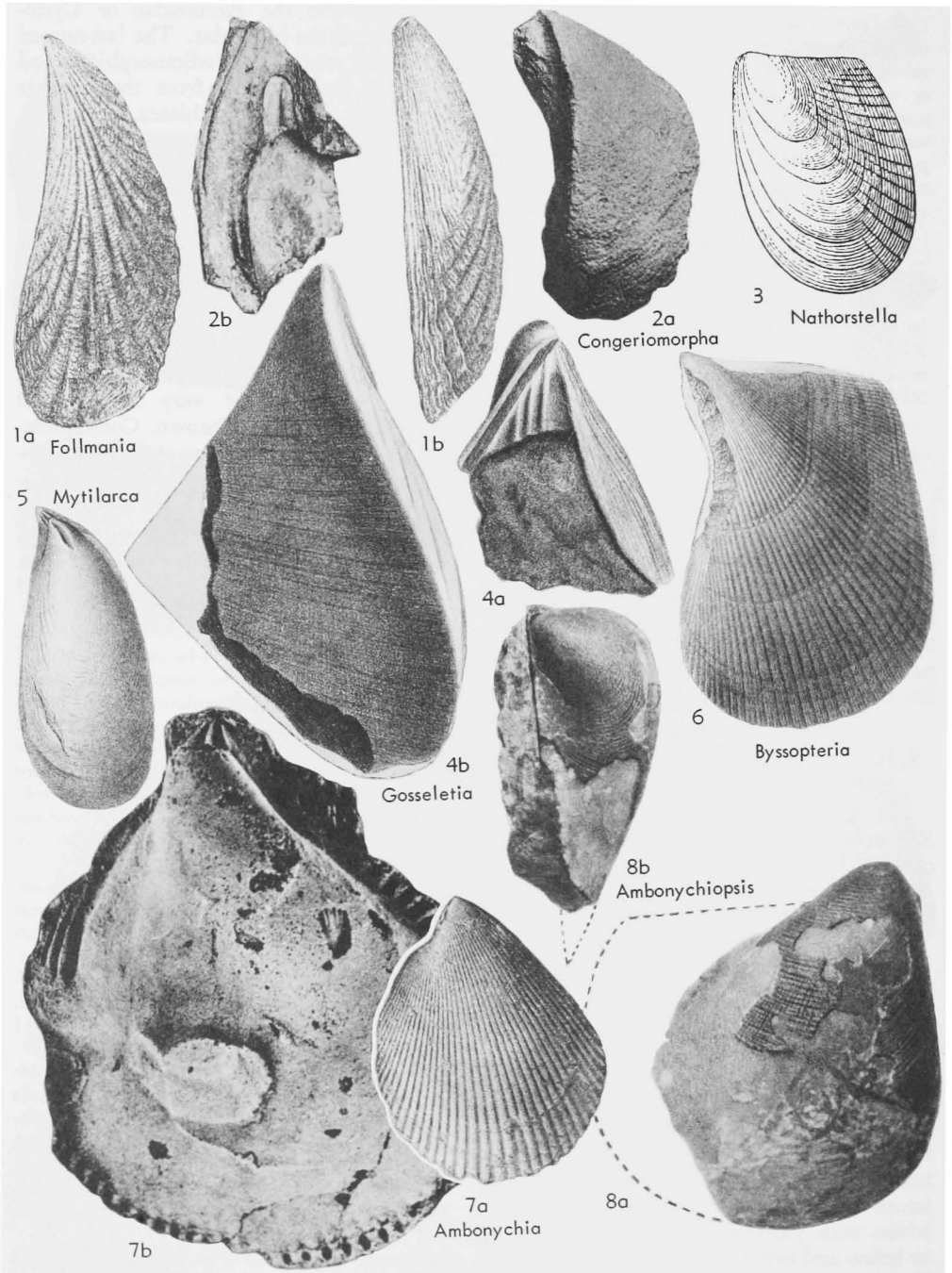


FIG. C25. Ambonychiidae (p. N285, N287).



- FIG. C26.7. *\*A. leidy*, Wis.; LV int. mold,  $\times 1$  (Hall, 1865).
- Anomalocoelia** ISBERG, 1934 [*\*A. transplicata*; OD]. Similar to *Amphicoelia* but with shorter anterior end; ligamental area with strong fold. *U.Ord.*, Eu.—FIG. C26.1. *\*A. transplicata*, Boda Ls., Sweden (Dalarna); *1a*, LV ext. (holotype),  $\times 1$ ; *1b*, RV hinge (holotype),  $\times 2$  (439).
- Anomalodonta** S. A. MILLER, 1874, p. 16 [*\*A. gigantea*; SD MILLER, 1874, p. 333]. Large, simplicicostate monomyarian upright ambonychiids similar to *Ambonychia*; lacking lateral teeth and with only single poorly developed cardinal tooth in RV. [May be synonymous with *Ambonychia* s.s.] *U.Ord.*, E.N.Am.—FIG. C26.4. *\*A. gigantea*, USA (Cincinnati, Ohio); *4a,b*, LV int., part of RV ext.,  $\times 1$  (618).
- Byssopteria** HALL, 1883, p. 4 [*\*B. radiata*; M]. Shell erect, superficially like *Ambonychia* but with multicostate (fasciculate) ornamentation and nasute lobation in front of beaks; hinge unknown. [*Byssopteria* differs from *Opisthoptera* in lacking a posterior wing and in having costae rather than costellae.] *U.Dev.* (*Chemung.*), USA (Pa.).—FIG. C25.6. *\*B. radiata*; LV ext.,  $\times 1$  (376).
- Cleionychia** ULRICH, 1892, p. 97 [*\*Ambonychia lamellosa* WHITFIELD, 1882 (= *A. lamellosa* HALL, 1862, *A. cancellosa* HALL, 1861, *nom. null.*, *nom. oblit.*); OD] [= *Anoptera* ULRICH, 1893 (1895), p. 6 (type, *A. miseneri*; M); ?*Ambonychinia* ISBERG, 1934, p. 29 (type, *A. undulata*; OD); *Elasmodophora* ISBERG, 1934 (type, *E. acutirostris*; OD)]. Similar to *Ambonychia*, but without radial ornamentation or byssal opening; 1 cardinal tooth just under beak in some species, no posterior laterals. *M.Ord.*-*U.Ord.* (*Chazy.-Richmond.*), ?*M.Sil.* (*Niag.*), E. N. Am. - Sweden - Norway - Scot.-Ire.-USSR-Korea.—FIG. C26.3. *\*C. lamellosa* (HALL), *M.Ord.* (L.Trenton), USA (Wis.); *3a,b*, LV int. mold, LV ant.,  $\times 1$  (930).
- ?**Congeriomorpha** STOYANOW, 1948 [*\*C. andrusovi*; OD]. Modioloid, subtriangular, carinate, with well-defined byssal sinus; depressed umbonal or myophoric platform within beaks, narrow ligamental area; 1 posterior lateral tooth in RV and 2 in LV; cardinal teeth absent. *U.Dev.*, USA (Ariz.).—FIG. C25.2. *\*C. andrusovi*; *2a,b*, LV ext., int.,  $\times 2$  (Stoyanow, 1948).
- ?**Enkelbergia** WEDEKIND in SCHINDEWOLF, 1924, p. 274 [*\*E. semiglobosa*; M]. Beaks opisthogyre. *U.Dev.* (*Cheiloceras-Stufe*), Ger.
- Gosseletia** BARROIS, 1882, p. 273 [*\*G. devonica*; SD FOLLMAN, 1885]. Subtriangular, beaks terminal, surface without radial ornamentation or byssal gape; umbonal carina prominent; hinge with several oblique cardinals behind beaks and with 2 or 3 posterior laterals below and mainly behind ligament. *L.Dev.*-*M.Dev.*, W.Eu.-N.Am.—FIG. C25.4. *\*G. devonica*, L.Dev., Spain (Asturias); *4a,b*, LV hinge int., RV ext., both  $\times 1$  (Barrois, 1882).
- ?**Myalinopterella** KHALFIN, 1940, *Dev.*, USSR (Altai).
- Mytilarca** HALL & WHITFIELD, 1869, p. 19 [*\*Inoceramus chemungensis* CONRAD, 1842; OD] [= *Plethomytilus* HALL, 1883, p. 4 (type, *Mytilarca ponderosa* HALL & WHITFIELD, 1869; SD S. A. MILLER, 1889); *Cyrtodontopsis* FRECH, 1891 (type, *Gosseletia? kayseri* FRECH in KAYSER, 1889; SD LA ROCQUE & NEWELL, herein); *Lophonychia* POHL, 1929 (type, *Mytilarca trigonale* CLELAND, 1911; OD)]. Mytiliform, commonly somewhat falcate, with terminal beaks; without radial ornamentation or byssal gape; umbonal carina less pronounced than with *Gosseletia*; few oblique cardinals and 2 or 3 laterals in each valve. *L.Sil.* (*Brassfield*)-*U.Dev.*, ?*L.Miss.*, Eu.-N.Am.—FIG. C25.5. *\*M. chemungensis* (CONRAD), *U.Dev.* (*Chemung*), USA (N.Y.); RV int. mold,  $\times 1$  (377).
- Nathorstella** KAYSER, 1901, p. 10 [*\*N. semiplicata*; M]. Beaks terminal, mytiliform, without anterior lobation; ornamented with outward curving costae; hinge unknown. *Dev.*, Ger.-Spitz.
- N.** (**Nathorstella**). Subrhombic, costae confined to area behind umbonal ridge. *Dev.*, Spitz.—FIG. C25.3. *\*N. (N.) semiplicata*, Spitz. (Gray Hook); LV ext.,  $\times 1$  (Kayser, 1901).
- N.** (**Follmannia**) DREVERMANN, 1907, p. 32 [*\*Gosseletia pseudaelectryonia* FRECH, 1891; M]. Slender, falcate, with coarse, pinnate costae diverging outward from umbonal ridge. *L.Dev.* (*Coblentz.*), Ger.—FIG. C25.1. *\*N. (F.) pseudaelectryonia* (FRECH), Coblentz, Rhinel.; *1a,b*, RV ext., LV ant.,  $\times 1$  (323).
- Opisthoptera** MEEK, 1872, p. 319 [*pro Megaptera* MEEK & WORTHEN, 1868 (*non* GRAY, 1846)] [*\*Ambonychia casei* MEEK & WORTHEN, 1866; M] [= *Opistholobata* ULRICH in HUSSEY, 1926, p. 165 (type, *O. gouldi*; M)]. Subtriangular, umbones terminal, hinge line very long; surface with numerous radial, bifurcating costae; byssal opening present; hinge said to contain 2 small cardinals in each valve; without posterior laterals. *U.Ord.*, USA (Ohio Valley); *L.Sil.* (*Llandov.*), Scot.—FIG. C26.5. *\*O. casei* (MEEK & WORTHEN), *U.Ord.* (Cincinnati), USA (Ky.-Ind.); *5a*, LV ext.; *5b*, ant. view int. mold both valves; both  $\times 1$  (929).
- ?**Palaeocardia** HALL, 1865 [*\*P. cordiformis*; M]. Beaks large, anterior but not terminal, hinge line short; surface with numerous fine, radial costellae; no byssal opening; dentition unknown. *Sil.* (*Niagar.*), USA-Can.—FIG. C26.2. *\*P. cordiformis*, USA (Wis.); *2a*, RV int. mold; *2b*, post. view int. mold; both  $\times 1$  (374).
- Paramytilarca** ISBERG, 1934 [*\*P. levis*; OD]. Similar to *Cleionychia* but with 2 or more posterior laterals and without cardinals. *M.Ord.*-*U.Ord.*, Sweden.—FIG. C27.2. *\*P. levis*, *U.Ord.*, Boda Ls., Kallholn; *2a,b*, RV ext., ant.,  $\times 2$  (439).

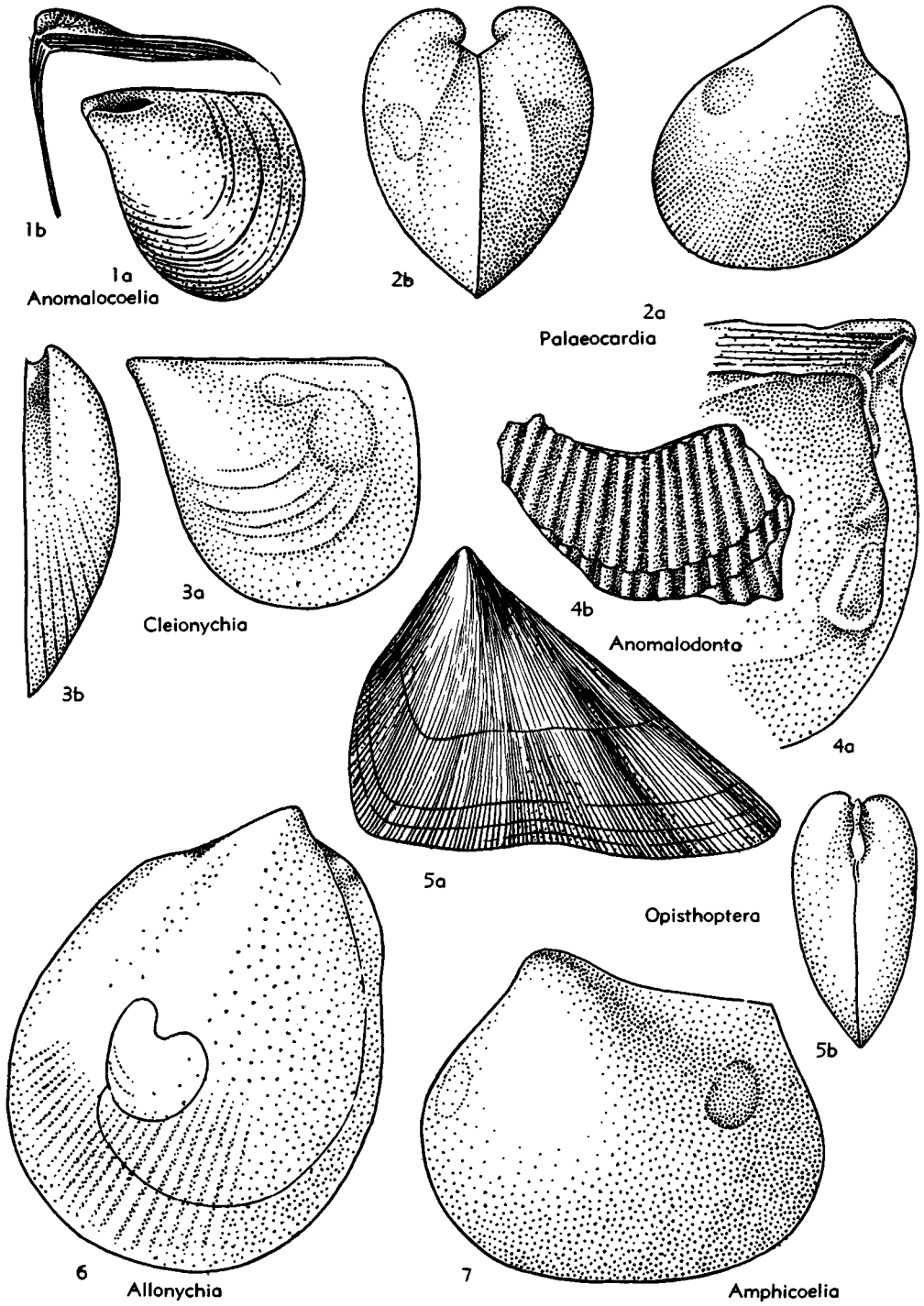


FIG. C26. Ambonychiidae (p. N285-N287).

?**Pompeckjina** WEDEKIND in SCHINDEWOLF, 1924, p. 275 [*\*Inoceramus semiorbicularis* MÜNSTER; M]. *U.Dev.* (*Cheiloceras-Stufe*), Ger.

**Praeanomalodonta** ISBERG, 1934, p. 91 [*\*P. scutulata*; OD]. Similar to *Anomalodonta* but without radial ornamentation. *U.Ord.* (*Boda Ls.*), Sweden (Dalar-na).—FIG. C27,3. *\*P. scutulata*, Kallholn, Sweden; 3a, LV ext. (holotype); 3b, LV hinge; both  $\times 2$  (439).

**Psilonychia** ULRICH, 1895, p. 648 [*\*P. perangulata*; OD]. Beaks terminal, pointed; without radial ornamentation; byssal gape small, elongate oval; hinge wide, edentulous. *U.Ord.*, N.Am.—FIG. C27,4. *\*P. perangulata*, USA (Ohio); 4a,b, LV ext., ant.,  $\times 1$ ; 4c, LV hinge,  $\times 1$  (929).

**Stappersella** MAILLIEUX, 1920, p. 144 [*\*Gosselettia truncata* ROEMER, 1844; SD MAILLIEUX, 1937] [= ?*Demanetia* MAILLIEUX, 1937, p. 104 (type, *Myalina lodanensis* FRECH, 1891; SD LAROCQUE & NEWELL, herein)]. Subtrigonal to mytiliform, beaks not quite terminal, without byssal gape, ornamented with coarse, simple costae reflected on internal molds as marginal plicae; hinge as in *Mytilarca* with cardinals and laterals more or less radial with respect to beaks. Some slightly inequivalved individuals said to be edentulous (*Demanetia*). *L.Dev.*, W.Eu.—FIG. C27,5. *\*S. truncata* (ROEMER), U.Coblentz., Ger. (Rhinel.); LV int. mold,  $\times 1$  (323).

?**Streptomylus** KINDLE & BREGER, 1904, p. 452 [*\*S. wabashensis*, M]. Shell cuneiform, beaks terminal, long, pointed; without radial ornamentation; said to be edentulous and with unstriated ligament area. *M.Sil.* (*Niagar.*), N.Am. (Ind.-Wis., N.Ont.).—FIG. C27,1. *\*S. wabashensis*, USA (Wabash, Ind.); 1a,b, LV ext., ant. (holotype),  $\times 1$  (470).

### Family MYALINIDAE Frech, 1891

[Diagnosis by N. D. NEWELL] [Materials for this family prepared by N. D. NEWELL, JOHN WEIR, and L. R. COX, as indicated]

Inequivalved, with RV slightly less convex than LV; edentulous, or with cardinal tooth or boss beneath beak of RV and corresponding furrow in LV; pallial line entire, generally pitted. ?*L.Dev.*, *L.Miss.-L. Jur.*, ?*U.Jur.*

### MARINE MYALINIDAE

[Materials for this section prepared by N. D. NEWELL]

**Myalina** DE KONINCK, 1842 [*\*M. goldfussiana*; SD STOLICZKA, 1871, p. 366]. Mytiliform shells with nearly terminal beaks, generally unornamented, surface of LV in some species roughened by prominent growth lamellae; RV less convex and commonly slightly smaller than LV; umbonal deck lacking. *L.Miss.-U.Perm.*, cosmop.

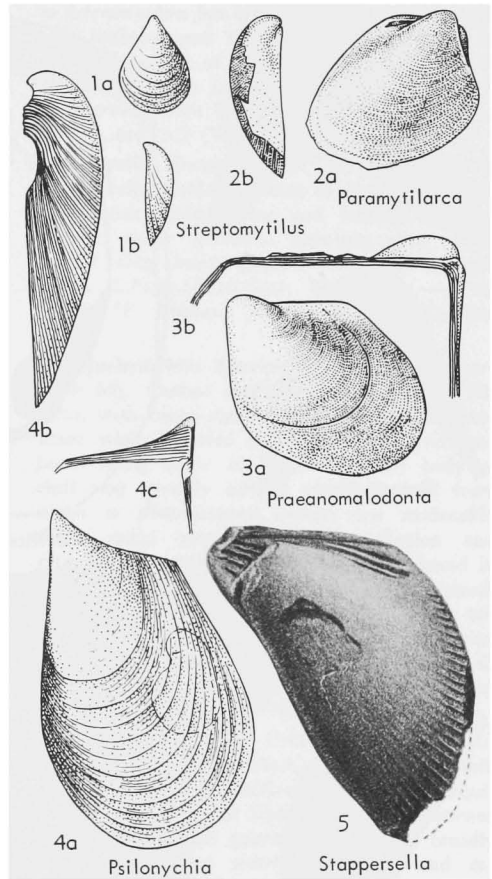


FIG. C27. Ambonychiidae (p. N287, N289).

**M. (Myalina)**. Thick-shelled species with well-developed anterior lobe, at least on LV; primitive species nearly equivalved with marked procline obliquity, advanced species inequivalved, becoming acline or opisthocline and developing posterior auricle. *L.Miss.-U.Perm.*, cosmop.—FIG. C28,5a. *M. (M.) copei* (WHITFIELD), L. Perm. (Moran), USA (Tex.); LV ext.,  $\times 0.7$  (666).—FIG. C28,5b. *\*M. (M.) goldfussiana*, L. Carb. (Visean), Belg.; LV int. showing muscle marks and dental socket,  $\times 1$  (666).

**M. (Orthomyalina)** NEWELL, 1942 [*\*M. slocomi* SAYRE, 1930; OD]. Subquadrate, nearly acline, thick-shelled, without anterior lobation. *M.Penn.* (*Desmoines.*)-*Perm.* (*Wolfcamp.*), USA.—FIG. C28,2. *\*M. (O.) slocomi* (SAYRE), U.Penn. (Virgil.), USA (Kans.); LV int. showing muscle marks and dental socket,  $\times 1$  (666).

**Atomodesma** VON BEYRICHT, 1864 [*\*A. exaratum*; SD WANNER, 1922, p. 63] [= *Maitaia* MARWICK,

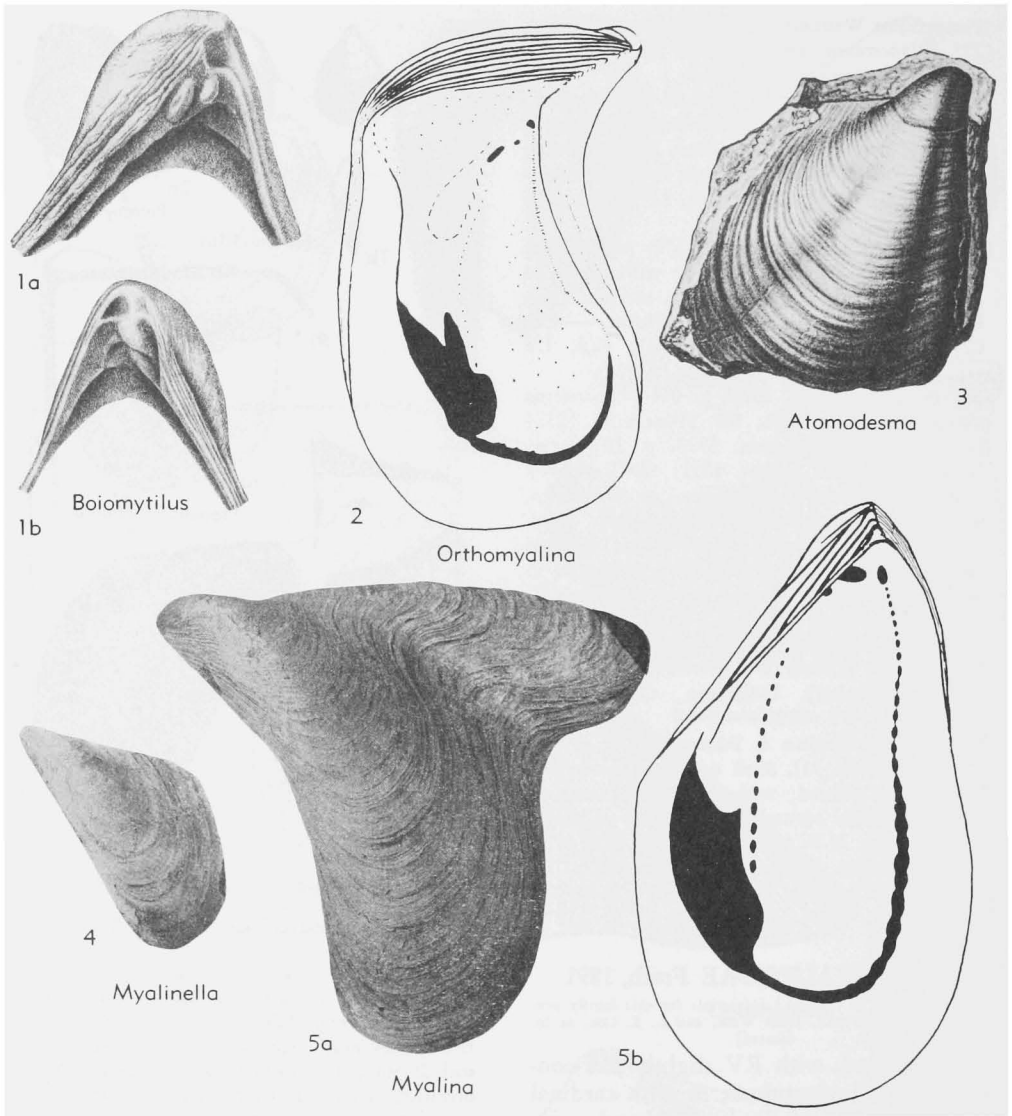


FIG. C28. Myalinidae (marine) (p. N289-N291).

1934 (type, *M. trechmanni* MARWICK, 1934, OD); *Kolymia* LIKHAREV, 1941 (type, *K. inoceramiformis*; OD); *Intomodesma* ПОРОВ, 1957 (type, *I. costatum*; OD)]. Prosocline, duplivinular, ovoid shells of inoceramid aspect, with acute, terminal, or nearly terminal beaks, concentric folds, and small, internal umbonal deck or septum; prismatic layer well developed in both valves; lamellar layer thin. ?*U.Penn.*, *L.Perm.*-*U.Perm.*, Australasia-N.Z.-Greenl. (Waterhouse, 1963).—FIG. C28.3. \**A. exaratum*, Timor (fide DICKINS, 1956, p. 25); RV ext.,  $\times 1$  (Wanner, 1922).

?*Aviculomyalina* ASSMANN, 1916 [\**A. lata*; OD]. *M.Trias.* (Karchowitz beds), Pol. (Tarnowitz, Upper Silesia).

?*Boiomytilus* RŮŽIČKA & PRANTL, 1961 [\**B. newelli*; OD]. Mytiloid, LV more convex than RV; surface marked by growth lamellae only; 2 small subpyriform teeth separated by socket in LV below beaks, single tooth in RV, lateral teeth apparently lacking; subcircular pit of uncertain function lies immediately ahead of cardinal teeth and small anterior adductor scars occurs just below them, below level of hinge plate; posterior adductor scar

large, situated near the posterior margin. *L.Dev.*, C.Boh.—FIG. C28,1. \**B. newelli*; 1a,b, LV and RV hinge,  $\times 1$  (818).

**Eurydesma** MORRIS, 1845 [\**E. cordatum*; OD] [= *Leiomyalina* FRECH, 1891 (type, *L. antarctica*)]. Acline, heavy, smooth, obliquely oval as viewed laterally, ventricose, with deep, cordate lunule; outer ostracum relatively thick, more than 0.25 thickness of shell. *L.Perm.*, Australia-India-S. Afr.-Arg.—FIG. C29,1. \**E. cordatum*, *L.Perm.*, Australia (New S.Wales); 1a-c, RV beak, LV beak, RV ext.,  $\times 0.7$  (Etheridge & Dun, 1910).<sup>1</sup>

**Liebea** WAAGEN, 1881 [\**Mytilus squamosus* SOWERBY, 1829; SD Cox, 1936, p. 38]. Shell small, rarely attaining length greater than 2.5 cm.; mytiloid, strongly prosocline, subrhombic; RV relatively smooth and almost imperceptibly less convex than squamose LV; single cardinal tooth of LV overlying single tooth in RV; anterior adductor seated in pit along anteroventral edge of umbonal deck; ligament grooves strongly oblique, 6 or 8 intersecting hinge axis. *Perm.*, E.Hemis., widespread.—FIG. C29,2. \**L. squamosa* (SOWERBY), *U. Perm.* (Zechstein), Ger.; 2a,b, hinge view and LV,  $\times 3$  (Newell, 1939).

**Myalinella** NEWELL, 1942 [\**Myalina meekei* DUNBAR, 1924; OD, p. 60]. Thin-shelled, small strongly prosocline, triangular, with obtuse posterodorsal margins; beaks slender, not lobed; LV only slightly more rugose than RV. *Penn.* (*Desmoines.*)-*L.Trias.*, Eu.-USA-India-Greenl.—FIG. C28,4. \**M. meekei* (DUNBAR), *L.Perm.* (Big Blue), USA (Kans.); LV,  $\times 2$  (666).

?**Pachymytilus** ZITTEL, 1881 [\**Mitylus petasus* D'ORBIGNY, 1850; SD COSSMANN, 1915]. Large, mytiliform, with terminal beaks; test very thick, especially near beaks; exterior smooth or with faint radial striae; anterior marginal region usually reflected, margin forming sinus from deepest point of which groove runs to beak; thick test in anterior angle may bear amorphous, toothlike protuberances. Ligamental area broad, subinternal, usually with single groove for ligament, but in 1 species with about 4 grooves; posterior adductor scar very large. *U.Jur.*, Eu.—FIG. C29,4. \**P. petasus* (D'ORBIGNY), *U.Oxford.*, Yonne, France; RV int.,  $\times 0.7$  (1025). [Cox]

**Posidoniella** DEKONINCK, 1885 [\**Inoceramus vetustus* SOWERBY, 1829; OD]. Ventricose shells of inoceramid aspect without radial ornamentation, anterior auricle, or umbonal deck; prismatic layer thin. *Carb.* (*Vise.-Namur.*), Eu.; *Penn.* (*Pottsville*), USA.—FIG. C29,5. \**P. vetusta* (SOWERBY), *L. Carb.*, Eng.; LV ext.,  $\times 1$  (Ramsbottom, 1959).

**Promyalina** KITTL, 1904 [\**P. hindi*; OD]. Similar

to *Selenimyalina* but with somewhat more prominent umbones and with single cardinal tooth in each valve, that of RV overlying tooth of LV. ?*U.Perm.*, Yugo.; *L.Trias.*, cosmop.—FIG. C29, 3. *P. groenlandica* (NEWELL), *L.Trias.*, E.Greenl.; LV int., ext.,  $\times 2$  (Newell, 1955).

**Pseudomyalina** DICKINS, 1956 [\**P. obliqua*; OD]. Large shells, similar in form to *Septimyalina* but with weak radial costae and lacking umbonal septum; outer prismatic ostracum very much thicker than inner lamellar ostracum in both valves. *L.Perm.* (*Coolkilya*), W.Australia.—FIG. C29,6. \**P. obliqua*; LV ext.,  $\times 0.5$  (Dickins, 1956).

**Pseudopachymytilus** KRUMBECK, 1923 [\**P. timorensis*; M]. Outline pteriiform rather than mytiliform, with hinge margin produced to form posterior wing, rounded at its extremity, and umbones rising above it; beaks terminal; body of shell very strongly inflated along diagonal from umbo to posteroventral corner; test moderately thick; radial ornament absent; reflection and grooving of anterior marginal region, as found in *Pachymytilus*, absent; ligamental area flattened, subinternal, in many forms relatively wide; adductor scars located on platform-like elevations, anterior scar deeply impressed. *L.Jur.* (*Lias.*), E. Indies (Timor).—FIG. C29,7. \**P. timorensis*; 7a,b, LV ext., int.,  $\times 1$  (486). [Cox]

**Selenimyalina** NEWELL, 1942 [\**Myalina meliniformis* MEEK & WORTHEN, 1866; OD]. Small, strongly prosocline to acline, smooth, nearly equi-valve, without anterior lobation; umbones flattened and poorly defined; posterodorsal margin broadly rounded; ligament grooves numerous and extremely fine; dentition similar to *Myalina* except that single cardinal tooth of RV and corresponding triangular socket of LV are situated on hinge plate which partly covers very shallow umbonal recess. *Penn.* (*Desmoines-Virgil.*), USA.—FIG. C30,2. \**S. meliniformis* (MEEK & WORTHEN), *Desmoines.*, USA (Ill.); LV int., showing muscle marks,  $\times 2$  (666).

**Septimyalina** NEWELL, 1942 [\**Myalina perattenuata* MEEK & HAYDN, 1858; OD]. Prosocline, rhomboidal to falcate, or acline, thick-shelled myalines with slender extended beaks and obsolescent anterior lobe below each beak; both valves smooth or rugose; inequivalved; umbonal cavity covered anterodorsally by broad hinge plate; dentition weak, as in *Myalina*. *L.Carb.* (*Visean*)-*L.Perm.* (*Wolfcamp.*), USA-W.Eu.—FIG. C30,1. \**S. perattenuata* (MEEK & HAYDEN), *U.Penn.*, USA (Kans.); LV ext., int.,  $\times 1$  (666).

## NONMARINE AND BRACKISH-WATER MYALINIDAE

[Materials for this section prepared by JOHN WEIR]

<sup>1</sup> BRUCE RUNNEGAR (pers. commun.) recognizes family Eurydesmidae REED, 1932 (*recte* Eurydesmatidae), which he places with Pectinacea. According to his evidence ligament in *Eurydesma* is not duplivincular and inner ostracum is crossed-lamellar (cf. *Chaenocardia* and *Pergamidia*).

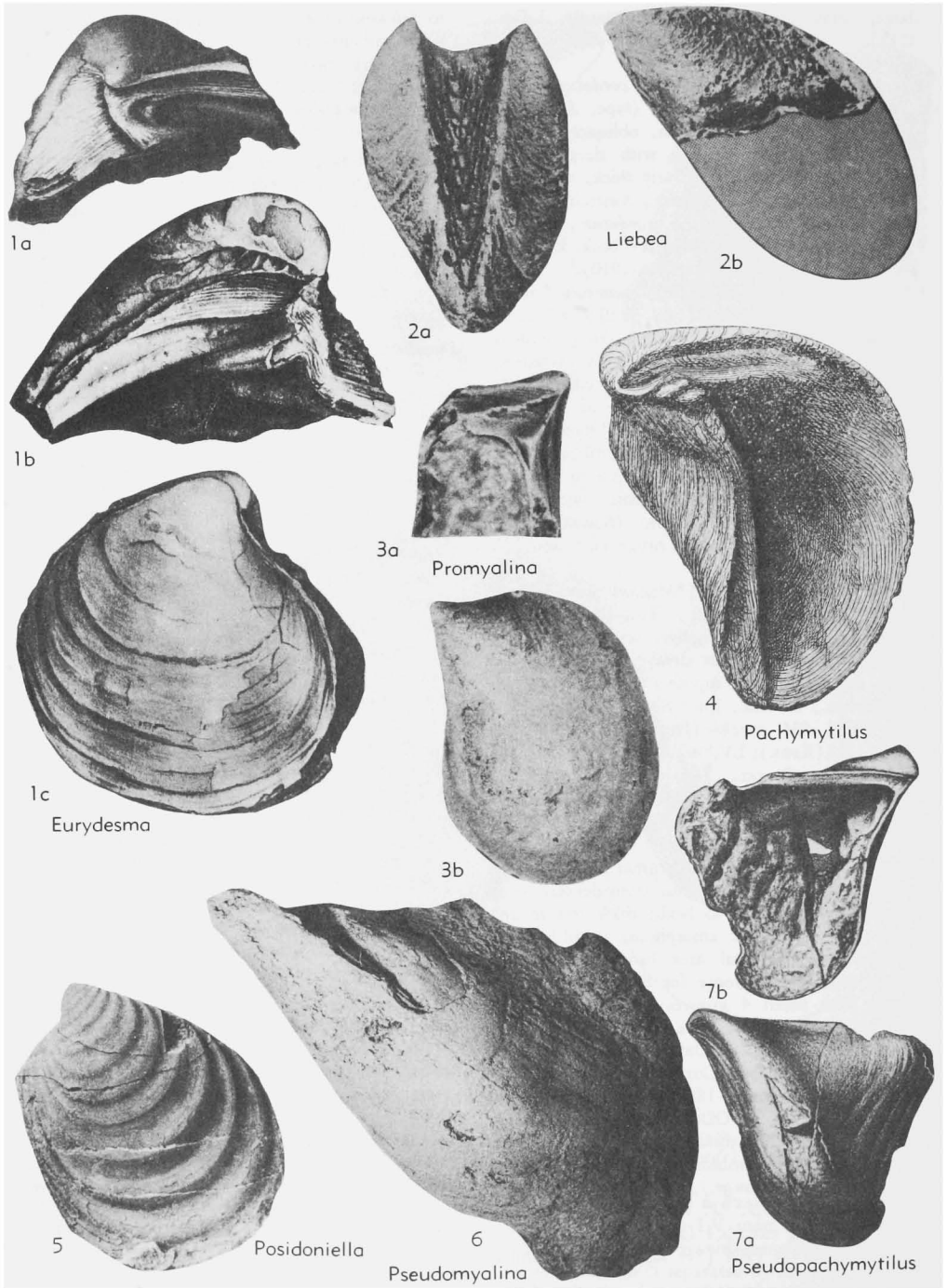
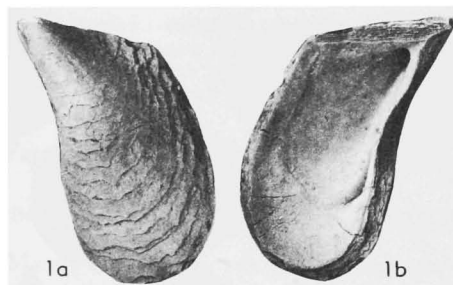


FIG. C29. Mayalinidae (marine) (p. N291).

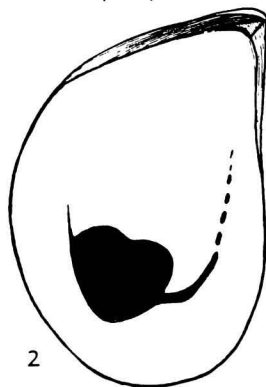
**Anthraconaia** TRUEMAN & WEIR, 1946 (April) [*pro Anthracomya* SALTER, 1861 (*non* RONDANI, 1856)] [*\*Anthracomya adamsii* SALTER, 1861; OD] [=Saltermya PALMER, 1946 (Sept.) (obj.)]. Obliquely subovate, submodioliform or elongate-trapeziform; integripalliate, inequilateral, equivalved (or slightly inequivalved), with straight hinge line; anterior end narrow in subovate and submodioliform species, posterior end expanded, rounded, or truncated (vertically or obliquely), dorsal and ventral margins subparallel in elongate forms; obtuse carinal swelling in some shells runs obliquely from umbo toward posteroventral angle, and wide byssal sinus may occur; umbones not prominent, situated within anterior third of shell. Hinge straight, linear, edentulous; ligament duplivincular, slightly amphidetic, inserted as in *Myalina*, in elongated grooves ("striae"), some with no more than 2 in each narrow ligamental area; anterior adductor scar ?semicircular, almost marginal, posterior adductor scar unknown. *U. Carb.* (*Westphal.-Stephan.*), W.Eu.-USSR (Donetz)-N.Am. (E.Can.).—FIG. C31,1a. *\*A. adamsii* (SALTER), *U. Carb.* (U.Amman.), Eng.; 1a-c, ?lectotype, LV ext., RV ext., both valves dorsal,  $\times 0.7$  (964b).—FIG. C31,1d. *A. sp.* cf. *A. fisheri* (WRIGHT), *U. Carb.* (L.Amman.), Eng.; hinge and ligament grooves,  $\times 2$  (Weir, n).

**Anthraconauta** PRUVOST, 1930 [*\*Unio phillipsii* WILLIAMSON, 1836] [=*Anthracomya* HIND, 1895 (*partim*); *Anthracomya* DAVIES & TRUEMAN, 1927 (*partim*)]. Equivalved, inequilateral; subovate, cordate or subtriangular, with inconspicuous umbones, straight hinge line and obliquely extended posterior end semielliptical, spatulate or acuminate in outline. Hinge line 50-80 percent of length, forming with straight or curved posterior margin obtuse angle ( $\beta$ ), which may be sharp or rounded, never auriculate; dorsal and ventral margins converging toward anterior end which may be quite acute; umbones small, situated well forward but not terminal, rising little or not at all above level of hinge line in type subgenus. Shell substance thin; ornament of concentric growth lines, folds or rugae, subgenera showing in varying degrees radial striation of delicate straight lines probably comprising trace of prismatic or periostracal structure shown through worn periostracum. Internal features unknown. *U. Carb.-Perm.*, cosmop.

**A. (Anthraconauta)**. Like *Naiadites*, but usually smaller, and umbones, situated farther from anterior end, lack proximal spiral twist; carina, byssal sinus and posterior auricle absent; posteroventral angle ( $\beta$ ) not rounded. Shell thin, periostracum well developed. Inflation low (shells usually flattened). Hinge and musculature unknown but probably as in *Naiadites*. *U. Carb.* (*Westphal.C.-Stephan.*), W.Eu.-USSR (Donetz); *U. Carb.-Perm.*, USSR (Sib.).—FIG. C31,2. *\*A. (A.) phillipsii* (WILLIAMSON), *U. Carb.* (Morgan.; *Westphal. C.*), Eng.; LV ext. (type),  $\times 2$  (Weir, 1960, in 915).



Septimyalina



Selenimyalina

FIG. C30. Myalinidae (marine) (p. N291).

[Derivative of *Naiadites*. In the Upper Carboniferous-Permian coal basins of Siberia, as a member of an otherwise mainly endemic nonmarine fauna, it proliferated into a large number of forms, some of which are approximately homeomorphic with heterochronous European equivalents (*A. pseudophilipsii*, *A. phillipsii*), and others have been named as genera by Russian paleontologists. At highest they are probably only of subgeneric rank, and some are so defined below. These subgenera, like *A. (Anthraconauta)*, occur at various horizons in the upper Carboniferous and Permian deposits of the Kuznetsk Basin and are doubtless products of variation, although this has still to be confirmed by formal studies of association and variation. Other genera which were endemic to these upper Paleozoic nonmarine deposits of Siberia do not seem to be intimately related to *Anthraconauta*; their internal characters are unknown, but those with straight hinge line and obliquely subovate outline are here, in certain cases (following KHALFIN), assigned to the Myalinidae, but with a query. The remainder have not been placed in families by Russian authors, even tentatively.]

**A. (Augea)** KHALFIN, 1950 [*\*A. ovata*; OD]. Like *Kineraella*; inconspicuous umbones forwardly directed at anterior end of shorter hinge line; less elongate diagonally. *U. Carb.-L. Perm.*, USSR (W.Sib.).—FIG. C31,6. *\*A. (A.) ovata*, L. Perm.; RV ext.,  $\times 2$  (Ragozin, 1955).

**A. (Kineraella)** KHALFIN, 1950 [*\*Parallelodon balakhonskiensis* RAGOZIN, 1931; OD]. Like *Mrassiella* but more transversely rhomboidal in outline, small, forwardly projecting umbones set nearer to anterior end; concentric rugae and radial striation especially prominent. *U. Carb.*, USSR (W.Sib.).—FIG. C31,3. *\*A. (K.) balakhonskiensis* (RAGOZIN); LV ext.,  $\times 2$  (Ragozin, 1955).



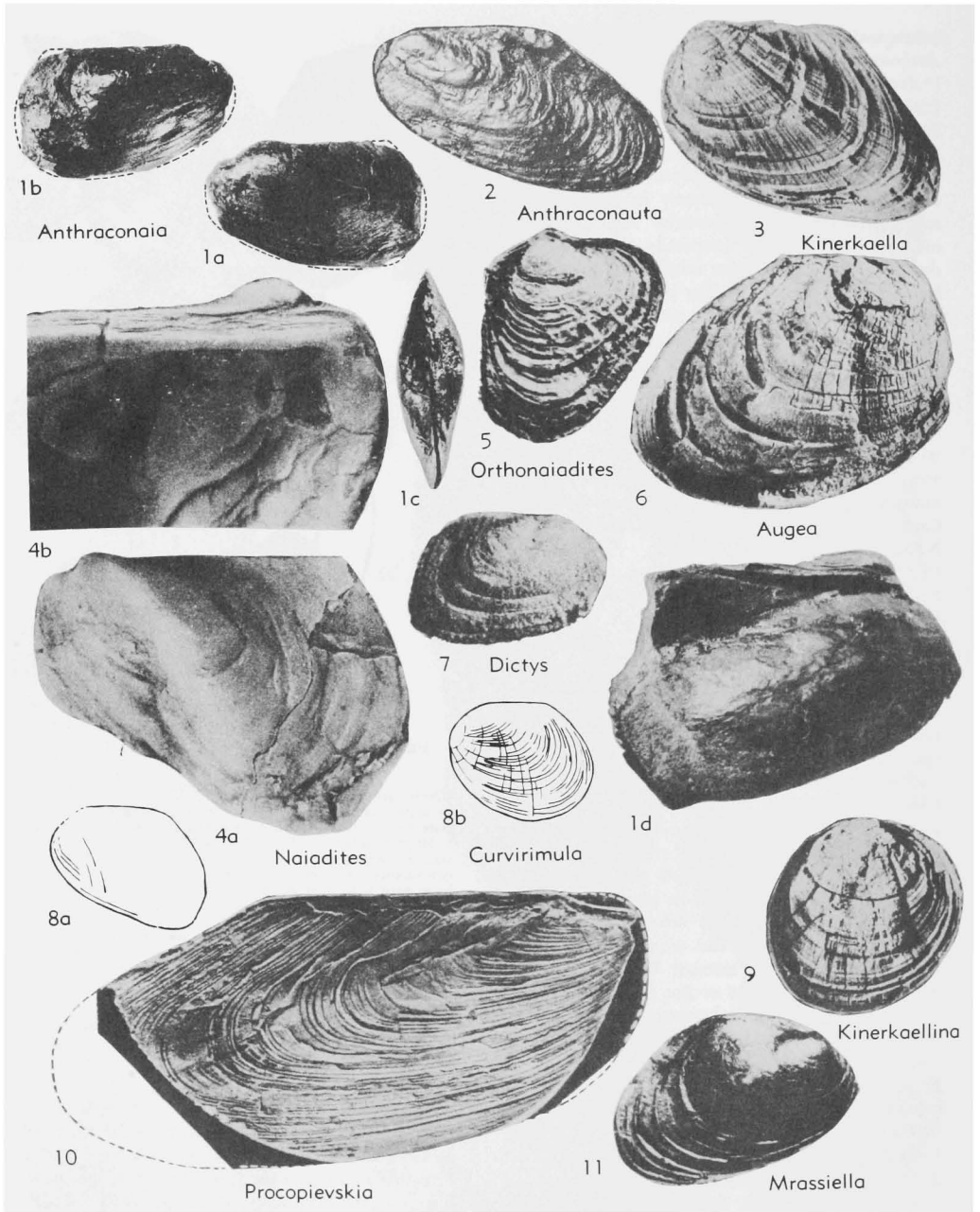


FIG. C31. Myalinidae (nonmarine) (p. N293-N295).

**A. (Mrassiella)** RAGOZIN, 1935 [*M. magniforma*; OD]. Like *A. (Anthraconauta)* but obliquely cordate and more inflated, with rounded margins and angles; small umbones projecting slightly and subcentrally above rather short, straight or gently curved hinge line. *U.Carb.-L.Perm.*, USSR (W.Sib.).—FIG. C31,11. \**A. (M.) magniforma*, *U.Carb.*; RV ext.,  $\times 1.5$  (Ragozin, 1955).

**A. (Procopievskia)** RAGOZIN, 1933 [*Anthracomya phillipsii* var. *gigantea* RAGOZIN, 1931; OD]. Like *Anthraconauta* but larger, with more acute anterior end; posterior extremity obliquely extended, making wide angle between straight dorsal and posterior margins; valves almost flat, umbones situated near anterior end, inconspicuous, not rising above level of hinge line. Perio-

stracum and prismatic layer thin. *L.Perm.*, USSR (W.Sib.).—FIG. C31,10. \**A. (P.) gigantea* RAGOZIN; RV ext. (outline restored by WEIR),  $\times 1.5$  (Ragozin, 1955).

?*Curvirimula* WEIR, 1960 [\**Anthracomya belgica* HIND, 1912; OD]. Like *A. (Anthraconauta)* but smaller, with orbicular and elongate-scalene tendencies; posterodorsal angle always rounded, never auriculate; crushed valves (usual condition) showing distinctive system of curved, subradial cracks (in crushed *Anthraconauta* cracks infrequent and straight). *Carb. (U. Dinant.-Amman.)*, W. Eu.; *Carb. (Cumberland.)*, Can. (N.S.).—FIG. C31,8a. \**C. belgica* (HIND), Namur, Belg.; LV ext. (lectotype),  $\times 2$  (964a).—FIG. C31,8b. *C. scotica* (ETHERIDGE, JR.), L. Carb. (Oil Shale Gr.), Scot.; LV ext. (holotype, counterpart),  $\times 2$  (Weir, n).

?*Dictys* KHAFLIN, 1950 [\**D. inflatus*; OD]. Small, inflated shells with inconspicuous umbones; trapeziform (anthraconaiiform), strongly inequilateral, posterior end slightly expanded and truncated. [The slightly convex ventral margin and straight dorsal margin are nearly parallel, but converge toward the rather deep anterior end.] *L. Perm.*, USSR (Sib.).—FIG. C31,7. \**D. inflatus*; RV ext.,  $\times 4$  (Ragozin, 1955).

?*Kinerkaellina* KHALFIN, 1950 [\**Kinerkaella (K.) imitabilis*; OD]. Small, orthocline-ovate; valves uniformly and gently convex, umbones subcentral, projecting slightly above short hinge line; radial striation irregular. *U. Carb.*, USSR (W.Sib.).—FIG. C31,9. \**K. imitabilis*; RV ext.,  $\times 3.5$  (Ragozin, 1955).

*Naiadites* DAWSON, 1860 [*non Najadites* AMALITSKY, 1892] [\**N. carbonarius*; SD HIND, 1894] [= *Anthracopectera* SALTER, 1863]. Like *Myalina* internally, apart from minor differences of anterior musculature resulting from relatively greater length of anterior end in *Naiadites*; modioliform, umbones not terminal. Ligament duplivincular, slightly amphidetic; area narrow, marked by grooves (2 to 7 or 8) of ligamental attachment; LV usually more inflated than RV; wide and shallow byssal sinus present in some; carina (umbonal ridge) of variable curvature, inflation and prominence runs from umbo of 1 or both valves toward posteroventral margin, defining region of maximum inflation and usually large in LV; posterior auricle ("ear" or "wing") may be present. *L. Carb. (Dinant.)*, Scot.; *U. Carb.*, Eu.-N. Am. (Namur., G. Brit., Westphal. A.B, W. Eu., USSR, Donetz).—FIG. C31,4. \**N. carbonarius*, *U. Carb.*, N. Scot.; lectotype, 4a, LV ext.,  $\times 3$ ; 4b, LV int., showing ant. musculature and duplivincular ligamental area,  $\times 5$  (666).

?*Orthonaiadites* KHALFIN, 1950 [\**O. triangularis*; OD]. Scalene, orthocline, main diagonal almost coincident with long, straight (or slightly curved) anteroventral margin, which runs almost at right angles to hinge line; antero- and posterodorsal

angles rounded, orthogyral umbones projecting slightly; ventral region produced, acutely rounded. *U. Carb.*, USSR (W.Sib.).—FIG. C31,5. \**O. triangularis*; RV ext.,  $\times 3.8$  (Ragozin, 1955).

## ?Family LUNULACARDIIDAE Fischer, 1887

[Materials for this family prepared by N. D. NEWELL & AURÈLE LA ROCQUE]

Mainly small shells, equivalve, monomyarian, opisthodontic, with beaks at front of hinge; edentulous; character of ligament unknown. [These forms are similar to Ambonychiidae in many respects but their affinities will remain uncertain until their morphology is better known.] *L. Ord.-Miss.*

*Lunulacardium* MÜNSTER, 1840, p. 69 [\**L. semistriatum*; SD STOLICZKA, 1870] [= *Pinnopsis* HALL, 1843, p. 244 (type, *P. acutirostrum*; SD LA ROCQUE & NEWELL, herein); *Chaenocardiola* HOLZAPFEL, 1889, p. 61 (type, *Cardita halioideoidea* ROEMER; SD BEUSHAUSEN, 1895)]. Triangular to elongate oval, thin-shelled, with prominent beaks and long byssal gape. *U. Sil.-L. Carb.*, N. Am.-Eu.

*L. (Lunulacardium)*. Beaks opisthogyre, shell surface with prominent radial costae. *U. Sil.-L. Carb.*, N. Am.-Eu.—FIG. C32,1. \**L. (L.) semistriatum*, U. Dev., Ger.; 1a,b, RV ext., ant.,  $\times 2$  (136).

*L. (Honeoyea)* CLARKE, 1904, p. 225 [\**H. erinacea*; OD]. Similar to *L. (Lunulacardium)* but radial ornamentation consisting of several ranks of intercalating ribs; anterior and posterior margins commonly spinose. *U. Dev.*, USA (N.Y.)-Ger.—FIG. C32,5. \**L. (H.) erinacea*, U. Dev. (Naples), USA (N.Y.); 5a, LV ext.,  $\times 5$ ; 5b,c, LV ant., post.,  $\times 10$  (136).

*L. (Prosochasma)* BEUSHAUSEN, 1895 [\**L. pyri-forme* MÜNSTER, 1840; SD CLARKE, 1904, p. 228] [= ?*Onychocardium* WHITFIELD, 1905, p. 18 (type, *O. portlandicum*; M)]. Similar to *L. (Lunulacardium)* but with smooth or finely costellate surface and short byssal gape. *Dev.*, Ger.-USA (N.Y.).—FIG. C32,7. *L. (P.) bickense* (HOLZAPFEL), L. Dev., Bicken, Ger.; 7a,b, dorsal and side views; both  $\times 1$  (47).

*Euchasma* BILLINGS, 1865, p. 360 [\**E. blumenbachi*; M]. Trigonal, with truncate anterior and slightly gaping front end; posterior end extended slightly in rounded wing; surface ornamented with radial costae; hinge ankylosed?. *L. Ord.*, Can. (Maritime prov.).—FIG. C32,8. \**E. blumenbachi*, L. Ord., E. Can.; 8a,b, RV ext., both valves ant.,  $\times 1$  (52).

*Maminka* BARRANDE, 1881, p. 106 [\**M. comata*; SD LA ROCQUE & NEWELL, herein] [= *Matercula* BARRANDE, 1881 (obj.)]. Subtrigonal, with approximately median beaks; anterior end acuminate, truncate, not gaping, bordered by carina; in-

equivalve, with radial sulcus on either RV or LV; ornamented with radial costae. *Ord.(Ds)-Sil.(E1,2)*, Boh.—FIG. C32,3. \**M. comata*, Sil.(E1); 3a,b, RV int. mold, ext., ant., 3c, RV hinge view; all ?X1 (27).

Mila BARRANDE, 1881, p. 106 [\**M. complexa*; OD] [= *Dilecta* BARRANDE, 1881, p. 106 (obj.)]. Subtriangular, with subquadrate posteriorly; slightly inequivalve; beaks terminal with RV beak slightly ahead of LV; beaks terminal; without byssal gape;

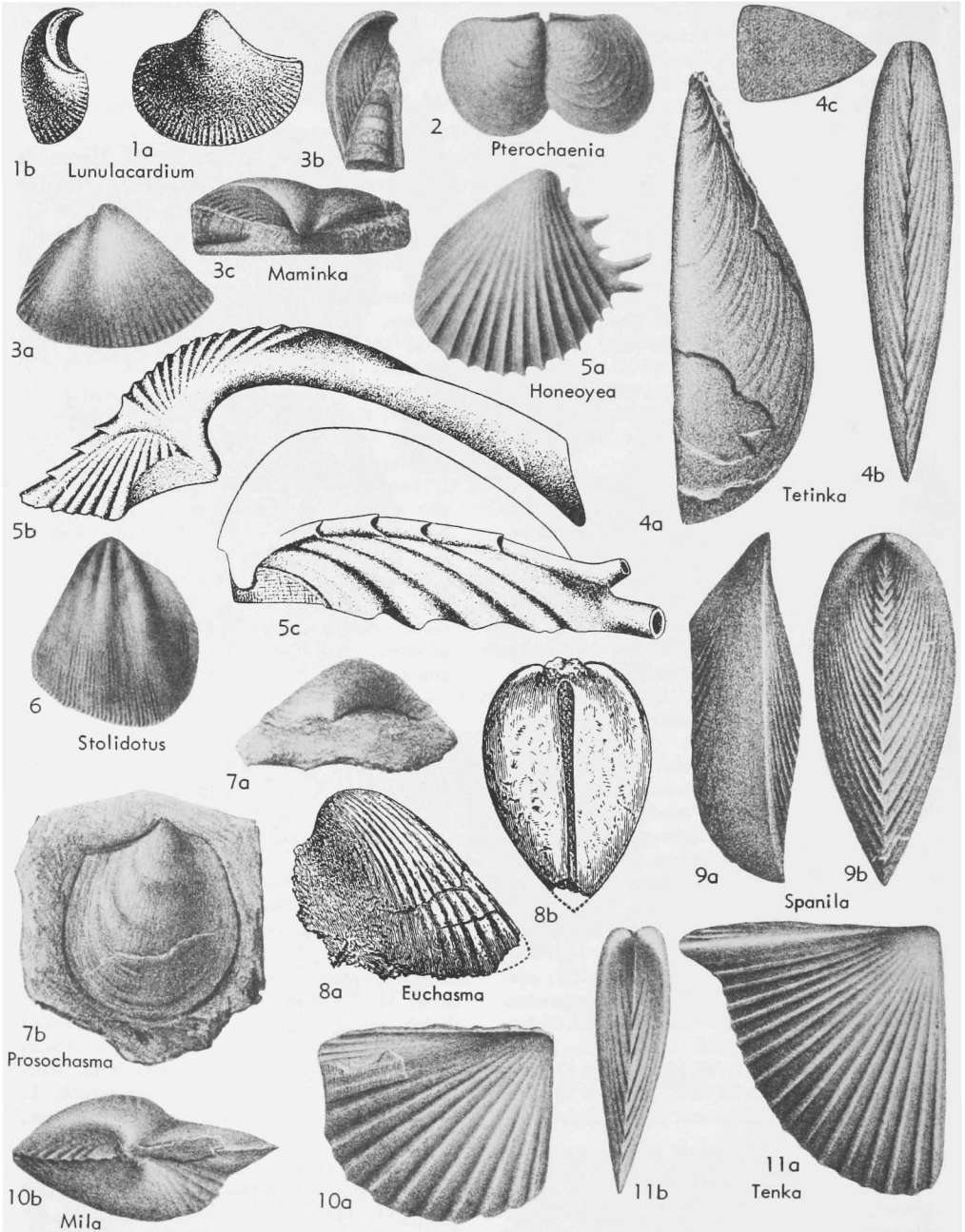


FIG. C32. Lunulacardiidae (p. N295-N297).

surface with strong radial costae; strong sulcus behind umbonal fold on LV. *Sil.*( $E_2$ )-*Dev.*( $F_1$ ), Boh.—FIG. C32,10. \**M. complexa*, *Sil.*( $E_2$ ), Dlauha Hora; 10a,b, int. mold RV ext. and dorsal views,  $\times 2$  (27).

**Pterochaenia** CLARKE, 1904, p. 247 [\**Avicula fragilis* HALL, 1843; SD SHIMER & SHROCK, 1944] [= *Dvorecia* RŮŽIČKA, 1949, p. 104 (type, *Avicula contempta* BARRANDE, 1881; OD); ?*Joachymia* RŮŽIČKA, 1949, p. 102 (type, *Avicula falcata* BARRANDE, 1881; OD)]. Similar to *Lunulacardium* but with internal costellae, small anterior auricle, and prosogyre beaks. ?*Sil.*( $E_2$ ), Boh., *M.Dev.-U.Dev.*, USA(N.Y.), Timan.—FIG. C32,2. \**P. fragilis* (HALL), *U.Dev.*(Genesee Sh.), USA(N.Y.); ext. both valves,  $\times 2$  (136).

**Spanila** BARRANDE, 1881, p. 161 [\**S. discipulus*; SD RŮŽIČKA & PRANTL, 1960] [= *Venusta* BARRANDE, 1881 (non BOETTGER, 1877) (vernacular translation of *Spanila* (obj.)); ?*Patrocardia* FISCHER, 1887, p. 1041 (type, *Hemicardium dimidiatum* BARRANDE, 1881, SD RŮŽIČKA & PRANTL, 1960); ?*Conocardiopsis* BEUSHAUSEN, 1895, p. 378 (type, *Cardium lyelli* D'ARCHIAC & DE VERNEUIL, 1842; M)]. Cuneiform, equivalve, with strong anterior carina; strongly truncate anteriorly; lunular depression closed; beaks terminal, pointed, surface with radial costae. [Resembles *Euchasma* BILLINGS, 1865.] *Sil.*, Boh.; ?*Dev.*, Ger.—FIG. C32,9. \**S. discipulus*, *Sil.* ( $E_{1-2}$ ), Boh.; 9a,b, RV lat., both valves ant.,  $\times 2$  (27).

**Stolidotus** HEDE, 1915, p. 34 [\**S. siluricus*; OD]. Trigonal shells with broad anterior gape; ornamented by fine radial costellae and 3 broad radial furrows that tend to flatten out along margin. *Sil.*, Sweden.—FIG. 32,6. \**S. siluricus*, Colonus Sh.; LV ext.,  $\times 3$  (Hede, 1915).

**Tenka** BARRANDE, 1881, p. 163 [\**T. bohémica*; OD] [= *Tenuis* BARRANDE, 1881, p. 163 (obj.); *Lepetynoconcha* FRECH, 1891, p. 249 (nom. van. pro *Tenka*)]. Similar to *Spanila*, but without carina and with blunt spurlike posterior wing. *Ord.*( $D_3$ )-*Sil.*( $E_2$ ), Boh.—FIG. C32,11. \**T. bohémica*, *Sil.* ( $E_2$ ); 11a, RV int. mold; 11b, both valves ant.; both approx.  $\times 2$  (27).

**Tetinka** BARRANDE, 1881, p. 164 [\**T. sagitta*; SD LA ROCQUE & NEWELL, herein] [= *Amita* BARRANDE, 1881, p. 164 (obj.); *Goniophorella* FRECH, 1891, p. 249 (nom. van. pro *Tetinka*)]. Similar to *Spanila* but without carina; triangular in lateral outline, truncated anteriorly. *Ord.*( $D_3$ )-*Sil.*( $E_2$ ), Boh., ?*Sil.*, Ger.—FIG. C32,4. \**T. sagitta*, *Sil.* ( $E_2$ ), Boh.; 4a, RV ext., 4b, both valves ant., 4c, cross section both valves, cardinal margin to left; all  $\times 2$  (27).

## Family MONOPTERIIDAE Newell, new family

[Materials for this family prepared by N. D. NEWELL]

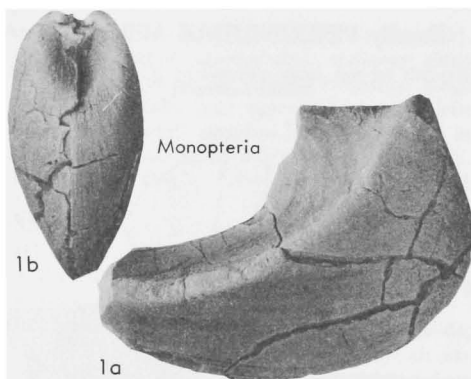


FIG. C33. Monopteriidae (p. N297).

Shell form pteroid, equivalve, without radial ornamentation; shell body slender, produced posteriorly in concave arc extending well behind extended rear dorsal wing; prominent umbonal carina reaching from beaks downward and backward in smooth curve, becoming horizontal posteriorly; beaks terminal, small, prosogyre; anterior end truncate, depressed in deep lunule in which are visible one or two interlocking teeth in each valve, those of LV overlying equivalent teeth of RV; ligament as in Myalinidae and Ambonychiidae. *L.Penn.-U.Penn.*, USA(Midcontinent); ?*L.Perm.*, SW.USA.

**Monopteria** MEEK & WORTHEN, 1866, p. 20 [\**Gerwillia longispina* Cox; OD]. Characters of family. *L.Penn.-U.Penn.*, ?*L.Perm.*, USA(Midcontinent-SW.).—FIG. C33,1. \**M. longispina* (Cox), U. Penn., Jacksboro, Tex.; 1a,b, RV ext., both valves ant.,  $\times 2$  (Newell, n).

## Superfamily PTERIACEA Gray, 1847 (1820)

[nom. transl. DALL, 1894 (ex Pteriidae GRAY, 1847; = *Aviculidae* GOLDFUSS, 1820)] [Diagnosis by N. D. NEWELL]

Inequivalve, inequilateral, RV generally less convex than LV, markedly prosocline at least in juveniles with beaks situated well forward; ligament external, opisthodontic, variable otherwise; prismatic or crossed lamellar, endostracum aragonitic, pallial line anteriorly discontinuous; characteristically byssate throughout life with byssal notch in RV at least in juvenile stages. *Ord.-Rec.*

**Family PTERINEIDAE Miller, 1877**

[Materials for this family prepared by N. D. NEWELL and AURELE LAROCQUE]

Inequivalve, LV more convex than RV, orbicular to strongly prosocline, pteroid, commonly with small or obsolescent an-

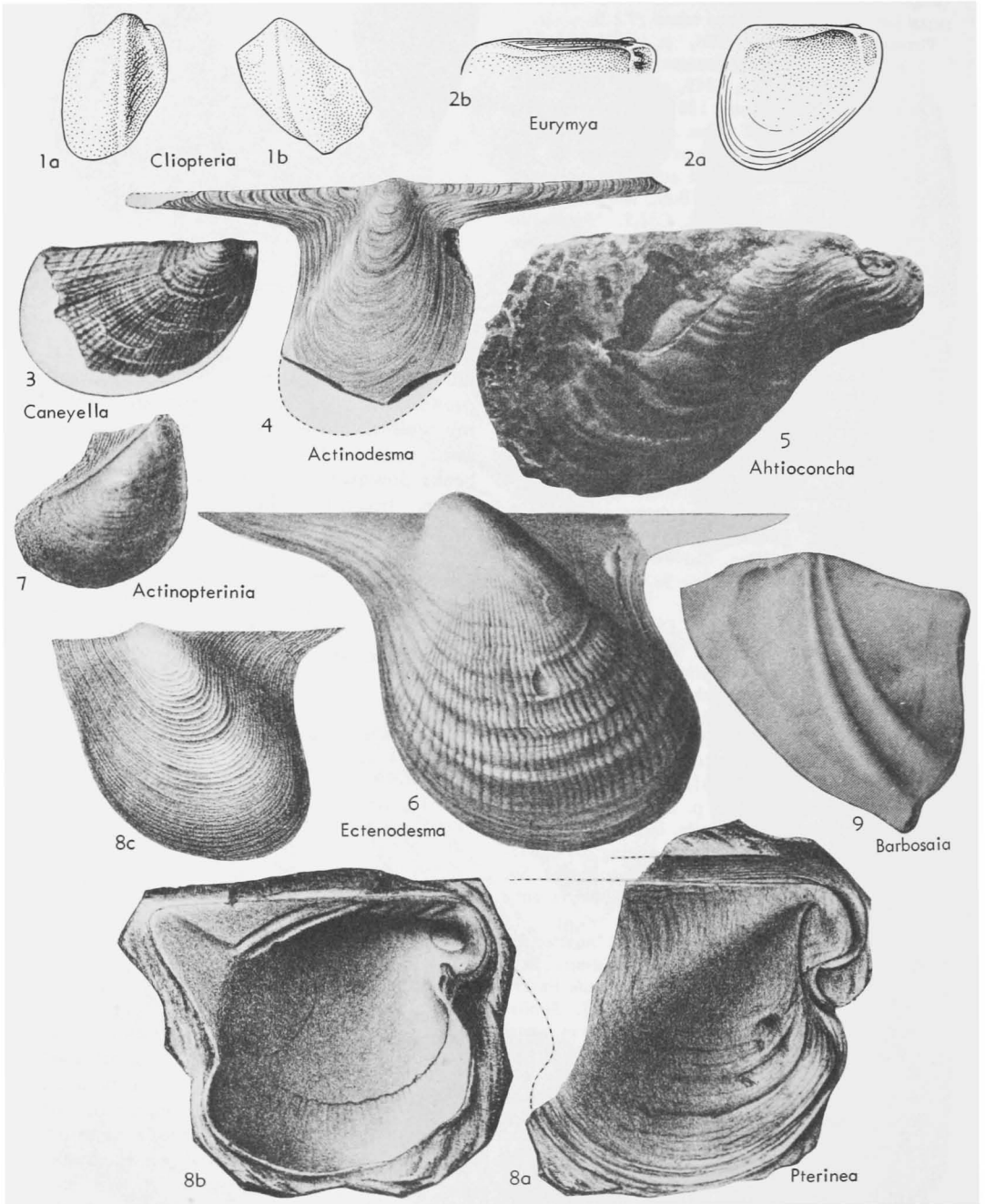


FIG. C34. Pterineidae (p. N299).

terior auricles; ligament duplivincular, more or less opisthodic; heteromyarian or monomyarian, anterior muscles reinforced in several genera by septum or buttress; dentition absent to strong, actinodont or parallelodont, with variable number of small cardinals and commonly posterior laterals diverging from vicinity of beaks. *Ord.-U. Perm.*

Many genera have been based on slight variations in obliquity, form, dentition, and strength of the myophoric buttress. Others are based on supposed stratigraphic or geographic restrictions. Since most are known only from rare or poorly preserved material, it is difficult to evaluate these variations. In comparison with living Pteriidae, many may be of specific rather than generic significance.

**Pterinea** GOLDFUSS, 1826, p. 133 [*\*P. laevis*; SD STOLICZKA, 1871] [= *Micropteria* FRECH, 1891, p. 80 (type, *Pterinea ventricosa* GOLDFUSS, 1832; OD); *Caritodens* FOERSTE, 1910, p. 71 (type, *Pterinea demissa* CONRAD, 1842; OD); *Beushausenia* MAILLIEUX, 1913, p. 33 (type, *Pterinea expansa* MAURER, 1886); *Maillieuxia* COSSMANN, 1920, p. 137 (pro *Beushausenia* MAILLIEUX, 1913, non COSSMANN, 1897)]. Upright suborbicular shells without radial ornamentation and possessing a well-developed rounded auricle and well-defined posterior wing. *U.Ord.-L.Dev.*, cosmop.—FIG. C34,8a,b. *\*P. laevis*, L.Dev., Ger.; 8a,b, RV ext., LV int.,  $\times 1$  (323).—FIG. C34,8c. *P. demissa* (CONRAD), U.Ord., USA (Ohio); LV ext.,  $\times 1$  (381).

**Actinodesma** SANDBERGER, 1850 [*\*A. malleiforme*; M]. Upright pteroid shells with pointed and more or less extended hinge extremities; anterior adductor small or lacking. *L.Dev.-U.Dev.*, Eu.-USA.

**A. (Actinodesma)** [= *Glyptodesma* HALL, 1883 (type, *G. erectum*; SD MILLER, 1889)]. Without radial ornamentation. *L.Dev.-U.Dev.*, Eu.-USA.—FIG. C34,4. *\*A. (A.) malleiforme*, L.Dev., Ger.; RV ext.,  $\times 1$  (323).

**A. (Ectenodesma)** HALL, 1883 [*\*A. (E.) birostratum*; SD S. A. MILLER, 1889; OD] [= *As-sellbergia* MAILLIEUX, 1931 (type, *Avicula obsoleta* GOLDFUSS, 1826; OD)]. With radial or reticulate ornamentation. *L.Dev.-U.Dev.*, Eu.-USA (N.Y.).—FIG. C34,6. *\*A. (E.) birostratum* (HALL), U.Dev., N.Y.; LV ext.,  $\times 1$  (377).

**Actinopterina** ISBERG, 1934, p. 214 [*\*A. semicircularis*; OD]. Prosocline, smooth, falcate shells similar to *Leptodesma* but lacking(?) anterior auricle. *M.Ord.*, Sweden.—FIG. C34,7. *\*A. semicircularis*, Leptaena Ls., Kullberg, Sweden; RV ext.,  $\times 3$  (439).

**Ahtioconcha** ÖPIK, 1930, p. 17 [*\*A. auris*; OD]. Large, ear-shaped, asymmetrical; umbones about 0.3 hinge length behind anterior extremity; hinge line behind umbo bent sigmoidally toward left; posterior expanded, spatulate but not extended in wing; hinge unknown. *Ord. (Kukruse Stage)*, NE. Est.—FIG. C34,5. *\*A. auris*; RV ext.,  $\times 1$  (687).

**?Alnifa** TERMIER & TERMIER, 1950 [*\*A. clariondi*; M]. *M.Ord. (Llandeil.)*, Morocco.

**?Anderkenia** KHALFIN, 1958, p. 163 [*\*A. laedae-morpha*; OD]. *Ord.*, USSR (Kazakhstan).

**?Barbosaia** MENDES, 1952, p. 70 [*\*B. angulata*; OD]. Subtriangular, prosocline; shell smooth except for 2 prominent oblique ridges that radiate from beak to posterior extremity. *Perm. (Corumbatai)*, S. Brazil.—FIG. C34,9. *\*B. angulata*; LV ext.,  $\times 2$  (Mendes, 1952). [NEWELL]

**Caneyella** GIRTY, 1909, p. 32 [*\*C. richardsoni*; OD]. Elongate-ovoid, with quadrate anterior auricles and obtuse posterior wing; beaks terminal; surface marked by fine costae which divide in fascicles of 2 or 3 ribs becoming weak in some individuals; otherwise similar to *Ptychopteria*, s.s. *U. Miss.*, S.C. USA-W. USA.—FIG. C34,3. *\*C. richardsoni*, Caney Sh., Okla.; RV ext.,  $\times 2$  (Girty, 1909).

**?Cliopteria** WILLIAMS, 1912, p. 391 [*\*C. bicostata*; OD]. Nearly equivalve, anterior auricle small, posterior wing lacking; RV with 1 or 2 radiating, rounded, cordlike costae, LV with corresponding furrows; ligament area broad; RV with 2 short anterolaterals and 2 short posterolaterals; LV with 1 strong anterolateral and 1 strong posterolateral; hinge margin with small teeth between laterals. *Sil. (Pembroke)*, USA (Me.).—FIG. C34,1. *\*C. bicostata*; 1a,b, RV ext., LV int. mold,  $\times 1$  (984).

**Dolichopteron** MAURER, 1886. *L.Dev.*, Ger. Not seen.

**?Eurymya** ULRICH, 1894, p. 512 [*\*Modiolopsis plana* HALL, 1861; OD]. Subtriangular with broad and winglike posterior and greatly narrowed anterior end; base oblique; hinge line straight; beaks small, situated near anterior extremity; hinge strong; LV with 1 cardinal tooth; RV with corresponding depression; ligamental area broad and longitudinally striated, posterior to beaks. *M.Ord. (Blackriver-Trenton.)*, USA (Minn.-Ky.).—FIG. C34,2. *\*E. plana* (HALL), Trenton., Minn.; 2a, LV int.,  $\times 1$ ; 2b, LV hinge,  $\times 2$  (930).

**Leptodesma** HALL, 1883, p. 4 [*\*L. potens*; SD S. A. MILLER, 1889] [= *Cobrachephalus* WHIDBORNE, 1897, p. 118 (type, *C. angulosus*; M); *Pterinopsis* STUCKENBERG, 1898, p. 37 (type, *P. permocarbo-nicus*; M); *Cyrtodontarca* YAKOVLEV, 1903, p. 12 (type, *C. bakewelliioides*; OD); ?*Pseudobakewellia* NOINSKY, 1913, p. 44 (nom. nud.); *Rousseauia* MAILLIEUX, 1920, p. 140 (type, *Avicula pseudo-capuliformis* BEUSHAUSEN in MAILLIEUX, 1920; M); *Pegasella* CASTER, 1930, p. 57 (type, *P. ales*; OD); *Peraptera* DAHMER, 1935, p. 651 (type, *P.*



*unkelensis*; OD); *Dozierella* NEWELL, 1940, p. 282 (type, *Bakewellia gouldii* BEEDE, 1902; OD); *Diodontopteria* LAROCQUE, 1950, p. 288 (type, *D. ehlersi*; OD); *Springeria* ELIAS, 1957, p. 761 (type, *S. matheri*; OD)]. Without radial ornamentation;

left umbo more prominent than right; posterior wing commonly well developed; myophoric buttress weak; cardinal teeth few and variable in number. *M.Sil.-U.Perm.*, cosmop.

L. (*Leptodesma*). Anterior auricle angular and

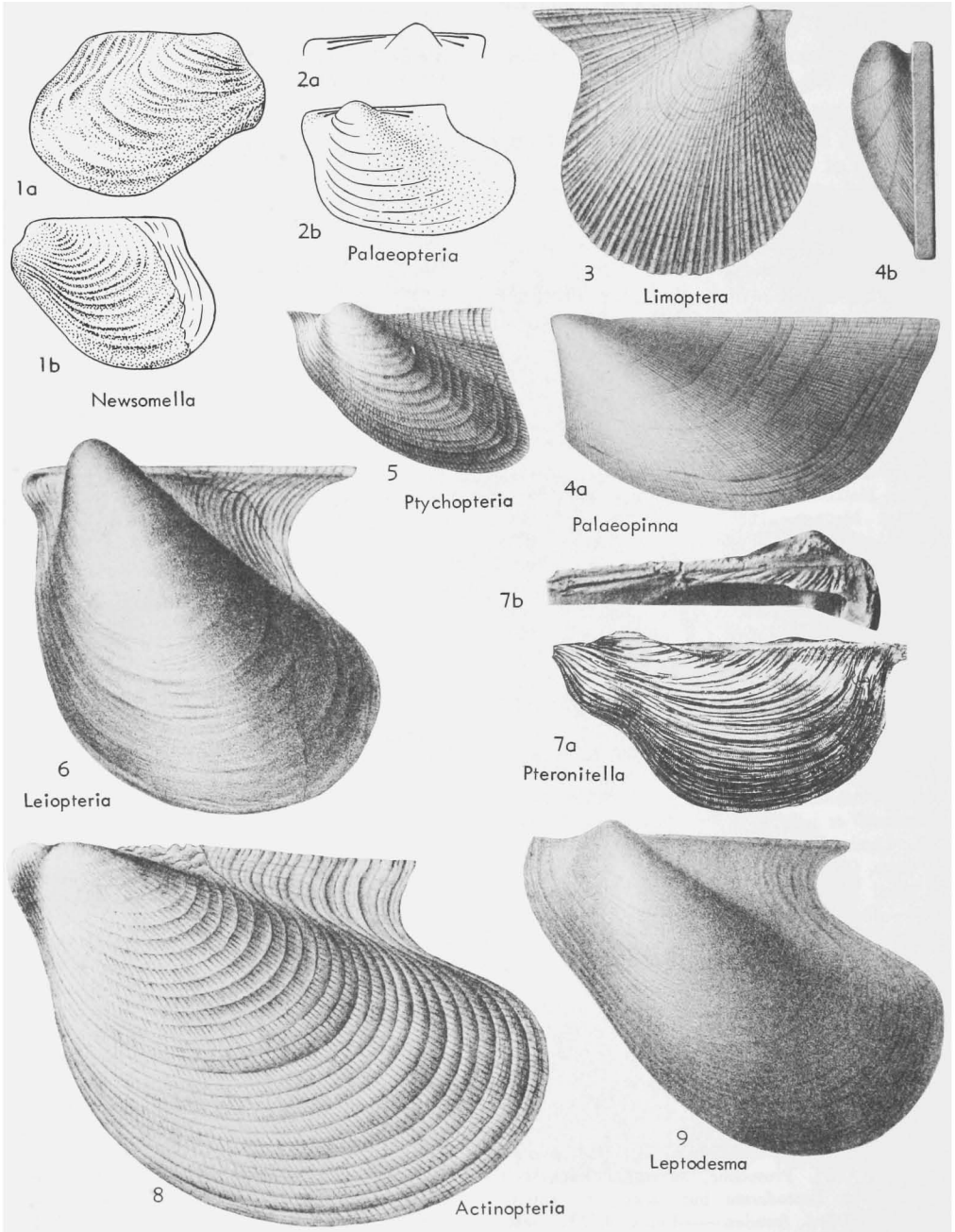


FIG. C35. Pterineidae (p. N300-N302).



nasute. *M.Sil.-Perm.*, cosmop.—FIG. C35,9. \**L. (L.) potens*, U.Dev., USA(N.Y.); LV ext.,  $\times 1$  (377).

**L. (Leiopteria)** HALL, 1883, p. 4 [\**L. deKayi*; SD S. A. MILLER, 1889]. Anterior auricle lobate. *M.Sil.-L.Perm.*, cosmop.—FIG. C35,6. \**L. (L.) deKayi* (HALL), M.Dev., USA(N.Y.); LV ext.,  $\times 1$  (377).

**Limoptera** HALL & WHITFIELD, 1869, p. 15 (see COOPER, 1931) [\**Lima macroptera* CONRAD, 1838; OD] [= *Myalinodonta* OEHLERT, 1881, p. 29 (type, *Avicula normanniana* D'ORBIGNY, 1847; M); ?*Paropsis* OEHLERT, 1888 (type, *P. orbicularis*; M); ?*Klinoptera* DIENST, 1935, p. 388 (type, *K. rhenana*; M)]. Orbicular, with weak to strong radial costae, elongate posterior wing and very small or obsolete anterior auricle; anterior adductor small or lacking in adults. *U.Sil.-M.Dev.*, W.Eu.-USA.—FIG. C35,3. \**L. macroptera* (CONRAD), M.Dev.(Hamilton), USA(N.Y.); RV ext.,  $\times 1$  (377).

**Merismopteria** ETHERIDGE, 1892, p. 271 [\**Pterinea macroptera* MORRIS, 1845; OD]. Externally like *Leptodesma* (*Leiopteria*) without radial ribs; with very thin, high myophoric septum in each valve separating large, elongate, anterior adductor from relatively large pedal retractor muscles, situated behind septum; anterior part of pallial line discontinuous. *Perm.*, Australia-?India.—FIG. C36, 1. \**M. macroptera* (MORRIS), New S.Wales; *1a,b*, RV and dorsal views of shell; *1c,d*, RV and dorsal views of int. mold; *1e*, LV int. showing ligament area; all latex casts,  $\times 1$  (Newell, n).

**Newsomella** FOERSTE, 1909, p. 67 [\**Rhombopteria (N.) ulrichi*; SD NEWELL & LAROCQUE, herein]. Similar externally to *Leiopteria*; ornamented with concentric rugae and on RV with 2 sets of radial costellae crossing each other at angle of about 30 degrees, most conspicuous along umbonal ridge. *M.Sil.(Waldron)*, USA(Tenn.).—FIG. C35,1. \**N. ulrichi* (FOERSTE); *1a,b*, RV ext., LV ext.,  $\times 1$  (315).

?**Palaeopinna** HALL, 1883, p. 4 [\**P. flabellum*; SD S. A. MILLER, 1889]. Elongate, with small, terminal beaks; truncate anterior margin and broad, posterior region extended in acute, compressed wing; surface ornamented with radial costellae; hinge and RV unknown. *L.Dev.-M.Dev.*, N.Am.—FIG. C35,4. \**P. flabellum*, M.Dev.(Oriskany), USA(N.Y.); *4a,b*, LV ext., RV ant.,  $\times 0.7$  (377).

?**Palaeopteria** WHITEAVES, 1897, p. 181 [\**P. parvula*; M]. Beaks anterior, surface unknown; hinge with thin laminar teeth on each side of beak, nearly parallel to cardinal margin, 2 anterior and 2 posterior in RV; 2 anterior and 3 posterior in LV; muscle scars unknown. *U.Ord.*, Can.(Man.).—FIG. C35,2. \**P. parvula*; *2a*, RV hinge,  $\times 6$ ; *2b*, LV int. mold,  $\times 2$  (Whiteaves, 1897).

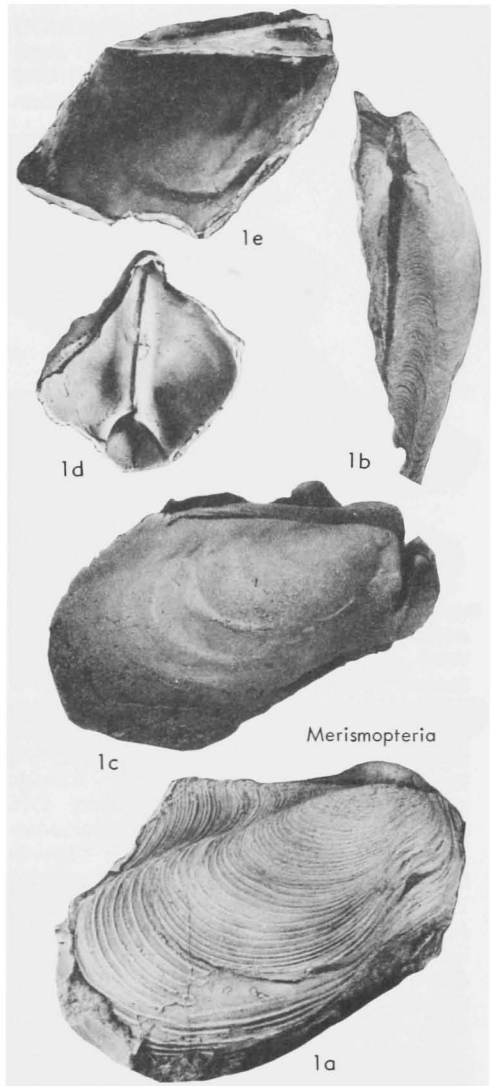


FIG. C36. Pteriineidae (p. N301).

**Pteronitella** BILLINGS, 1874, p. 302 [\**Avicula retroflexa* HISINGER, 1826 (= *Mytilites retroflexus* WAHLENBERG, 1821); M]. Similar externally to *Leptodesma s. s.*, but with arcuate ventral margin and with numerous actinodont teeth. *U.Sil.*, Sweden (Gotl.)-Wales-Can.(N.S.).—FIG. 35,7. \**P. retroflexa* (WAHLENBERG), Ludlov.; *7a*, LV ext. (Wales),  $\times 1$ ; *7b*, LV hinge (Gotl.),  $\times 1$  (Walmsley, 1962).

?**Pteronitina** KHALFIN, 1958 [\**P. aenigmatica*; OD]. *Sil.*, Caradoc., USSR(Kazakhstan).



FIG. C37. Kochiidae (p. N302).

**Ptychopteria** HALL, 1883, p. 3 [\**P. eugenia* (= *P. salamanca* HALL, 1884) (obj.); SD S. A. MILLER, 1889] [= *Actinoptereilla* WILLIAMS, 1908 (type, *Pterinea radialis* CLARKE, 1907; OD); *Cornellites* WILLIAMS, 1908 (type, *Pterinea fasciculata* GOLDFUSS, 1832; OD); *Tolmaia* WILLIAMS, 1908 (type, *Pterinea lineata* GOLDFUSS, 1863); *Folmannella* WILLIAMS, 1908 (type, *Pterinea mainensis* CLARKE, 1907; OD); ?*Diaphragmella* ETHERIDGE, 1916 (type, *D. merismopteroides*; OD); *Dipterophora* FUCHS, 1920 (type, *D. triculta*; OD); *Oleanella* CASTER, 1930 (type, *Ptychopteria expansa* HALL, 1884; OD); *Crassialaria* DAHMER, 1932 (type, *Pterinea quirini* DAHMER, 1931; OD); *Beushausenella* DAHMER, 1935 (type, *B. mailleuxi*; OD) (pro *Pterinea expansa* FRECH, 1891); *Augustaia* RŮŽIČKA, 1949 (type, *Avicula expulsa* BARRANDE, 1881; OD); *Kodymia* RŮŽIČKA, 1949 (type, *Avicula dispersa* BARRANDE, 1881; OD); *Prantliella* RŮŽIČKA, 1949 (type, *Avicula pallista* BARRANDE, 1881; OD)]. Strongly prosocline with anterior auricle and posterior wing well developed; LV convex, RV less convex, to flattened or concave; dentition highly variable, actinodont to paralleodont or obsolescent; anterior adductor scar on auricle, small and commonly deep, with or without buttress; radial costae well developed on LV, obsolescent to strong on body of RV. *Sil.-L.Perm.*, cosmop.

**P. (Ptychopteria)**. Anterior auricle obliquely truncated. *U.Dev.*, USA.—FIG. C35,5. \**P. (P.) eugenia* (HALL), Chemung, N.Y.; LV ext.,  $\times 1$  (377).

**P. (Actinopteria)** HALL, 1884, p. xii [\**Avicula decussata* HALL, 1843; SD BASSLER, 1915] [= *Actinoptera* HALL, 1883 (non RONDANI,

1861)]. Anterior auricle lobose. *Sil.-Dev.*, cosmop.; *L.Penn.*, USA (Ill.); *L.Perm.*, Australia (New S.Wales).—FIG. C35,8. \**P. (A.) decussata* (HALL), M.Dev. (Hamilton), USA (N.Y.); LV ext.,  $\times 1$  (377).

### ?Family KOCHIIDAE Maillieux, 1931

[*nom. transl.* NEWELL, herein (ex Kochiinae MAILLIEUX, 1931)] [Materials for this family prepared by N. D. NEWELL]

Shell capuliform, very inequivalve, LV highly convex and narrow, wings small and poorly delimited; RV flat or concave, operculate; dentition obscure or ?lacking; with or without radial ornamentation. *Dev.*, Eu.

**Kochia** FRECH, 1891 [pro *Roemeria* KOCH, 1881 (non MILNE-EDWARDS & HAIME, 1851)] [\**Avicula capuliformis* KOCH, 1881; OD] [= *Onychia* SANDBERGER, 1889 (obj.), DE BLAINVILLE, 1823; *soxopteria* FRECH, 1891 (type, *Avicula dispar* SANDBERGER, 1889; SD NEWELL, herein)]. Characters of family. *L.Dev.-U.Dev.*, W.Eu.—FIG. C37,1. \**K. capuliformis* (KOCH), L.Dev. (Siegener Grauwacke), Ger. (Rheinl.); ant.,  $\times 1$  (323).

### Family PTERIIDAE Gray, 1847 (1820)

[*nom. correct.* MEEK, 1864 (pro Pteriidae GRAY, 1847); = *Aviculidae* GOLDFUSS, 1820 (*nom. correct.* GRAY, 1840, pro *Aviculae* GOLDFUSS, 1820); name Pteriidae retained in accordance with provisions of Article 40a, of Zool. Code (1961)] [*non* Pteriidae BRODERIP, 1839 (Penny Cyclopaedia, v. 14, p. 321), employed for gastropods known as "wing-shells" (*aîlées*) such as *Rostellaria*, *Pterocera*, *Strombus*] [Materials for this family prepared by L. G. HERTLEIN & L. R. COX]

Obliquely ovate to suborbicular, usually with triangular winglike projection bordering each end of straight hinge line; subequivalve to strongly inequivalve, LV usually more inflated; inequilateral, umbones placed well toward anterior end; anterior wing (or auricle) smaller, byssal notch present beneath it in RV; both valves with obtusely triangular cardinal area bearing shallow triangular ligament pit directed posteriorly from beak; dentition variable, teeth (when present) usually short and transverse near beak, elongated posteriorly in longitudinal direction; dimyarian in juvenile stages, monomyarian or with anterior adductor much reduced in adult; posterior adductor impression large; pallial line commonly discontinuous; interior pearly; sculpture variable, relatively smooth forms predominating. *Trias.-Rec.*

**Pteria** SCOPOLI, 1777, p. 397 [\**Mytilus hirundo* LINNÉ, 1758, p. 706] [= *Avicula* BRUGUIÈRE, 1792 (*nom. et fig.*); *Avicula* CUVIER, 1798 (type, *M. hirundo*; SD KENNARD, SALISBURY & WOOD-

WARD, 1931, p. 14); *Glaucus* POLI, 1795; *Glaucoderma* POLI, 1795 (non FOSTER, 1777, nec GME-LIN, 1791); *Hirundigenus* RENIER, 1807 (sup-pressed ICZN); *Anonica* OKEN, 1815 (obj.)

(ICZN rejected work); *Austropteria* IREDALE, 1931 (type, *A. saltata*; OD); *Magnavicula* IREDALE, 1939 (type, *M. bennetti*; OD)]. Obliquely ovate, moderately inflated, slightly inequivalve; elongate

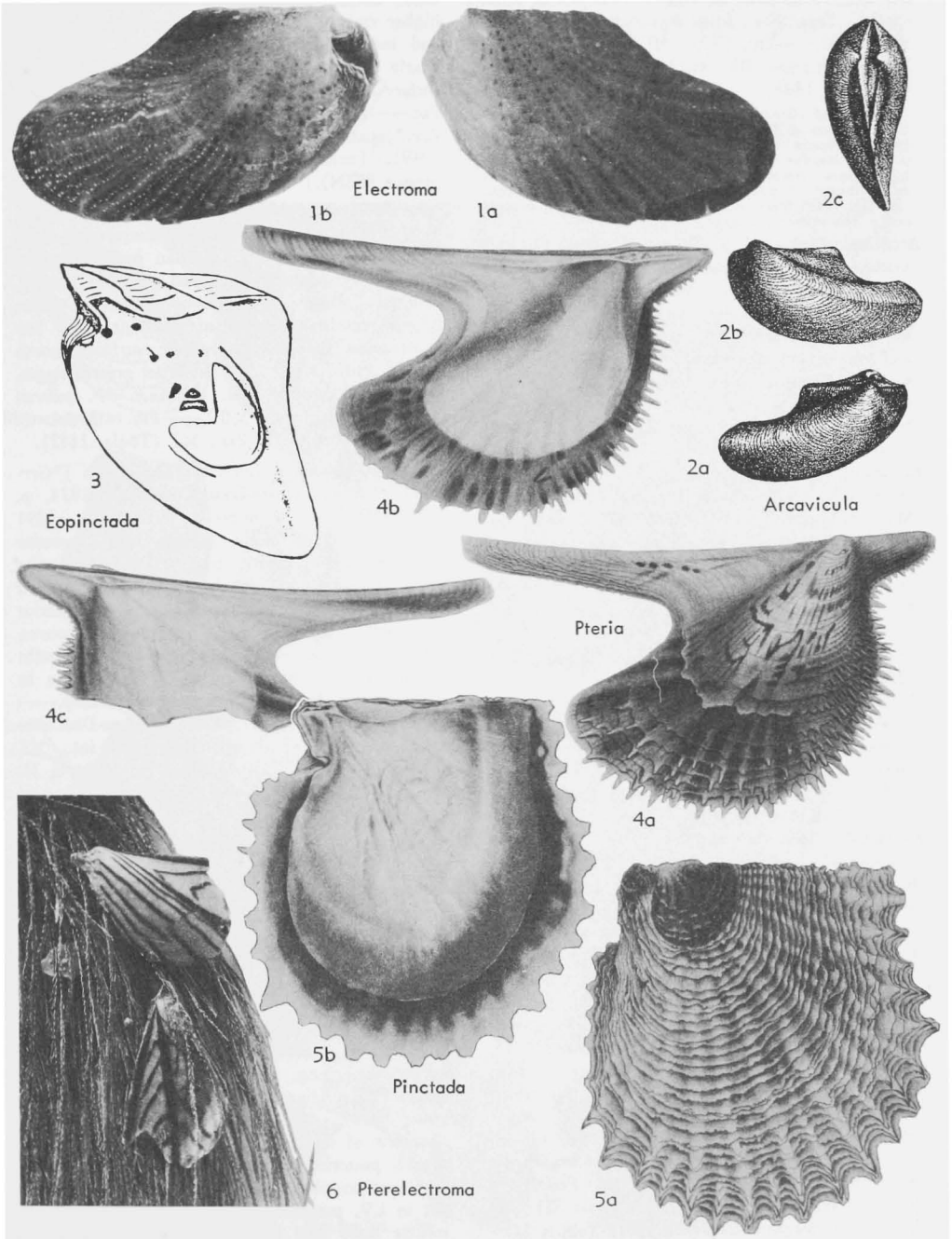


FIG. C38. Pteriidae (p. N302-N304).

posterior wing commonly present; hinge with 1 or 2 toothlike processes below umbo and longitudinal posterior lamina, absent in some forms; exterior commonly smooth except for growth lines, but with radial rows of lamellar processes in some species. *Trias.-Rec.*, fossil forms cosmop., *Rec.* in warm seas.—FIG. C38,4. \**P. hirundo* (LINNÉ), *Rec.*, *Medit.*; 4*a-c*, RV ext., LV int., RV int.,  $\times 0.7$  (Deshayes, 1848).

[*Glaucus* and *Glaucoderma*, both of POLI, 1795, are objective synonyms of *Pteria* in consequence of type designations by WINCKWORTH (1930, *Proc. Malac. Soc. Lond.*, vol. 19, p. 116). *Mytilus hirundo* was stated by POLI on p. 222 of his *Testacea urisusque Siciliae*, vol. 2, to belong to *Glaucus*, although it was not one of the two species (both Limidae) listed under the genus on p. 254. WINCKWORTH'S action thus seems permissible.]

**Arcavicula** COX, 1964, p. 47 [*pro Arcuatula* GUGENBERGER, 1934, p. 45 (*non* LAMY, 1919)] [\**Avicula arcuata* von MÜNSTER, 1836, p. 128; OD]. Small, only slightly inequivalve, with arcuate body, acute to bluntly rounded, undemarcated anterior auricles and obtuse posterior wings; dentition unknown; surface smooth or with radial threads. *M.Trias.-U.Trias.*, Eu.—FIG. C38,2. \**A. arcuata* (VON MÜNSTER), *U.Trias.*, S.Alps; 2*a,b*, RV, LV,  $\times 3$ ; 2*c*, dorsal view,  $\times 3$  (58).

**Electroma** STOLICZKA, 1871, p. 391 [\**Avicula smaragdina* REEVE, 1857, explan. pl. 12, fig. 45; M] [= *Electrina* VON MARTENS, 1872 (*non* BAIRD, 1850)]. Elongate, oblique, thin-shelled, more inequivalve than *Pteria*; hinge line short. *U.Cret.-Rec.*, Eu.—SW.Pac.

**E. (Electroma)**. Posterior wing almost lacking. *U.Cret.*, N.Z.; *Rec.*, W.Pac.—FIG. C38,1. *E. (E.) smaragdina* (REEVE), *Rec.*, Moluccas; 1*a,b*, LV ext., RV ext.,  $\times 1$  (COX, n).

**E. (Ptelerectroma)** IREDALE, 1939, p. 332 [\**Avicula zebra* REEVE, 1857, explan. pl. 11, fig. 36; OD]. Smaller than *E. (Electroma)* with definite posterior wing. *Rec.*, Australia.—FIG. C38,6. \**E. (P.) zebra* (REEVE); 2 syntypes on algal growth,  $\times 1.3$  (COX, n).

**Eopinctada** TAMURA, 1961, p. 147 [\**Pinctada (Eopinctada) matsumotoi*; OD]. Like *Pinctada* but oblique, subtrigonal rather than quadrate, with anteroventral and posterior margins converging to meet at subangular posteroventral extremity; cardinal area broad. *Cret. (Cenoman. or Turon.)*, Japan.—FIG. C38,3. \**E. matsumotoi*; RV int.,  $\times 0.5$  (Tamura, 1961).

**Pinctada** RÖDING, 1798, p. 166 [\**Mytilus margaritifera* LINNÉ, 1758, p. 704; SD IREDALE, 1915, p. 305] [= *Unionium* LINK, 1807 (type, *Mytilus margaritifera* LINNÉ; SD COX herein); *Margaritiphora* MEGERLE VON MÜHLFELD, 1811 (obj.); *Margarita* LEACH, 1814 (type, *M. sinensis* LEACH, = *Mytilus margaritifera* LINNÉ); *Margaritifera* SCHUMACHER, 1816 (*nom. null.*); *Perlamater* SCHUMACHER, 1817 (type, *P. vulgaris*; SD COX herein); *Meleagrina* LAMARCK, 1819 (obj.); *Margaritifera* SCHUMACHER, 1823 (*nom. null.*); *Pincta-*

*dina* DE BLAINVILLE, 1826 (obj.); *Pentadina*, *Pintadina* GRAY in GRIFFITH'S CUVIER, 1834 (obj.); *Margaritifera* ADAMS & ADAMS, 1857 (obj.)]. Less oblique and usually thicker-shelled than *Pteria*, subquadrate, commonly slightly higher than long, nearly equivalve; posterior wing and indentation of posterior margin lacking or nearly so; ligamental pit broad; no hinge teeth; surface lamellose. *Mio.-Rec.*, pantrop., espec. Indo-Pac.—FIG. C38,5. \**P. margaritifera* (LINNÉ), *Rec.*, Japan; 5*a,b*, LV ext., RV int.,  $\times 0.4$  (CAHN, 1949). [= *Margaritifera* BROWNE, 1789 (suppressed ICZN).]

**Pterinella** TOULA, 1882, p. 31 [\**P. petersi*; M]. Very similar to *Pteroperma* but subequivalve, with LV less convex and taller than in that genus; hinge margin much thickened, bearing narrow, elongate, oblique crenulations along its entire length; external grooves of posterior wing less conspicuous than in *Pteroperma*; surface smooth or with radial ribs on LV in earlier growth stages. *L.Cret.*, Balkans.—FIG. C39,6*a,b*. \**P. petersi*; 6*a,b*, LV ext., int.,  $\times 0.7$ .—FIG. C39,6*c*. *P. crassitesta* TOULA; LV ext.,  $\times 1$  (Toula, 1882).

**Pteroperma** MORRIS & LYCETT, 1853, p. 16 [\**Ger-villia costatula* EUDES-DESLONGCHAMPS, 1824, p. 131; OD] [= *Pterinoperma* WHITFIELD, 1891 (*nom. van.*)]. Oblique, bialate, with posterior wing sharply pointed; inequivalve, LV umbo more or less protruding; hinge margin thickened and transversely crenulated anteriorly; posterior wing with up to 4 external longitudinal grooves, lowest of which correspond to internal teeth; radial ribs present on earlier growth stages in some species. *U.Trias.*, Malaya; *Jur.*, cosmop.—FIG. C39,4*a*. \**P. costatula* (EUDES-DESLONGCHAMPS), M.Jur.(Bathon.), Eng.; RV int.,  $\times 1$  (COX, n).—FIG. C39,4*b*. *P. plana* LYCETT, M. Jur.(Bajoc.), Eng.; RV ext.,  $\times 1$  (COX, n).

**Rhaetavicula** COX, 1962, p. 594 [\**Avicula contorta* PORTLOCK, 1843, p. 126; OD]. Small, narrow, lunate, strongly prosocline, highly inequivalve, valves probably discordant; LV strongly convex, upcurved posteriorly with twisted appearance, its margins not in one plane; LV umbo narrowly rounded, protruding, anteriorly placed; RV almost flat, probably smaller than LV; posterior wings narrow, elongate, acutely pointed, that of LV flattened and well demarcated from body; left anterior wing small, right anterior auricle small, higher than long, not separated by notch from body of valve; ligament area narrow; body of LV with narrow, unevenly spaced, rounded radial ribs, few of their intervals with secondary radial thread; posterior wing of LV smooth; RV smooth or almost so; elongate posterior lateral tooth present in LV, presence of anterior tooth inconstant; muscle scars and pallial line not observed. *U. Trias. (Rhaet.)*, Eu.-Asia-N. Am. (Nev.).—FIG.

C39,2. \**R. contorta* (PORTLOCK), Eng.; 2a, LV ext.; 2b, RV ext.,  $\times 1.5$  (Cox, n).

?*Rhynchopterus* GABB, 1864, p. 31 [\**R. obesus*; M]. Trapeziform, oblique, LV with relatively large pointed anterior wing but not alate posteriorly; LV umbo protruding slightly, near mid-

dle of hinge margin; RV and hinge structure unknown. *Trias.*, USA (Calif.)-Bear Is.—FIG. C39, 3. \**R. obesus*, M.Trias., USA (Calif.); LV ext.,  $\times 1$  (333).

*Somapteria* TAMURA, 1960, p. 224 [\**S. koiakensis*; OD]. Rather small, rhomboidal, oblique, longer

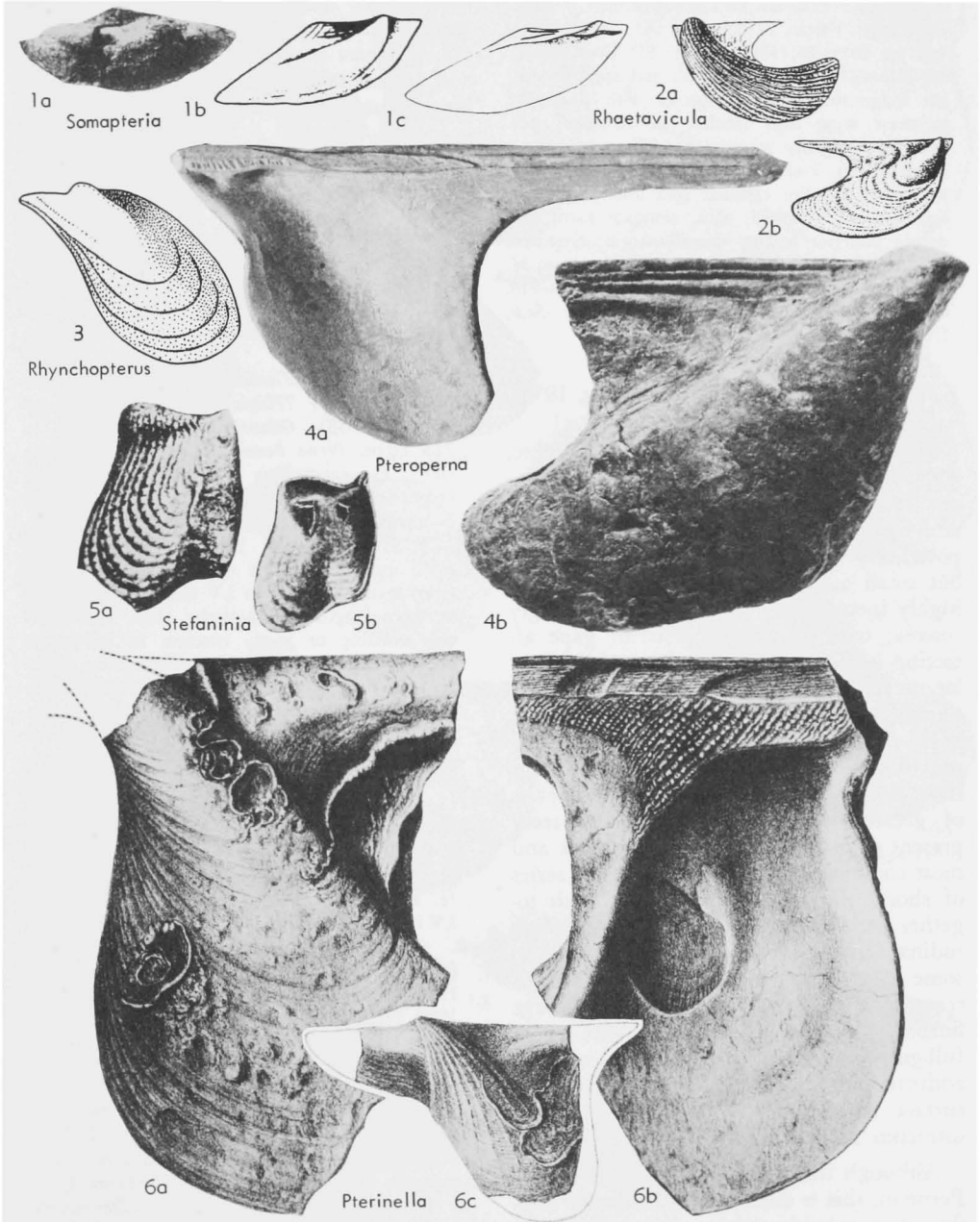


FIG. C39. Pteriidae (p. N304-N306).

than high, almost equivalve; both valves with obtuse posterior wing and moderately large, pointed anterior wing, not distinctly differentiated from body of shell; umbones protruding only slightly; several short transverse anterior teeth and 2 thin, longitudinal posterior teeth in each valve. *U. Jur.*, Japan.—FIG. C39,1. \**S. kōikensis*; 1a-c, LV ext., RV ext., LV int.,  $\times 1$  (Tamura, 1960).

\**Stefania* VENZO, 1934, p. 165 [\**Gervilleia? ogilviae* BITTNER, 1895, p. 88; SD Cox herein]. Mytiliform, with terminal beak and slightly arcuate hinge margin; type species with ill-defined posterior wing and lobelike anteroventral protuberance; slightly inequivalve, RV more convex (unusual in Pteriidae); anterior margins with slight byssal gape; cardinal area and position of ligament not observed; thin, elongate tooth bordering posterior half of dorsal margin; ornament of concentric ribs notched by radial grooves. *M. Trias.*(*Ladin.*), Eu.(*S. Tyrol-Rhodes.*)—FIG. C39,5. \**S. ogilviae* (BITTNER), Rhodes; 5a,b, LV ext., RV int.,  $\times 1$  (Venzo, 1934).

### Family BAKEVELLIIDAE King, 1850

[Materials for this family prepared by L. R. Cox]

Highly inequilateral, subovate, rhombic, rhomboidal, trapeziform or ensiform Pteriacca, usually with multiple ligamental pits and with hinge teeth; more or less oblique, posteriorly alate or subalate, with or without small anterior auricle; subequivalve to highly inequivalve, with LV more strongly convex; with or without anterior gape affecting both valves, and lacking subauricular notch in RV; ligamental areas flat, external; ligamental pits multiple except in adult *Phelopteria*, extending to lower margin of ligamental area, and usually rather irregularly distributed, with some intervals of greater width than pits; hinge teeth present at least in early growth stages and most commonly consisting of anterior series of short, more or less transverse teeth together with small number of elongate longitudinal teeth on posterior wing, but in some forms numerous, weak, more or less transverse, and extending along entire hinge line, in others tending to obsolescence in full-grown shell; anisomyarian with anterior adductor much reduced, or monomyarian; surface smooth or radially ribbed; inner ostracum nacreous. *Perm.-Eoc.*

Although the type genus appeared in the Permian, this is essentially a Mesozoic family. It is possible that to some extent the

various genera here included in it arose independently from the Pteriidae by multiplication of the ligamental pits. *Aviculoperna*, represented by several lower Eocene species, was formerly regarded as a subgenus of *Pteria*, but has the essential features of the Bakevelliidae. A lower Eocene species which has been included in *Gervilleia* (*G. eocenica* DESHAYES) is, however, rare and imperfectly known and its ligamental area has not been observed.

*Bakevella* KING, 1848, p. 10 [\**Avicula antiqua* VON MÜNSTER in GOLDFUSS, 1836, p. 126 (*non* DEFRENCE, 1816) (= \**Avicula binneyi* BROWN, 1841, p. 65); OD] [= *Bakewellia* GRUENWALDT, 1851 (*nom. van.*)]. Small to medium-sized, trapeziform or rhomboidal, not greatly elongated; anterior auricle small to moderately large, posterior wing obtuse or with acutely pointed tip; never strongly inequivalve, anterior gape narrow. *Perm.-Cret.*, cosmop.

*B. (Bakevella)* [= *Goniodus* DUNKER, 1848 (*non* AGASSIZ, 1838); ?*Plagia* PHILIPPI, 1899 (*non* MEIGEN, 1838); *Odontoperna* FRECH, 1891, p. 215 (type, *Perna bouei* HAUER, 1857, p. 562; OD); *Pseudogervilleia* GILLET, 1922, p. 106 (type, *Gervilleia episcopalis* GILLET; M); *Maizuria* NAKAZAWA, 1959 (type, *B. (M.) kambei*; OD, *L.Trias.*, Kyoto Pref., Japan)]. Typically with small number of short obliquely transverse anterior teeth (1 fewer in LV than in RV) and 1 or more longitudinal posterior teeth, but dentition variable or partly obsolete in full-grown shell in some species; some earlier species anisomyarian, later ones mostly monomyarian; smooth or with weak radial riblets. [*Odontoperna* was thought to be characterized by the absence of longitudinal posterior teeth, but these have now been observed in some specimens of the type species.] *Perm.-Cret.*, cosmop.—FIG. C40,1a-d. \**B. (B.) binneyi* (BROWN), U.Perm., Eng.; 1a-d, LV ext., RV ext., LV int. showing adductor scars, dorsal view, all  $\times 1$  (King, 1850).—FIG. C40, 1e. *B. costata* (VON SCHLOTHEIM), *M.Trias.*, Ger.; LV int.,  $\times 2$  (Credner, 1851).

*B. (Bakevellioides)* TOKUYAMA, 1959, p. 148 [\**Gervilleia hekiensis* KOBAYASHI & ICHIKAWA, 1952, p. 76; OD] [= *Neobakevella* NAKAZAWA, 1959 (type, *Gervilleia costata* VON SCHLOTHEIM, 1820; OD, *L.Trias.-M.Trias.*, W.Eu.)]. Like *B. (Bakevella)* but with several transverse anterior teeth; posterior teeth about 2; monomyarian. *Trias.-Jur.*, Eu.-Asia.—FIG. C40,3. \**B. (B.) hekiensis* (KOBAYASHI & ICHIKAWA), U.Trias. (Carn.), Japan; RV int.,  $\times 1$  (Tokuyama, 1959). *Aguilerella* CHAVAN, 1951, p. 211 [\**Perna kobyi* DE LORIOI, 1901, p. 99; OD] [= *Dentoperna* OKUNEVA, 1960, p. 57 (type, *Perna khudyae*)



KRIMHOLTZ, 1938, p. 272; OD)]. Medium-sized, rhomboidal, mytiliform, height well exceeding length; subequivalve, rather weakly inflated, with-

out protruding umbones; beaks subterminal; anterior teeth 1 or more, short, oblique; posterior teeth narrow, 1 in LV, 1 or 2 in RV; surface

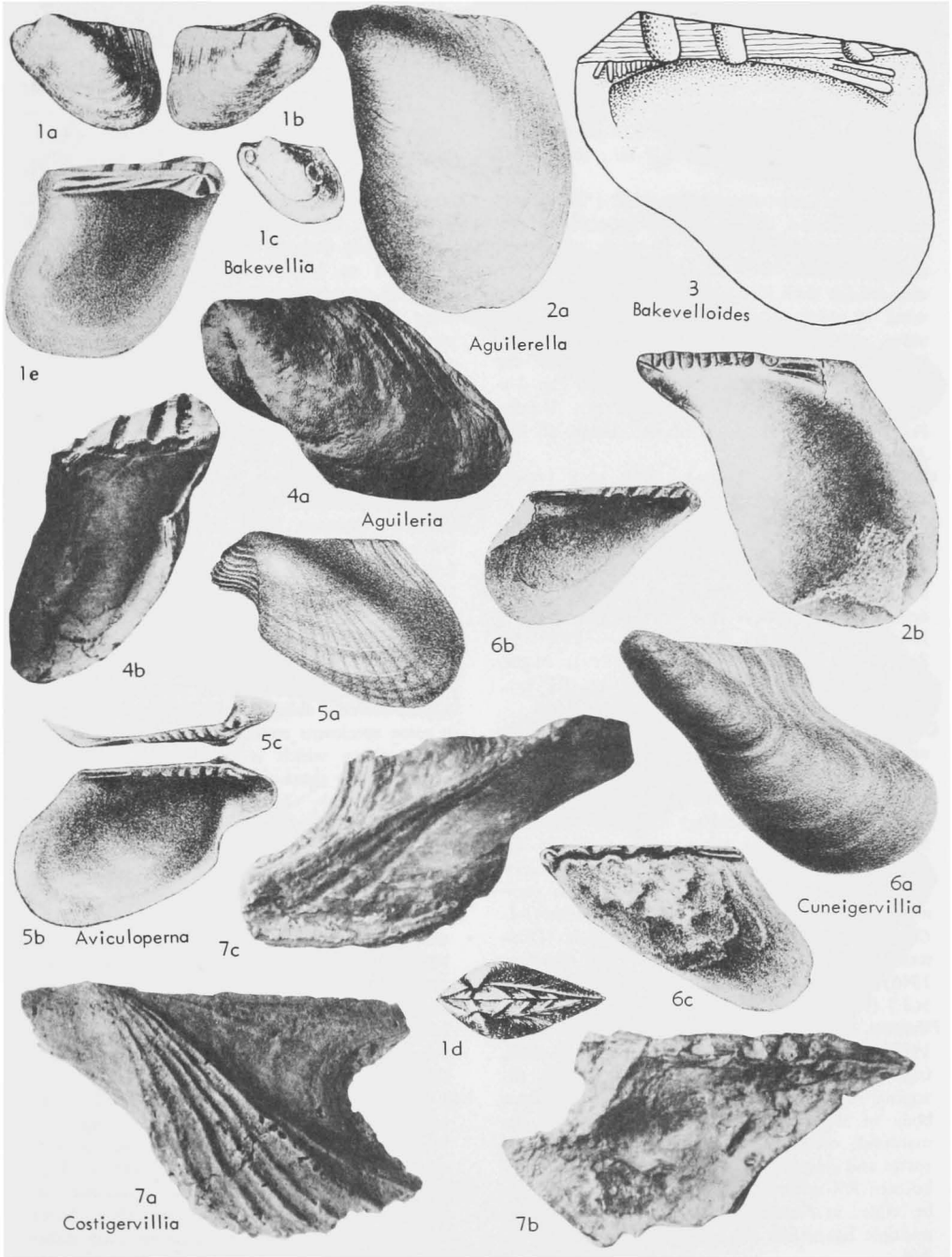


FIG. C40. Bakevelliidae (p. N306-N308).



- smooth. *Jur.* (*Toarc.-Oxford.*), Eu.-Asia-N. Afr. —FIG. C40,2. \**A. kobyi* (DE LORIO), Oxford, Switz.; 2*a,b*, LV ext., RV int., both  $\times 0.7$  (de Loriol, 1901).
- Aguileria** WHITE, 1887, p. 35 [\**A. cumminsi*; OD]. Medium-sized, like *Bakevellia* in shape, subequivalve; hinge teeth not differentiated into anterior and posterior series, but consisting of numerous irregular transverse crenulations. *Cret.*, N.Am. —FIG. C40,4. \**A. cumminsi*, U.Cret. (Cenoman.), USA (Tex.); 4*a,b*, LV ext., LV int., both  $\times 0.7$  (890).
- Aviculoperna** COSSMANN, 1887, p. 168 [\**Perna aviculina* DESHAYES, 1864, p. 56; OD]. Small, trapeziform, oblique, with obtuse posterior wing and distally rounded, well-differentiated anterior auricle; anterior teeth 1 in LV, 2 in RV, short, oblique, weak in some forms; posterior teeth 1 in each valve, rather short; LV or both with radial riblets. [CHAVAN has included a species from the Jurassic of France in this genus.] *Eoc.*, Eu. —FIG. C40,5. \**A. aviculina* (DESHAYES), U.Eoc., France; 5*a-c*, LV ext., LV int., RV hinge, all  $\times 2$  (Deshayes, 1864).
- Costigervillia** COX & ARKELL, 1948, p. 9 [\**Gervillia crassicosta* MORRIS & LYCETT, 1853, p. 23; OD]. Medium-sized, oblique, bialate, with comparatively long, acute anterior wing; LV of moderate to strong convexity, with strong radial costae; RV flat or almost so, smooth or with weak radial ornament; dentition as in *Bakevellia* (*Bakevellia*). *Jur.* (*Bathon.-Oxford.*), Eng.-France. —FIG. G40, 7. \**C. crassicosta* (MORRIS & LYCETT), M.Jur. (Bathon.), Eng.; 7*a-c*, LV ext., LV int., RV ext., all  $\times 1$  (Cox, n).
- Cuncigervillia** COX, 1954, p. 48 [\**Gervillia hagenowii* DUNKER, 1846, p. 37; OD]. Rhomboidal or trapeziform, subequivalve, rather feebly inflated, with terminal or subterminal beaks and oblique, cuneiform body not always distinctly separated from obtuse posterior wing; anterior auricle absent or small; earlier growth stages with anterior and posterior teeth as in *Bakevellia*, teeth commonly obsolete in later stages. *L.Jur.* (*L.Lias.*)-*L. Cret.*, Eu. —FIG. C40,6. \**C. hagenowii* (DUNKER), L.Lias., Ger.; 6*a*, LV ext.  $\times 1$  (Dunker, 1846); 6*b,c*, young shells, LV int., RV int., both  $\times 2.7$  (Philippi, 1897).
- ?**Euptera** DARTEVELLE in DARTEVELLE & FRENEIX, 1957, p. 65 [\**E. zambiensis*; OD]. Medium-sized, trigonal; LV strongly convex, with acutely triangular wings, anterior part well demarcated from body of shell by sinus, posterior less well demarcated; ornament of numerous unequal radial costae and concentric lamellae; hinge structure unknown; RV unknown. [This genus is thought to be related to *Pseudoptera*. It is uncertain whether multiple ligamental pits are present.] *U.Cret.*, W. Afr.
- Gervillaria** COX, 1951, p. 49 [\**Modiola? alaeformis* J. SOWERBY, 1819, p. 93; OD]. Medium-sized to large, highly inequivalve, oblique, bialate; narrow byssal gape present; body of LV strongly inflated, with its umbo rising rather prominently above hinge margin and beak strongly prosogyrous; RV feebly convex, flat or concave; hinge in adult shell with numerous unequal, transverse, somewhat oblique crenulations. *Jur.-Cret.*, Eu. —FIG. C41,5. \**G. alaeformis* (J. SOWERBY), L.Cret., Eng.; 5*a*, LV ext.,  $\times 0.5$ ; 5*b*, RV ext.,  $\times 0.5$ ; 5*c*, LV int.,  $\times 0.7$  (Woods, 1905).
- Gervillella** WAAGEN, 1907, p. 98 [\**Perna aviculoides* J. SOWERBY, 1814, p. 147; SD COX, 1940, p. 112] [= *Gervillela* GILLET, 1922 (*nom. null.*)]. Medium-sized to large, slightly inequivalve, longitudinally elongated, only slightly oblique; posterior wing narrow and obtuse, anterior wing acutely pointed; no byssal gape; dentition consisting of anterior series of 2 to 4 and posterior series of 1 or 2 elongate teeth, all slightly oblique to longitudinal. *Trias.-Cret.*, cosmop. —FIG. C41,2*a*. \**G. aviculoides* (J. SOWERBY), U.Jur. (Corall.), Eng.; LV ext.,  $\times 0.3$  (Cox, n). —FIG. C41,2*b*. *G. sublanceolata* (D'ORBIGNY), L.Cret. (Apt.), Eng.; LV int.,  $\times 0.5$  (Deecke, 1902).
- Gervillia** DEFRANCE, 1820, p. 502 [\**G. solenoidea* (*sic*); SM DEFRANCE, 1824, p. 316] [= *Gervillia* RANG, 1826 (*nom. null.*); *Gervillea* FLEMING, 1828 (*nom. null.*); *Gervilleia* ROMINGER, 1846 (*nom. van.*); *Hydrodaetes* GISTL, 1848 (obj.); *Gervillia* PETHÖ, 1906 (*nom. null.*); *Gervilleia* GILLET, 1922 (*nom. null.*)]. Medium-sized, longitudinally elongated, narrow, ensiform, slightly curved, scarcely oblique, with terminal beaks and in some specimens rostrum-like anteroventral projection above which is wide gape of margins; posterior wing short and obtuse. *U.Trias.-U.Cret.*, cosmop.
- G. (Gervillia)** [= *Gervillioopsis* WHITFIELD, 1885, p. 73 (type, *Gervillia ensiformis* CONRAD, 1858, p. 328; OD); *Dalliconcha* WHITE, 1887, p. 34 (type, *D. invaginata* (= *G. ensiformis*); OD); *Ensigervillia* DIETRICH, 1910, p. 236 (type, *Gervillia silicea* QUENSTEDT var. *husii*; OD)]. Narrow, unequal transverse crenulations present along each end or all of hinge margin, with elongate longitudinal teeth (1 in RV and 2 in LV) at posterior end. *U.Jur.-Cret.*, cosmop. —FIG. C41,4. \**G. (G.) solenoidea*, U.Cret. (Senon.), Ger.; 4*a,b*, LV ext., LV int.,  $\times 1$  (415).
- G. (Cultriopsis)** COSSMANN, 1904, p. 510 [\**G. (Cultriopsis) falciformis*; M] [= *Angustella* WAAGEN, 1907, p. 98 (type, *Gervillia angusta* VON MÜNSTER, 1836, p. 122; SD DIENER, 1923, p. 97)]. Differing from *Gervillia* (*Gervillia*) in absence of transverse crenulations along hinge margin; some specimens with rudimentary transverse tooth in anterior angle as well as elongate

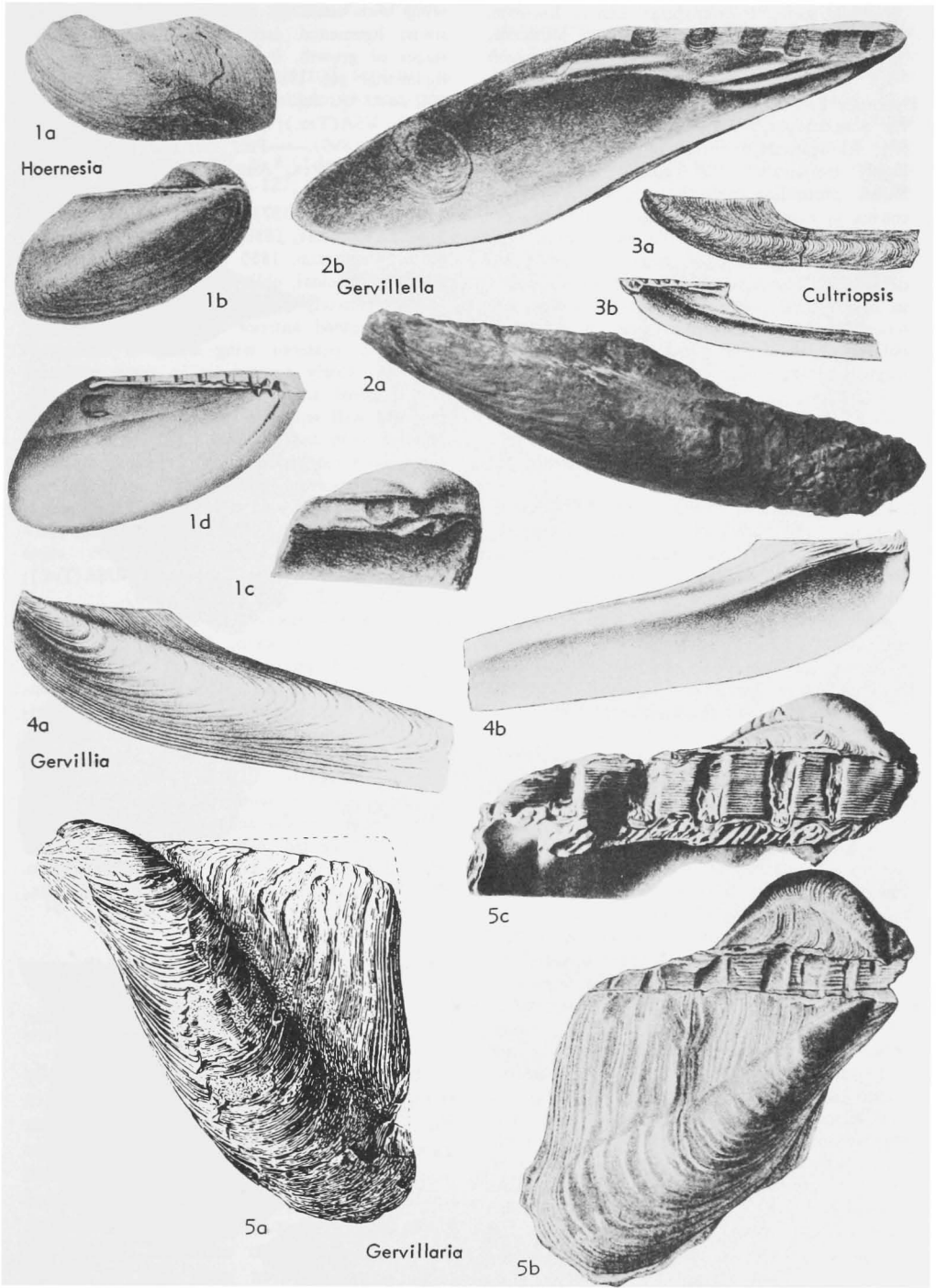


FIG. C41. Bakevelliidae (p. N308, N310).

posterior teeth. *U.Trias.-L.Jur.(Lias.)*, Eu.-Asia.  
—FIG. C41,3. *G. (C.) angusta* VON MÜNSTER,  
*U.Trias.*, S.Tyrol; 3a, LV ext.; 3b, RV int., both  
×1 (58).

**Hoernesia** LAUBE, 1866, p. 52 [*\*Mytilites socialis*  
VON SCHLOTHEIM, 1823, p. 112; SD TATE, 1868, p.  
67]. Elongate-trapeziform, only slightly oblique,  
highly inequivalve; LV strongly convex, with  
broad, protruding umbonal region, RV feebly  
convex to concave; valve margins commonly not  
in single plane; anterior wing well defined; low  
internal swelling may correspond to slight radial  
depression of umbonal region, but septum found  
in *Septihoernesia* (Cassianellidae) is absent; an-  
terior dentition varying from single large, slightly  
oblique tooth to series of narrow, oblique ridges;  
single narrow, elongate tooth on posterior wing.  
*Trias.-M.Jur.*, Eu.-Asia.—FIG. C41,1. *\*H. so-  
cialis* (VON SCHLOTHEIM), *M.Trias.*, Ger.; 1a-c, LV  
ext., RV ext., ant. teeth of LV, all ×1 (Philippi,  
1898); 1d, LV int. showing posterior tooth, ×1  
(Credner, 1851).

**Kobayashites** HAYAMI, 1959, p. 138 [*\*K. hemicyl-  
indricus*; OD]. Rather small, elongate-rectangular,  
not oblique; with elongate hinge margin but not  
alate; beaks subterminal; LV moderately convex,  
with broadly rounded, slightly protruding umbo  
and prosogyrous beak; RV almost flat; byssal gape  
wide; ligamental area narrow, with 4 or more  
well-separated ligamental pits; each valve with  
1 or 2 anterior teeth on hinge plate supported  
by septum-like thickening below umbo, and  
weak, elongate posterior tooth; surface smooth.  
*M.Jur.(Bajoc.)*, Japan.—FIG. C42,3. *\*K. hemi-  
cylindricus*; LV ext., ×2 (392).

**Langsonella** PATTE, 1926, p. 139 [*\*Gervilleia (Cul-  
trioipsis) elongata* MANSUY, 1919, p. 7 (non *Ger-  
villia elongata* PORTLOCK, 1843) (= *\*Langsonella  
mansuyi* Cox, 1961; M)]. Rather small, elongate,  
subcylindrical, not oblique, highly inequivalve;  
LV strongly convex, diagonally carinate, with  
broad, scarcely protruding umbonal region and  
large, indistinctly delimited anterior wing; denti-  
tion imperfectly known. *Trias.*, Tonkin-Malaya.

**Panis** STEPHENSON, 1952, p. 67 [*\*P. cuneiformis*;  
OD]. Moderately large, subrectangular, scarcely  
oblique, high in proportion to length, only slightly  
inequivalve; umbones not protruding; anterior  
wings small, bluntly pointed; posterior wings not  
well demarcated; ligamental area broad, with  
about 3 unequal ligamental pits; no hinge teeth;  
surface smooth. *Cret.*, N.Am.-S.Am.—FIG. C42,  
2. *\*P. cuneiformis*, *U.Cret.(Cenoman.)*, USA  
(Tex.); 2a,b, RV int., RV ext., both ×0.7 (890).

**Phelopteria** STEPHENSON, 1952, p. 68 [*\*Pteria? dalli*  
STEPHENSON, 1936, p. 389; OD]. Medium-sized  
*Pteria*-like, slightly inequivalve, convexity mod-  
erate; anterior wing acutely angular, well de-  
marcated from body in both valves; posterior

wing with acute tip but only shallow marginal  
sinus; ligamental area multivincular in earlier  
stages of growth, later with one long, shallow  
ligamental pit. *Cret.*, N.Am.-Eu.-W.Afr.—FIG.  
C42,1a-c. *\*P. dalli* (STEPHENSON), *U.Cret.(Ceno-  
man.)*, USA(Tex.); 1a-c, LV, dorsal view, RV,  
all ×1 (890).—FIG. C42,1d. *P. caudigera*  
(ZITTEL), *U.Cret.*, Aus.; RV ext., ×1 (Zittel,  
1866).

**Pseudoptera** MEEK, 1873, p. 489 [*\*Avicula anomala*  
J. DE C. SOWERBY, 1836, p. 342; OD] [= *Pseudo-  
pteria* WHITFIELD, 1880 (*nom. van.*)]. Medium-  
sized, rhomboidal, oblique, inequivalve; LV with  
angular, scarcely protruding umbo, rather large,  
round-margined anterior auricle, much extended  
downward, posterior wing which is obtuse ex-  
cept for acutely pointed tip in some specimens  
and diagonal angulation or rib; ligamental pits  
few and well separated; LV with strong, oblique  
anterior tooth and elongate, longitudinal posterior  
tooth, both received between 2 teeth in RV; LV  
commonly bearing weak radial threads. *Cret.*,  
Eu.-N.Am.-Japan.—FIG. C42,4a. *\*P. anomala*  
(J. SOWERBY), *L.Cret.(Alb.)*, Eng.; LV ext., ×0.7  
(Woods, 1905).—FIG. C42,4b,c. *P. viana*  
(STEPHENSON), *U.Cret.(Cenoman.)*, USA(Tex.);  
4b,c, LV int., RV int., both ×2 (890).

**Tenuipteria** STEPHENSON, 1955, p. 110 [*\*Inocera-  
mus argenteus* CONRAD, 1858, p. 329; OD].  
Medium-sized, pteriiform, height and length al-  
most equal, highly inequivalve; LV strongly con-  
vex, with broadly rounded, well-protruding um-  
bonal region, very small anterior auricle, and un-  
differentiated posterior wing; RV feebly convex,  
with small, obtusely angular anterior wing and  
flattened posterior wing; ligamental pits 3 or  
more, unequal in size and irregularly spaced; both  
valves ornamented with weak, unequal radial  
ribs. *U.Cret.(Owl Creek)*, USA(Mo.).—FIG.  
C42,5. *\*T. argenteus* (CONRAD); 5a,b, LV ext.,  
RV ext., both ×1 (Stephenson, 1955).

### Family CASSIANELLIDAE Ichikawa, 1958

[=Paraviculidae GUGENBERGER, 1935 (family name invalid,  
not based on generic name)] [Materials for this family pre-  
pared by L. R. Cox]

Shell oblique, posteriorly alate, usually  
strongly inequivalve (but subequivalve in  
*Burckhardtia*), with or without anterior  
gape affecting both valves; no subauricular  
notch; LV strongly convex, with prominent  
umbo; radial depression, to which internal  
ridge or septum corresponds, either crossing  
or lying anterior to umbonal region; ex-  
ternal cardinal area with one to several  
ligamental pits, except apparently in *Reu-  
benia*. Surface smooth or with radial orna-

ment; inner ostracum nacreous. ?Perm., Trias.

The presence of an internal septum is the chief distinction of this group from the Bakevelliidae.

*Cassianella* BEYRICH, 1862, p. 9 [\**Avicula gryphaeata* VON MÜNSTER, 1836, p. 127; OD] [=*Grypho-*

*rhynchus* MEEK, 1864, p. 217 (obj.); *Actinophorus* MEEK, 1864, p. 218 (type, *Avicula decussata* GOLDFUSS, 1836, p. 128; OD)]. Very inequivalve, bialate, usually relatively high, rarely pronouncedly inequilateral or oblique; LV with relatively large, pointed anterior wing, separated from umbonal region by radial depression characteristic of family; marginal sinus below this wing lying in plane almost at right angles to one passing

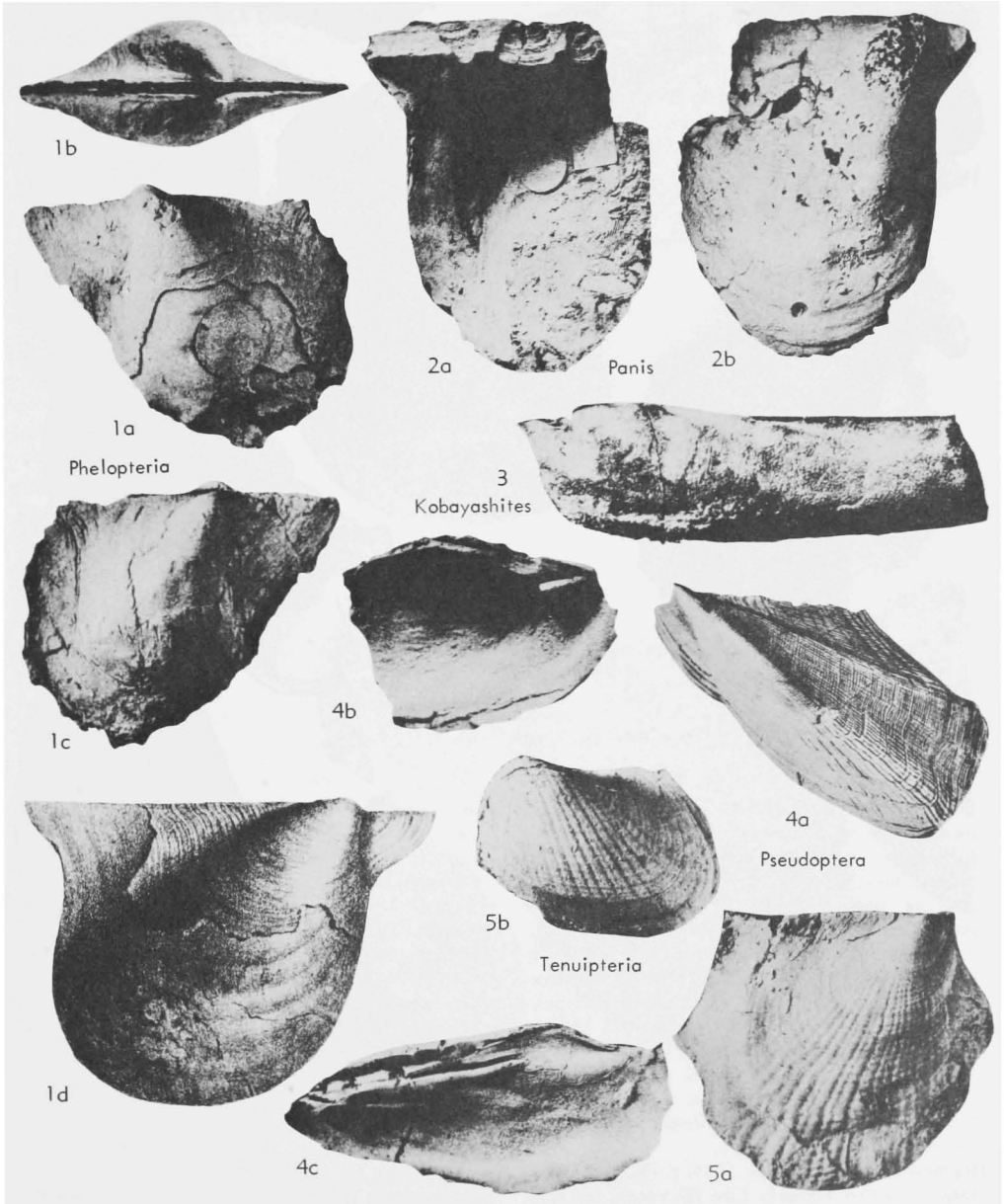


FIG. C42. Bakevelliidae (p. N310).

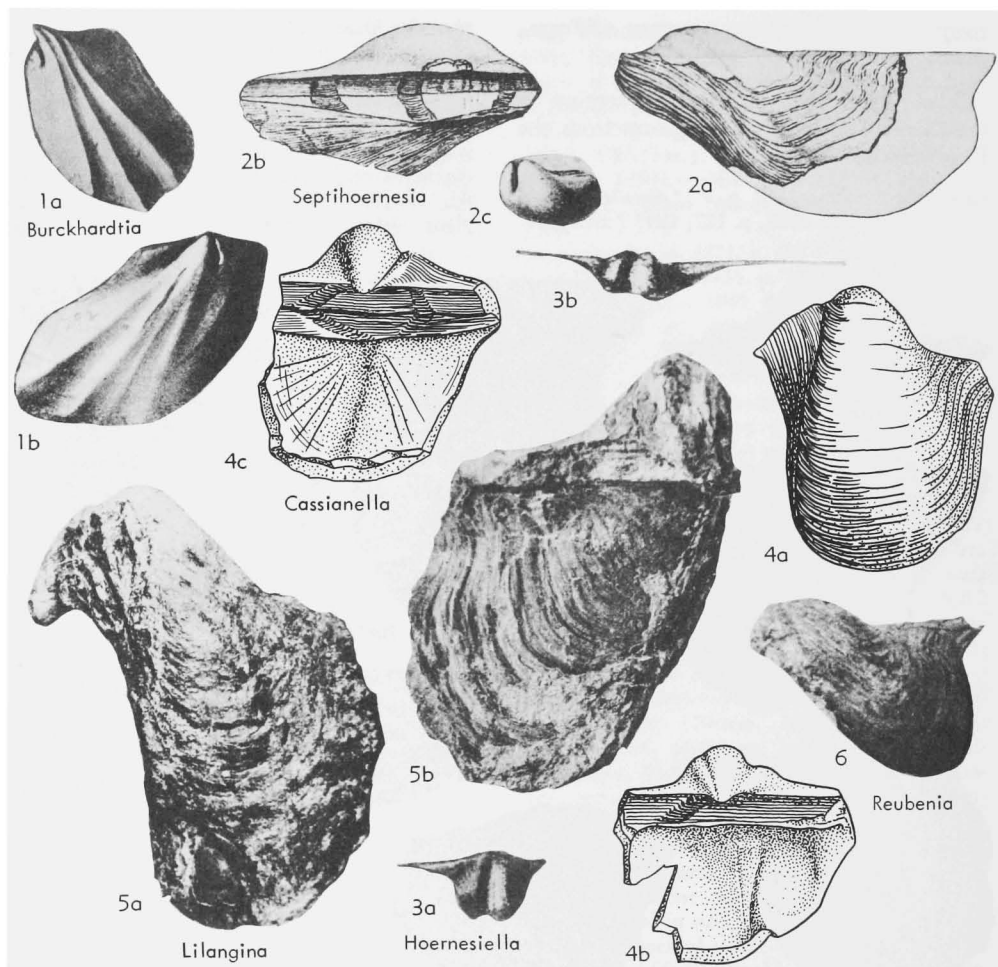


FIG. C43. Cassianellidae (p. N312-N313).

through hinge margin; RV concave or flat; ligamental pits usually single but some duplicated; few short, transverse subumbonal hinge teeth present together with longitudinal lateral teeth, posterior ones elongate, anterior short; surface smooth or radially ribbed. ?*Perm.*(*Guadalupian*), *Trias.*, cosmop.—FIG. C43,4. *C. beyrichi* BITTNER, *U.Trias.*, S.Tyrol; 4a, LV ext.; 4b, LV ligamental area with one pit; 4c, valves in juxtaposition, ligamental areas with 2 pits; all  $\times 1$  (58).

**Burckhardtia** FRECH, 1907, p. 334 [*\*B. boesei*; SD DIENER, 1923, p. 34]. Valves equally convex, radially ribbed; wings obtuse. *U.Trias.*(*Carn.*), Mex.—FIG. C43,1. *B. aguilerae* FRECH; 1a,b, LV, RV,  $\times 1.3$  (Frech, 1907).

**Hoernesella** GUGENBERGER, 1934, p. 46 [*\*H. carinthiaca*; SD COX herein]. Like *Hoernesia*, but with exceptionally long and acute wings, and with radial depression running vertically from middle

of umbonal region to lower margin of body. *U.Trias.*(*Carn.*), Carinthia.—FIG. C43,3a. *\*H. carinthiaca*; LV,  $\times 1$ .—FIG. C43,3b. *H. horrida* GUGENBERGER; LV,  $\times 1$  (both Gugenberger, 1934).

**Lilangina** DIENER, 1906, p. 768 [*\*L. nobilis*; SM DIENER, 1908, p. 62]. Like *Septihoernesia*, but with LV umbo very prominent, beak strongly prosogyrous and no anterior wing. *U.Trias.*(*Carn.*), Kashmir.—FIG. C43,5. *\*L. nobilis*; 5a,b, LV, RV,  $\times 0.7$  (Diener, 1908).

**Reubenia** COX, 1924, p. 61 [*\*R. hesbanensis*; OD]. Externally like *Septihoernesia*, but with anterior wing much reduced; ligamental area seemingly subinternal. *U.Trias.*, Jordan.—FIG. C43,6. *\*R. hesbanensis*; LV ext.,  $\times 1$  (Cox, n).

**Septihoernesia** COX, 1964, p. 40 [*\*Gervillia johan-nisaustriaca* KLIPSTEIN, 1845, p. 249; OD]. Elongated transversely; radial depression deep, almost

on middle of umbonal region; internal septum narrow and prominent, dividing umbonal cavity into 2 chambers; ligamental pits 1-3; LV usually with 2 divergent oblique teeth at anterior end of hinge margin; posterior teeth unknown; surface smooth. *Trias.*, Eu.-Asia.—FIG. C43,2a,b. \**S. johannisaustriacae* (KLIPSTEIN), M.Trias.(Ladin.), S.Tyrol; 2a,b, LV and dorsal view, both  $\times 1$  (58).—FIG. C43,2c. *S. subglobosa* (CREDNER), M.Trias.(Muschelkalk), Ger.; LV int. mold, slit representing septum,  $\times 1$  (Assmann, 1915).

Family PERGAMIDIIDAE Cox,  
new family

Shell medium-sized, equivalve to moderately inequivalve with RV more convex, ovate or mytiliform, recalling some Inoceramidae; hinge margin straight, moderately elongate, umbones more or less anterior, no differentiated posterior wing, anterior auricle present or absent, byssal gape present;

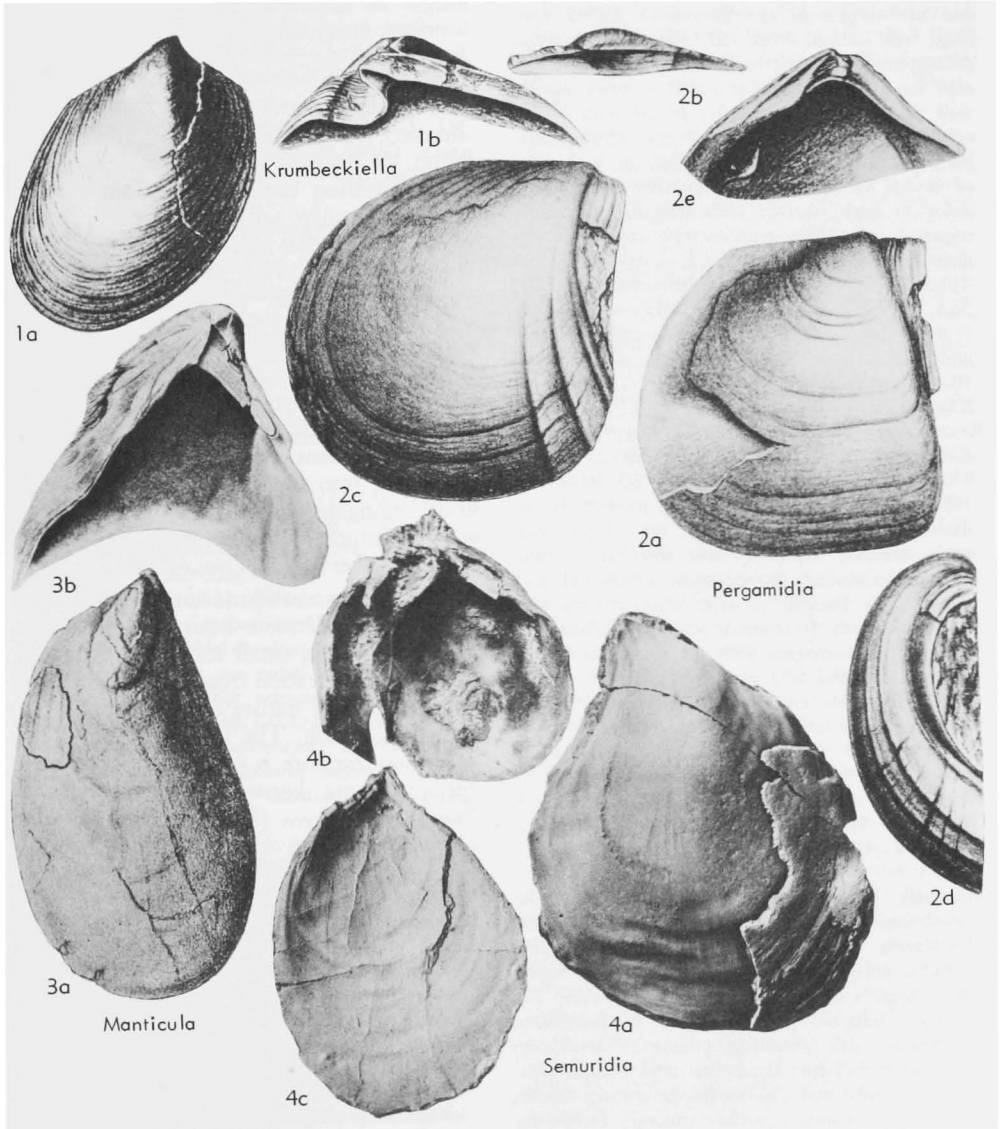


FIG. C44. Pergamidiidae (p. N314).

ligamental area triangular, external or subinternal, with single triangular ligamental pit or with no observed pit (*Mantacula*); hinge edentulous or with weak posterior lateral tooth (*Semuridia*); monomyarian; shell structure varied, inner nacreous layer observed only in *Semuridia*. *U.Trias.-L.Jur.* (*Lias*).

**Pergamidia** BITTNER, 1891, p. 103 [*\*P. eumenea*; SD DIENER, 1923, p. 135]. Equivalve, subovate, and not oblique or else mytiliform, higher than long, well inflated, with only slightly protruding, prosogyrous umbones; beaks terminally placed except for dorsoventrally extended anterior auricle well demarcated from body; byssal gape correspondingly extended, variable in width; ligamental area subinternal, extending to both sides of beak; ligamental pit triangular, broad, posterior to beak; surface with irregular concentric rugae, some species with narrow radial ribs on anterior region. *U.Trias.*(*Nor.*), Anatolia-Yunnan-Timor.—FIG. C44,2a,b. *\*P. eumenea*, Anatolia; 2a,b, RV ext. and hinge,  $\times 0.6$  (56).—FIG. C44, 2c,d. *P. attalea* BITTNER, Anatolia; 2c,d, RV, side and ant. views showing byssal gape,  $\times 0.7$  (Bittner, 1892).—FIG. C44,2e. *P. timorensis* KRUMBECK, Timor; LV hinge,  $\times 3$  (487).

**Krumbeckiella** ICHIKAWA, 1958, p. 196 [*pro Timoria* KRUMBECK, 1924, p. 218 (*non* KAYE, 1919)] [*\*Timoria timorensis* KRUMBECK; SD ICHIKAWA, 1958, p. 196]. Almost equivalve, moderately inflated, obliquely ovate, longer than high; umbones narrow, more or less anteriorly placed, slightly protruding, prosogyrous; ligamental area of moderate breadth in each valve, mainly posterior to beak; ligamental pit fairly broad, oblique; anterior margin with deep sinus extending below ligamental area and giving rise to sharply margined lunule and earlike projection of hinge margin; lunule broader in RV than in LV, where its margin is affected by byssal gape; surface smooth, but loss of outer layers commonly exposes finely ribbed inner ostracum. *U.Trias.*(*Nor.*), Timor.—FIG. C44,1; *\*K. timorensis* (KRUMBECK), 1a,b, RV ext., RV hinge region int.,  $\times 1$  (487).

**Mantacula** WATERHOUSE, 1960, p. 428 [*\*Mytilus problematicus* ZITTEL, 1864, p. 28; OD] [= *Maoria* WILCKENS, 1927 (non LAPORTE, 1868)]. Inequivalve, roughly mytiliform, higher than long, with completely anterior beaks; RV strongly inflated, grotesquely so in full-grown specimens, with protruding umbo; LV weakly to moderately inflated; ligamental area broad, transversely striated and without pit; no distinct lunule; byssal gape narrow; surface smooth except for irregular concentric folds; ostracum very thick in full-grown specimens. *U.Trias.*(*Carn.*), N.Z.-N.

Caledonia.—FIG. C44,3. *\*M. problematica* (ZITTEL), N.Z.; 3a,b, RV ext., RV int.,  $\times 0.7$  (Wilckens, 1927; 957).

**Semuridia** MELVILLE, 1956, p. 116 [*\*S. jacksoni* (= *Inoceramus dorsetensis* Cox, 1926, p. 183); OD]. Subequivalve, broadly mytiliform, well inflated, with unprotruding, anterior, prosogyrous umbones; anterior auricles small, blunt, with convex outer margin; byssal gape moderate; ligamental area with broad, triangular ligamental pit; weak longitudinal tooth close to posterior end of margin of ligamental area; surface irregularly lamellose; inner ostracum nacreous. *L.Jur.*(*L.Lias.-Sinemur.*), Eng.—FIG. C44,4a,b. *\*S. dorsetensis* (Cox), Dorset(Charmouth); 4a,b, RV int. mold (holotype), RV int. showing ligamental area, both  $\times 1$  (Cox, n).—FIG. C44,4c. *S. quadrata* MELVILLE, Gloucs.(Stowell Park borehole); LV int.,  $\times 1$  (Cox, n).

### ?Family DATTIDAE Healey, 1908

[Materials for this family prepared by L. R. Cox]

Shell small, *Pteria*-like, known only by LV; posterior wing obtuse, no anterior auricle, anterodorsal angle rounded off, with external narrow ligamental area containing 2 ligamental pits, one below beak, other well posterior to it; spoonlike structure also present, possibly a chondrophore, projecting into shell cavity just in front of beak; elongate lateral tooth on posterior wing; adductor muscle scars and pallial line not observed. *U.Trias.*(*Rhaet.*).

This family was founded on what appears to be the inadequate basis of a single internal mold of a small left valve. Whether it deserves separation from the Bakevelliidae depends on the nature of the spoonlike internal projection. The interpretation of this as a chondrophore is suspect. No additional specimens are known to have been collected.

**Datta** HEALEY, 1908, p. 64 [*\*D. oscillaris*; OD]. Characters of family. *U.Trias.*(*Rhaet.*), Burma.—FIG. C45,1. *\*D. oscillaris*; 1a, LV int. mold,  $\times 2$ ; 1b, wax squeeze, reproducing features of hinge,  $\times 4.5$  (Healey, 1908).

### Family INOCERAMIDAE Giebel, 1852

[*nom. transl.* STEINMANN, 1903 (*ex* Inoceraminae ZITTEL, 1861)] [= *Sphenoceramidae* HEINZ, 1932] [Materials for this family prepared by L. R. Cox]

Variouly shaped, concentrically lamellose or plicated *Pteria*acea with multiple ligamental pits; subequivalve to highly inequi-





FIG. C45. Dattidae (p. N314).

valve, with LV more convex than RV; radial ribbing present only rarely; commissure plane except where affected by radial ribbing; no anterior gape; posterior wing present or absent; anterior wing usually absent or small; ligamental area with usually numerous regularly arranged ligamental pits which commonly have curved sides and do not indent margins of area; hinge teeth absent except in some *Parainoceramus*; inner ostracum nacreous (but not preserved in many specimens); outer ostracum formed of prismatic calcite. *L.Perm.-U. Cret., ?Oligo.*

**Inoceramus** J. SOWERBY, 1814, p. 448 [*\*I. cuvierii*; M, confirmed by ICZN (Opinion 473, 1957)] [= *Catillus* BRONGNIART, 1822 (type, *I. cuvierii* SOWERBY, 1814; SD COX HEREIN); *Catillus* NILSSON, 1827 (*nom. null.*)]. Subequivalve to strongly inequivalve, ovate, trapeziform or suborbicular; posterior wing variably developed; ligamental area concave transversely; no radial ornament except in *I. (Birostrina)*; outer ostracum very thick in some species. *L.Jur.(Lias.)-U.Cret., cosmop.*

**I. (Inoceramus)** [= *Haploscapa* CONRAD, 1874 (type, *H. capax*, = *Inoceramus deformis* MEEK, 1871; M); *Cucullifera* CONRAD, 1875 (type, *Haploscapa (Cucullifera) eccentrica*; M); *Neocatillus* FISCHER, 1886 (type, *Inoceramus lamarcki* "BRONGNIART"; OD); *?Athletoceramus*, *?Drepanoceramus*, *?Euphyoceramus*, *?Idioceramus* HEINZ, 1932 (all *nom. dubia*); *Abathoceramus*, *Alloцерamus*, *Astatoceramus*, *Aulaceramus*, *Callistoceramus*, *Camptoceramus*, *Ceratoceramus*, *Climacoceramus*, *Cosmioceramus*, *Cricoceramus*, *Cycloceramus*, *Epiceramus*, *Gnesioceramus*, *Gonioceramus*, *Heroceramus*, *Heteroceramus*, *Homaloceramus*, *Inaequiceramus*, *Megaloceramus*, *Mimoceramus*, *Orophoceramus*, *Orthoceramus*, *Oxyoceramus*, *Paraceramus*, *Platyceramus*, *Pleiaceramus*, *Proteoceramus*, *Schizoceramus*, *Scolioceramus*, *Smodingoceramus*, *Striatoceramus*, *Tethyoceramus*, *Xenoceramus* HEINZ, 1932 (*nom.*

*nud.*)]. Medium-sized to large, equivalve to moderately inequivalve, feebly to strongly inflated, height exceeding length, not or only slightly oblique; anterior margin not strongly convex or protruding; prominence of LV umbo variable; posterodorsal wing present, more or less flattened, well differentiated from body of valve in some species, undifferentiated in others; surface lamellae more or less regularly spaced; concentric plications variably developed. *L. Jur. (Lias.)-U.Cret., cosmop.*—FIG. C46, 1a, b. *\*I. (I.) cuvierii*; 1a, SENON., Eng., RV,  $\times 0.5$ ; 1b, TURON., Eng., ligamental area of LV,  $\times 0.5$  (both Woods, 1912).—FIG. C46, 1c. *I. (I.) lamarcki* PARKINSON, TURON., Eng.; LV,  $\times 1$  (Woods, 1912).

[The great majority of the generic and specific names published by HEINZ in 1932 rank as *nomina nuda*, as they do not comply with the joint requirements of publication with a diagnosis and with the citation of a type species, although some would have been valid had they been published prior to 1930. Some of these names have been used subsequently by HEINZ himself and a few other authors, but only one (*Besairieia*) appears to have acquired validity thereby. Hence the three names introduced by HEINZ which are adopted in this *Treatise* are stated to be those of new genera or subgenera and become valid in view of their publication herein with a cited type species and a diagnosis. In a few cases, when published with a few descriptive words and the citation of a single new nominal species, HEINZ's genera appear to be technically valid, with the species in question the type by monotypy. Unfortunately, in every such case the type species is unrecognizable, and it is necessary to dismiss these generic names as *nomina dubia*.]

**I. (Birostrina)** J. SOWERBY (*ex DE LUC*, MS), 1821, p. 183 [*\*I. sulcatus* PARKINSON, 1819; SD COX HEREIN] [= *Actinoceramus* MEEK, 1864 (obj.); *Taenioceramus* HEINZ, 1932 (*nom. nud.*)]. Small for family, gibbose, inequivalve, tall; hinge margin short, no posterodorsal wing; LV umbo narrow and prominent; beak prosogyrous; broad radial folds present on all or part of surface in some species, other species with concentric ornament only. *Cret.(Neocom.-Cenoman.)*, cosmop.—FIG. C46, 2a. *\*I. (B.) sulcatus* PARKINSON, L.Cret.(Alb.), Eng.; LV,  $\times 1$  (Woods, 1911).—FIG. C46, 2b. *I. (B.) subsulcatus* WILTSHIRE, L.Cret.(Alb.), Eng.; LV,  $\times 1$  (Woods, 1911).

**I. (Cataceramus)** COX, n. subgen., herein (*ex HEINZ, nom. nud.*) [*\*I. goldfussianus* D'ORBIGNY, 1846, p. 517 (= *I. balticus* BÖHM, 1907, p. 113)] [= *Boehmiceramus*, *Dimeroceramus*, *Haploceramus*, *Selenoceramus* HEINZ, 1932 (*nomina nuda*)]. Medium-sized to large, subequivalve, ovate, length exceeding height, not oblique or only slightly so; umbones broadly rounded, not prominent; hinge line fairly elongate, but no differentiated posterodorsal wing present; concentric plications strong, regular. *U.Cret.(Senon.)*, cosmop.—FIG. C46, 4. *\*I. (C.) goldfussianus* D'ORBIGNY, (Campan.), Ger.; LV,  $\times 0.5$  (Böhm, 1909).

**I. (Cremnoceramus)** COX, n. subgen., herein (*ex HEINZ, nom. nud.*) [*\*I. inconstans* WOODS, 1912, p. 285 (lectotype, Cox herein designated, Woods,

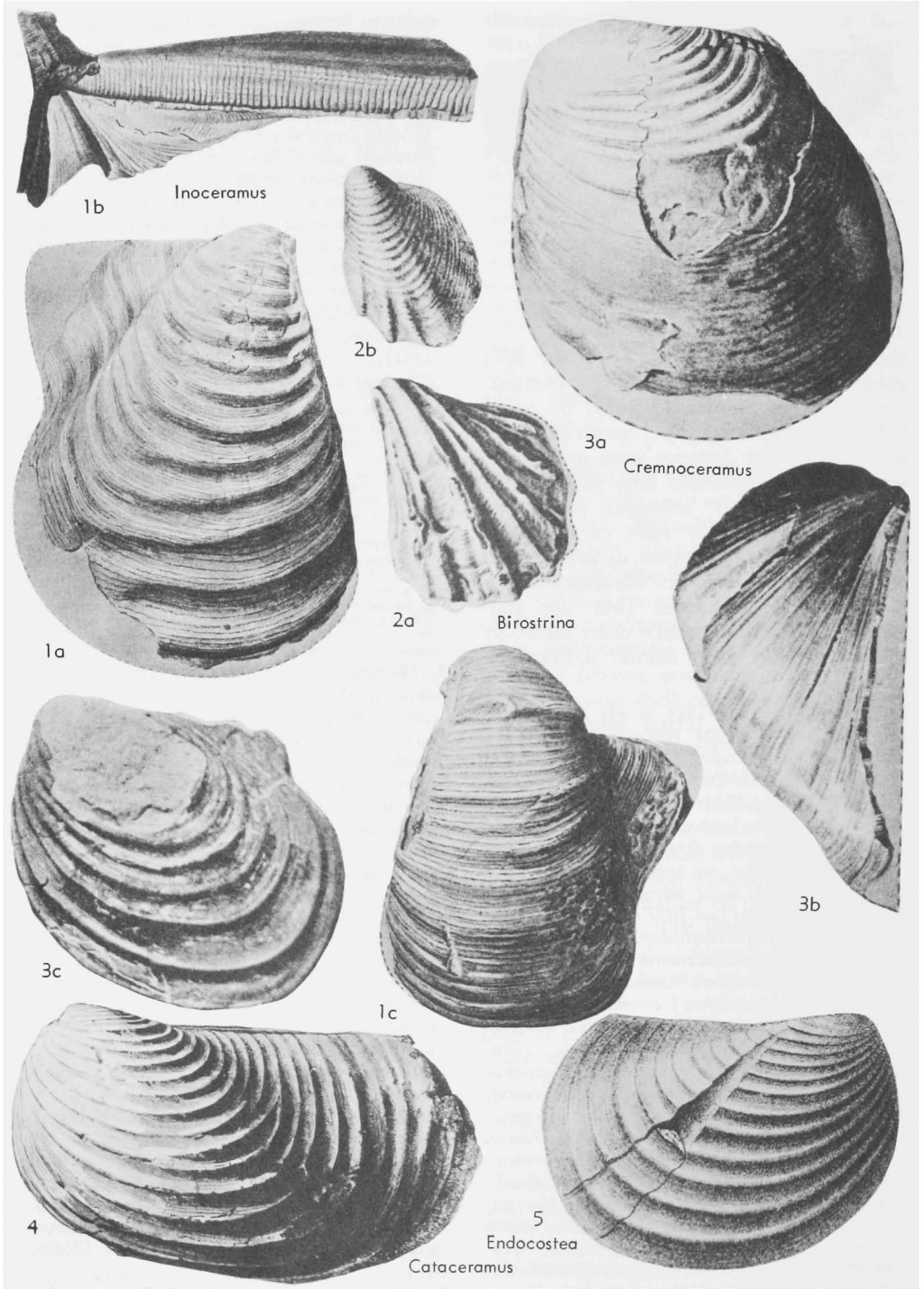


FIG. C46. Inoceramidae (p. N315, N317).

- text-fig. 43<sup>1</sup>) [=? *Acroceramus*, ? *Alloceramus*, ? *Bathmoceramus*, ? *Cephaloceramus*, ? *Discoceramus*, ? *Gnathoceramus*, ? *Madagiceramus*, ? *Onco-*  
*ceramus*, ? *Sphaeroceramus*, ? *Stenoceramus*, ? *Stolley-*  
*ceramus*, ? *Symboloceramus* HEINZ, 1932 (*nom.*  
*nuda*); ? *Enanticeramus*, ? *Manoceramus*, ? *Rha-*  
*chidoceramus*, ? *Syngenoceramus*, ? *Trachycera-*  
*mus* HEINZ, 1932 (*nom. dubia*)]. Medium-sized,  
suborbicular to rhombic, slightly to moderately  
oblique, subequivalve or inequivalve; LV weak-  
ly convex in early growth stages, later increasing  
rapidly in convexity, some specimens with con-  
centric angulation where convexity begins to in-  
crease; umbones broadly rounded, not promi-  
nent; posterodorsal wing absent or narrow; orna-  
ment of irregular concentric rugae and plica-  
tions. *U.Cret.*(*Turon.-Senon.*), cosmop.—FIG.  
C46,3a,b. \**I. (C.) inconstans* WOODS, *Turon.*,  
Eng.; 3a,b, LV,  $\times 1$  (Woods, 1912).—FIG.  
C46,3c. *I. (C.) crassus* PETRASCHKEK, *Senon.*,  
Eng.; LV,  $\times 0.7$  (Woods, 1912).
- I. (Endocostea)** WHITFIELD, 1877, p. 31 [\**E.*  
*typica*; OD]. Like *I. (Cataceramus)*, but with  
riblike swelling crossing interior of shell diag-  
onally from posterior side of umbo, forming  
groove on internal mold. *U.Cret.*(*Senon.*),  
cosmop.—FIG. C46,5. \**I. (E.) typicus*, N.Am.;  
RV, part of internal rib broken off and remain-  
ing in groove forming its mold,  $\times 1$  (Newton &  
Jenney, 1880).
- I. (Haenleinia)** J. BÖHM, 1907, p. 317 [\**I. flexu-*  
*osus* HAENLEIN, 1889; SD COX, herein] [= *Besairi-*  
*eia* HEINZ (1932, *nom. nud.*), 1933 (type, *Haen-*  
*leinia (Besairieia) besairiei* HEINZ, 1933; M);  
*Cordiceramus*, *Cyrtoceramus*, *Germanoceramus*  
HEINZ, 1932 (*nom. nud.*)]. Medium-sized, sub-  
equivalve, gibbose, ovate, without posterior wing;  
sinus of posteroventral margin of LV correspond-  
ing to radial sulcus of flank; ornament as in *I.*  
(*Inoceramus*). *U.Cret.*(*Senon.*), cosmop.—FIG.  
C47,1a. \**I. (H.) flexuosus* HAENLEIN, *U.Senon.*,  
Ger., LV,  $\times 0.7$  (Böhm, 1909).—FIG. C47,1b.  
*I. (H.) cordiformis* J. DE C. SOWERBY, *L.Senon.*,  
Eng., LV,  $\times 0.7$  (Woods, 1912).
- I. (Mytiloceramus)** ROLLIER, 1914, p. 416 [\**I.*  
*polyplocus* ROEMER, 1857; OD]. Medium-sized,  
rounded rhombic, slightly oblique, slightly in-  
equivalve; umbones narrowly rounded, not  
prominent; LV with small anterodorsal wing pro-  
jecting toward RV; ornament of fairly regular  
concentric folds. *M.Jur.*(*Aalen.*), Eu.-Japan.—  
FIG. C47,3. \**I. (M.) polyplocus* ROEMER, Alsace;  
RV,  $\times 0.7$  (Benecke, 1905).
- I. (Mytiloides)** BRONGNIART, 1822, p. 320 [\**Ostra-*  
*cites labiatus* VON SCHLOTHEIM, 1813; M]  
[= *Mytiloida* BRONGNIART, 1832 (*nom. van.*);
- Mytiloides* CONRAD, 1874 (*nom. null.*); *Orpheo-*  
*ceramus*, ? *Citharoceramus*, ? *Aristoceramus*  
HEINZ, 1932 (*nom. nud.*)]. Medium-sized, ob-  
liquely ovate and elongated, subequivalve, of  
slight convexity; hinge line short; concentric  
plications variably developed. *L.Jur.-U.Cret.*,  
cosmop.—FIG. C47,4a. \**I. (M.) labiatus*  
(SCHLOTHEIM), *U.Cret.*(*Turon.*), Eng.; LV  
 $\times 0.5$  (Woods, 1911).—FIG. C47,4b. *I. (M.)*  
*galoi* BÖHM, *U.Jur.*(*Callov.*), Argentina; LV,  
 $\times 1$  (Stehn, 1924).
- Anopaea** EICHWALD, 1861, p. 301 [\**Inoceramus*  
*lobatus* AUERBACH & FREARS, 1846 (*non* GOLD-  
FUSS, 1836) = \**I. brachovi* ROUILLIER, 1849; M].  
Medium-sized, subequivalve, elongated, rather  
pyriform, with low, lobelike anterior region, com-  
monly separated by broad sulcus from rest of  
shell; no demarcated posterior wing; inflation  
only moderate; umbones narrow, scarcely pro-  
truding; beaks prosogyrous; cordiform lunule  
present; ligamental pits small and numerous; LV  
with internal rib below beak; ornament of con-  
centric lamellae and broad plications. *U.Jur.*,  
Eu.-Indon.-N.Z.—FIG. C47,2. \**A. brachovi*  
(ROUILLIER), U.Volgian, USSR; 2a,b, LV and  
dorsal views,  $\times 0.5$  (Pavlov, 1905).
- Aphanaia** DE KONINCK, 1877 [\**Inoceramus mitch-*  
*ellii* M'COY, 1847; SD NEWELL, 1942]. Ovate to  
subpyriform, prosogyre, subequivalve, RV slightly  
less convex than LV; ornament of irregular con-  
centric undulations; lunule shallow, broad and  
elongate; hinge edentulous, short, without um-  
bonal septum; resilifer pits numerous, closely  
spaced. *Perm.*, Australia.—FIG. C48,5. \**A.*  
*mitchellii* (M'COY), L.Perm. (Glendon F.), New  
S.Wales, Australia; 5a, RV, composite mold,  
 $\times 0.3$ ; 5b, RV, latex cast interior of same,  $\times 0.7$   
(BROWNE and NEWELL, 1966). [NEWELL]
- Arcticeramus** KOSCHELKINA, 1962, p. 41 [\**Ino-*  
*ceramus arcticus* KOSCHELKINA, 1962, p. 72; OD].  
Of medium size, inequivalve, LV the more con-  
vex and with more protruding umbo; ornament  
of concentric folds; internal characters unknown.  
*M.Jur.*(*Callov.*)-*U.Jur.*(*L.Volgian*), USSR (Sib.).
- Inoceramya** ULRICH, 1904, p. 134 [\**I. concentrica*;  
M]. Medium-sized, thin-shelled, suborbicular,  
compressed, probably equivalve; umbones near  
middle of hinge margin, not protruding; liga-  
mental pits small and numerous, decreasing in  
size toward ends of hinge margin; internally with  
riblike swelling which extends obliquely backward  
from umbo; ornament of regular concentric pli-  
cations which are absent from posterodorsal re-  
gion. *Yakutat Formation (Mesoz., system un-*  
*certain)*, Alaska.—FIG. C48,5. \**I. concentrica*;  
5a, RV (reconstr.),  $\times 0.7$ ; 5b, post. part of hinge  
and internal rib,  $\times 1$  (Ulrich, 1904).
- Lenella** KOSCHELKINA, 1962, p. 31 [\**L. tiungensis*;  
M]. Small to medium-sized, equivalve, mytili-  
form; posterior wing obtuse, flattened; anterior

<sup>1</sup> ANDERT (1913) and HEINZ have restricted Woods' inter-  
pretation of *I. inconstans*, but neither has selected a lecto-  
type.

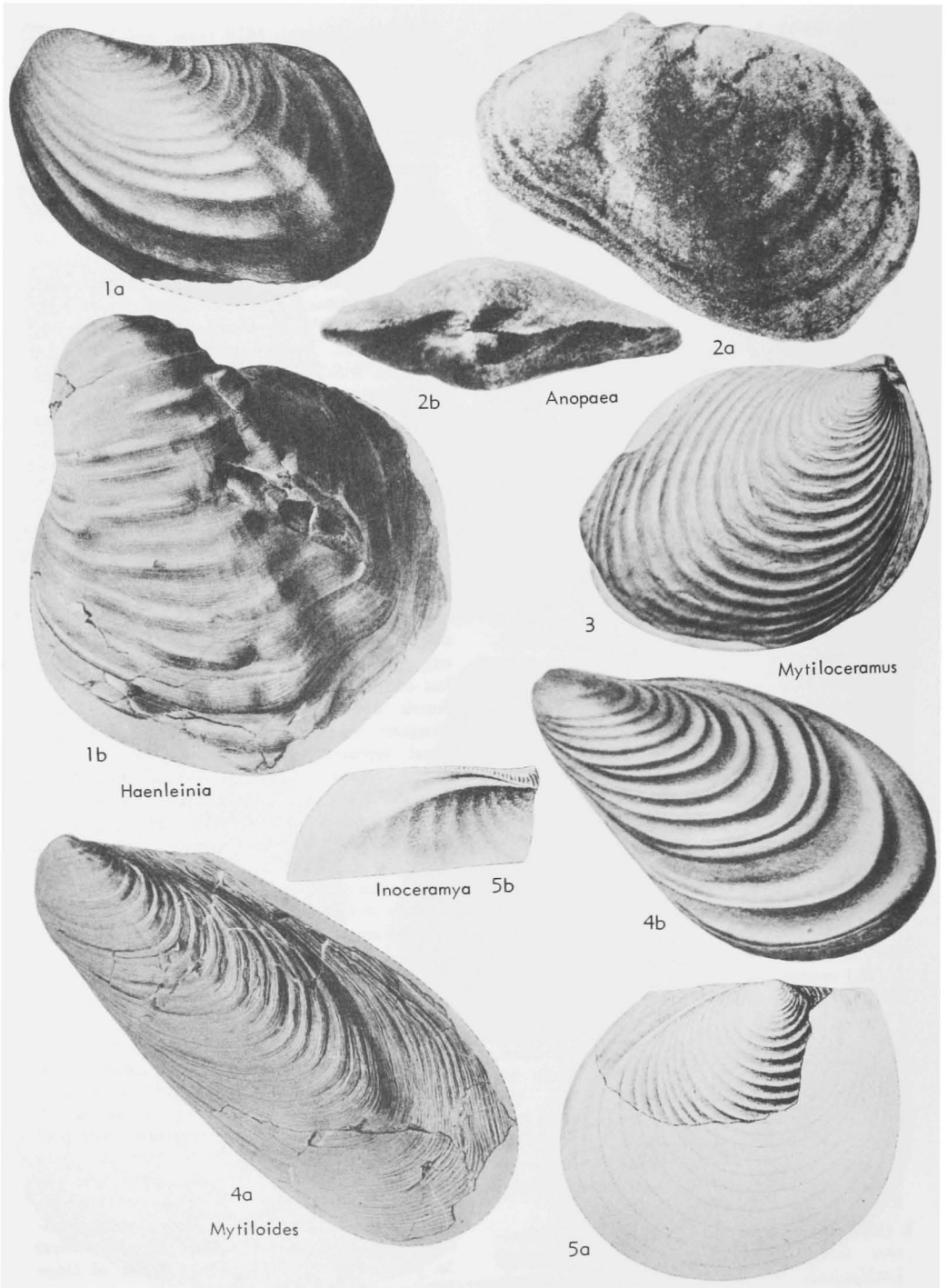


FIG. C47. Inoceramidae (p. N317).

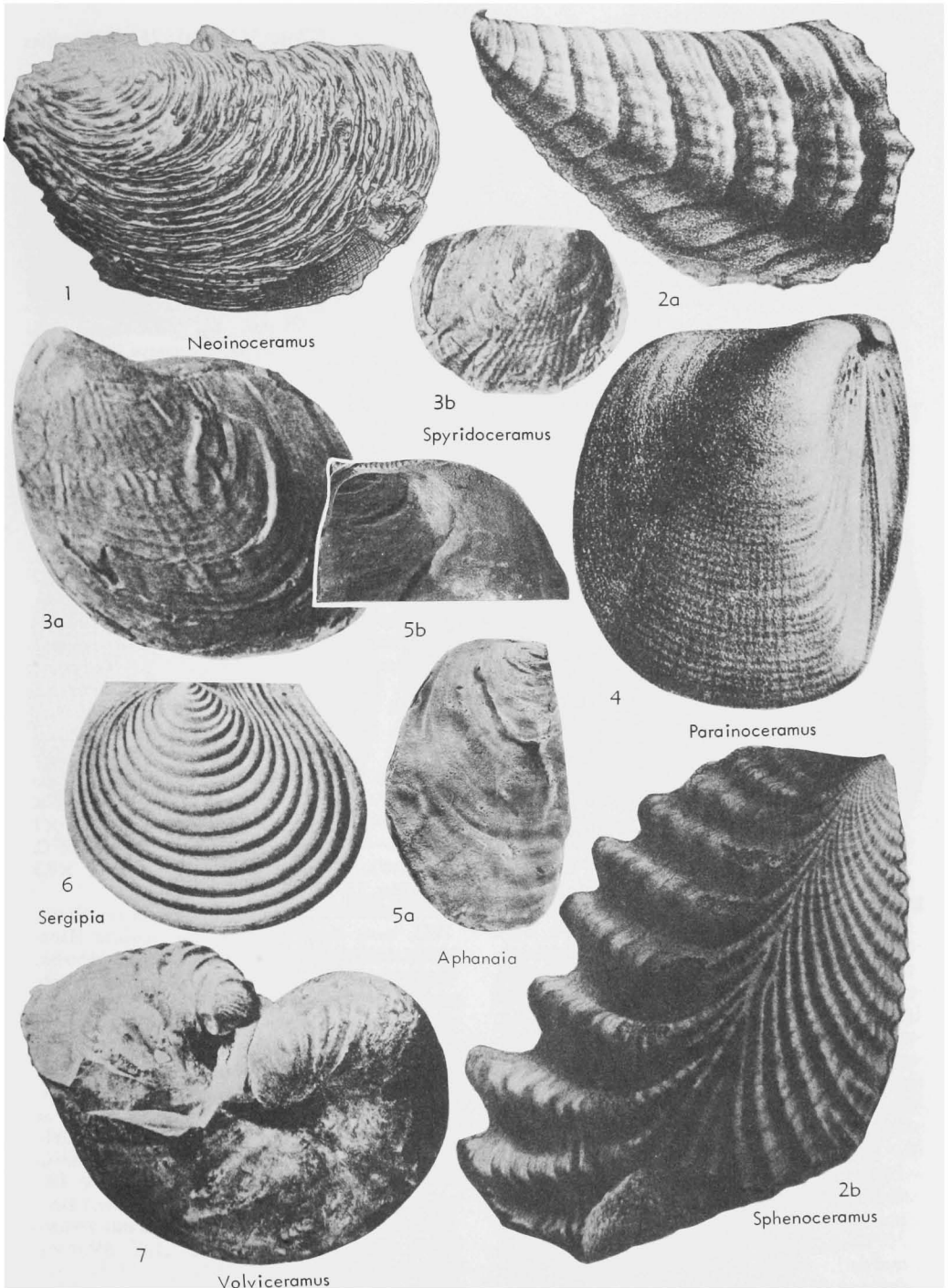


FIG. C48. Inoceramidae (p. N317, N320-N321).

- auricle well defined, acute, with byssal sinus below it; ligamental pits few and well separated; shell wall moderately thick; ornament of distant narrow concentric folds with broad posteroventral sinus; small anterior adductor present in early growth stages, later becoming obsolete; pallial line split up into small pits. *L.Jur.* (*Domer.*), USSR (E. Sib.).
- ?**Neoinoceramus** IHERING, 1902, p. 134 [\**N. ameghinoi*; M]. Large, obliquely ovate, irregular in outline; with relatively short hinge margin and ill-defined anterodorsal and posterodorsal wings; ligamental area and internal characters imperfectly known; ornament of very irregular concentric plications and ridges. ?*Oligo.* (base of Patagonian Molasse), Patagonia.—FIG. C48,1. \**N. ameghinoi*; LV,  $\times 0.4$  (Ameghino, 1906).
- Parainoceramus** VORONETZ, 1936, p. 23 [\**P. bulkurensis*; SD Cox, 1954, p. 47]. Small to medium-sized, equivalve, of moderate convexity, rectangular or trapeziform, posteriorly subulate; umbones protruding only slightly above hinge margin, beaks subterminal; anterior face of shell more or less impressed; ligamental area flat, pits numerous; short anterior and elongate posterior teeth present in some species, at least in early growth stages; surface smooth or with weak concentric plications. *U.Trias.-Jur.*, cosmop.—FIG. C48,4. *P. substriatus* (VON MÜNSTER), *L.Jur.* (L.Lias.), Ger.; both valves,  $\times 1$  (341b).
- Pseudomytiloides** KOSCHELKINA, 1963, p. 129 [\**Mytiloides marchaensis* PETROVA, 1947, p. 130; SD Cox, herein]. Rather small, subequivalve, well inflated, mytiliform; hinge line short, posterior wing virtually absent; no anterior auricle; shell wall thin; ornament of regular closely spaced concentric folds. *L.Jur.* (Lias.), Eu.-Asia.—FIG. C49,2. *P. dubius* (J. DE C. SOWERBY), U.Lias. (Toarc.), Eng.; RV ext.,  $\times 1$  (BMNH).
- Retroceramus** KOSCHELKINA, 1957, p. 29 [\**Inoceramus retrorsus* KEYSERLING, 1848, p. 250; OD]. Medium-sized, equivalve, subrhomboidal or obliquely oval; umbones protruding slightly above hinge margin, weakly prosogyrate, beaks not quite terminal; ligament pits closely arranged, alternating in width; small anterior adductor present, pallial line broken up into oval depressions; prismatic layer of shell wall thick, ornament of broad concentric folds. ?*U.Trias.*, *L.Jur.* (*Pliensbach.*)-*U.Jur.* (*Kimmeridg.*), cosmop.
- R. (Retroceramus)** [= *Eoinoceramus* VORONETZ, 1961, p. 81 (type, *Inoceramus porrectus* EICHWALD, 1871)]. Obliquely oval, broadening in ventral direction; concentric folds regularly arranged. ?*U.Trias.*, *L.Jur.* (*Pliensbach.*) - *U.Jur.* (*Kimmeridg.*), cosmop.—FIG. C49,1a. \**R. (R.) retrorsus* (KEYSERLING), ?*U.Trias.*, USSR (Olének, Sib.); RV ext.,  $\times 1$  (von Middendorf).—FIG. C49,1b,c. *R. (R.) porrectus* (EICHWALD), L. Cret. (Neocom.), USA (Alaska); *1b,c.*, both valves (dorsal), RV ext.,  $\times 0.7$  (Eichwald).
- R. (Fractoceramus)** KOSCHELKINA, 1957, p. 29 [\**Inoceramus formosulus* VORONETZ, 1937, p. 18; OD]. Mytiliform; concentric ornament irregular. *M.Jur.*, USSR (Sib.)-Can.
- R. (Striatoceramus)** KOSCHELKINA, 1959, p. 100 [\**Inoceramus vakhrameevi* KOSCHELKINA, 1961, p. 150; SD KOSCHELKINA, 1961]. Irregularly subtriangular; ornament of concentric folds, with narrow radial ribs appearing during growth. *M.Jur.*, USSR (Sib.).
- Sergipia** MAURY, 1925, p. 596 [\**Inoceramus (Sergipia) posidonomyaformis*; M]. Thin-shelled, suborbicular, very similar to *Inoceramya*, except that internal riblike swelling has not been observed; ligamental pits minute and numerous. [Like *Inoceramya*, this appears to constitute a link between *Steinmannia* of the Posidoniidae and the Inoceramidae.] *Cret.*, S.Am. (Brazil).—FIG. C48, 6. \**S. posidonomyaformis*; LV ext.,  $\times 2$  (Maury, 1935).
- Sphenoceramus** J. BÖHM, 1915, p. 183 [\**Inoceramus cardissoides* GOLDFUSS, 1836; SD VIALOV *et al.*, 1960, p. 81] [= *Sphenoceramus* BÖHM, 1922 (*nom. null.*); *Beloceramus*, *Cinclidoceramus*, *Cladoceramus*, *Dactyloceramus*, *Dictyoceramus*, *Eugenerceramus*, *Euryceramus*, ?*Heliooceramus*, *Strebloceramus*, *Thoracoceramus*, ?*Trochoceramus* HEINZ, 1932 (*nom. nud.*)]. *Inoceramus*-like, but tall and trigonal, commonly large, with very narrow, sharply rounded umbo and short hinge margin; equivalve; with radial or obliquely divergent ribbing superposed on concentric plications. *U.Cret.* (*Senon.*), cosmop.—FIG. C48,2a. \**S. cardissoides* (GOLDFUSS), Ger.; LV ext.,  $\times 1$  (341b).—FIG. C48,2b. *S. digitatus* (J. DE C. SOWERBY), L.Senon., Ger.; RV ext.,  $\times 0.3$  (Schlüter, 1877).
- Spyridoceramus** Cox, new genus, herein (*ex* HEINZ, 1932, *nom. nud.*) [\**Inoceramus tegulatus* HAGENOW, 1842, p. 559]. Medium-sized, ovate-rhombic, longer than high, inequivalve; LV rather strongly convex with moderately prominent umbo, somewhat resembling a *Pholadomya* valve, RV almost flat; small anterior wing present in both valves; ornament (both valves) of irregular concentric rugae and weak radial riblets; relatively thin-shelled; ligamental area a continuous groove at base of which individual ligamental pits are barely distinguishable. [*Inoceramus argenteus* CONRAD is the North American representative of this genus.] *U.Cret.* (*Campan.*), Rügen (Ger.)-Denmark-N.Am.—FIG. C48,3. \**S. tegulatus* (HAGENOW), Campan., Denm.; *3a,b.*, LV, RV,  $\times 1$  (Ødum, 1922).
- Steinmannia** FISCHER, 1886, p. 960 [*pro Aulacomya* STEINMANN, 1881 (*non* MÖRCH, 1853)] [\**Posidonia bronni* VOLTZ, in ZIETEN, 1833, p. 72; M].



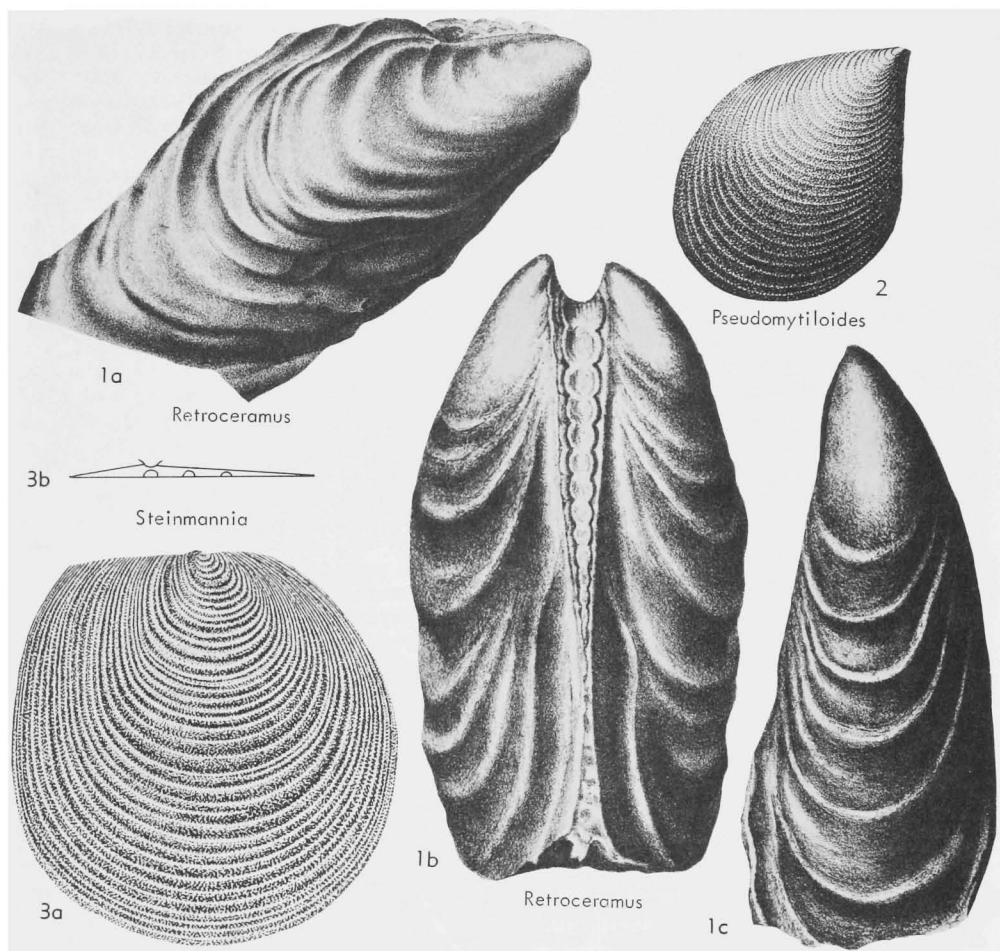


FIG. C49. Inoceramidae (p. N320-N321).

Suborbicular, not auriculate, equivalve, gibbose (but commonly crushed), thin-shelled, *Posidonia*-like; posterior end with shallow groove running obliquely from beak to posterior margin; ornament concentric ridges and threads; ligamental area narrow, obtusely triangular, extending on both sides of beak and bearing small number (3 or 4) of shallow transverse ligamental pits. *L. Jur. (Toarc.)*, Eu.-Asia-N. Afr.-Madag. — FIG. C49,3. \**S. bronnii* (VOLTZ); 3a, Eng.(Lincoln), RV,  $\times 1$  (202); 3b, Fr.(Nancy), ligamental area,  $\times 1.4$  (352).

?*Turkmenia* KRIMHOLTZ, 1936, p. 96 [\**T. balkhanensis*; M]. Small, trigonally ovate with sharply pointed umbo, posteriorly subulate, longer than high, inequivalve, thought possibly to have grown attached by RV (more convex), to substratum; with narrow ligamental area bearing 4-6 liga-

mental pits; ornament of broad concentric plications. *L.Cret. (L.Barrem.)*, Turkmenia.

*Volviceramus* STOLICZKA, 1871, p. 394 [\**Inoceramus involutus* J. DE C. SOWERBY, 1828; OD] [= ?*Opsiceramus* HEINZ, 1932, p. 17 (type, *Inoceramus rumphii* BÖHM, 1924; OD); ?*Colpoceramus*, ?*Condyloceramus*, *Cymatoceramus*, ?*Rhadinoceramus*, *Tactoceramus*, ?*Xiphoceramus* HEINZ, 1932 (*nom. nud.*)]. Large, highly inequivalve, LV coiled in spiral, RV feeble to moderate in convexity; beak directed anteriorly; ornament of concentric plications. *U.Cret. (Senon.)*, Eu.-N.Am. — FIG. C48,7. \**V. involutus* (SOWERBY), Senon., Eng.; both valves ant.,  $\times 0.7$  (Woods, 1912).

#### Family ISOGNOMONIDAE Woodring, 1925



[=Pernaridia RAFINESQUE, 1815; Pernadae FLEMING, 1828, also GUILDING, 1828; Melinidae STOLICZKA, 1871; Pernidae ZITTEL, 1895; Isognomonidae IREDALE, 1939] [Materials for this family prepared by L. R. Cox]

Subequivalve to strongly inequivalve, highly to moderately inequilateral, variously shaped but rarely pronouncedly oblique Pteriacea with multiple ligamental grooves but without hinge teeth in adult shell; LV more strongly convex in inequivalve forms, commissure plane or undulating; with or without anterior byssal gape affecting both valves; posterior wing undifferentiated to well defined, anterior auricle present only rarely; ligamental area external, usually flat, ligamental grooves reaching and indenting its lower margin; monomyarian; pallial line commonly discontinuous, broken up into small pits; surface of shell smooth, concentrically lamellose or irregularly undulating; radial ornament absent (except in *Mulletia*); ostracum very thick in most but not all species, inner ostracum nacreous. *U.Perm.-Rec.*

The Isognomonidae appear to have arisen from the Bakevelliidae in Triassic time, losing the *Pteria*-like form characteristic of typical genera of that family. BERNARD's work on the ontogeny of the shell in the Recent species *Isognomon ephippium* has shown that hinge teeth are present in the earliest growth stages but soon become obsolete (Fig. C50,2a-e). Beginning with a single one, the number of ligamental grooves steadily increases during growth. Living Isognomonidae have much thinner shells than most fossil species.

**Isognomon** LIGHTFOOT, 1786, p. 41, 52 [\**Ostrea perna* LINNÉ, 1767, p. 1149; M] [= *Isognoma* LIGHTFOOT, 1786 (obj.)]. Shell subequivalve, usually higher than long, more or less compressed, of various shapes; umbo directed anteriorly and not protruding above hinge margin; ligamental area broad and flat, scarcely undercut; ligamental grooves numerous, regularly arranged; narrow byssal gape present below beaks, with corresponding reflection of anterior margin. *U.Trias.-Rec.*, cosmop.

**I. (Isognomon)** [= *Melina* RETZIUS, 1788, p. 22 (type, *Ostrea ephippium* LINNÉ, 1758, p. 700; SD HERRMANNSEN, 1847, p. 37); *Perna* BRUGUIÈRE, 1789 (non RETZIUS, 1788); *Pernigenus* RENIER, 1807 (nom. van.); *Sutura* MEGERLE VON MÜHLFELD, 1811, p. 65 (type, *O. ephippium* LINNÉ; M); *Pernaria* RAFINESQUE, 1815 (nom.

van.); ?*Pernomytilus* ROLLIER, 1914, p. 338 (type, *Mytilus pernoides* ROEMER, 1836, p. 89; M); *Aviculoperna* PHELINTSEV, 1931 (non COSSMANN, 1887); *Casteria* TUCKER & WILSON, 1933, p. 3 (type, *Pedalion (Casteria) kecia*; OD); *Parviperna* IREDALE, 1939, p. 322 (type, *P. perexigua*; OD); *Anisoperna* IREDALE, 1939, p. 321 (type, *Perna australica* REEVE, 1858, pl. 3; OD)]. Rhomboidal to pyriform, beak at anterior end of hinge margin, produced and pointing anteriorly; lower part of anterior margin in some species strongly convex and extending well forward of beak, entire anterior margin in other species straight or almost so and inclined so as to form slightly acute angle with hinge margin; hinge margin rather short, posterior wing obtuse and seldom well differentiated; ligamental grooves subequal, intervals between them lying in general plane of ligamental area; surface lamellose. *U.Trias.-Rec.*, cosmop.—FIG. C50,2a-e. I. (I.) *ephippium* (LINNÉ), Rec., Mauritius; 2a,b, RV ext., RV int.,  $\times 0.5$  (Cox, n); 2c-e, early ontogenetic stages, showing hinge teeth later obsolete, much enl. (44).—FIG. C50,2f,g. I. (I.) *isognomonoides* (STAHL), M.Jur.(Bathon.); 2f, Switz., RV,  $\times 0.7$  (Greppin, 1900); 2g, Ger., LV ligamental area,  $\times 0.7$  (341b).

**I. (Hippo chaeta)** PHILIPPI (ex SANGIOVANNI, MS), 1844, p. 55 [\**Perna soldanii* DESHAYES in LAMARCK, 1836, p. 79 (= \**P. maxillata* LAMARCK, 1801, p. 134); M] [= *Hypo chaeta* ZILCH, 1938 (nom. van.)]. Large, rhomboidal or rectangular, usually slightly oblique, commonly very thick-shelled; beak terminal, posterior wing not differentiated; without ridge passing from beak to lower extremity of shell; ligamental grooves numerous, narrow and shallow, situated on platforms separated by deep, narrow, furrows; 3 accessory muscle scars present on posterodorsal part of shell interior, aligned obliquely and radially from beak. *Eoc.-Plio.*, cosmop.—FIG. C50,1. \*I. (H.) *maxillatus* (LAMARCK), Plio., Italy; 1a, LV. ext.,  $\times 0.5$ ; 1b, RV dorsal region int. showing ligamental area and accessory scars,  $\times 0.3$  (both Cox, n); 1c, cross section of ligamental area showing deep furrows between ligamental grooves (L), lower figs. corresponding cross section in 2 species of I. (*Isognomon*) (Zilch, 1938).

**I. (Isognomum)** RÖDING, 1798, p. 168 [\*I. *norma* (= \**Ostrea isognomum* LINNÉ, 1758, p. 699); T] [= *Pedalion* DILLWYN (ex HUDDSFORD, vernac.), 1817, p. 282 (type, *Ostrea isognomon* LINNÉ, 1764, = *O. isognomum* LINNÉ, 1758; T); *Malleoperna* IREDALE, 1939, p. 323 (type, *M. intricata*; OD)]. Medium large; tall, narrow, malleiform, rather irregular, with undulating commissure; narrow, moderately elongate posterior wing and small, pointed anterior wing

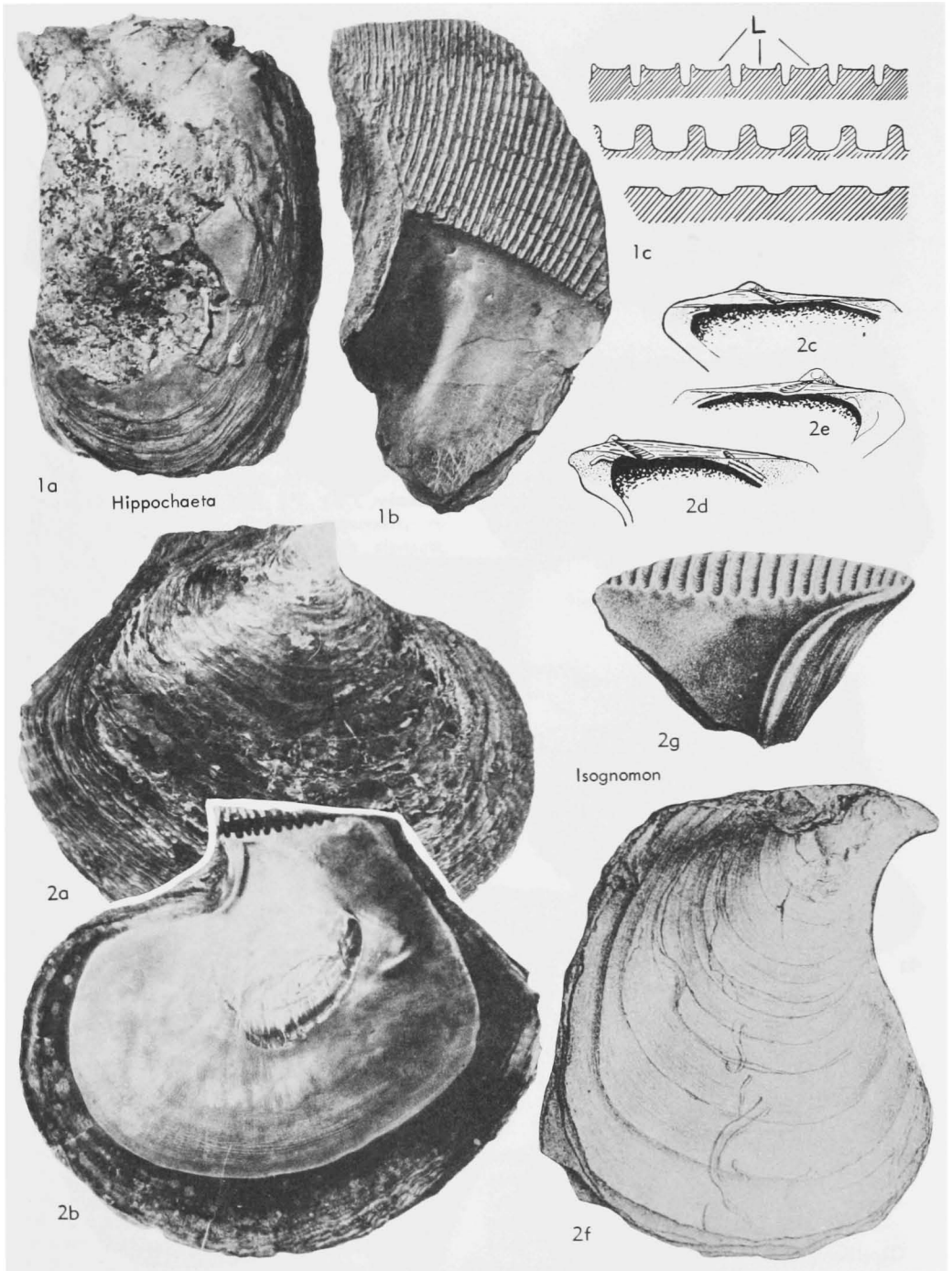


FIG. C50. Isognomonidae (p. N322).

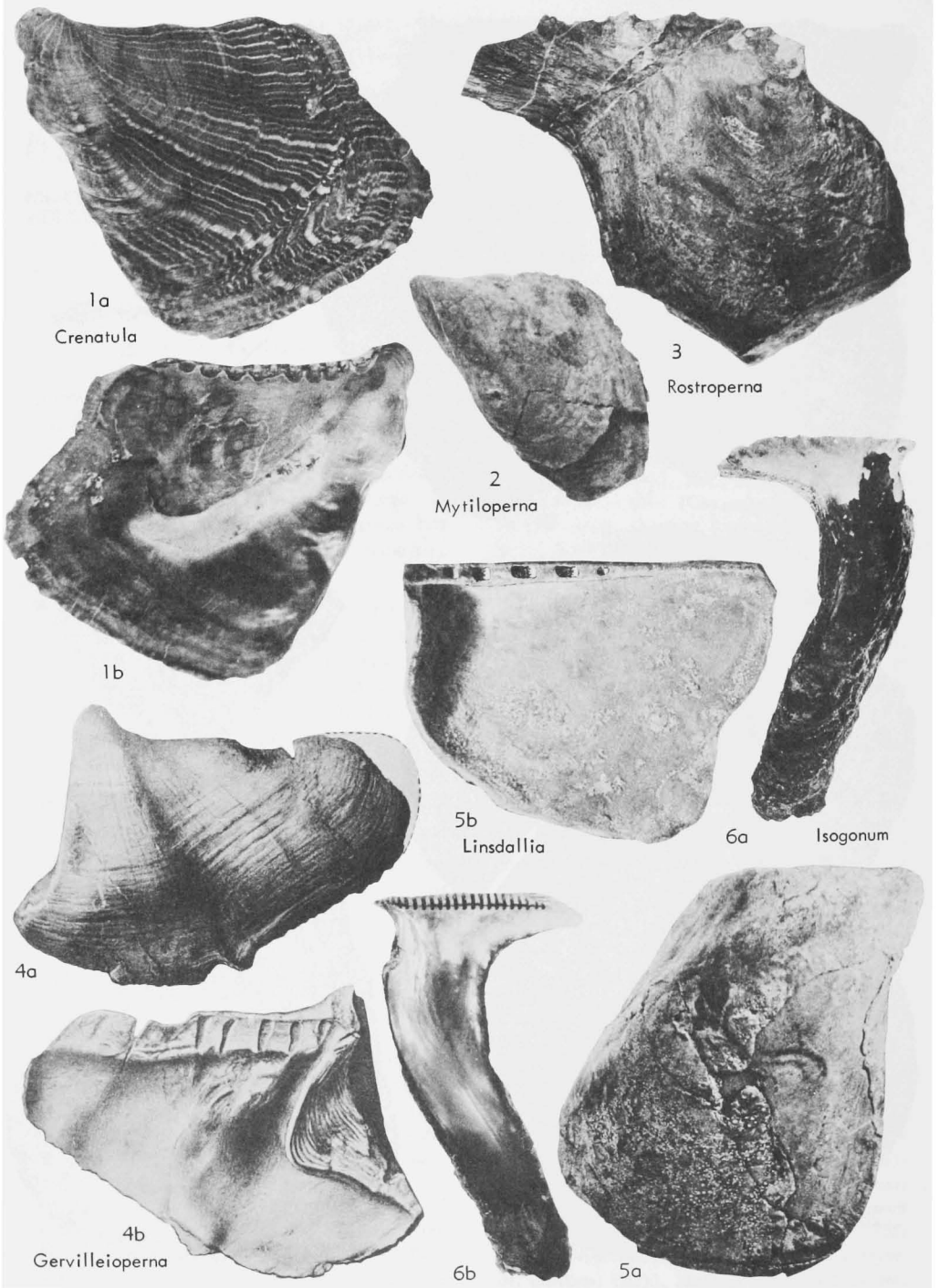


FIG. C51. Isognomonidae (p. N323, N325-N326).

commonly present; relatively thin-shelled for genus; ligamental grooves numerous and narrow, arranged as in *I. (Isognomon)*. *Rec.*, IndoPac.-Australia.—FIG. C51,6. *I. (I.) isognomum* (LINNÉ), Ind.O.; 6a,b, RV ext., RV int.,  $\times 0.3$  (Cox, n).

**I. (*Mytiloperna*)** VON IHERING, 1903, p. 123 [*\*Perna americana* FORBES in DARWIN, 1846, p. 266; M] [= *Mytiloperna* ROLLIER, 1914, p. 426 (type, *Perna mytiliformis* SCHLIPPE, 1888, p. 141; SD Cox, herein), proposed independently]. Shell smaller than in other subgenera of *Isognomon*, equivalve, mytiliform, commonly with ridge running from subterminal beak to lower extremity; posterior wing undifferentiated; no distinct byssal gape; ligamental grooves depressed below their intervals as in *I. (Isognomon)* but fewer and more separated. *L.Jur. (Lias.)-U.Jur.*, cosmop.—FIG. C51,2. *I. (M.) murchisonii* (FORBES), M.Jur.(Bathon.), Scot. (Skye); LV ext.,  $\times 1.3$  (Cox, n).

**I. (*Rostroperna*)** COX, 1961 [*\*I. (R.) schencki*; OD]. Medium large, slightly inequivalve, resembling *I. (Isognomon)* but with elongate, sharply acute, beaklike posterior wing; ligamental grooves broad, irregular and unequal, with intervals as in *I. (Isognomon)*. *Cret.*, Iran.—FIG. C51,3. *\*I. (R.) schencki*; RV,  $\times 0.5$  (Cox, n).

***Crenatula*** LAMARCK, 1803, p. 30 [*\*C. avicularis*; SD STOLICZKA, 1871, p. 395] [= *Crenatuligenus* RENIER, 1807; *Cranatula* CHILDREN, 1823 (*nom. null.*); *Dalacia* GRAY, 1825, p. 139 (type, *Crenatula folium* LAMARCK, 1803; M)]. Medium-sized, subequivalve, compressed, length exceeding height to varying extent; bialate in earlier growth stages, later irregular in form with anterior wing small and round-margined, posterior wing undifferentiated; thin-shelled, foliaceous; no byssal gape (byssus obsolete); ligamental area narrow, undercut anteriorly; ligamental grooves shallow, semicircular, with relatively narrow intervals; adductor scar dorsally placed; commensal in sponges. *U. Tert.-Rec.*, IndoPac.-Australia-W.S.Am.—FIG. C51,1. *C. picta* (GMELIN), *Rec.*, Red Sea; 1a,b, LV ext., LV int.,  $\times 1$  (Cox, n).

***Gervilleioperna*** KRUMBECK, 1923, p. 76 [*\*G. timorensis*; M]. Large; LV moderately convex, with vertically extended cuneiform body, narrow, prominent umbo, and broad, greatly elongated posterior wing; beak strongly prosogyrous, with well-impressed lunule below it, margin of lunule with narrow byssal gape; RV imperfectly known; ligamental pits few, irregular, relatively narrow, with broader intervals. *L.Jur. (M.Lias.)*, Timor.—FIG. C51,4. *\*G. timorensis*; 4a,b, LV ext., LV int.,  $\times 0.5$  (486).

?***Leuproconcha*** GIEBEL, 1856, p. 67 [*\*L. paradoxa*; M]. Small, orbicular, externally like *Ostrea*, but with 3 or 4 ligamental pits. *M.Trias.*, Ger.

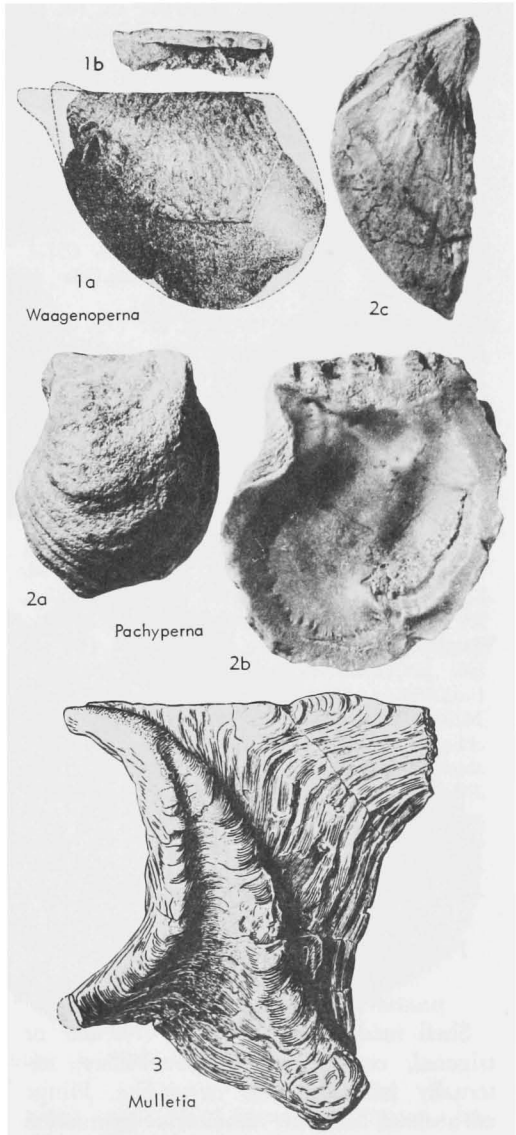


FIG. C52. Isognomonidae (p. N326).

***Linsdallia*** COX & ARKELL, 1948, p. 48 [*\*Perha quadrata* J. DE C. SOWERBY, 1825, p. 149; OD]. Large, strongly inequivalve, broadly trapeziform, longer than high, posteriorly subalate, with relatively wide lunule and broad anterior gape; LV strongly inflated diagonally, with prominent umbo and strongly prosogyrous terminal beak; RV feebly convex; ligamental area rather narrow, well undercut anteriorly; ligamental pits broad, not numerous, irregularly arranged. *M.Jur. (Bajoc.)*,

Eng.—FIG. C51,5. \**L. quadrata* (J. DE C. SOWERBY); 5*a,b*, LV ext., RV int.,  $\times 0.7$  (Cox, n). *Mulletia* P. FISCHER, 1886, p. 956 [\**Perna mulletii* DESHAYES in LEYMERIE, 1842, p. 8; OD]. Quadrangular, thick-shelled, with long attenuated posterior wing; slightly inequivalve; 2 broad, curved, riblike swellings in each valve diverging from umbo to ends of lower margin, where they form prominent projections; between latter valve margins project prominently outward to right; byssal gape narrow. *L.Cret.*, Eu.-S.Am.—FIG. C52,3. \**M. mulletii* (DESHAYES), Apt., Eng.(Isle of Wight); LV,  $\times 0.45$  (Woods, 1905).

*Pachyperna* OPPENHEIM, 1900, p. 237 [\**P. laverdana*; M]. Moderately small, ovate, higher than long, not oblique, subequivalve, strongly convex; shell wall very thick; with small anterior auricle but with no differentiated posterior wing; umbones ill-defined, not protruding; anterior face with broad, shallow lunule but without byssal gape; ligamental area broad, with not more than 5 relatively wide pits; adductor scar large, situated near posterior margin. *Eoc.*, France-N.Italy.—FIG. C52,2. *P. franci* (G. B. SOWERBY), M. Eoc., France(Cotentin); 2*a*, LV ext.,  $\times 0.85$ ; 2*b,c*, RV int. and anterior face,  $\times 0.85$  (Cox, n).

*Waagenoperna* TOKUYAMA, 1959, p. 151 [\**Edentula lateplanata* WAAGEN, 1907, p. 97; OD] [= *Edentula* WAAGEN, 1907 (*non* NITZSCH, 1820)]. Mytiliform, subequivalve, compressed, oblique, with terminal or subterminal beaks; obsolescent anterior auricle, posterior wing undifferentiated; anterior teeth but no posterior teeth present in young shell, all teeth later obsolete. *U.Perm.-U.Trias.*, Eu.-Asia(Japan).—FIG. C52, 1. \**W. lateplanata* (WAAGEN), *U.Trias.*, Japan; 1*a,b*, LV ext. and ligamental area,  $\times 0.85$  (950).

### Family PULVINITIDAE Stephenson, 1941

[Materials for this family prepared by L. R. Cox]

Shell medium-sized, ovate, orbicular or trigonal, compressed, not auriculate; externally lamellose and oyster-like. Hinge edentulous, but with rather wide ligamental area in each valve bearing series of narrow, elongate, subparallel, transverse ligamental pits. RV flat or slightly concave, with circular byssal foramen below middle of ligamental area; LV feebly convex; with circular, radially striated byssal (pedal) retractor scar opposite foramen of RV; single adductor scar located medially in each valve; inner ostracum nacreous. *U.Jur.-Rec.*

This family is best known by the type genus, well-preserved specimens of a species

of which are found in the Ripley Formation (U.Cret.) of Coon Creek, Tennessee. The discovery of the rare living genus *Foramulina* has confirmed the fact that the foramen in the right valve served for passage of a byssus. In this genus a suture leads from the foramen to the anterior extremity of the ligamental platform, suggesting that the foramen was derived from a byssal sinus by the closing of its margins and its migration inwards. A similar suture has not been observed in the fossil genera. The wide intervals of time that separate the known occurrences of the three genera belonging to this family might suggest that they had evolved independently. The three genera, however, agree so closely in shell morphology that it seems more probable that they are related lineally and that the wide stratigraphical gaps between their recorded occurrences are due to imperfection of the record.

*Pulvinites* DEFRANCE, 1824, p. 316 [\**P. adansonii*; M]. Orbicular or broadly trigonal; adductor scar orbicular, situated in the center of each valve and well separated from foramen or from corresponding byssal muscle scar; lower margin of ligamental area straight. *U. Cret.* (*Cenoman.-Maastricht.*), France-Lebanon-N.Am.—FIG. C53,2. *P. argenteus* (CONRAD), Campan.(Ripley), USA(Tenn.); 2*a,b*, RV ext., RV int. showing byssal foramen; 2*c,d*, LV ext., LV int.; all  $\times 0.7$  (951).

*Foramulina* HEDLEY, 1914, p. 70 [\**F. exempla*; OD]. Trigonal, relatively large; adductor scar smaller than byssal muscle scar and separated from it by about its own breadth; lower margin of ligamental area straight; byssus a dense bundle of threads (not calcified as in *Anomia*). *Rec.*, Australia.—FIG. C53,3. \**F. exempla*; 3*a,b*, RV ext., RV int.,  $\times 0.7$  (399).

*Hypotrema* D'ORBIGNY, 1853, p. 435 [\**Pulvinites rupellensis* D'ORBIGNY, 1850, p. 24; SD Cox, herein]. Taller and narrower than *Pulvinites*; adductor scar in LV touching byssal muscle scar; ligamental area arched. *U.Jur.*(*Oxford.*), Eu. (France). — FIG. C53,1. \**H. rupellense* (D'ORBIGNY); 1*a*, LV int. mold; 1*b*, RV int. mold showing foramen; both  $\times 1$  (d'Orbigny, 1853; Fischer, 1886).

### Family MALLEIDAE Lamarck, 1819

[*nom. correct.* BRODERIP, 1839 (*pro* Malleacea GRAY, 1823)] [= les malleacées LAMARCK, 1819 (family name now generally accepted as from this publication in the vernacular); Malleaceae BRONN, 1824; Malleacea LEA, 1833; Vulsellidae ADAMS & ADAMS, 1857; Eligmidae GILL, 1871; Stefaniniellidae TAVANI, 1939] [Previously BOWDICH (1822) and PARKINSON (1822) have both used the name Malleaceae for groups of

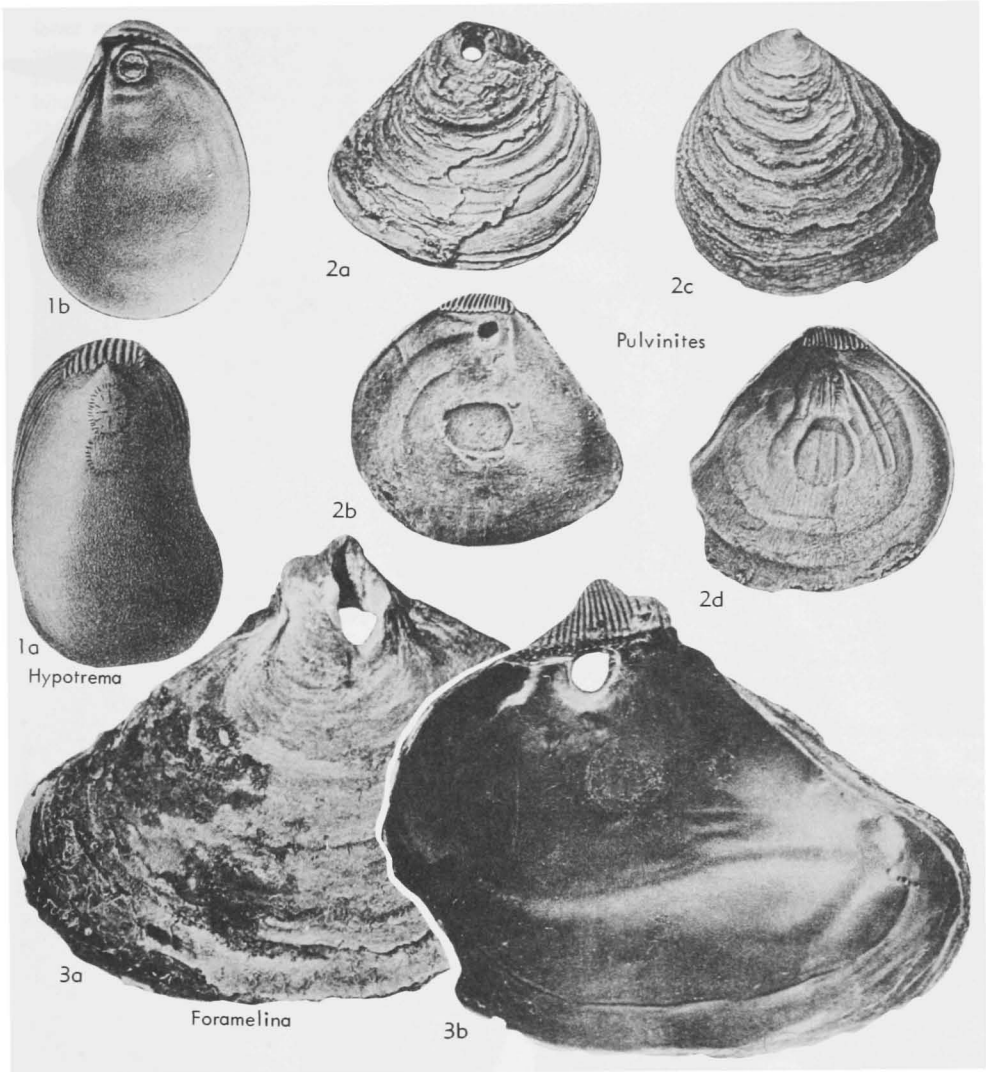


FIG. C53. Pulvinitidae (p. N326).

genera (alluded to as "divisions" in the case of the first author) which were virtually equivalent to families although not so termed] [Materials for this family prepared by L. G. HERTLEIN & L. R. COX]

Shell subequivalve or inequivalve, irregular in form but not cemented by either valve, with or without byssus; valve margins commonly gaping or irregularly notched posteriorly; ligamental area triangular, internal to external, partly or almost wholly occupied by median triangular pit which is very much like that of *Ostrea*, but in some genera has strongly convex, protruding lower margin; mostly monomyarian in

adult stage; inner ostracum nacreous. *Jur.-Rec.*

**Malleus** LAMARCK, 1799, p. 82 [*\*M. vulgaris* (= *\*Ostrea malleus* LINNÉ, 1758, p. 699); T] [= *Malligenus* RENIER, 1807 (obj., also suppressed ICZN); *Malleolus* RAFINESQUE, 1815 (obj.); *Tudes* OKEN, 1815 (ICZN rejected work) (obj.); *Himantopoda* SCHUMACHER, 1817 (obj.); *Himantopoda* LATREILLE, 1825 (*nom. null.*); *Himotopoda* PAETEL, 1875 (*nom. null.*)]. Subequivalve or inequivalve, with body of shell elongated dorsoventrally and not oblique; posterior wing variably developed, anterior wing present or absent; ligamental pit deep, oblique, semiconical, with projecting



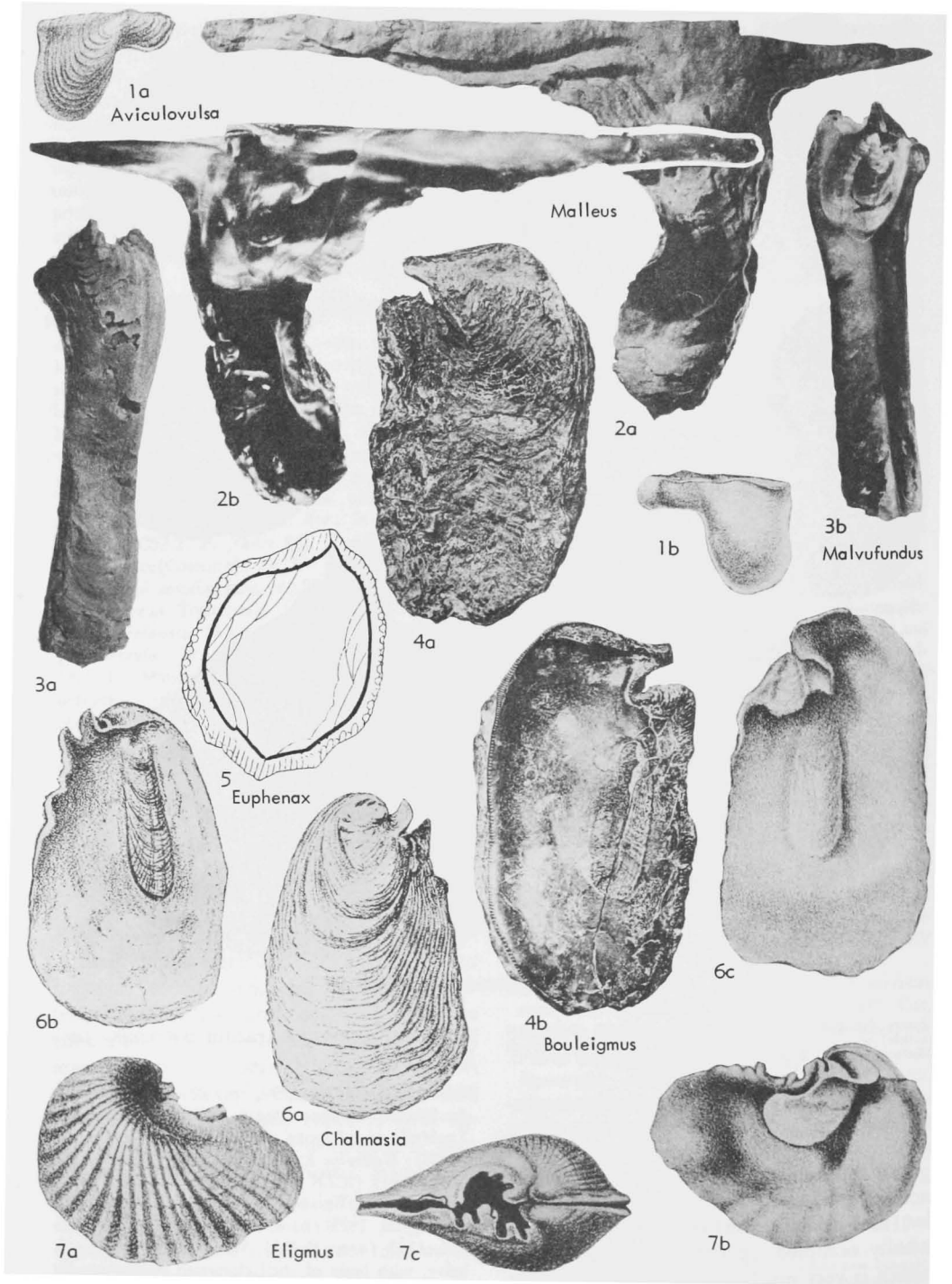


FIG. C54. Malleidae (p. N327, N329).



- lower margin; dorsal margin of RV or of both valves deeply notched on anterior side of ligamental area for protrusion of byssus; no true hinge teeth; nacreous lining of shell interior much restricted, its border widely separated from margins of shell especially on body, more ventral part of which bears submedian internal ridge in each valve; muscle scar large, flush, variously shaped; valve margins smooth internally. *Rec.*, IndoPac.-Australia-Medit.
- M. (Malleus)**. Subequivalve, hammer-shaped, with long, narrow, sharply pointed anterior and posterior wings, former commonly at lower level than latter; some species with fine crenellations along inner side of dorsal margin behind and in front of ligamental area; byssal notch narrow; body of shell commonly waved and irregularly lamellose. *Rec.*, IndoPac.—FIG. C54,2. \**M. (M.) malleus* (LINNÉ), China; 2*a,b*, RV ext., int.,  $\times 0.5$  (Cox, n).
- M. (Malvufundus)** DE GREGORIO, 1885, p. 122 [\**Ostrea regula* FORSKÅL, 1775, p. 124; SD COX, herein] [= *Fundella* DE GREGORIO, 1884, p. 73 (non ZELLER, 1848) (type, *F. lioyi*; M); *Parimalleus* IREDALE, 1931, p. 205 (type, *P. cursor*; OD); *Parvimalleus* SALISBURY, 1932 (nom. null.); *Brevimalleus* McLEAN, 1947, p. 70 (pro *Fundella* DE GREGORIO, 1884, non ZELLER, 1848)]. Subequivalve or inequivalve; posterior wing short and blunt, anterior wing short or absent; byssal notch commonly relatively broad sinus; no internal crenulations of dorsal margins; earlier growth stages with irregular concentric lamellae. *Rec.*, IndoPac.-Australia-Medit.—FIG. C54,3. \**M. (M.) regula* (FORSKÅL), Ind.O.; 3*a,b*, RV ext., RV int.,  $\times 0.5$  (Cox, n).
- Aviculovulsa** COSSMANN, 1887, p. 170 [\**Avicula macrotis* DESHAYES, 1864, p. 48; OD]. Shell small, oblique, resembling *Pteria*; with relatively large anterior ear, separated from body of shell by broad sinus; cardinal area narrow; muscle scar nearly central, transverse, bilobed above; surface concentrically lamellose. *M.Eoc.-U.Eoc.*, Eu. (France).—FIG. C54,1. \**A. macrotis* (DESHAYES), M.Eoc. (Lutet.); 1*a,b*, RV ext., RV int.,  $\times 3$  (Deshayes, 1864).
- Bouleigmus** BASSE, 1933, p. 111 [\**B. douvillei*; M]. Known only by RV, which is tall, subrectangular, flat, thick-shelled; umbo narrow, placed and pointing posteriorly, below it, deep notch of posterior margin, with its lower edge transversely wrinkled; muscle scar tall, narrow, flush; margins delicately denticulate internally; surface irregularly lamellose. *U.Cret.*, Madag.—FIG. C54,4. \**B. douvillei*; 4*a,b*, RV ext., RV int.,  $\times 0.7$  (31).
- Chalmasia** STOLICZKA, 1871, p. 397 [\**Vulsella turonensis* DUJARDIN, 1837, p. 228; OD] [= *Vulsellopsis* DOUVILLÉ, 1907, p. 17 (type, *Vulsella caillaudi* ZITTEL, 1881, p. 40; OD)]. Subequivalve, linguiform; valves gaping posterodorsally, where margins commonly have jagged or rounded projections, of which that closest to ligamental area may extend internally over its tip; ligamental area rather broad; muscle scar tall, narrow, slightly anterior to median with its posterior edge protruding; surface with concentric lamellae or undulations. *U.Cret. (Senon.)-Eoc.*, Eu. (France)-Afr. (Libya-Egypt).—FIG. C54,6. \**C. turonensis* (DUJARDIN), *U.Cret. (Senon.)*, France; 6*a,b*, LV ext., LV int.,  $\times 1$  (Fischer, 1886); 6*c*, RV int.,  $\times 1$  (Dujardin, 1837).
- Eligmus** J. A. EUDES-DESLONGCHAMPS, 1856, p. 272 [\**E. polytypus*; SD TATE, 1868, p. 67] [= *Beaumontia* J. A. EUDES-DESLONGCHAMPS, 1856 (non EDWARDS & HAIME, 1851); *Heligmus* FISCHER, 1886 (nom. van.) (non DUJARDIN, 1845, nec CANDEZE, 1865); *Proheligmus* COSSMANN, 1909 (pro *Eligmus* EUDES-DESLONGCHAMPS, 1856, non *Eligma* HUEBNER, 1816)]. Subequivalve, more or less ovate, compressed to moderately inflated, radially costate to varying extent; gaping posterodorsally where margins may also be notched; prominent myophorous platform present on interior of each valve close to ligamental area. *Jur. (Bathon-Callov.)*, Eu.-Asia-N. Afr.-E. Afr.-Madag.—FIG. C54,7. \**E. polytypus*, Bathon., France; 7*a-c*, LV ext., LV int., dorsal view, all  $\times 1$  (Eudes-Deslongchamps, 1856).
- Euphenax** COX, 1931, p. 177 [\**Pseudoheligmus? jamaicensis* TRECHMANN, 1923, p. 358; OD]. Ovate, moderately to strongly inflated, subequivalve to strongly inequivalve; valve margins closed except (in some specimens) for posterodorsal notch just behind ligamental area; ostracum thick, with cavernous outer layer composed of prismatic cells, compact middle layer, and chambered inner layer; no myophorous platform; exterior with or without radial ribbing. *M.Eoc.*, Jamaica-N. Afr.-Pakistan.—FIG. C54,5; C55,2. \**E. jamaicensis* (TRECHMANN); C54,5, Pak., transv. sec. showing internal chambers,  $\times 1.3$  (173); C55,2*a-c*, Somaliland, RV int. and 2 views RV ext.,  $\times 1$  (173).
- Heligmina** DOUVILLÉ, 1907, p. 109 [\**Ostrea uncinata* LAMARCK, 1806, p. 164; SD COX, herein]. Ovate to subtriangular, slightly higher than long, LV inflated, RV flat, both valves with large rounded sinus of posterodorsal margin extending to region of muscle scar, which is flush and almost median in position; ligamental area acutely triangular; surface concentrically lamellose. *U.Cret.*, Madag., *M.Eoc.-L.Mio.*, Eu. (France).—FIG. C55,1. \**H. uncinata* (LAMARCK), M.Eoc., Paris Basin; 1*a,b*, LV int., RV int.,  $\times 2$  (273).
- Heligmopsis** MUNIER-CHALMAS IN FISCHER, 1886, p. 926 [\**Ostrea petrocoriensis* COQUAND, 1869, p. 92; OD]. Ovate, somewhat elongated dorsoventrally, subequivalve, rather feebly inflated, not gaping, *Loph-*like, with broad radial ribs producing irregular plications of margin on both

sides or on posterior side only; muscle scar elongate, ventrally situated, raised on its posterior side. *U.Cret.* (*Cenoman.-Coniac.*), Eu. (France); ?*Eoc.*, Egypt.—FIG. C55,3. \**H. petrocoriensis* (COQUAND), Coniac, France; 3a,b, LV ext., LV int.,  $\times 1$  (273).

*Nayadina* MUNIER-CHALMAS, 1864, p. 99 [*\*N. heberti*; M] [= *Naiadina* FISCHER, 1886 (*nom. van.*)]. Subequivalve, of various shapes, commonly elongate and inequilateral; valves with or without narrow, simple gape; ligamental area well exposed to exterior, with broad, deeply concave liga-

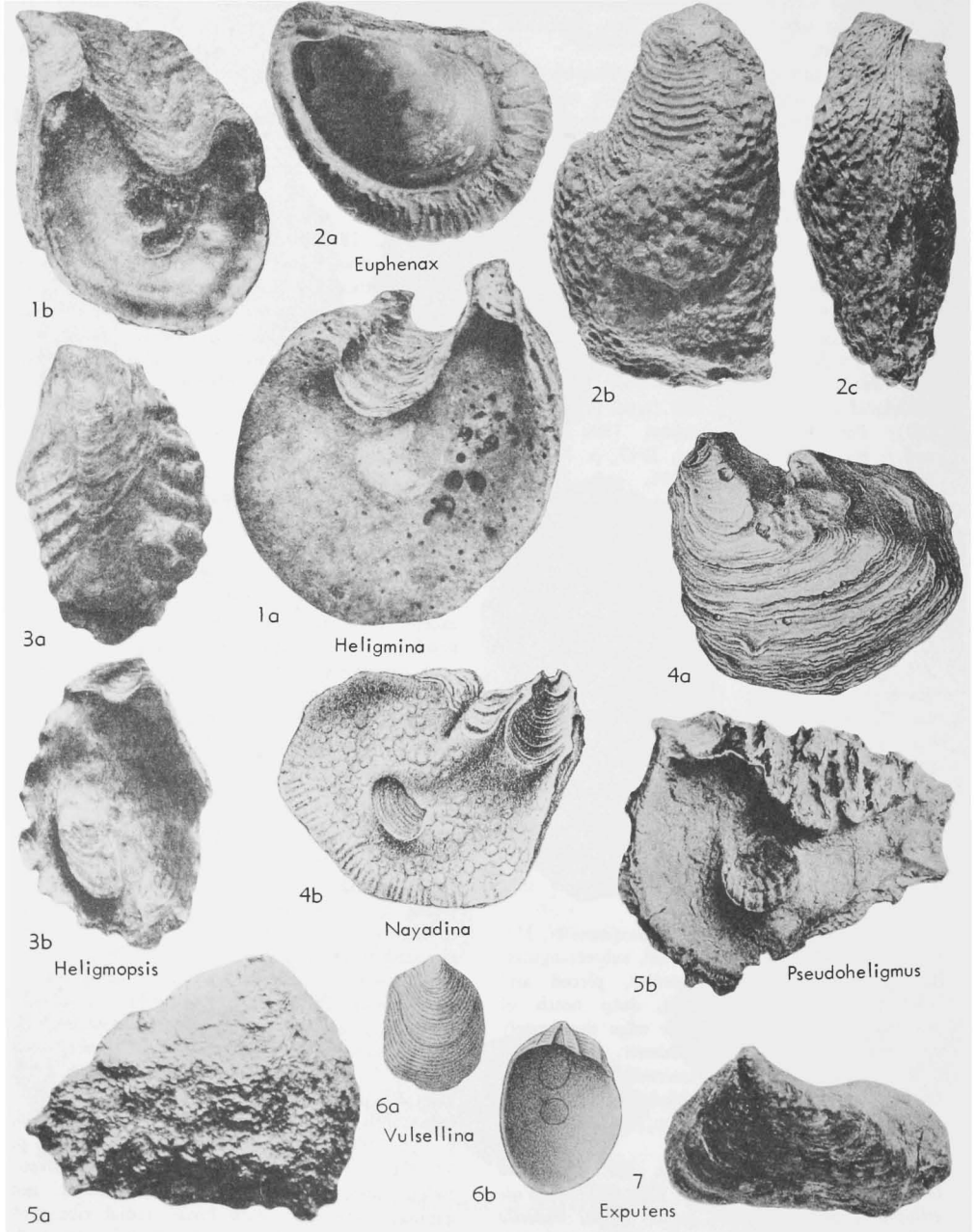


FIG. C55. Malleidae (p. N329-N332).

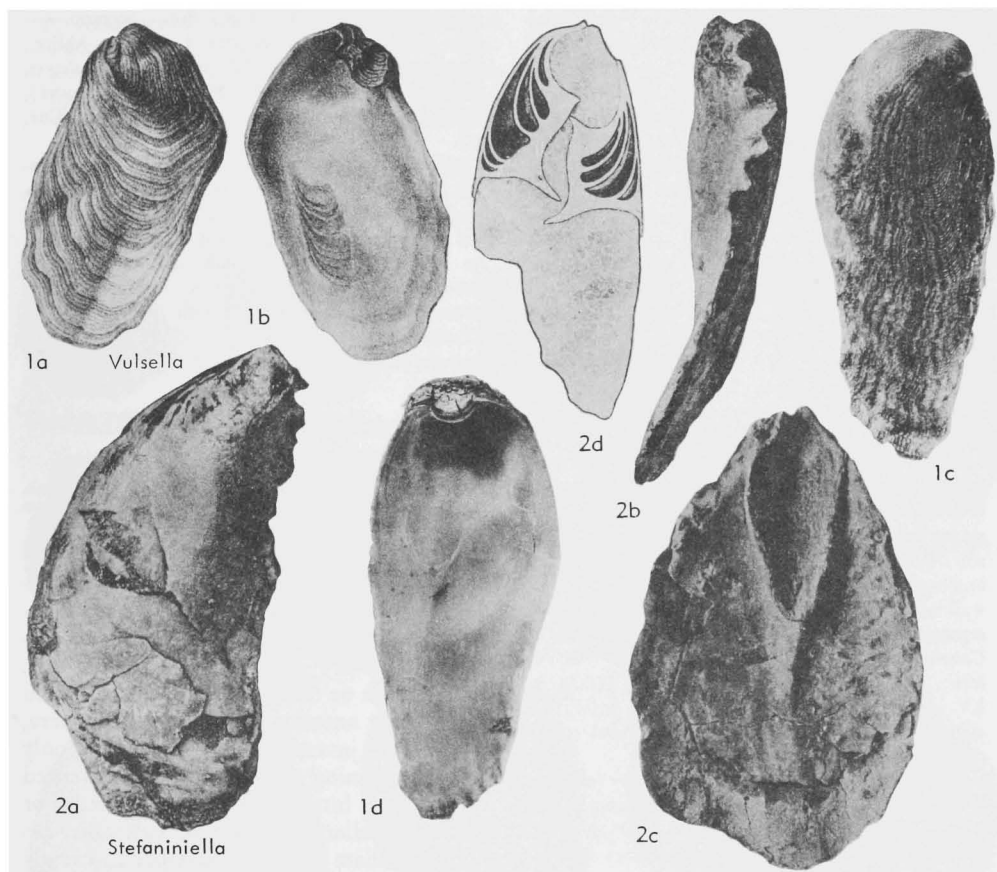


FIG. C56. Malleidae (p. N332).

mental pit occupying most of its width; muscle scar (or main scar) placed in relatively ventral position. *U.Cret.(Cenoman.)-M.Eoc.*, Eu.-N.Am.-N.Afr.-SW. Asia.

**N. (Nayadina).** Rather thick-shelled, more or less lunate, variably elongated; gape of valves narrow and simple or absent; muscle scar rather small, with projecting lower margin; exterior lamellose. *U.Cret.(Cenoman.-U.Senon.)*, Eu. (France)-Persia-Madag.-N.Afr.—FIG. C55,4. *N. (N.) gaudryi* THOMAS & PERON, Cenoman., Tunisia; 4a,b, LV ext., LV int.,  $\times 0.7$  (Peron, 1893).

**N. (Exputens)** CLARK, 1934 [*E. llajasensis*; OD]. Elongate, oblong, inequilateral, with posterior end extended; subauriculate anteriorly; valve margins not gaping; umbones commonly pointed and prominent; ligamental area broad, overhanging platform extending posterior from umbones; small anterior adductor scar present in addition to main scar; surface smooth except for well-marked growth lines. *M.Eoc.*, USA-(Calif.)-

Carib.(Jamaica).—FIG. C55,7. *N. (E.) llajasensis*; LV ext.,  $\times 1$  (134).

**Ostreinella** COSSMANN in COSSMANN & PEYROT, 1914, p. 398 [*Ostrea neglecta* MICHELOTTI, 1847, p. 81; OD]. Shell very small, less than 18 mm. high, thin, fragile, translucent; both valves convex, LV deeper; outline oblique oval, opisthoclinal at 35 to 60 degrees to hinge line; LV umbo small, pointed, not projecting much above hinge axis, pointing posteriorly and outward, cavity on inside reaches beneath hinge plate up to tip of umbo; commissural shelf of LV exceedingly narrow, distinct only near hinge in few old individuals, rarely with 5 or 6 simple pits on one side; attachment scar generally long and narrow (about 1 by 9 mm.); both valves without radial ribs but with low smooth minor concentric undulations and few smooth appressed growth squamae; ligamental area 1.5 to 2 times longer than high. [Listed by author as subgenus of *Liostraea* (Ostreidae), but GLIBERT & VAN DE POEL (1965, p. 6) have pointed

out that genus belongs rather in Vulsellidae.] *Oligo.*(Tongrian)-*Mio.*(Tortonian), S.Eu.(France-Italy).

**Pseudoheligmus** DOUVILLÉ, 1904, p. 264 [\**P. morgani*; M]. Of various shapes, equivalve, with posterior depression in which are long, narrow, simple or bifurcating marginal fissures; muscle scar more or less median in position, on elevated platform as in *Eligmus*; surface with small, convex, quincuncially arranged scales (in type species) or merely irregularly rugose. *U.Cret.*(Santon)-*M.Eoc.*, Iran-Eu.(France).—FIG. C55,5. *P. trigoniaeformis* (COQUAND), *U.Cret.*(Santon.), France; 5a,b, RV ext., RV int.,  $\times 1$  (273).

**Stefaniella** TAVANI, 1939, p. 94 [\**S. colosii*; M]. More or less inequivalve, tall, linguiform, oyster-like; with undulating posterior margin but without posterior gape; ligamental pit large, internal or subexternal, hollowed-out spoonlike process representing entire ligamental area and welded to interior of valve by shelly matter continued as ridge below lower extremity of process; muscle scar submedian, with slightly raised margins; anteromedian part of shell wall, including part of wall of ligamental process, divided into chambers separated by thin, curved lamellae. *U.Cret.*(*U.Cenoman.*), Somaliland.—FIG. C56,2. \**S. colosii*; 2a,b, LV direct and post. views,  $\times 0.7$ ; 2c, LV int. showing large ligamental pit,  $\times 0.7$ ; 2d, transv. sec. showing chambering of dorsal region of shell,  $\times 1$  (Tavani, 1939 & 1942).

**Vulsella** RÖDING, 1798, p. 156 [\**V. major* (= *Mya vulsella* LINNÉ, 1758, p. 671); SD PRASHAD, 1932, p. 88, also ICZN Opinion 325 (1955)] [*Mya vulsella* LINNÉ was not the type species of *Vulsella* by absolute tautonymy, as RÖDING recognized 2 nominal species of *Vulsella* (*V. major*, *V. minor*) and included *Mya vulsella* (in part) in the synonymy of both. By placing *Vulsella* on the Official List of Generic Names in Zoology this Opinion has dismissed the objection that etymologically it was a virtual homonym of *Vol-sella* SCOPOLI, 1777] [= *Vulselligenus* RENIER, 1807 (suppressed ICZN); *Reniella* SWAINSON, 1840, p. 386 (type, *R. dilatata*; M); *Vulcella* D'ORBIGNY, 1846 (*nom. null.*); *Baphia* "GEVERS" GRAY, 1847, p. 199 (obj.); *Pulsella* WEYENBERGH, 1875 (*nom. null.*); *Valsella* MARTENS, 1880 (*nom. null.*); *Abisa* DE GREGORIO, 1884, p. 58 (type, *Vulsella navicula* DE GREGORIO, 1884; SD COX, herein); *Madrela* DE GREGORIO, 1884, p. 62 (type, *Vulsella virginis* DE GREGORIO, 1884; SD COX, herein); *Madrila* FUCHS, 1887 (*nom. null.*)]. Shell elongated dorsoventrally, linguiform, subequivalve, compressed, gaping anteriorly and posteriorly; ears absent or small; muscle scar smaller than in *Malleus*, flush; surface concentrically lamellose, radial ribbing present in some forms; not byssiferous; living forms commonly commensal in

sponges. *U.Cret.*(*Cenoman.*)-*Rec.*, cosmop.—FIG. C56,1a,b. *V. deperdita* LAMARCK, M.Eoc., France; 1a,b, LV ext., LV int.,  $\times 1$  (Deshayes, 1832).—FIG. C56,1c,d. \**V. vulsella* (LINNÉ), *Rec.*, Ind.O.; 1c,d, LV ext., LV int.,  $\times 0.7$  (Cox, n).

**Vulsellina** RAINCOURT, 1876, p. 290 [\**V. chaussyensis*; M] [= *Vulsinella* DALTON, 1876 (*nom. null.*)]. Small, subrectangular, flattened; ligamental pit narrow; muscle impression situated very close to ligamental area, and with another small impression below it on adult shells; surface unornamented except for growth rugae. *M.Eoc.* (*Lutet.*), Eu.(France).—FIG. C55,6. \**V. chaussyensis*; 6a,b, RV ext. and int.,  $\times 3$  (160).

## Superfamily PECTINACEA Rafinesque, 1815

[*nom. transl. et correct.* DALL, 1896 (ex subfamily Pectenidae RAFINESQUE, 1815)] [= Pectinidae FLEMING, 1822; Pectenacea REEVE, 1841] [Superfamily diagnosis prepared by N. D. NEWELL] [Materials on this superfamily prepared by L. G. HERTLEIN, L. R. COX, and N. D. NEWELL]

Adult shells generally orbicular, monomyarian, subequilateral, with winglike extensions of hinge margin (auricles); pleurothetic, with RV underneath when at rest; free, byssate or cemented, with byssal notch below right anterior auricle in most genera, at least in juveniles; sculpture commonly radial, becoming plicate in some advanced forms; main inner layer of shell nacreous or crossed-lamellar aragonite in Paleozoic, becoming foliate calcite in Mesozoic, usually with thin outer prismatic layer, especially in RV; ligament area alivincular, diverging upward in most Paleozoic forms, becoming internal in most post-Paleozoic shells. *Ord.-Rec.*

## Family PTERINOPECTINIDAE Newell, 1938

[Materials for this family prepared by N. D. NEWELL]

Prosoline or upright pectinoids with posterior auricle longer and less well differentiated; cardinal areas divergent upward, ligament duplivincular. *U.Sil.-L.Perm.* (*Leonard.*).

**Pterinopecten** HALL, 1883 [\**P. undosus*; SD S. A. MILLER, 1889, p. 507]. Orbicular or subrhomboidal shells with intercalating costae; rear auricle poorly differentiated; byssal notch of RV narrow, slitlike. *U.Sil.-U.Dev.*, cosmop.

**P.** (**Pterinopecten**). Hinge margin shorter than shell height. *U.Sil.-U.Dev.*, cosmop.—FIG. C57, 6. \**P.* (*P.*) *undosus*, M.Dev. (Hamilton), USA (N.Y.); 6a,b, RV ext., LV ext.,  $\times 1$  (376).

**P. (Fascinewellipecten)** RŮŽIČKA, PRANTL & PŘIBYL, 1959 [*\*Aviculopecten consolans* BARRANDE, 1881; OD]. Closely similar to *P. (Newellipecten)* but with fasciate costae. *L.Dev.*, Eu. (Boh.-Ger.).—FIG. C57,1. *\*P. (F.) consolans* (BARRANDE), Boh.; LV ext.,  $\times 1$  (820).

**P. (Newellipecten)** RŮŽIČKA, PRANTL, & PŘIBYL, 1959 [*\*Aviculopecten niobe* BARRANDE, 1881; OD]. Hinge margin longer than shell height.

*L.Dev.*, Eu.—FIG. C57,3. *\*P. (N.) niobe* (BARRANDE), Boh.; LV ext.,  $\times 1$  (27).

**P. (Vertumnia)** HALL, 1884 [*\*Pterinea reversa* HALL, 1883; SD POHL, 1929, p. 59]. Similar to *P. (Pterinopecten)* but with widely spaced costae and reversed convexity, LV flattened or concave in adults and RV convex. *M.Dev.*, N.Am.(USA).

**Anulipecten** RŮŽIČKA, PRANTL, & PŘIBYL, 1959 [*\*Aviculopecten amicus* BARRANDE, 1881; OD].

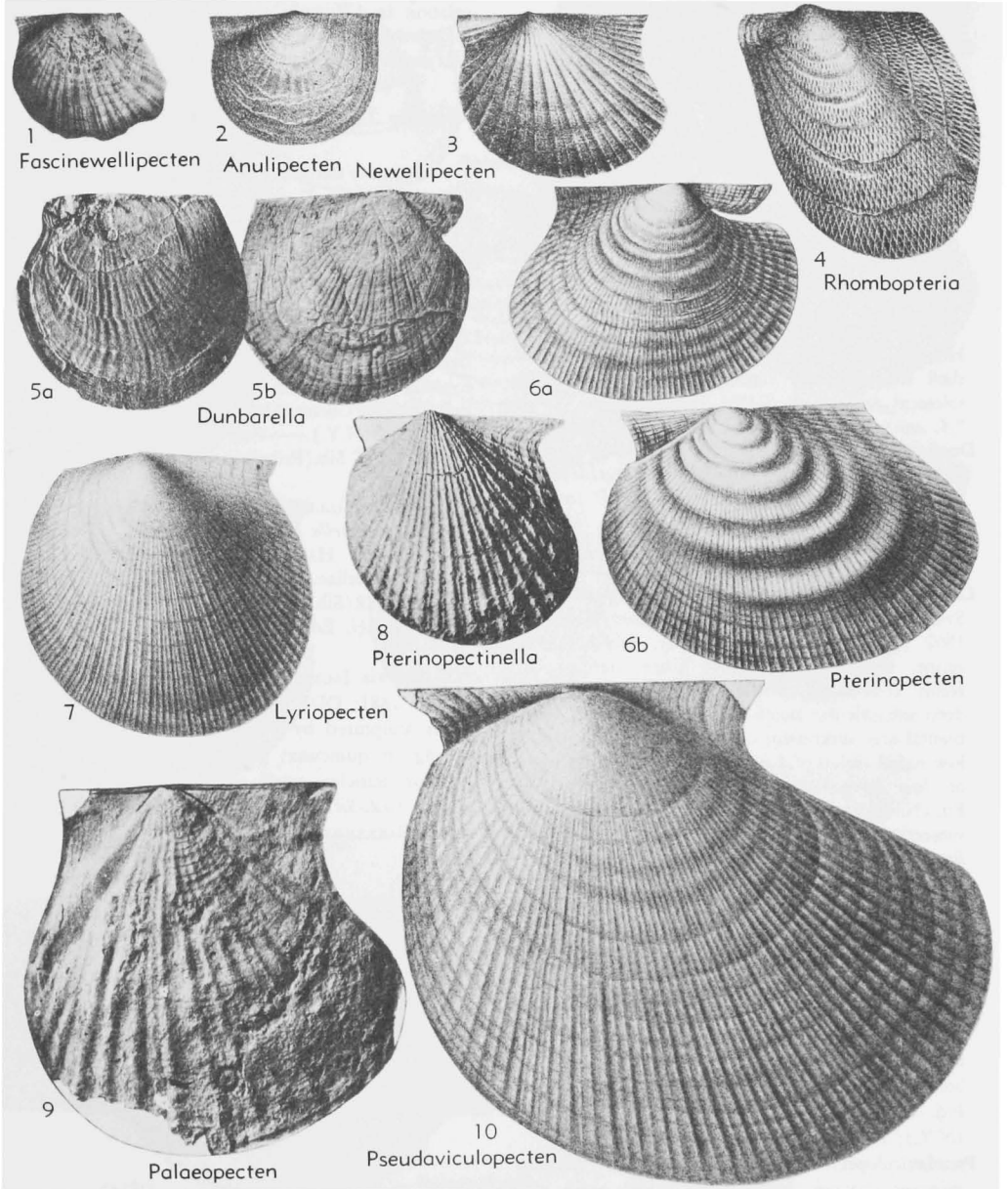


FIG. C57. Pterinopectinidae (1-3,5-8,10); Leiopectinidae (4,9) (p. N332-N334).

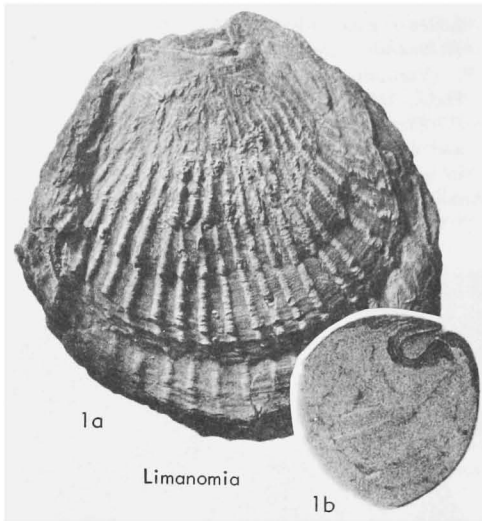


FIG. C58. Pterinopectinidae (p. N334).

Hinge margin longer than shell height; body of shell sculptured by concentric fila; costellae obsolescent or lacking. *L.Dev.*, Boh.—FIG. C57,2. \**A. amicus* (BARRANDE); LV ext.,  $\times 2$  (27).

**Dunbarella** NEWELL, 1938 [\**Aviculopecten whitei* MEEK, 1872; OD]. Similar to *Pterinopecten* (*Pterinopecten*) except that costae of RV increase in number by bifurcation. *Miss.-Penn.*, N.Am.-Eu.—FIG. C57,5. \**D. whitei* (MEEK), Penn. (Virgil.), Neb.; 5a,b, LV ext., RV ext.,  $\times 2$  (663).

**Limanomía** GRAY, 1850, p. 21 [\**L. grayiana*; SD STOLICZKA, 1871, p. 477] [= *Limanomya* RIGAUX, 1892 (*nom. van.*)]. Suborbicular, subequilateral, acline, with relatively short hinge margin; LV feebly convex, RV flat or slightly concave, with deep subauricular notch, broadening inward; ligamental area unknown; ornament of narrow lamellose radial riblets of 1 or 2 orders of strength, more or less irregularly distributed. *U.Dev.* (*Frasn.*), Eu. (N. France)-USSR (Novaya Zemlya). [?Senior subjective synonym of *Lyriopecten* HALL.].—FIG. C58,1a. \**L. grayiana*, France (Boulonnais); LV ext.,  $\times 1$  (Cox, n).—FIG. C58,1b. *L. lincolata* RIGAUX, France (Boulonnais); subauricular notch in RV,  $\times 1$  (Rigaux, 1892). [Cox]

**Lyriopecten** HALL in S. A. MILLER, 1877 [\**Avicula orbiculata* HALL, 1843; M] [= *Orbipecten* FRECH, 1891 (obj.)]. Similar to *Pterinopecten* except that ornamentation of LV in former is coarser, anterior auricles shorter and byssal notch of RV broadly sinuate. *M.Dev.-U.Dev.*, N.Am.-Eu.—FIG. C57,7. \**L. orbiculatus* (HALL), M.Dev., USA (N.Y.); LV ext.,  $\times 1$  (376).

**Pseudaviculopecten** NEWELL, 1938 [\**Monotis princeps* CONRAD, 1838; OD]. Shells with pro-

nounced forward obliquity, auricles subequal and well differentiated from shell body in both form and ornamentation; sculptured with intercalating costae similar in both valves and transversed by fine fila. *M.Dev.-L.Miss.*, N.Am.-Eu.—FIG. C57,10. \**P. princeps* (CONRAD), M.Dev. (Hamilton), N.Y.; LV ext.,  $\times 1$  (376).

**Pterinopectinella** NEWELL, 1938 [\**P. welleri*; OD]. Similar to *Pterinopecten* but ornamented with coarse, spinose costae which increase by intercalation in LV and by splitting in RV. *U.Miss.-L.Perm.* (Leonard.), N.Am.-Eu.—FIG. C57,8. \**P. welleri*, U.Penn., Kans.; LV ext.,  $\times 1$  (663).

### Family LEOPECTINIDAE Krasilova, 1959

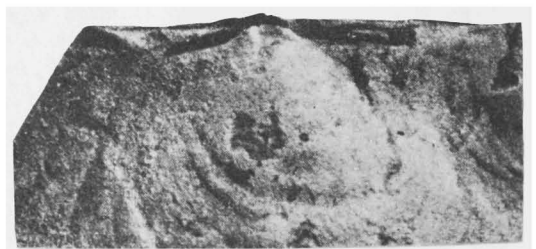
[Materials for this family prepared by N. D. NEWELL]

Valves prosocline, LV more convex than RV, without well-defined byssal notch or sinus; ligament area narrow, duplivincular; short auricular crura occur internally marginal to the beaks. *Ord.-L.Dev.*

**Leiopecten** KHALFIN, 1940, p. 259 [\**L. rectangularis*; OD]. Surface smooth or ornamented with concentric undulations. *U.Sil.-L.Dev.*, USSR (Sib., Pribalkhash, Gorny Altai, Karaganda Basin); *L.Dev.*, USA (N.Y.).—FIG. C59,1. \**L. rectangularis*, L.Dev., Sib. (Pribalkhash),  $\times 2.7$  (Krasilova, 1963).

**Palaeopecten** WILLIAMS, 1913 [\**P. cobscooki*; OD] [= ?*Leiopectinella* KRASILOVA, 1959 (type, *Avicula subequilatera* HALL, 1859)]. Ornamented by costae or costellae. *U.Sil.*, USA (Me.); *L.Dev.*, USA (N.Y.)-USSR (Sib., Pribalkhash).—FIG. C57,9. \**P. cobscooki*, Edmunds F. (Me.); LV ext.,  $\times 1$  (985).

**Rhombopteria** JACKSON, 1890 [\**Avicula mira* BARRANDE, 1881; OD]. Rhomboidal, nearly equivalve shells sculptured by 2 sets of fine grooves intersecting in quincunx; posterodorsal angle obtuse; anterior auricles small, sinuate, without byssal notch. *Ord.-Sil.*, N.Am.-Eu.—FIG. C57,4. \**R. mira* (BARRANDE), Sil., Boh.; LV ext.,  $\times 2$  (27).



Leiopecten

FIG. C59. Leiopectinidae (p. N334).



**Family AVICULOPECTINIDAE**  
**Meek & Hayden, 1864**

[*nom. transl.* S. A. MILLER, 1889 (*ex* Aviculopectininae MEEK & HAYDEN, 1864)] [Materials for this family prepared by N. D. NEWELL with additions by L. R. COX and L. G. HERTLEIN as indicated]

Pectiniform shells in which RV possesses deep byssal notch at least in early ontogeny

and is less convex than LV; ligament amphidetic and situated on two flat, diverging interareas, as in *Lima* and *Pinctada*; characteristically with triangular, oblique, subcentral resilifer beneath beak; edentulous, inner shell layer aragonite, nacreous or crossed lamellar; outer layer prismatic or fibrous. *U.Dev.-U.Jur.*

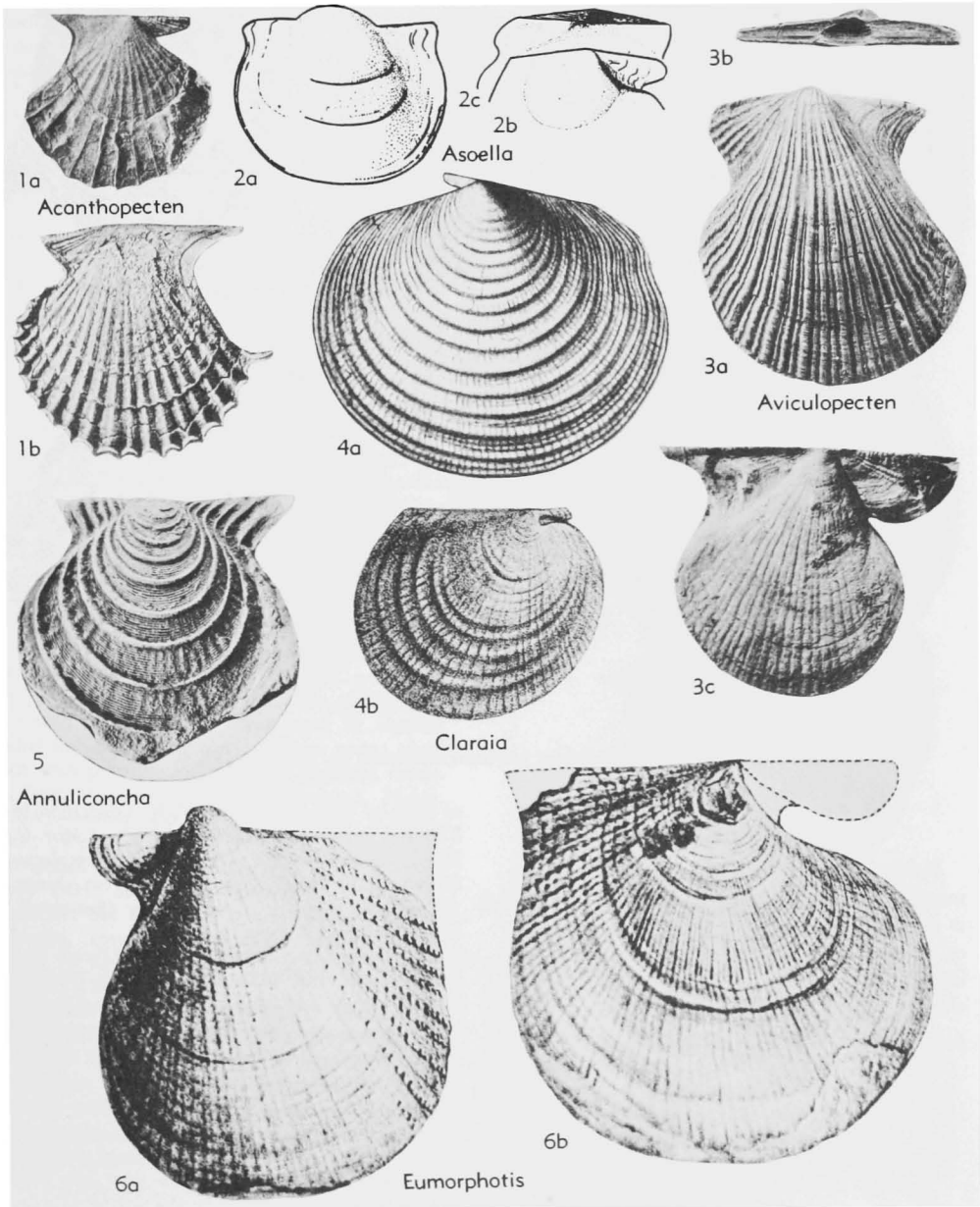


FIG. C60. Aviculopectinidae (Aviculopectininae) (p. N336-N337).



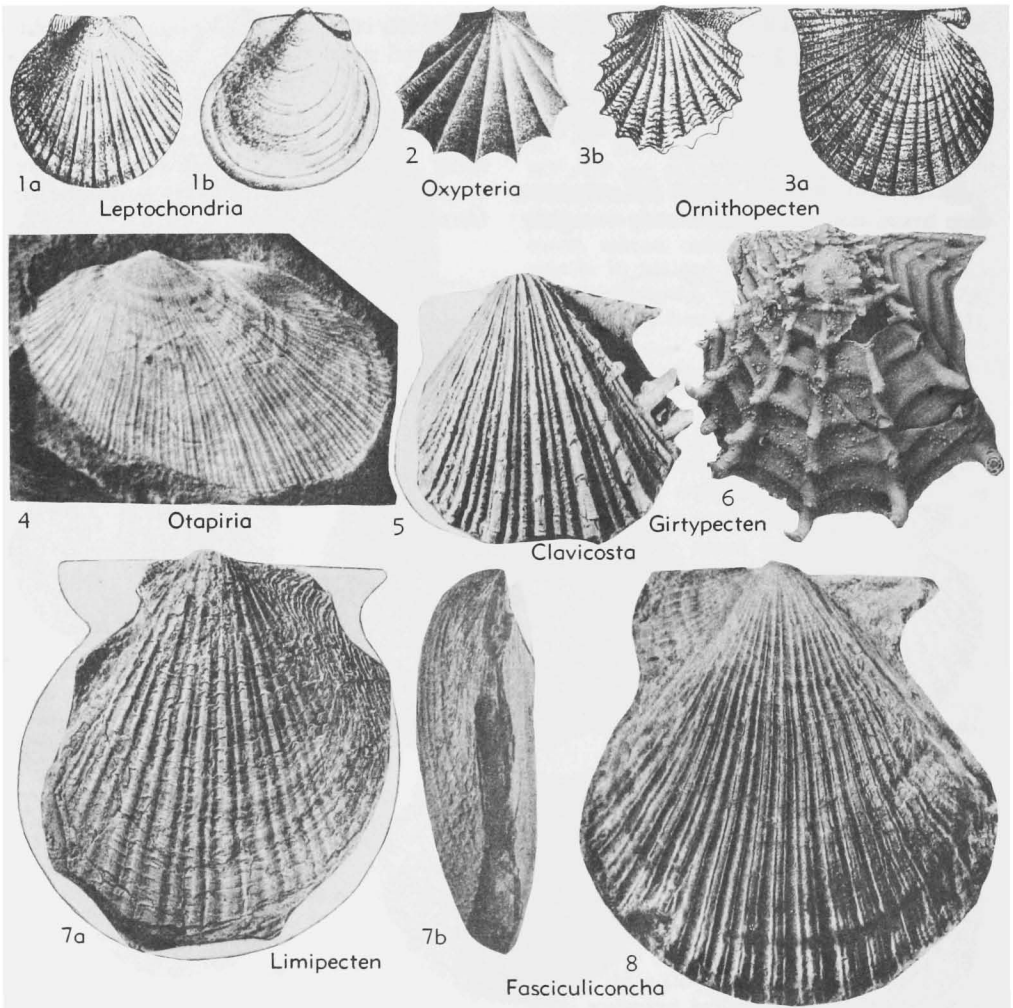


FIG. C61. Aviculopectinidae (Aviculopectininae) (p. N337-N339).

**Subfamily AVICULOPECTININAE**  
 Meek & Hayden, 1864

Prosocline to upright, radially ornamented, shells in which posterior auricle is as long as or longer than anterior; outer ostracum irregularly prismatic in RV, fibrous in LV; inner ostracum nacreous or crossed lamellar. *L.Miss.-U.Jur.*

*Aviculopecten* M'COY, 1851, p. 171 [*\*A. planoradiatus*; SD HIND, 1903, p. 66] [= *Limatulina* DE KONINCK, 1885 (type, *Avicula radula* DE KONINCK, 1842; *Heteropecten* KEGEL & DACOSTA, 1951 (type, *Aviculopecten catharinae* REED, 1930)]. Ornamentation radial, increasing on body

of shell by intercalation in LV, by bifurcation in RV; RV commonly smaller than left. *L.Miss.-U. Perm.*, cosmop.—FIG. C60,3a,b. *A. exemplarius* (NEWELL), U.Penn., Kans.; 3a,b, LV ext., hinge,  $\times 2$ .—FIG. C60,3c. *A. occidentalis* (SHUMARD), U. Penn., Kans.; RV ext.,  $\times 2$  (663). *Acanthopecten* GIRTY, 1903, p. 417 [*\*Pecten carboniferus* STEVENS, 1858, p. 261; OD]. Upright, orbicular shells with elongate, slender auricles, of which posterior is only slightly longer than anterior; costae coarse, not increasing in number during later ontogeny, crossed on LV, rarely on RV by regular imbricating growth lamellae which are extended peripherally between costae in short spines. *L.Carb.-U.Perm.*, cosmop.—FIG. C60,1.

\**A. carboniferus* (STEVENS), U.Penn., USA (Neb.); 1a,b, RV ext., LV ext.,  $\times 2$  (663).

**Annuliconcha** NEWELL, 1938, p. 76 [*\*Aviculopecten interlineatus* MEEK & WORTHEN, 1860, p. 454; OD]. Equivalve, upright, orbicular shells with subequal, acute auricles; ornamented by 2 ranks of concentric, regularly spaced fila; radial ornamentation weak or absent. *L.Miss.-U.Perm.*, cosmop.—FIG. C60,5. \**A. interlineata* (MEEK & WORTHEN), U.Penn., USA (Ill.); LV ext.,  $\times 2$  (663).

**Asoella** TOKUYAMA, 1959, p. 2 [*\*Eumorphotis (A.) confertoradiata*; OD]. Small (height ca. 10 mm.), quadrately suborbicular, almost acline; LV strongly convex, with broadly rounded, projecting umbo; RV feebly convex; wings of LV and right posterior wing subequal, obtuse or slightly acute, not well delimited, marginal sinus below each shallow or absent; right anterior auricle almost as long as posterior wing, subauricular notch relatively shallow; surface with fine radial riblets or smooth. *U.Trias. (Nor.)*, Japan.—FIG. C60,2. *A. laevigata* (TOKUYAMA); 2a-c, LV ext., dorsal part RV ext., int., all  $\times 6$  (Tokuyama, 1959). [Cox]

**Claraia** BITTNER, 1901, p. 568 [*\*Posidonomya clarae* VON HAUER, 1850, p. 112 (ex EMMRICH, 1844, *nom. nud.*); SD DIENER, 1923, p. 38]. Medium-sized, suborbicular, prosocline; LV feebly convex, with narrow, slightly protruding umbo, RV flat or feebly convex; posterior wings obtuse, left anterior wing small, acute, earlike; right anterior auricle small, subauricular notch narrow, widening inward; ornament of irregular concentric folds, and of faint radial costellae in some specimens; small attachment scar usually present. *L.Trias.*, cosmop.—FIG. C60,4. \**C. clarae* (VON HAUER), Werfen beds, S.Tyrol; 4a, LV ext.,  $\times 1$  (Wittenburg, 1910); 4b, RV ext.,  $\times 1$  (60). [Cox]

**Clavicosta** NEWELL, 1938, p. 79 [*\*C. echinata*; OD]. Equivalve, upright, orbicular shells with subequal, acute auricles; ornamented by regular, radial costae of which coarse, spinose costae alternate with pairs of smaller, equal papillose costae. *U. Penn. (Missouri.)-L. Perm. (Wolfcamp.)*, N.Am. (USA).—FIG. C61,5. \**C. echinata*, U.Penn., Tex.; LV ext.,  $\times 3$  (27).

**Etheripecten** WATERHOUSE, 1963, p. 193 [*\*E. striatata*; OD]. Similar to *Aviculopecten* in most characters but RV bears intercalate, rather than bifurcate, costae. *Perm.*, Australia-N.Z.—FIG. C62,1. \**E. striatata*, U.Perm., N.Z.; 1a,b, RV ext., LV ext.,  $\times 2$  (958).

**Eumorphotis** BITTNER, 1901, p. 566 [*\*Pseudomonotis telleri* BITTNER, 1898, p. 170; SD COSSMANN, 1902, p. 75]. Medium-sized to large, acline or almost so; LV moderately convex, with rather narrow, prominent umbo, RV almost flat; posterior wings obtuse to slightly acute, with marginal sinus broad and shallow; left anterior wing narrow and very distinctly delimited from body

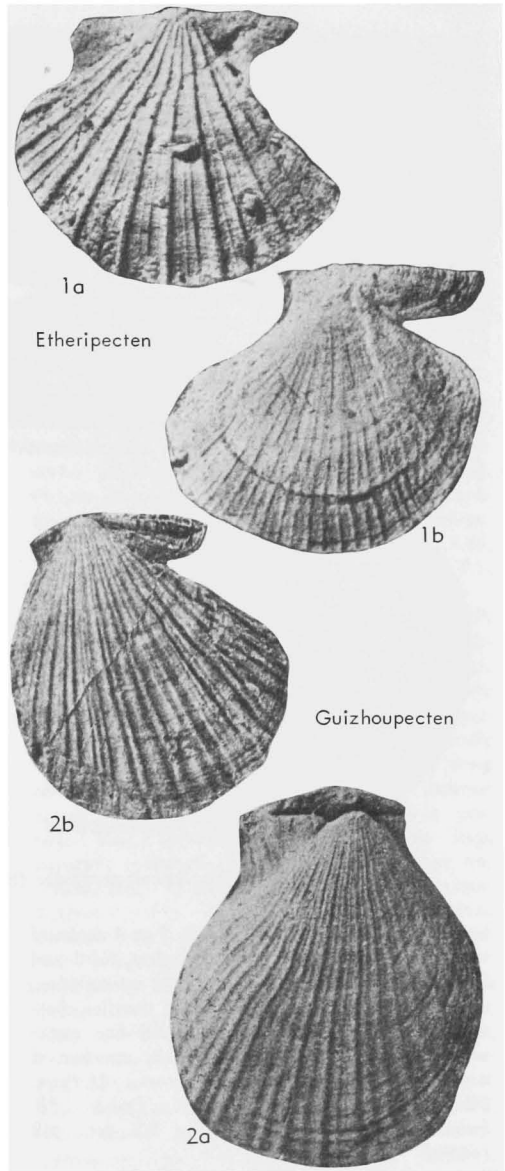


FIG. C62. Aviculopectinidae (Aviculopectininae) (p. N337-N338).

of valve by deep sinus, right anterior auricle with narrow, rounded, moderately deep sinus below it, both shorter than posterior wings although not greatly reduced; ornament of radial ribs weaker on RV than on LV, or wanting. *L.Trias.-U.Trias.*, cosmop.—FIG. C60,6. *E. kitli* (BITTNER), *L. Trias.*, Dalmat.; 6a,b, LV ext., RV ext., both  $\times 1$  (60). [Cox]

**Fasculiconcha** NEWELL, 1938, p. 64 [*\*F. knighti*; OD]. Upright, equilateral shells with subequal

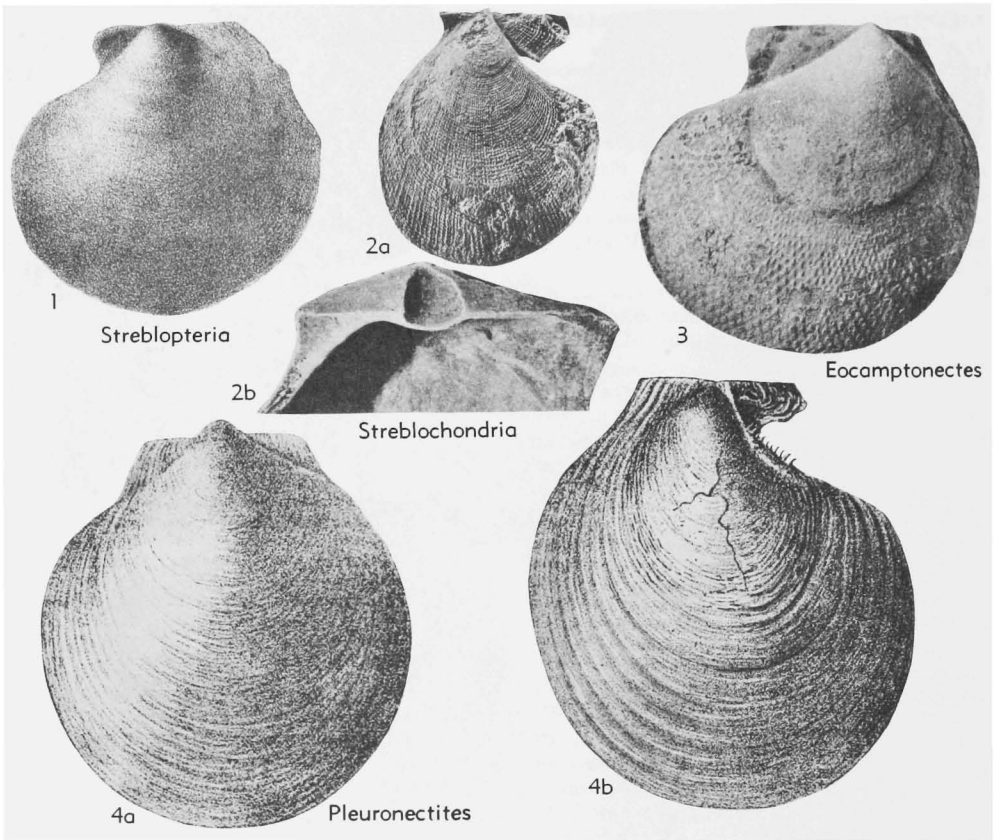


FIG. C63. Aviculopectinidae (Streblochondriinae) (p. N339).

auricles; costae of LV arranged in 3 or 4 ranks of which first 2 appear in early ontogeny; third and fourth series introduced later by intercalation, crowding closely to larger costae in bundles characteristic of genus; RV covered with fine costae which increase in number by periodic insertion of new elements. *M. Penn. (Desmoines.) - U. Penn. (Virgil.)*, N.Am.(USA).—FIG. C61,8. \**F. knighti*, U.Penn.(Missouri), Mo.; LV ext.,  $\times 2$  (663).

**Girtypecten** NEWELL, 1938, p. 77 [\**Aviculopecten sublaqueatus* GIRTY, 1908, p. 440; OD]. Suborbicular shells ornamented with coarse, widely spaced costae intersected by similarly spaced concentric ridges; cylindrical, erect spines from intersections of radial and concentric ornamentation. *Perm. (Guadalup.)*, USA(Tex.-Wyo.).—FIG. C61,6. \**G. sublaqueatus* (GIRTY), Tex.; LV ext.,  $\times 2$  (Newell, n).

**Guizhoupecten** CHEN, 1962, p. 201 [\**G. wangi*; OD]. Shell of *Streblochondria* form, but lacking strong concentric ornamentation; costae of LV intercalate, RV bifurcate; with or without auricu-

lar costae, umbonal folds broadly rounded; anterior auricle about twice as long as posterior; resifier with slight backward obliquity, with additional narrow radial furrow on both anterior and posterior areas of resifier. *Perm. (Leonard-Guadalup.)*, N.Am.(USA); *Perm. (Wuchiaping)*, China.—FIG. C62,2. \**G. wangi*, U.Perm.(Wuchiaping F.), China; 2a,b, RV ext., LV ext.,  $\times 1$  (Chen, 1962).

**Leptochondria** BITTNER, 1891, p. 101 [\**Pecten (L.) aeolicus*; M] [=? *Bittnerella* J. BÖHM, 1903 (non DALL, 1898)]. Small, suborbicular or ovate, acline or slightly prosocline; LV moderately convex, with slightly protruding umbo, RV flat or almost so; beaks near middle of hinge margin; posterior wings and left anterior wing obtuse, indistinctly delimited; below right anterior auricle a deep narrow subauricular notch extending almost to beak; LV with radial riblets of at least 2 orders, new ones arising by intercalation; RV smooth or weakly ribbed; external ligamental area with obtusely triangular pit. [This genus includes some of the small Triassic forms which authors

have referred to "*Velopecten*."] *L.Trias.-U.Trias.*, cosmop.—FIG. C61,1. *L. tirolica* (BITTNER), U. Trias., S.Tyrol; 1*a,b*, LV ext., RV ext., both  $\times 3$  (58).—FIG. C94,1. \**L. aeolica* (BITTNER), Asia M.; 1*a-c*, LV ext., RV ext., hinge,  $\times 1$  (56). [Cox, HERTLEIN]

**Limipecten** GIRTY, 1904, p. 721 [\**L. texanus*; OD]. Orbicular, robust shells with intercalating costae, those of RV appreciably finer and more numerous than those of LV; fine, concentric ornamentation of imbricating growth lamellae projecting peripherally between costae as short spines. *U.Miss.-L.Perm.(Wolfcamp.)*, Eu.-N.Am.—FIG. C61,7. \**L. texanus*, U.Penn., Tex.; 7*a,b*, LV ext., ant.,  $\times 1$  (663).

**Ornithopecten** COX, 1962, p. 596 [\**Aviculopecten bosniae* BITTNER, 1903, p. 592; OD]. Small, suborbicular, acline to slightly prosocline; left umbo scarcely projecting; posterior wings pointed, more or less acute, not well delimited, marginal sinus below each shallow in most species; left anterior wing and right anterior auricle relatively small, subauricular sinus shallow to moderately deep; ornament of narrow, well-separated radial riblets, any increase of which in either valve is by intercalation, and of concentric lamellae. *M.Trias.-U.Trias.*, Eu. (Bear Is.).—FIG. C61,3*a*. \**O. bosniae* (BITTNER), *M.Trias.(Anis.)*, Yugosl.; RV ext.,  $\times 1$ .—FIG. C61,3*b*. *O. beneckeii* (BITTNER), *U.Trias.(Carn.)*, S.Tyrol; LV ext.,  $\times 1.6$  (58). [Cox]

**Otapiria** MARWICK, 1935, p. 302 [\**Pseudomonotis marshalli* TRECHMANN, 1923, p. 270; OD]. Medium-sized, ovate, rather elongated, prosocline; LV feebly convex, with broad, scarcely protruding umbo, RV flat; posterior wings very obtuse or rounded, without marginal sinus, and quite undemarcated from body of shell; no left anterior wing, anterior and anterodorsal margins meeting in even curve; very small right anterior auricle present, almost overlapped by dorsal part of body; ornament of closely arranged radial riblets. [The general form of the shell and the small size of the auricle suggest affinity with the Monotidae, but the presence (according to MARWICK) of a triangular ligamental pit precludes reference to that family.] *U.Trias.(Rhaet.)-U.Jur.(Tithon.)*, N.Z.—FIG. C61,4. \**O. marshalli* (TRECHMANN), L. Jur. (L.Lias.); LV,  $\times 1$  (Cox, n). [Cox].

?**Oxypteria** WAAGEN, 1907, p. 93 [\**Aviculopecten (O.) bittneri*; M]. Small suborbicular, slightly opisthocline; wings of LV small, obtuse, subequal; ornament of few simple, sharp radial ribs producing scalloped margin; RV unknown. *U.Trias.(Carn.)*, Eu. (S.Tyrol).—FIG. C61,2. \**O. bittneri*; LV ext.,  $\times 2$  (950). [Cox]

#### Subfamily STREBLOCHONDRIINAE Newell, 1938

[Streblochondriinae NEWELL, 1938, p. 80]

Upright to opisthocline, nearly equivalve shells in which hinge line is short and auricles well developed; of these, posterior auricle is shorter than anterior auricle. Outer ostracum radially fibrous in both valves; structure of inner ostracum crossed lamellar. *Miss.-U.Trias.*

**Streblochondria** NEWELL, 1938, p. 80 [\**Aviculopecten sculptilis* MILLER, 1891, p. 92; OD]. Both valves ornamented by numerous intercalating costae crossed by fine regular fila which give latticed aspect to surface ornamentation becoming obsolescent in some species. *Miss.-Perm.*, N.Am.-Eu.—FIG. C63,2. \**S. sculptilis* (MILLER), U.Penn. (Missouri), Mo.; 2*a,b*, LV ext., hinge,  $\times 1$  (663).

**Eocamptonectes** NEWELL, new genus [\**Camptonectes ?papillatus* GIRTY, 1908, p. 434; OD herein]. Opisthocline, ornamented with radial curved costellae or rows of papillae arranged in quincunx. *L.Perm.-U.Perm.*, USA (Tex.-Wyo.).—FIG. C63,3. \**E. papillatus* (GIRTY), U.Perm. (Capitan F.), Tex.; RV ext.,  $\times 4$  (663).

**Pleuronectites** VON SCHLOTHEIM, 1820, p. 217 [\**P. laevigatus*; SD FISCHER, 1886, p. 945]. Large, suborbicular, opisthocline; LV moderately convex, with more or less protruding umbo; RV feebly convex, umbo level with hinge margin and pointing anteriorly; wings of LV obtuse, not clearly delimited from body of shell; right posterior wing obtuse, narrow, well delimited; right anterior auricle narrow, only slightly shorter than posterior wing; subauricular sinus moderately deep, narrowly rounded; ctenolium present; surface unornamented. *M.Trias.-U.Trias.*, Eu. (Ger.-France-S.Alps).—FIG. C63,4. \**P. laevigatus*, *M.Trias.* (Muschelkalk), Ger.; 4*a,b*, LV ext., RV ext., both  $\times 0.7$  (732). [Cox]

**Streblopteria** M'COY, 1851, p. 170 [\**Meleagrina laevigata* M'COY, 1844; SD MEEK & WORTHEN, 1866, p. 333] [= *Rutotia* DE KONINCK, 1885 (type, *Pecten hemisphaericus* PHILLIPS, 1836; SD NEWELL, herein)]. Orbicular, smooth shells with gibbous umbones; posterior auricle poorly defined, with obtuse posterodorsal angle. *Miss.-Perm.*, cosmop.—FIG. C63,1. \**S. laevigata* (M'COY), holo., L.Carb., Ire.; LV ext.,  $\times 1$  (407*b*).

#### Subfamily CHAENOCARDIINAE S. A. Miller, 1889

[*nom. transl.* NEWELL, herein (ex Chaenocardiidae MILLER, 1889, p. 458)]

Ovoid, prosocline to opisthocline shells with obtuse posterodorsal border, obsolescent radial ornamentation; anterior auricle of LV poorly differentiated, that of RV strongly set off, subcircular, with wide, wedge-shaped byssal notch; shell structure crossed lamellar. *L.Miss.-L.Perm.*

**Chaenocardia** MEEK & WORTHEN, 1869, p. 170  
 [\**C. ovata*; OD]. Shells with prosocline obliquity.  
*M.Penn.*(*Desmoines.*), N.Am.—FIG. C64,2. \**C.*



FIG. C64. Aviculopectinidae (Chaenocardiinae) (p. N340).

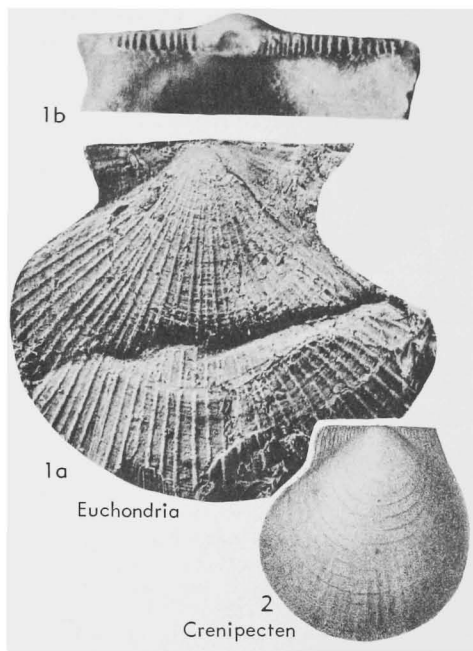


FIG. C65. Aviculopectinidae (Euchondriinae) (p. N340-N341).

*ovata*, *M.Penn.*, Ohio; 2a-c, LV int., ext., RV ext.,  $\times 2$  (Newell, n).

**Obliquipecten** HIND, 1903, p. 114 [\**O. laevis*; M]. Markedly opisthocline, flattened shells, nearly smooth except for few obscure radial costae on anterior part of each valve; hinge margin short, posterior auricle obsolete with very obtuse postero-dorsal border. *L.Miss.-L.Perm.*, N.Am.-Eu.—FIG. C64,1. \**O. laevis*, L.Carb., Eng.; 1a,b, RV ext., LV ext.,  $\times 1$  (663).

#### Subfamily EUCHONDRIINAE Newell, 1938

[*nom. transl.* NEWELL, herein (*ex* Euchondriidae NEWELL, 1938, p. 102)]

Small Paleozoic pectinaceans with dorsally divergent cardinal areas bearing closely spaced transverse alternating ridges and furrows. [Transverse grooves were interpreted by NEWELL (1938) as multiple ligament pits, but it now seems most likely that they represent a neotenus retention of the larval provinculum.] *U.Dev.-U.Perm.*

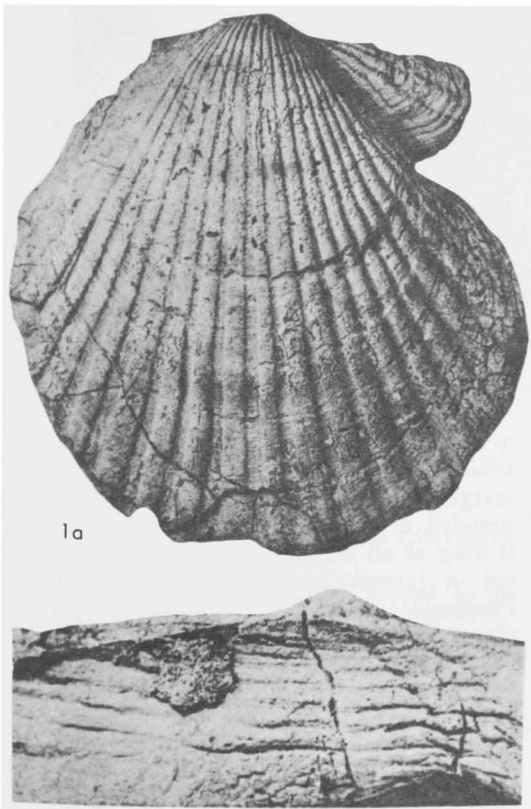
**Euchondria** MEEK, 1874, p. 445 [\**Pecten neglectus* GEINITZ; M]. Strongly prosocline, commonly produced posteriorly; hinge with central resilifer, as in *Aviculopecten*; LV ornamented by widely spaced intercalate costae; RV smooth or marked by concentric fila; inner ostracum crossed-lamellar

aragonite; outer ostracum calcite with square prisms in RV, apparently structureless in LV. *L. Miss.-U. Perm.*, N.Am.-Eu.-Japan.—FIG. C65,1a. \**E. neglecta* (GEINITZ), U.Penn., Neb.; LV ext.,  $\times 5$ .—FIG. C65,1b. *E. subcancellata* (NEWELL), M.Penn.(Desmoines.), Mo.; RV hinge,  $\times 12$  (663). **Crenipecten** HALL, 1883, p. xi [\**C. crenulatus*; SD S. A. MILLER, 1889]. Shell small, variable in form and ornamentation; hinge as in *Euchondria* except that central resilifer is lacking. *U.Dev.*, USA (N.Y.).—FIG. C65,2. \**C. crenulatus*; LV ext.,  $\times 1$  (377).

### Family DELTOPECTINIDAE Dickins, 1957

[Materials for this family prepared by N. D. NEWELL]

Pectinoid shells with simple radial plications and flattened cardinal areas without distinct central resilifer, as in *Aviculopectinidae*, or chevron-shaped ligament grooves



1b Deltopecten

FIG. C66. Deltopectinidae (p. N341).

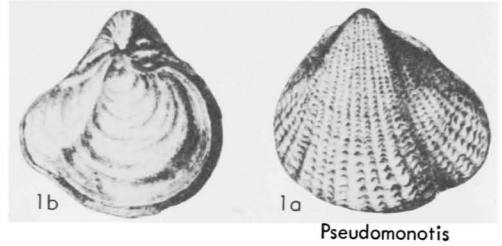


FIG. C67. Pseudomonotidae (p. N341).

characteristic of Pterinopectinidae. Distinct, longitudinal ridges, presumably growth lines, lie on ligament area more or less parallel with hinge axis. Traces of radial lines under beaks recall striated ligament area of certain arcoid genera (e.g., *Striarca*, *Noetia*). *L. Perm.*

**Deltopecten** ETHERIDGE, JR., 1892, p. 269 [\**Pecten illawarensis* MORRIS, 1845 (not figured), p. 277; OD]. Large, orbicular, radially plicate shells with or without fine costae; ligament area striated more or less parallel to hinge axis, resilifers lacking. *L. Perm.*(*Ariinsk.*), Australia.—FIG. C66,1. *D. waterfordi* (DICKINS), Callytharra F.; 1a, LV ext.,  $\times 0.45$ ; 1b, ligament area,  $\times 2.7$  (Newell, n).

### Family PSEUDOMONOTIDAE Newell, 1938

[*nom. transl.* NEWELL, herein (*ex* Pseudomonotinae NEWELL, 1938, p. 92)] [=Prospondylidae (*partim*) PHELINTSEVA, 1960] [Materials for this family prepared by N. D. NEWELL]

Suborbicular to irregular shells with short hinge margin; RV flat or concave and LV moderately to very convex with primitive procline rhombic form until relatively advanced ontogenetic stage; posterodorsal margin obtuse, never alate; byssal notch closed in adults as consequence of early degeneration of foot and cementation by umbo of RV; hinge and shell microstructure as in *Aviculopecten*. [Final elimination of the byssal notch in some Permian and Triassic forms led to the genus *Philippiella* WAAGEN and apparently eventually to the true oysters. Many Triassic species formerly classed with *Pseudomonotis* are more appropriately allocated with the *Aviculopectinidae*.] *L. Carb.-U. Perm.*

**Pseudomonotis** VON BEYRICH, 1862, p. 10 [\**Gryphites speluncarius* VON SCHLOTHEIM, 1820, p. 292; SD STOLICZKA, 1871, p. 389] [=*Eumicrotis*



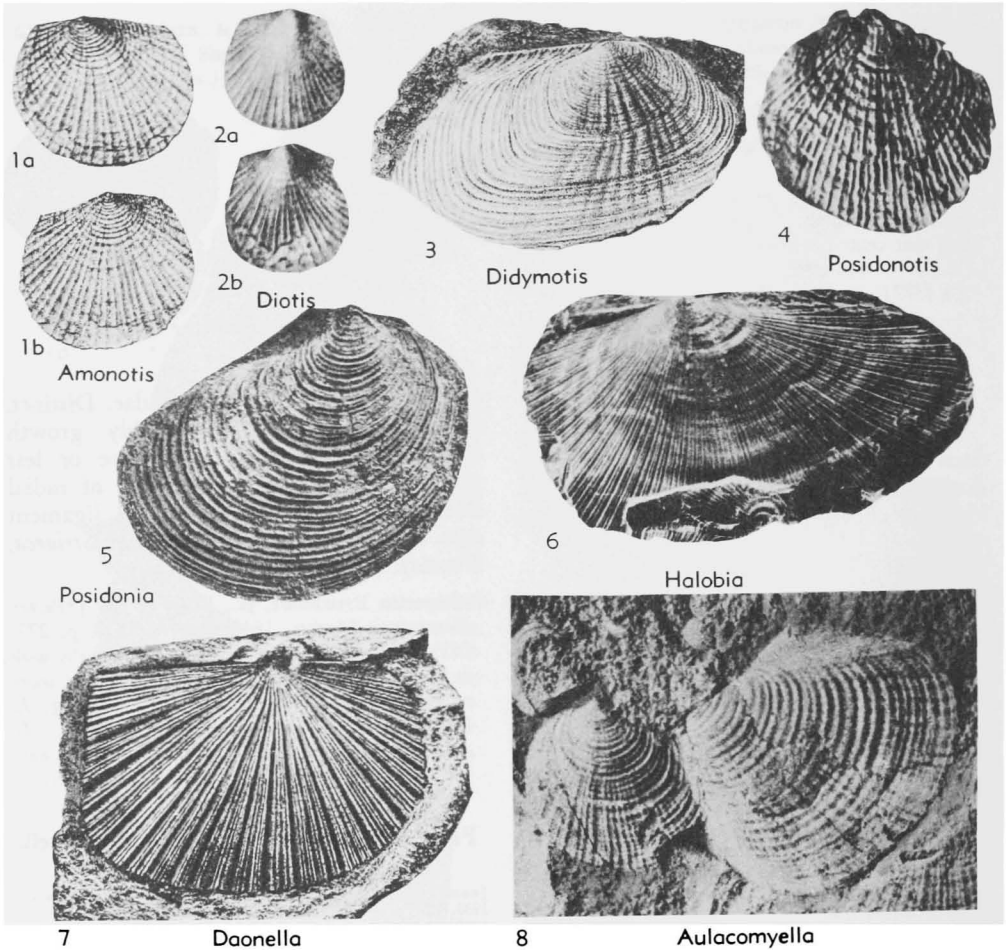


FIG. C68. Posidoniidae (p. N342-N344).

MEEK, 1864 (type, *Monotis hawni* MEEK & HAYDEN, 1958); *Pachypteria* DE KONINCK, 1885 (type, *Ostrea nobilissima* DE KONINCK, 1851); *Prospodylus* ZIMMERMANN, 1886 (type, *P. liebeanus*); *Aviculomonotis* GRABAU, 1931 (type, *A. mongoliensis*). Ornamentation irregular, consisting of radial, intercalate, commonly scabrose costae that are weakly developed or obsolete in some species. *L.Carb.*(*Visean*)-*U.Perm.*, widely distributed in northern hemisphere.—FIG. C67, 1. \**P. speluncaria* (VON SCHLOTHEIM), *U.Perm.*, Eng.; 1a,b, LV ext., RV ext., both  $\times 1$  (King, 1850).

**Family POSIDONIIDAE Frech, 1909**

[*nom. transl.* COX & NEWELL, herein (ex Posidoniinae FRECH, 1909) [=Halobiidae KITTL, 1912] [Materials for this family prepared by L. R. COX, with additions by N. D. NEWELL as indicated]

Ovate, thin-shelled, of low convexity, sub-equivalve, umbones low, median or anterior

to median; ornamented by fine radial costellae or concentric folds or both; hinge margin usually elongate, dorsal angles rounded or obtuse; byssal sinus or notch lacking at all stages in most genera, present in juveniles in some (Carboniferous *Posidonia*); ligament area narrow, rarely observable; hinge edentulous. *L.Carb.-U. Cret.* [COX & NEWELL]

*Posidonia* BRONN, 1828, p. 268 [\**P. becheri*; M]. [= *Posidonomya* BRONN, 1834 (obj.)]. Ovate to rhombic shells with concentric undulations; auricles lacking or poorly developed in adults; ovoid shells with umbones submedially situated along short hinge; weakly or not costate; byssal sinus of valves known only in juveniles of Carboniferous forms. Convergent with or ancestral to certain genera included here in the Inoceramidae, from which it differs in ligament structure.



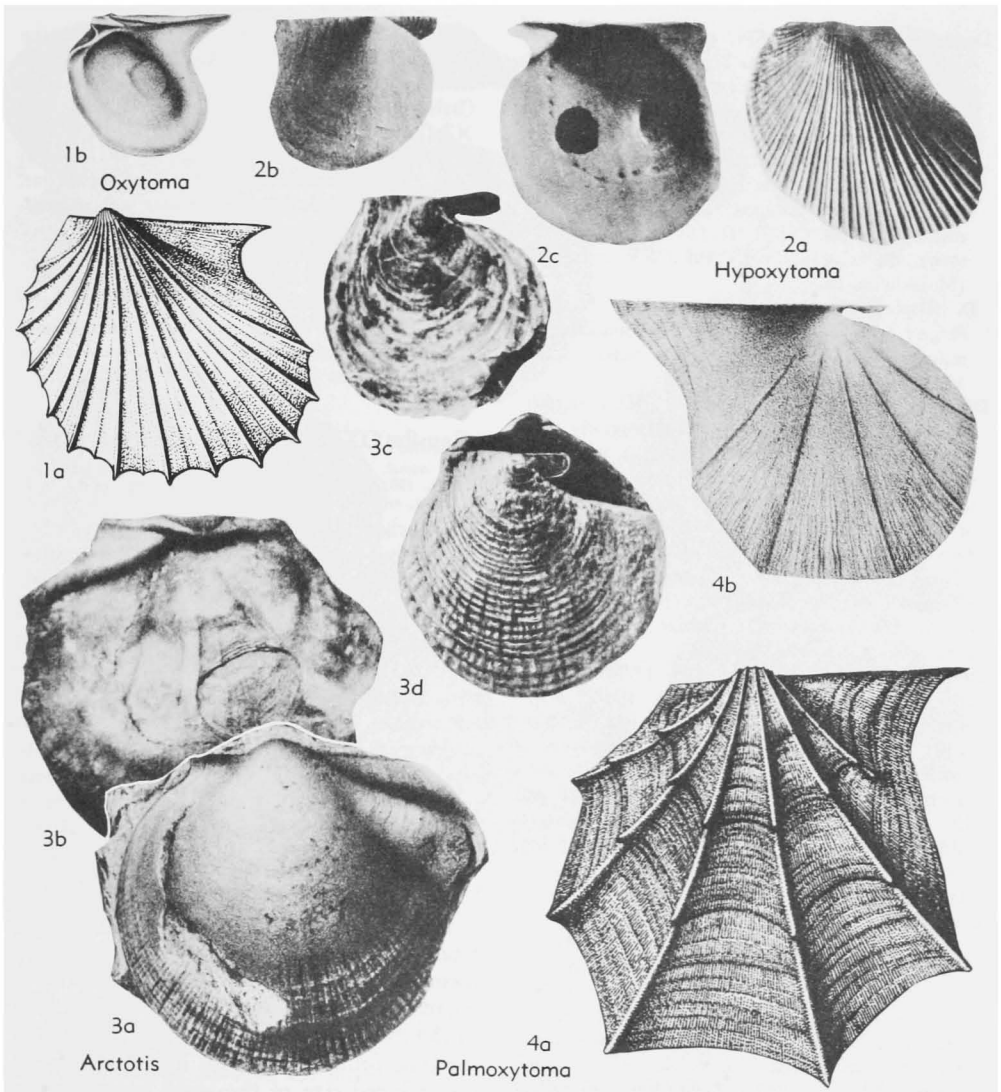


FIG. C69. Oxytomidae (p. N344-N345).

Some Upper Paleozoic species referred to this genus may belong to *Posidoniella* or *Atomodesma*. *L. Carb.-U. Jur.*, N. Am.-Eurasia-S. Am.-E. Afr.—FIG. C68, 5. \**P. becheri*, *L. Carb.*, Ger.; RV ext.,  $\times 1$  (961). [NEWELL]

**Amonotis** KITTL, 1904, p. 736 [\**A. cancellaria*; M]. Ovate, almost circular, not oblique; no delimited wings; ornament of narrow concentric folds crossed by weak radial riblets. *U. Trias.* (*Carn.*), Eu. (Yugosl.).—FIG. C68, 1. \**A. cancellaria*; 1a, b, LV ext., RV ext.,  $\times 1$  (Kittl, 1904).

**Aulacomyella** FURLANI, 1910, pl. 3 (explan.) [*pro Posidoniella* FURLANI, 1910 (*non* DE KONINCK,

1885)] [\**P. problematica*; M]. Resembling *Halobia* in shape and ornament, but lacking delimited anterior wings; externally like *Daonella* but separated from it mainly because of its very different geological age. *U. Jur.* (*Kimmeridg.*), Afr. (Somalil.)-Eu. (Dalmat.-Ger.)-S. USA-Mex.-?Japan.—FIG. C68, 8. \**A. problematica* (FURLANI), Dalmat., RV ext.,  $\times 1$  (Furlani, 1910).

**Bositra** DE GREGORIO, 1886, p. 11 [\**Posidonia ornati* QUENSTEDT, 1851 (= *Posidonia buchii* RÖMER, 1836; *P. alpina* GRAS, 1852); OD]. Externally like *Posidonia* but with alivincular ligament similar to that of *Pteria*. *Jur.*, Eu. (Jefferies & Minton, 1965).

**Daonella** MOJSISOVICS, 1874, p. 5 [*\*Halobia lommeli* WISSMANN, 1841, p. 22; SD DIENER, 1923, p. 46]. Like *Halobia* in external characters, but lacking delimited anterior wings; adductor scar subcentral, touched tangentially by 2 internal ridges diverging from the beak. *Trias.*, cosmop.

**D. (Daonella)**. Subovate; ornament of radial riblets commonly grouped in bunches. *Trias.*, cosmop.—FIG. C68,7. *\*D. (D.) lommeli* (WISSMANN), *M.Trias.*(Ladin.), Aus.; RV ext.,  $\times 1$  (Mojsisovics, 1874).

**D. (Dipleurites)** KITTL, 1912, p. 164 [*\*Halobia bergeri* SEEBACH, 1886, p. 7; M]. Semicircular; ornament of numerous very fine radial riblets. *M.Trias.*(*Muschelkalk*), Ger.

**Didymotis** GERHARDT, 1897, p. 178 [*\*D. variabilis*; M]. Paper-thin, elongate-ovate, posteriorly subtruncate, without delimited anterior wing but with flattened area posterior to beaks, bordered in some specimens by obscure groove; ornament of depressed radial ribs on median part of surface and irregular concentric rugae. *U.Cret.* (*Turon.-L.Coniac.*), S.Am.(Colom.-Venez.)-Carib. (Trinidad)-N. Am. (Mex.)-Asia (Japan). — FIG. C68,3. *\*D. variabilis*, L. Coniac., Colom.; RV ext.,  $\times 0.7$  (Gerhardt, 1897).

**Diotis** SIMONELLI, 1884, p. 125 [*\*Posidonomya janus* MENEGHINI, 1854, p. 67, M]. Rather small, equilateral, orbicular except for dorsal margins, which are not quite in alignment but meet at umbo in very obtuse angle; anterior margin with broad sinus; ornament of fine radial riblets and (in early growth stages) of narrow concentric folds. *L. Jur.* (*L. Lias.-M. Lias.*), Eu.(Italy-Spain). — FIG. C68,2. *\*D. janus* (MENEGHINI), *M.Lias.*, Italy; *2a,b*, RV ext., LV ext.,  $\times 1$  (Fucini, 1897).

**Enteropleura** KITTL, 1912, p. 162 [*\*Daonella guembeli* MOJSISOVICS, 1874, p. 8; SD DIENER, 1923, p. 52]. Suborbicular, hinge margin relatively short, umbo anteriorly placed, posterior wing more or less clearly delimited; with 2 internal ridges as in *Daonella*, anterior one obscure; ornament of broad concentric folds and obscure radial threads. *M.Trias.*(*Anis.*)-*U.Trias.*(*Nor.*), Eu.(Alps-Hung.).

**Halobia** BRONN, 1830, p. 284 [*\*H. salinarum*; M]. Semicircular or ovate, with long hinge margin; rarely appreciably oblique; anterior wing clearly delimited on each valve, commonly by groove; ornament of closely and irregularly spaced narrow radial threads or grooves and of concentric folds, threads, which in many species are most developed on posterior side, increasing by bifurcation; ligament area striated longitudinally, but rarely observable. *M.Trias.*(chiefly)-*U.Trias.*, cosmop.—FIG. C68,6. *H. dilatata* KITTL, *U.Trias.* (*Nor.*), Aus.; LV ext.,  $\times 0.7$  (Kittl, 1912).

**Posidonotis** LOSACCO, 1942, p. 11 [*\*P. dainellii*; M]. Orbicular, equilateral, hinge margin very short for family; wings small but clearly delimited;

ornament of narrow radial riblets, increasing by intercalation, and of narrow concentric folds, forming reticulate pattern. *M.Jur.*(*Aalen.*), Eu. (Italy).—FIG. C68,4. *\*P. dainellii*; LV ext.,  $\times 2$  (Losacco, 1942).

**Pseudodidymotis** GILLET, 1924, p. 75 [*\*P. lamberti*; OD]. Ovate, moderately inequilateral, prosocline, without delimited wings; umbones not protruding or only slightly; ornament of very fine radial threads. *L.Cret.*, Eu.(France).

**Veldidenella** ALMA, 1926, p. 118 [*\*V. dieneri*; M]. Very elongate, narrow anteriorly, broad posteriorly; umbo protruding slightly, anteriorly placed, prosogyrous; ornament of closely spaced radial riblets, not arranged in bunches. *U.Trias.*, Eu.(Aus.).

### Family OXYTOMIDAE Ichikawa, 1958

[*nom. transl.* Cox, 1961, p. 592 (ex Oxytominae ICHIKAWA, 1958, p. 158)] [Materials for this family prepared by L. R. Cox, with additions by N. D. NEWELL as indicated]

Suborbicular, subovate or lunate, commonly but not invariably strongly inequivalve, inequilateral; right anterior auricle small, subauricular notch deep; ligamental area external in RV and usually in LV also; more or less oblique ligamental groove present, sloping backward from beak; hinge edentulous or with interlocking protuberances and recesses; pallial line discontinuous, broken up into series of pits; ornament predominantly radial, commonly weaker in RV than in LV; inner ostracum calcitic, with crossed-lamellar structure, outer ostracum of RV prismatic. *L.Perm.-U.Cret.*

This family appears to have been derived from the Aviculopectinidae, from which its members differ in the replacement of a nacreous inner ostracum by a calcitic one, in the discontinuous pallial line, which is of the type found in modern Pteriidae, and in the reduced size of the right anterior auricle.

**Oxytoma** MEEK, 1864, p. 39 [*\*Avicula muensteri* BRONN, 1830, p. 164 (= *Avicula inequivalvis* ). SOWERBY, 1819, p. 78]; OD]. Suborbicular and acline to ovate or broadly lunate and prosocline; valves commonly discordant, LV varying in convexity with umbo protruding, RV flat or feebly convex; posterior wing of both valves more or less elongated, sharply pointed, left anterior wing small, subauricular notch deep, acute, with ctenolium; angular projection of shell margin extending on inner side of notch; ligamental area almost parallel with plane of valve margins in LV, almost perpendicular to it in RV; no hinge teeth. *U.Trias.-U.Cret.*, cosmop.

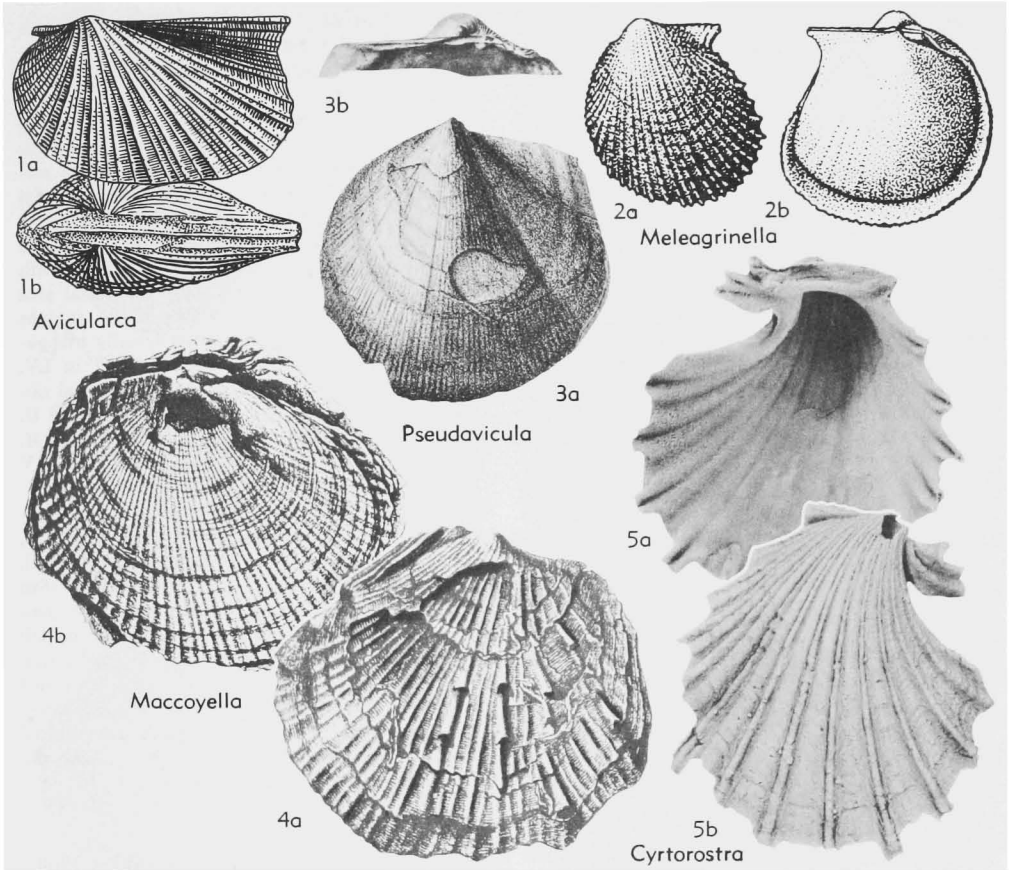


FIG. C70. Oxytomidae (p. N346).

**O. (Oxytoma)**. Medium-sized; LV with ribs and riblets commonly 3 orders of strength, primary ribs well separated; only first or first 2 orders present in some specimens; RV smooth or with weak radial threads; adductor scar placed somewhat posteriorly. *U.Trias.-L.Cret.*, cosmop.—FIG. C69,1. \**O. (O.) inequivalvis* (J. SOWERBY), *Jur., Eu.*; 1a, LV ext.,  $\times 2$  (Cox, n); 1b, RV int.,  $\times 2.7$  (341b).

**O. (Hypoxytoma)** ICHIKAWA, 1958, p. 164 [\**Avicula danica* RAVN, 1902, p. 11; OD]. Rather small; LV with closely spaced, subequal ribs, absent in earlier growth stages in some specimens; RV smooth; subauricular notch less deep than in *O. (Oxytoma)*. *L.Cret.-U.Cret.*, cosmop.—FIG. C69,2a. *O. (H.) tenuicostata* (ROEMER), *U.Cret., Ger.*; LV ext.,  $\times 2.3$  (VOIGHT, 1954).—FIG. C69,2b.c. \**O. (H.) danica* (RAVN), *U.Cret., Ger.*; 2b, RV ext.,  $\times 5$  (Voigt, 1954); 2c, RV int.,  $\times 6.7$  (423).

**O. (Palmoxytoma)** Cox, 1961, p. 593 [\**Pecten*

*cygnipes* YOUNG & BIRD, 1822, p. 235; OD]. Large, orbicular, only slightly prosocline; LV moderately to strongly convex, RV almost flat; LV with small number of narrow, prominent, spinose ribs which are continued by narrow digitations of valve margin and separated by broad, flat intervals which are smooth or bear fine radial striations; ribs increasing by intercalation in some specimens; RV with small number of faint, narrow radial grooves and, in some specimens, fine radial striations; posterior adductor scar more nearly median than in *O. (Oxytoma)*. *L. Jur. (L. Lias.-M. Lias.)*, N.Eu.—FIG. C69,4. \**O. (P.) cygnipes* (YOUNG & BIRD), *M.Lias., Eng.* (4a); France (4b); 4a, LV ext.,  $\times 1$  (Cox, n); 4b, RV ext.,  $\times 0.67$  (Dumortier, 1869).

**Arctotis** BODYLEVSKY, 1960, p. 44 [\**Hinnites lenensis* LAHUSEN, 1886, p. 4; OD]. Medium-sized, suborbicular or subovate, acline or almost so; LV moderately convex, RV almost flat; posterior wings obtuse, indistinctly delimited, left anterior

- wing and right anterior auricle shorter than posterior wings, although not greatly reduced; subauricular sinus moderately deep, angular; ligamental area broad, with deep and wide ligamental pit; pallial line discontinuous; ornament of irregularly arranged radial riblets, well developed on LV, weak or absent on RV. *L.Jur.(Lias.)-L.Cret.(Valang.)*, USSR (Sib.).—FIG. C69,3a-c. \**A. lenaensis* (LAHUSEN), M.Jur.; 3a, LV ext.,  $\times 0.5$  (Lahusen, 1886); 3b,c, RV int., ext., both  $\times 1.1$  (Borisiak, 1915).—FIG. C69,3d. *A. intermedia* BODYLEVSKY, U.Jur.(L.Volg.); RV ext.,  $\times 2$  (Bodylevsky, 1960).
- ?*Avicularca* VON BUBNOFF, 1921, p. 281 [\**Avicularca cardiiformis* VON MÜNSTER, 1841, p. 78; SD Cox, herein]. Small, ovate, more or less elongate, equi-valve, moderately convex, prosocline; umbones broadly rounded, protruding slightly; posterior wing long, acute-tipped, but with only shallow marginal sinus; left anterior wing small, acute; right anterior auricle unknown; rather broad, subhorizontal ligamental area, with very narrow, oblique ligamental pit, present in both valves; ornament (both valves) of radial riblets of 2 or more orders of strength. *U.Trias.*, Eu.(S.Alps).—FIG. C70,1. \**A. cardiiformis* (VON MÜNSTER), *U.Trias.*, S.Tyrol; 1a,b, LV ext., dorsal,  $\times 5$  (58).
- Cyrtorostra* BRANSON, 1930, p. 44 [\**C. varicostata*; OD] [= *Blanfordina* REED, 1944, p. 312 (type, *B. lunwalensis*); *Prooxytoma* MASLENNIKOV, 1955 (type, *Oxytoma caucasica* LIKHAREV, 1947)]. Suborbicular, accline to opisthocline, prosogyrate; ornamentation equal in the 2 valves, consisting of 2 orders of radial ribs, of which smaller one extends as marginal spines. [Frequently classed with the Mesozoic *Oxytoma*. Probably derived from *Clavicoستا* NEWELL.] *L.Perm.(Leonard.)-U.Perm.*, widely distributed in northern hemisphere.—FIG. C70,5. \**C. varicostata*, *L.Perm.* (Phosphoria), Wyo.; 5a,b, RV int., ext.,  $\times 3$  (132). [NEWELL]
- Maccoyella* ETHERIDGE, JR., 1892, p. 451 [\**Avicularca barklyi* MOORE, 1870, p. 245; OD] [= *Mimostreon* BONARELLI & NÁGERA, 1921, p. 21 (type, *Avicularca corbiensis* MOORE, 1870; SD STENZEL, 1947, p. 177)]. Medium-sized to large, ovate or suborbicular, irregular in form, accline or slightly prosocline; LV strongly convex, some species with well-incurved umbo; RV flat or feebly convex; posterior wings and left anterior wing obtuse and ill-defined; right anterior auricle small, thick; subauricular notch narrow, oblique, clearly seen only from interior of valve, or possibly absent in some specimens; ligamental area of LV broad and concave, with broad ligamental pit; rather large, amorphous tooth present below or on anterior side of area in some forms; pallial line discontinuous; ornament of radial ribs commonly of 2 or more orders of strength. ?*U.Jur.-L.Cret.*, Australia-N.Z.-Patagonia.—FIG. C70,4. \**M. barklyi* (MOORE),
- L.Cret.*, Australia; 4a,b, LV ext., RV ext., both  $\times 0.7$  (Etheridge, 1902).
- Meleagrinnella* WHITFIELD, 1885, p. 71 [\**Avicularca curta* HALL, 1852, p. 412; SD Cox, 1941, p. 134] [= *Clathrolima* COSSMANN, 1908, p. 296 (type, *C. lalmenti*); *Echinotus* MARWICK, 1935, p. 301 (type, *Avicularca echinata* SMITH, 1817)]. Small to medium-sized, orbicular; LV strongly convex, RV flat or feebly convex, valves strongly discordant; usually with small pointed posterior wings but no left anterior wing; right anterior auricle small, with deep, narrow subauricular notch; ligamental area almost in plane of valve margins in LV, at right angles to it in RV; ligamental pit broadly triangular, toothlike protuberance anterior to it in LV, which has narrow, commonly squamose radial riblets; RV smooth or with weak radial riblets. *U.Trias.(Rhaet.)-U.Jur.*, cosmop.—FIG. C70,2. *M. echinata* (SMITH), M.Jur., Eng.; 2a,b, LV ext., RV int.,  $\times 2$  (Cox, n).
- Pseudavicula* HUDLESTON, 1890, p. 244 (ex ETHERIDGE, JR., MS) [\**Lucina anomala* MOORE, 1870, p. 251; M]. Medium-sized, suborbicular or oval, accline, weakly biconvex, LV more inflated than RV although its umbo scarcely protrudes; posterior wings obtuse, indistinctly delimited, no left anterior wing; right anterior auricle small, subauricular notch small but distinct; ligamental area external, that of RV broadest in middle, where wide ligamental pit occurs; no hinge teeth; pallial line discontinuous; ornament of fine radial riblets. *L.Cret.*, Australia.—FIG. C70,3. \**P. anomala* (MOORE); 3a,b, RV ext., hinge,  $\times 1$  (440).

### Family ENTOLIIDAE Korobkov, 1960

[Materials for this family prepared by N. D. NEWELL, with additions by L. G. HERTLEIN as indicated]

Suborbicular, valves nearly equilateral and equally convex, smooth or with fine radial or concentric sculpture, byssal notch lacking in adults, auricles projecting above hinge margin in LV, hinge line straight in RV, auricular crura present. [This family resembles and may have led to *Amusium*.]

#### *L.Miss.-U.Cret.*

- Entolium* MEEK, 1865 [\**Pecten demissus* PHILLIPS, as illustr. by QUENSTEDT, 1858 (= *Pecten disciforme* SCHUEBLER in ZIETEN, 1833); OD]. Byssal notch lacking at any stage; margins closed laterally; incised ligamental area usually present and extending parallel to hinge line on each side of ligamental pit; auricular crura present; inner shell layer calcite, foliate; outer layer radially fibrous in both valves. *M.Trias.-U.Cret.*, cosmop. [HERTLEIN]
- E. (*Entolium*)** [= *Protamusium* VERRILL, 1897 (obj.); *Protamusium* PARIS & RICHARDSON, 1915 (nom. null.); *Protomusium* STEWART, 1930 (nom. null.); *Etolium* McLEARN, 1949 (nom.

null.]. Auricles of LV projecting above hinge, commonly as angular wings;<sup>1</sup> smooth (19b, 19c, 19i, 732c). *M.Trias.-U.Cret.*, cosmop.—FIG. C71,4. \**E. (E.) demissum* (PHILLIPS), M.Jur.

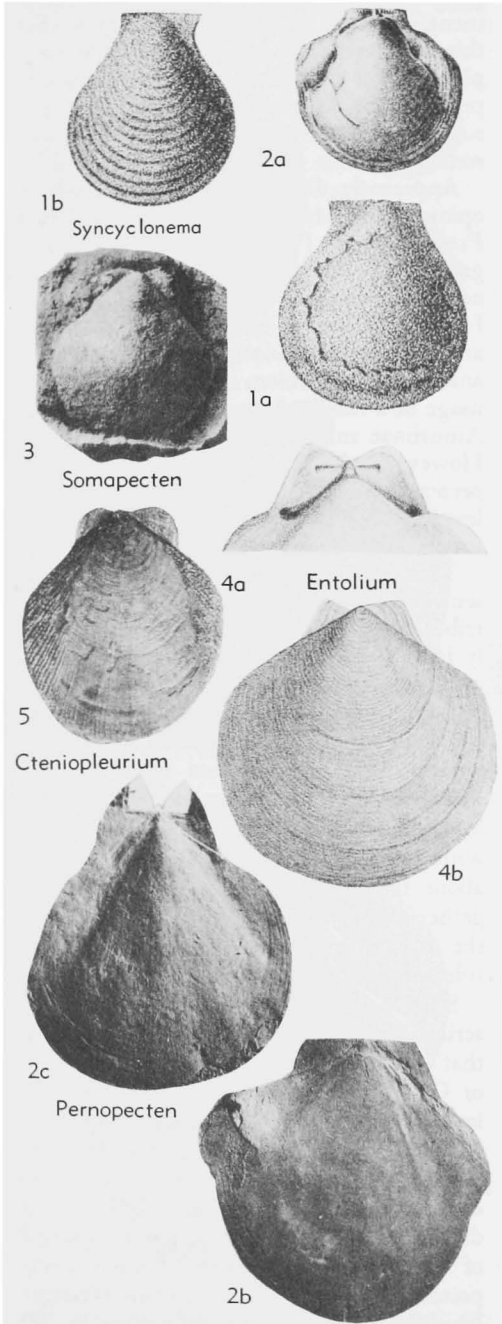


FIG. C71. Entoliidae (p. N346-N347).

(Bajoc.), Ger.; 4a,b, RV hinge, RV ext.,  $\times 1$  (Quenstedt, 1858). [= *Entholium* TZANKOV & BONCEV, 1932 (nom. null.).] [HERTLEIN]

**E. (Cteniolepturium)** FELDTMANN, 1951 [\**Syncyclonema subreticulatus* FELDTMANN, 1951; OD]. Differs from *Entolium* in that valves are sculptured with fine, usually spinose, radial riblets; byssal notch very slight or lacking. *U.Cret.* (*M.Senon.*), Australia.—FIG. C71,5. \**E. (C.) subreticulatum* (FELDTMANN), M.Senon. (Santon.), Australia; RV ext.,  $\times 1.5$  (Feldtmann, 1951). [HERTLEIN]

**Pernopecten** WINCHELL, 1865 [\**Aviculopecten limaformis* WHITE & WHITFIELD, 1862; OD]. Commonly, but not invariably, truncated behind, interior smooth or ribbed, with gaping front and rear margins; LV distinctly larger than right; byssal notch present in RV of juveniles, obsolete in adults; auricles of LV acuminate; inner ostracum with concentric crossed-lamellar structure, outer ostracum radially fibrous in LV and hexagonal prismatic in RV. *L.Miss.-U.Perm.*, cosmop.—FIG. C71,2a. \**P. limaformis* (WHITE & WHITFIELD), L.Miss. (Burlington), Iowa; RV int. mold,  $\times 1$  (377).—FIG. C71,2b,c. *P. ohioensis* (NEWELL), M.Penn. (Desmoines.), USA (Ohio); LV int., RV ext.,  $\times 3$  (663). [= *Protoentolium* YANISHEVSKY, 1960 (type, *Pecten sowerbyi* M'COY, 1844; OD)].

?**Somapeecten** KIMURA, 1951 [\**S. kamimanensis*; OD]. Shell similar to that of *Entolium* but hinge with strong triangular tooth in RV and corresponding socket in LV. [May not be referable to Entoliidae.] *Jur. (?Callov.-Tithon.)*, Japan.—FIG. C71,3. \**S. kamimanensis*, Torinosu Gr.; RV ext.,  $\times 1$  (469). [HERTLEIN]

?**Syncyclonema** MEEK, 1864 [\**Pecten rigida* HALL & MEEK, 1854 (non SOWERBY, 1818) [= *Pecten hallii* GABB, 1861]; OD] [= *Syncyclonema* MEEK, 1864 (see below); *Sinsyclonema* CONRAD, 1869 (nom. null.); *Syndonema* DALTON, 1878 (nom. null.); *Syncyclomena* CLESSIN, 1878 (nom. null.); *Synclonema* DE GREGORIO, 1886 (nom. null.); *Syncyclonema* DE GREGORIO, 1886 (nom. null.); *Syncyclomena* DE GREGORIO, 1898 (nom. null.)]. Differs from *Entolium* in straight, shorter hinge, in unequal auricles with rounded sinuosity under anterior ones, and in presence of small, rounded concentric ridges on RV (892). [The characters of the type species are not well known and their relationships are uncertain.] *U.Cret.*, N.Am.—FIG. C71,1. \**S. rigida* (HALL & MEEK), USA (Neb.); 1a,b, LV ext., RV ext.,  $\times 8$  (379). [HERTLEIN]

[*Syncyclonema* is rejected as an incorrect original spelling (Code, Art. 32a).]

<sup>1</sup>The right valve of *Entolium* traditionally has been considered to be the one with elevated dorsal wings. However, no evidence based on the adductor muscle impression has been available to indicate which valve is right and which left. Analogy with *Pernopecten* leads me to suspect that the valve with the elevated dorsal wings is the left one.—N. D. NEWELL.

## Family PECTINIDAE Rafinesque, 1815

[*nom. correct.* D'ORBIGNY, 1839 (*pro* Pectenidae FLEMING, 1822, *nom. transl. ex* subfamily Pectenidae RAFINESQUE, 1815)] [=Pectinides BOWDICH, 1822; Pectinidae PARKINSON, 1822; Pectinides "Lam." BRONN, 1824; Pectinides LATREILLE, 1825; Pectinida CROUCH, 1826; Pectinea MENKE, 1830] [Materials for this family prepared by L. G. HERTLEIN]

Shell varying in size, orbicular to oval, valves of some shells equally convex but usually one valve more inflated than other, margins usually, but not invariably closed; umbos central, on either side of which are triangular auricles (ears), anterior one on RV usually with distinct byssal notch or indentation below it; surface smooth or with radial ribs or folds, some species with concentric sculpture of raised lamellae; interior smooth or with fine radial riblets; hinge line straight; external ligament obsolete or nearly so, resilium internal, amphidetic, in triangular pit below umbones; young shells with small taxodont teeth which become obsolete later; cardinal crura or laminae commonly present, diverging from either side of ligamental pit; rounded laminae (auricular crura) present on interior of some shells where auricles join valves; adults monomyarian, with posterior adductor only; free, attached by byssus, or cemented by RV; upper (L) valve, usually more brightly colored; margin of mantle with short filaments and commonly with eyes; dioecious (256a-e, 732c, 936). *Trias.-Rec.*

Although many supraspecific units greatly resemble others in shell structure, their close relationship generally has not been proved. The similarities appear to confirm PHILIPPI's theory of iteration of shell form in this group of mollusks. For this reason it seems best to adopt a conservative course in arranging supraspecific units in groups within the Pectinidae. To define such groups as subfamilies or to separate them as families would imply relationships and distinctions based chiefly on supposition only.

The problem of where the amusiums should be placed in a scheme of classification is one not satisfactorily resolved at the present time. RIDGEWOOD, in 1903, proposed the family Amusiidae, based chiefly upon gill structure. On this basis he included *Plicatula* in the family, a decision which

almost no one follows because of the obvious conchological differences.

The *Propeamussium* group, having origin in the Mesozoic, has internal ribs but apparently the pattern of the rays, development, auricles, etc., does not suggest that this group gave rise to *Amusium*. The complete lack of any record of typical *Amusium* prior to the Miocene (Aquitanian) might suggest a rather sudden development from some unknown form.

Apparently COX and NORTH are of the opinion that *Amusium* was derived from *Pseudentolium* (= *Lentipecten*), an Eocene group with smooth shells, a distinct byssal notch, and lacking internal ribs. So far as I know, proof is lacking that *Amusium* arose from this Eocene group. I see no answer to the problem at this time. Possibly usage of a family Amusiidae or a subfamily Amusiinae might be a reasonable solution. However, when groups such as *Amussiopecten* are taken into account, I feel much less inclined to separate the amusiums from the Pectinidae.

This family, at the present time, is represented by about 350 species. These are distributed in all seas but occur most abundantly in shallow, warm waters, such as those of the East Indies, Japan, and Caribbean regions. The various species differ in size, convexity, sculpture, color, and habitat, but iteration and convergence often lead to similarity of form. Some are attached by byssal threads, others lie upon the bottom with the LV uppermost and some can swim about freely by clapping their valves together and ejecting a stream of water from the mantle below the auricles, first on one side and then on the other.

Several thousand species have been described as fossils. DAVIES (1934) pointed out that species occurring in strata of Eocene or Oligocene age rarely exceed 50 mm. in length. Much larger specimens occur in Mesozoic sediments as well as in those of post-Oligocene age. *Pecten* (*Amussiopecten*) *dregeri* VON TEPPNER, from strata of middle Miocene age in Austria, attains a length of 240 mm. The largest known living pecten is *P. caurinus* GOULD from Wrangell Narrows, Alaska, with valves up to 288

mm. long and 198 mm. high (GRAU, 1959).

The author of this portion of the *Treatise* wishes to acknowledge the aid and advice of Dr. K. F. NORTH, who generously permitted free access to his manuscript con-

taining the results of a comprehensive study of the supraspecific units of the Pectinidae. Acknowledgment also is made to Mr. GILBERT GRAU for aid and advice.

#### LENTIPECTEN GROUP

Usually small, rounded, valves gaping anteriorly and posteriorly; byssal notch present; usually smooth but some with radial folds or microscopic striae; hinge similar to that of *Amusium* but with fewer cardinal crura. *L.Eoc.-Rec.*

**Lentipecten** MARWICK, 1928 [*Pecten hochstetteri* ZITTEL, 1864; OD]. Differing from *Entolium* in that valves usually gape laterally, in presence of distinct byssal notch and in that outer margin of RV anterior auricle is rounded; hinge similar to *Amusium* but with fewer cardinal crura (13). *L.Eoc.-U.Plio.*, Eu.-Asia-N.Z.

**L.** (**Lentipecten**) [= *Pseudentolium* Cox, 1948 (type, *Pecten corneus* J. SOWERBY, 1818)]. Valves suborbicular in outline, smooth. *L.Eoc.-U.Plio.*, Eu.-N.Z.—FIG. C72,3a. \***L.** (**L.**) *hochstetteri* (ZITTEL), L.Mio.(Hutchinson), N.Z.; RV ext.,  $\times 1$  (Zittel, 1864).—FIG. C72,3b,c. **L.** (**L.**) *corneus* (SOWERBY), Eoc., Eng.; 3b,c, RV ext., int.,  $\times 0.7$  (J. Sowerby, 1818).

**L.** (**Entoliopsis**) EAMES, 1951 [*Amusium (Entoliopsis) uniradiatum*; OD]. Differs from *Lentipecten* in that anterior portion of interior of each valve bears radial ridge not extending to umbo or ventral margin; 1 auricular ridge delimiting each auricle internally on right and 2 ridges corresponding to each of these on LV. *L.Eoc.*, Asia(Pak.).—FIG. C72,2. \***L.** (**E.**) *uniradiatus* (EAMES); 2a, LV ext.,  $\times 3$ ; 2b, LV int.,  $\times 3$  (288).

**Adamussium** THIELE, 1934 [*Pecten colbecki* E. A. SMITH, 1902; OD]. Rounded, thin, gaping anteriorly and posteriorly, corrugated with shallow radial folds and bearing microscopic radial striae; right anterior ear rounded, shallow byssal notch beneath it. *Rec.*, Antarctic.—FIG. C72,1. \***A.** *colbecki* (SMITH); RV ext.,  $\times 0.5$  (E. A. Smith, 1902).

#### AMUSIUM GROUP

Disc-shaped forms, smooth to finely sculptured externally, interior with radial riblets. [Genera may have been derived from different groups.] *Jur.-Rec.*

**Amusium** RÖDING, 1798 [*Ostrea pleuronectes* LINNÉ, 1758; SD HERRMANNSEN, 1846] [= *Anusium* GRAY, 1826 (*nom. null.*); *Pleuronectes* BRONN, 1831 (*non* LINNÉ, 1758); *Pleuronectia* SWAINSON, 1840 (type, *P. laevigata* SWAINSON,

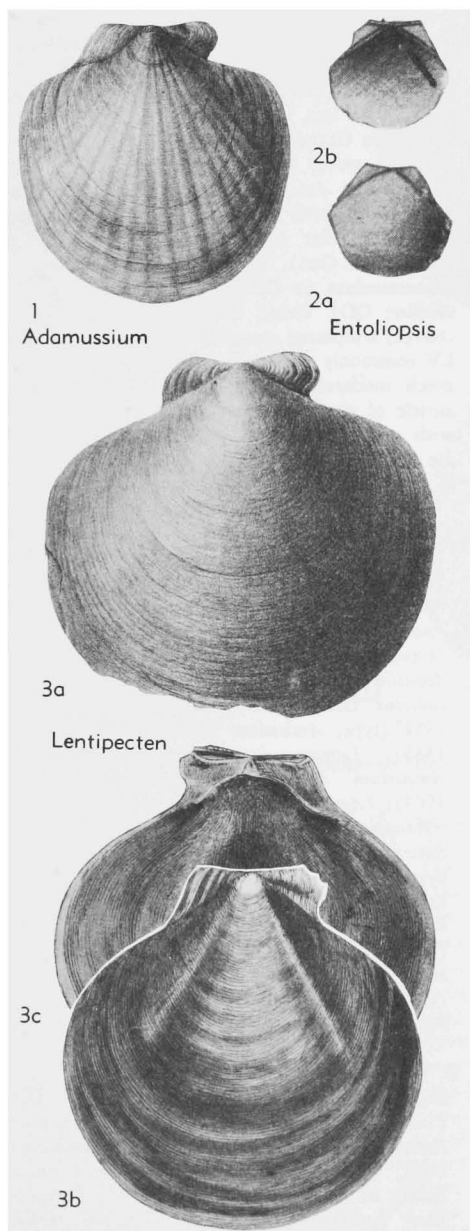


FIG. C72. Pectinidae (Lentipecten Group) (p. N349).



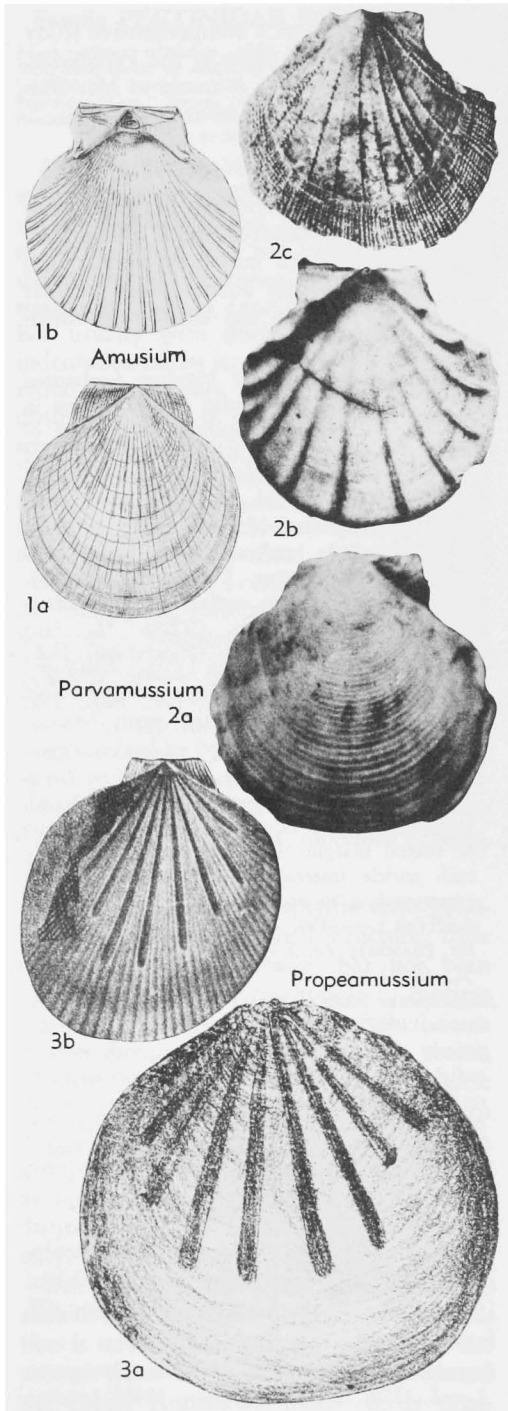


FIG. C73. Pectinidae (Amusium Group) (p. N349-N351).

1840,=*Ostrea pleuronectes* LINNÉ, 1758); *Pleuropecten* TUCKER-ROWLAND, 1938 (pro *Pleuronectia*); *Amusium* HERRMANNSEN, 1846 (nom. van.). Fairly large, thin, valves slightly convex and gaping along margins below auricles; trace of byssal notch present; internal lirae commonly in pairs; hinge with pair of short ridges diverging from shallow ligamental pit and extending toward margins; auricular crura present (256a-e). *L.Mio.-Rec.*, tropic-subtropic.—FIG. C73,1. \**A. pleuronectes* (LINNÉ), *Rec.*, IndoPac.; 1a, RV ext.,  $\times 1$ ; 1b, RV int.,  $\times 1$  (7c).

**Korobkovia** GLIBERT & VAN DE POEL, 1965, p. 10 [\**Pecten woodi* NYST, 1861 (non 1853); OD]. Differs from *Amusium* in lacking ribs in interior of RV, and from *Lentipecten* in presence of fine ribs in interior of LV. *U.Mio.(Auvers.)*, Eu. (Belg.-Neth.-Ger.).

**Propeamussium** DE GREGORIO, 1884 [\**Pecten (P.) ceciliae*; OD]. Small, thin, valves nearly equally convex; sculptured externally with concentric lines, LV commonly with radial striae or riblets; byssal notch moderately deep to slight; right anterior auricle of some shells with radial riblets; interior with radial riblets which usually extend to middle or to margin. *L.Jur.-Rec.*, cosmop.

**P. (Propeamussium)** [= *Propeamussium* DALL, 1886 (nom. van.); *Propeamussium* JACKSON, 1890 (nom. null.); *Paramussium* VERRILL, 1897 (type, *Amusium dalli* E. A. SMITH, 1885); *Propeamussium* DE GREGORIO, 1898 (nom. null.); *Propeannessium* COSSMANN & PISARRO, 1906 (nom. null.); *Occultamussium* KOROBKOV, 1937 (type, *Pecten semiradiatus* MAYER, 1861); *Pseudopalliorum* OYAMA, 1944 (type, *Pecten interradiatus* GABB, 1869); *Flavamussium* OYAMA, 1951 (type, *Amusium caducum* E. A. SMITH, 1885); *Luteamussium* OYAMA, 1951 (type, *Amusium sibogai* DAUTZENBERG & BAVAY, 1904); ?*Actinopecten* BONARELLI, 1951 (type, *A. ripidopsis* BONARELLI, 1951)]. Valves rather flattened, usually gaping along lateral margins; byssal notch slight; internal ribs extend about halfway (farther in some) to margin (256a-e, 802). *L.Jur.-Rec.*, cosmop.—FIG. C73,3a. \**P. (P.) ceciliae* (DE GREGORIO), *Mio.*, Sicily; RV ext., (type) (imperfect, auricles lacking),  $\times 1$  (DE GREGORIO, 1898).—FIG. C73,3b. *P. (P.) anconitanum* (FORESTI), *L.Mio.*, Italy; RV ext.,  $\times 1.5$  (256e).

**P. (Parvamussium)** SACCO, 1897 [\**Parvamussium duodecimlamellatum* BRONN, 1831; OD] [= *Variamussium* SACCO, 1897 (type, *Amusium cancellatum* E. A. SMITH, 1885); *Parviamussium* DALL, 1898 (nom. null.); *Variopecten* SACCO, BROILLI in ZITTEL, 1924 (nom. null.); *Ctenamussium* IREDALE, 1929 (type, *Amusium thetidis* HEDLEY, 1902); *Glyptamussium* IREDALE, 1939 (type, *Amusium torresi* E. A. SMITH, 1885); *Graptamussium* OYAMA, 1944 (type, *P. torresi*

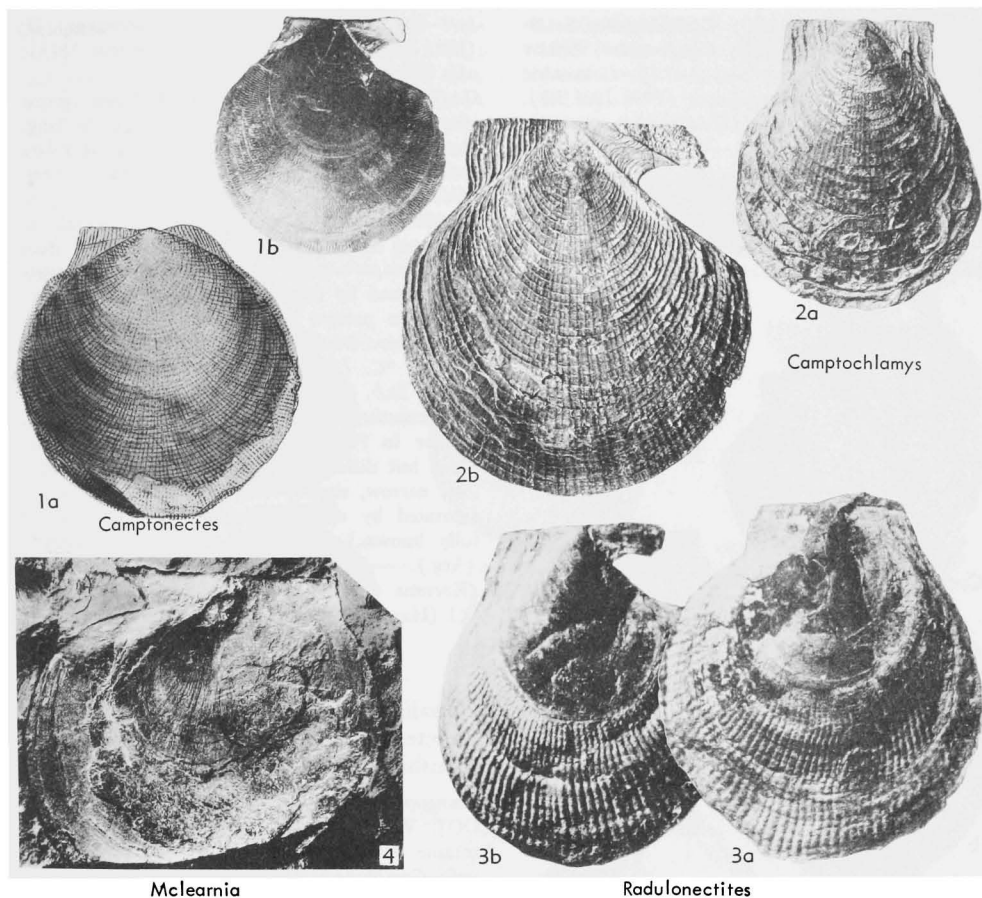


FIG. C74. Pectinidae (Camptonectes Group) (1-3); Group Uncertain (4) (p. N351-N352).

E. A. SMITH, = *Amussium torresi* E. A. SMITH, 1885); *Squamamussium* OYAMA, 1944 (type, *Amusium squamigerum* E. A. SMITH, 1885, = *Amussium squamigerum* E. A. SMITH, 1885); *Xenamussium* OYAMA, 1944 (type, *Pecten hoskynsi* FORBES, 1844); *Bathyamussium* OYAMA, 1951 (type, *Amussium jeffreysi* E. A. SMITH, 1885); *Micramussium* OYAMA, 1951 (type, *Ctenamussium siratama* OYAMA, 1951) *Polynemamussium* HABE, 1951 (type, *Pecten intuscostatus* YOKOYAMA, 1920)]. Differs from *P. (Propeamussium)* in its usually more rounded shape, lacking lateral gape, in presence of well-developed byssal notch, and in that internal ribs extend to or almost to margin; differs from *Cyclopecten* in possessing internal ribs (821a,b). *U.Cret.-Rec.*, cosmop.—FIG. C73,2a,b. \**P. (P.) duodecimlamellatum* (BRONN), Mio., Italy; 2a, RV

ext.,  $\times 4$ ; 2b, RV int.,  $\times 4$  (Depéret & Roman, 1928).—FIG. C73,2c. *P. (P.) felsinum* (FORESTI), Plio., Italy; LV ext.,  $\times 4$  (256e).

#### CAMPTONECTES GROUP

Left valve more convex than right; smooth, or with strong *Camptonectes* (divaricate striae) sculpture; large byssal notch present. ?*Trias.*, *L.Jur.-U.Cret.*

**Camptonectes** AGASSIZ in MEEK, 1864 [\**Pecten lens* J. SOWERBY, 1818; SD STOLICZKA, 1871]. Exterior sculptured with fine, oblique, divergent, curved, crenulated, commonly punctate striae and concentric lines, or raised laminae (19b, 19c, 19i). *L.Jur.-U.Cret.*, cosmop.

**C. (Camptonectes)** [= *Camptonecetes* VON TEPP-

NER, 1922 (*nom. null.*); *Camptonectes* SALISBURY, 1939 (*nom. null.*); *Camponectes* VYALOV & KOROBKOV, 1939 (*nom. null.*). Concentric sculpture of fine growth lines (19b, 19c, 19i). *L. Jur. (U. Lias.)-U. Cret. (Maastricht.)*, cosmop.

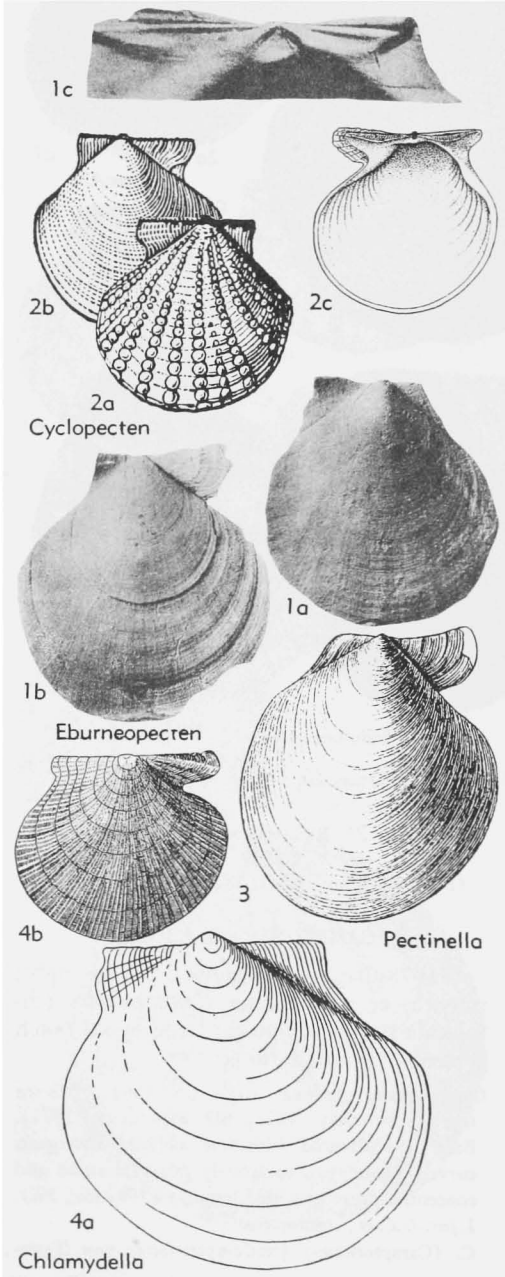


FIG. C75. Pectinidae (Eburnopecten Group) (p. N352-N354).

—FIG. C74,1. \**C. (C.) lens* (J. SOWERBY), U. Jur., Eng.; 1a, LV ext.,  $\times 1$  (Sowerby, 1818); 1b, RV ext.,  $\times 1$  (19b).

**C. (Boreionectes)** ZAHAROV, 1965 [*\*Pecten cinctus* SOWERBY, 1823; OD]. Orbicular, hinge line long, byssal notch well developed; exterior of valves smooth except for concentric grooves. *Cret. (Valangin.)*, USSR (Sib.).

**C. (Camptochlamys)** ARKELL, 1930 [*\*Pecten intertextus* ROEMER, 1839; OD]. Differing from *C. (Camptonectes)* in that weak radial riblets are crossed by concentric laminae giving rise to reticulate pattern of sculpture (19b, 19c, 19i). *Jur. (Bajoc.-Portland.)*, G. Brit. (Eng.).—FIG. C74,2. \**C. (C.) intertextus* (ROEMER), U. Jur., Eng.; 2a, b, LV ext., RV ext.,  $\times 0.5$  (19b).

?**Radulonectites** HAYAMI, 1957 [*\*R. japonicus*; OD]. Similar to *Pleuronectites* in general shell characters but differing in that it is sculptured with low, narrow, slightly wavy radial ribs which are separated by narrow grooves. [Relationship not fully known.] ?*Trias.*, Eu.; *L. Jur.*, Japan-S. Am. (Arg.).—FIG. C74,3. \**R. japonicus*, L. Jur. (Kuruma Gr.), Japan; 3a, b, LV ext., RV ext.,  $\times 1$  (Hayami, 1957).

**EBURNEOPECTEN GROUP**

Small, thin; interior without radial riblets; tcnolium present in some shells. Relationships not fully known. *U. Cret.-Rec.*

**Eburnopecten** CONRAD, 1865 [*\*Pecten scintillatus*; OD]. Valves not gaping, nearly smooth except for minute radial striae, some forms (*Micronectes*) with *Camptonectes* sculpture and with fine concentric grooves; anterior auricle larger, with radial sculpture; hinge with cardinal crura; with or without auricular crura (256d). *U. Cret.*, Japan; *Eoc.-Oligo.*; E. N. Am.

**E. (Eburnopecten)** [= *Eburnopecten* DE GREGORIO, 1898 (*nom. null.*); *Euburnopecten* TUCKER-ROWLAND, 1838 (*nom. null.*)]. Smooth except for fine lines of growth and microscopic divaricating radial striae generally restricted to marginal areas; auricular crura present on type species (256d). *Eoc.-Oligo.*, E. N. Am.—FIG. C75,1. \**E. scintillatus* (CONRAD), *Eoc.*, USA (Miss.); 1a, b, LV ext., RV ext.,  $\times 2$ ; 1c, RV hinge,  $\times 5$  (389).

**E. (Micronectes)** ICHIKAWA & MAEDA, 1958 [*\*Micronectes bellaturus*; OD]. Differs from *Eburnopecten s.s.* in presence of fine, widely spaced, incised, concentric grooves on valves and in lacking auricular crura. Relationships not well known. *U. Cret.*, Japan.

**Cyclopecten** SEGUENZA, 1877 [*\*C. peloritanus*; OD]. Small, thin, with concentric folds, apparently with radiating striae externally. Characters not fully known. *Plio.*, Italy.

**Cyclopecten** VERRILL, 1897 [\**C. pustulosus* VERRILL, 1893 (= *Pecten pustulosus* VERRILL, 1893); SD SYKES, SMITH, & CRICK, 1898]. Small, thin, not gaping, RV flexible and upturned at margin in some forms; sculptured with concentric lamellae on one valve and radial riblets or rows of pustules on other, or both valves smooth; auricles well delimited; cardinal crura single, commonly feebly developed, hinge generally bearing vertical transverse striae; byssal notch large, but few or no pectinidial teeth. *Mio.-Rec.*, cosmop.

**C. (Cyclopecten)** [= *Cyclopecten* DE GREGORIO, 1898 (*nom. null.*); *Cycloclamys* FINLAY, 1926 (*nom. null.*) (type, *Pecten transenna* SUTER, 1913)]. RV with concentric lamellae or nearly smooth, LV with radial rows of arched scales or pustules (936). *Mio.-Rec.*, cosmop.—FIG. C75, 2a,b. \**C. (C.) pustulosus*, Rec., N.Foundl.; 2a,b, LV ext., RV ext.,  $\times 2$  (936).—FIG. C75,2c. *C. (C.) simplex* VERRILL, Rec., W.Indies; RV int.,  $\times 8$  (936).

**C. (Chlamydella)** IREDALE, 1929 [\**C. favus* HED-

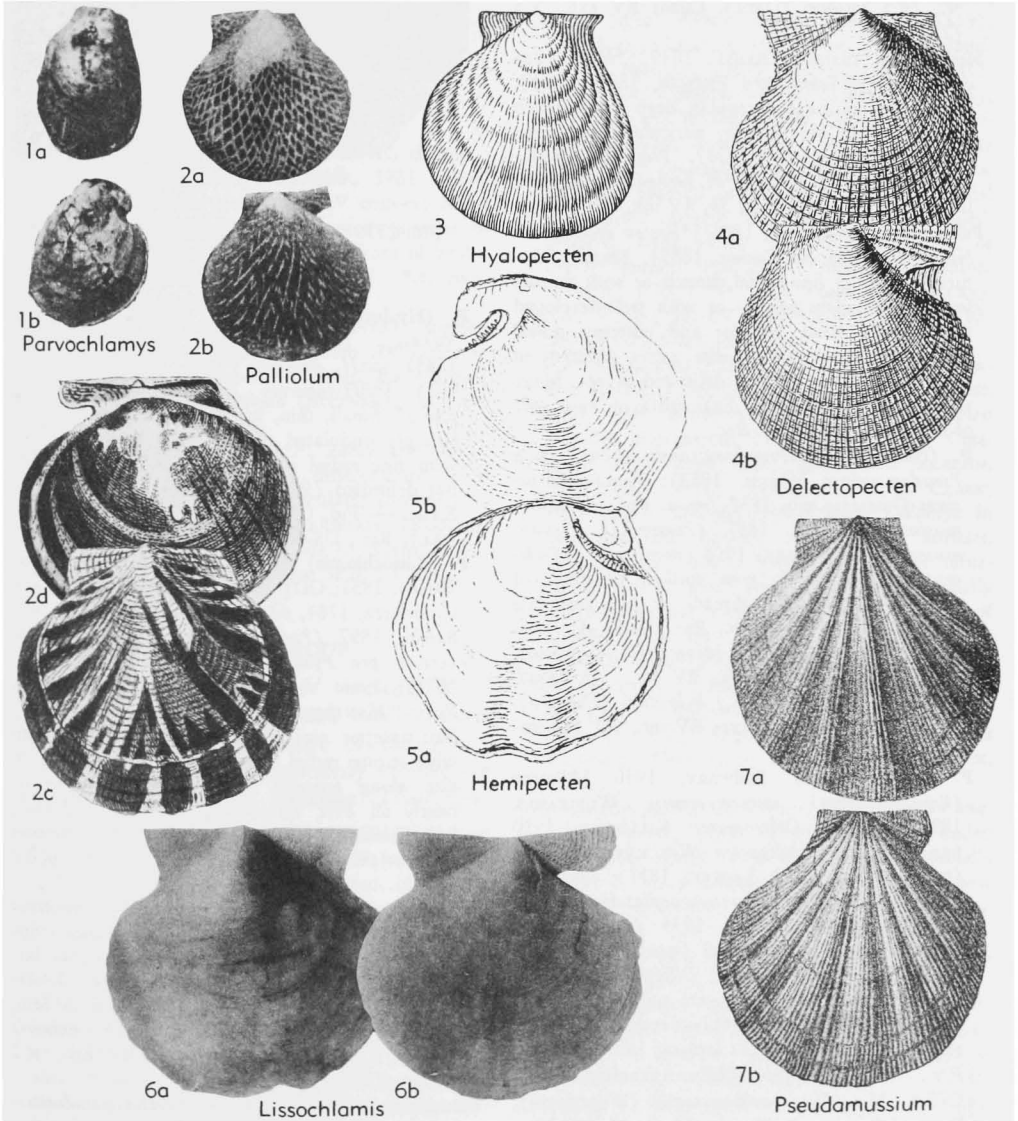


FIG. C76. Pectinidae (Eburnopecten Group) (p. N354-N355).

LEY, 1902; OD]. Differs from *C. (Cyclopecten)* in elongated (anteroposterior) form and in that RV is sculptured with fine radial riblets separated by raised scales, LV with fine concentric raised lines (802). *Rec.*, Australia.—FIG. C75,4. \**C. (C.) javus* HEDLEY; 4a,b, LV ext., RV ext.,  $\times 13$  (397).

**C. (Pectinella)** VERRILL, 1897 [\**Pecten (Pseudamussium) sigsbeei* DALL, 1886 (= *Pseudamussium sigsbeei* DALL, 1886); OD]. Auricles unequal and oblique; surface of valves smooth except for growth lines (936). *Rec.*, Carib.—FIG. C75,3. \**C. (P.) sigsbeei* (DALL), Cuba; RV ext.,  $\times 3$  (216).

**Hemipecten** ADAMS & REEVE, 1849 [\**H. forbesianus*; M] [= *Semipecten* FISCHER, 1886 (obj.)]. Attached inequivalve, irregular, deep byssal notch and ctenolium, only slightly auriculated posteriorly; hinge edentulous (936). *Plio.-Rec.*, Indo-Australia.—FIG. C76,5. \**H. forbesianus*, *Rec.*, E. Indies; 5a, RV ext.,  $\times 1.5$ ; 5b, RV int.,  $\times 1.5$  (7c).

**Palliolium** MONTEROSATO, 1884 [\**Pecten incomparabilis* RISSO, 1826; SD CROSSE, 1885]. Small, sculptured with very fine radial threads or with threads forming reticulate pattern or with well-developed threads only along anterior and posterior dorsal margins, sculpture of opposite valves different in some species; posterior ear delimited or not; hinge with 1 pair of small cardinal crura on each side of ligamental pit. *U.Eoc.-Rec.*

**P. (Palliolium)** [= *Pseudamussium* AUCTT. (non *Pseudamussium* MÖRCH, 1853); *Pseudoamussium* GEMMELLARO, 1887 (nom. null.); *Pseudamussium* VERRILL, 1897 (?emend.); *Pseudomuseum* B. L. CLARK, 1918 (nom. null.); *Palliorum* OYAMA, 1944 (nom. null.)]. Sculpture of nearly obsolete radial threads or fine reticulate pattern (793, 892). ?*Eoc., Rec.*, Medit.-Afr.—FIG. C76,2a,b. \**P. (P.) incomparabile* (Risso), *Rec.*, Medit.; 2a,b, LV ext., RV ext.,  $\times 2$  (89a). —FIG. C76,2c,d. *P. (P.) hybridum* (GMELIN), *Rec.*, W.Afr.; 2c,d, LV ext., RV int.,  $\times 1$  (Chemnitz, 1795).

**P. (Delectopecten)** STEWART, 1930 [\**Pecten (Pseudamussium) vancouverensis* WHITEAVES, 1893; OD] [= *Delectopecten* SALISBURY, 1930 (nom. null.); *Similipecten* WINCKWORTH, 1932 (type, *Pecten similis* LASKEY, 1811); *Arctinula* THIELE, 1934 (type, *Pecten groenlandicum* SOWERBY); *Aretinula* NEAVE, 1939 (nom. null.); *Catillopecten* IREDALE, 1939 (type, *Pecten murrayi* E. A. SMITH, 1885)]. Differs from *Hyalopecten* in that undulations are subdued or lacking and sculpture commonly develops reticulate pattern or may be almost lacking (892). *U.Eoc.-Rec.*, W.N.Am.-Japan-N.Eu.-Australia.—FIG. C76,4. \**P. (D.) vancouverense* (WHITEAVES), *Rec.*, Vancouver I., Can.(B.C.); 4a,b, LV ext., RV ext.,  $\times 5$  (Dall, 1921).

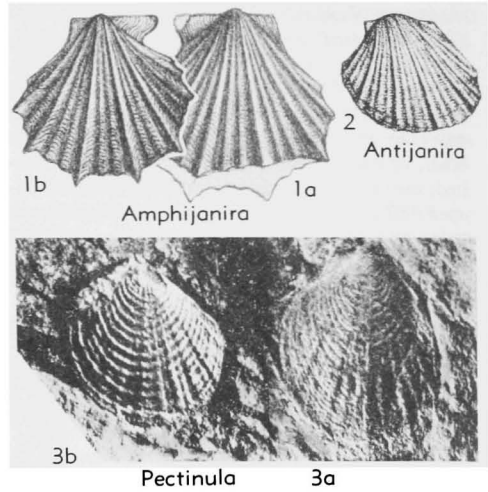


FIG. C77. Pectinidae (Antijanira Group) (p. N355).

**P. (Hyalopecten)** VERRILL, 1897 [\**H. undatus* VERRILL, 1885 (= *Pecten undatus* VERRILL, 1885) (= *H. dilectus* VERRILL & BUSH, 1897); OD] [= *Hylopecten* STEWART, 1930 (nom. null.)]. Small, thin, hyaline; valves nearly equal, strongly undulated concentrically and sculptured with fine radial striae; posterior auricle on RV not delimited (936). *L.Mio.-Rec.*, E.Atl.-W.Atl.-E.Pac.—FIG. C76,3. \**P. (H.) undatum* (VERRILL), *Rec.*, USA(Mass.); LV ext.,  $\times 1.5$  (936).

**P. (Lissochlamis)** SACCO, 1897 [\**Pecten excisus* BRONN, 1831; OD] [= *Pyxis* FORESTI, 1877 (non CHEMNITZ, 1784, non BELL, 1827); *Lissochlamis* SACCO, 1897 (?emend.); *Pixis* UGOLINI, 1906 (errore pro *Pyxis* MENEGHINI in DE STEFANI, 1878); *Pyxis* VON TEPNER, 1922 (errore pro *Pyxis* "MENEGHINI")]. LV convex, RV nearly flat; anterior auricle longer than posterior, both with strong radial riblets which are variable in size along anterior and posterior portions or nearly all over valves (821a,b). *U.Mio.-L.Plio.*, Italy-France.—FIG. C76,6. \**P. (L.) excisum* (BRONN), *L.Plio.*, 6a,b, LV ext., RV ext.,  $\times 0.7$  (821a).

**P. (Parvochlamys)** SACCO, 1904 [\**Parvochlamys oolaevis*; OD]. Somewhat ovoid in shape, sculptured only with radiating riblets on upper lateral areas; right anterior auricle short. [Relationship not well known (821a,b).] *M.Mio. (Helvet.)*, Italy.—FIG. C76,1. \**P. (P.) oolaevis* (SACCO); 1a, LV ext.,  $\times 4$ ; 1b, RV ext.,  $\times 3$  (Sacco, 1904).

**Pseudamussium** MÖRCH, 1853 [\**Pecten pseudamussium* CHEMNITZ, 1784 (= *Pecten septemradiatus* MÜLLER, 1776); ICZN] [= *Pseudamussium* KLEIN,

1753 (pre-Linnean); *Peplum* BUCQUOY, DAUTZENBERG & DOLLFUS, 1889 (type, *Ostrea clavata* POLI, 1795); *Platipecten* MONTEROSATO, 1889 (type, *Pecten subclavatus* CANTRAINE, 1835)]. Small, RV more convex than LV, hinge lines short, auricles unequal; entire valve sculptured with radial riblets of variable strength and whole folded into several broad radial corrugations (802, 892). *M.Mio.*, Iran; *U.Mio.-Rec.*, Eu.; *Rec.*, E.Pac.—FIG. C76, 7. \**P. septemradiatum* (MÜLLER), Plio., Sicily; 7a,b, LV ext., RV ext.,  $\times 1$  (Philippi, 1900).

#### ANTIJANIRA GROUP

Approximately every third or fourth rib larger than others, sculpture of radial ribs and concentric imbrications; reticulate as in *Pectinula*. *U.Trias.-L.Jur.*

**Antijanira** BITTNER, 1901 [\**Pecten* (*A.*) *hungaricus*; M] [= *Antijanirula* BITTNER, 1901 (*nom. null.*)]. RV flat or nearly so, LV convex; about every third radial rib of LV raised (similar to *Neithea*); lanciform area mostly in front of beaks. *U.Trias.*, Eu.(Hung.).—FIG. C77,2. \**A. hungarica* (BITTNER); LV ext.,  $\times 1$  (61).

**Amphijanira** BITTNER, 1901 [\**Pecten janirula* BITTNER, 1895; OD]. Differs from *Antijanira* in that both valves are convex. *U.Trias.*, Eu.(Hung.).—FIG. C77,1. \**P. janirula* (BITTNER); 1a,b, LV ext., RV ext.,  $\times 3$  (58).

**Pectinula** LEANZA, 1943 [\**P. cancellata*; OD]. Small, auricles smooth and differentiated from shell by groove; sculpture reticulate; convexity of valves and hinge characters unknown. [Relationship unknown.] *L.Jur.(M.Lias.)*, S.Am.(Arg.).—FIG. C77,3. \**P. cancellata*; 3a,b, LV ext., RV ext.,  $\times 1.5$  (Leanza, 1943).

#### CHLAMYS GROUP

Both valves convex, LV usually more than RV; with large byssal notch below right anterior ear; sculpture of radial elements fine to coarse, commonly crossed by concentric imbricating lamellae. *Trias.-Rec.*

**Chlamys** RÖDING, 1798 [non KOCH, 1801] [\**Pecten islandicus* MÜLLER, 1776; SD HERRMANNSEN, 1847]. Higher than long or rounded, commonly somewhat oblique; LV usually more convex but in some species valves nearly equally convex; auricles clearly delimited, usually large; byssal notch large; ctenolium usually present; sculpture of radial (usually stronger) and concentric elements, with scalcelike spines commonly developed at their junctions, especially on LV but some shells nearly smooth; interspaces of many forms with intercalaries in adult; margin usually scalloped; cardinal crura variable in number and size. *Trias.-Rec.*, cosmop.

**C. (Chlamys)** [= *Clamys* LEACH, 1815 (*nom. null.*); *Chalmys* DOLLFUS & DAUTZENBERG, 1886 (*nom. null.*); *Actinochlamys* ROVERETO, 1898 (type, *Chlamys virgulata* ROVERETO, 1898); *Myochlamys* VON IHERING, 1907 (obj.) (pro *Chlamys* BOLTEN, 1898, non KOCH, 1801); *Chlamydina* COSSMANN, 1907 (obj.) (pro *Myochlamys* VON IHERING, 1907, non FAIRMAN, 1876); *Zygochlamys* VON IHERING, 1907 (type, *Pecten geminatus* G. B. SOWERBY, 1896); *Belchlamys* IREDALE, 1929 (type, *Pecten aktinos* PETTERD, 1886); *Mimachlamys* IREDALE, 1929 (type, *Pecten asperimus* LAMARCK, 1819); *Scaechlamys* IREDALE, 1929 (type, *Pecten lividus* LAMARCK, 1819); *Talochlamys* IREDALE, 1929 (type, *Chlamys famigerator* IREDALE, 1925); *Veprichlamys* IREDALE, 1929 (type, *Chlamys perillustris* IREDALE, 1925); *Coralichlamys* IREDALE, 1939 (type, *C. acroporicola*). Usually higher than long, anterior auricle longer than posterior one; sculpture of numerous, generally grooved or striated and spinose, radial ribs; inner margin commonly with rounded, grooved, weak riblets; cardinal crura weak or nearly obsolete (19b,c,i). *Trias.-Rec.*, cosmop.—FIG. C78,5. \**C. (C.) islandica* (MÜLLER), *Rec.*, N.Atl.; 5a, LV ext.,  $\times 0.5$  (Gould, 1870); 5b, RV ext.,  $\times 0.2$  (829).

**C. (Acquiptecten)** FISCHER, 1886 [\**Ostrea opercularis* LINNÉ, 1758; M] [= *Amoebea* FONTANNES, 1878 (non EHRENBERG, 1830) (type, *Pecten amoebeus* FONTANNES, 1878); *Aequiptectus* COSSMANN, 1910 (*nom. null.*); *Aequivalvis* JEKELIUS, 1915 (*nom. null.*); *Equiptecten* B. L. CLARK, 1929 (*nom. null.*)]. Differs from *Chlamys* in more rounded outline, nearly equal auricles, smaller byssal notch, fewer, usually not bifurcating radial ribs, and flattened, marginally pointed internal riblets near margin; pair of cardinal crura and auricular denticles (or weak auricular crura) present (19b,c,i, 219). [Probably polyphyletic.] ?*U.Jur.*, *L.Cret.-Rec.*—FIG. C78, 7. \**C. (A.) opercularis* (LINNÉ), *Rec.*, France; RV ext.,  $\times 0.7$  (Chenu, 1844). [= *Merklinia* SOBETSKY, 1960 (type, *Pecten asper* LAMARCK, 1819).]

**C. (Anatipoecten)** HERTLEIN, 1936 [\**Pecten anatipes* MORTON, 1833; OD]. About 5 rounded radial ribs which with interspaces are radially threaded; byssal notch small; hinge with coarse cardinal crura (802). *Oligo.-Plio.*, N.Am.—FIG. C78,2. \**C. (A.) anatipes* (MORTON), *Oligo.* (Vicksburg F.), USA (Miss.); 2a, LV ext.,  $\times 1$  (Cooke, 1926); 2b, RV ext.,  $\times 2$  (802).

**C. (Annachlamys)** IREDALE, 1939 [\**Pecten leopardus* REEVE, 1853; OD]. Differs from *Equichlamys* in narrower, more numerous ribs and in lacking radial threads. *Mio.-Rec.*, Eurasia (Tethyan)-Australia.—FIG. C78,6a,b. *C. (A.) kuhnholtzi* (BERNARDI), *Rec.*, New Caledon.; 6a,b, RV ext., portion LV int.,  $\times 0.6$  (Bernardi,



1860).—FIG. C78,6c. \**C. (A.) leopardus* (REEVE), Rec., Australia; LV ext.,  $\times 0.42$  (Reeve, 1853).

**C. (Antipeecten)** COSSMANN & PEYROT, 1914 [\**C. sacyi*; OD]. RV nearly flat, LV convex; auricles very large, hinge line oblique (793). *Mio.*(*Bur-*

*digal.-Helvet.*), Eu.(France).—FIG. C78,3. \**C. (A.) sacyi*, Burdigal.; 3a,b, LV, RV ext.,  $\times 0.7$  (Cossmann & Peyrot, 1914).

**C. (Argopecten)** MONTEROSATO, 1899 [\**Pecten solidulus* REEVE, 1853; OD] [= *Plagiocentrum* DALL, 1898 (type, *Pecten ventricosus* SOWERBY,

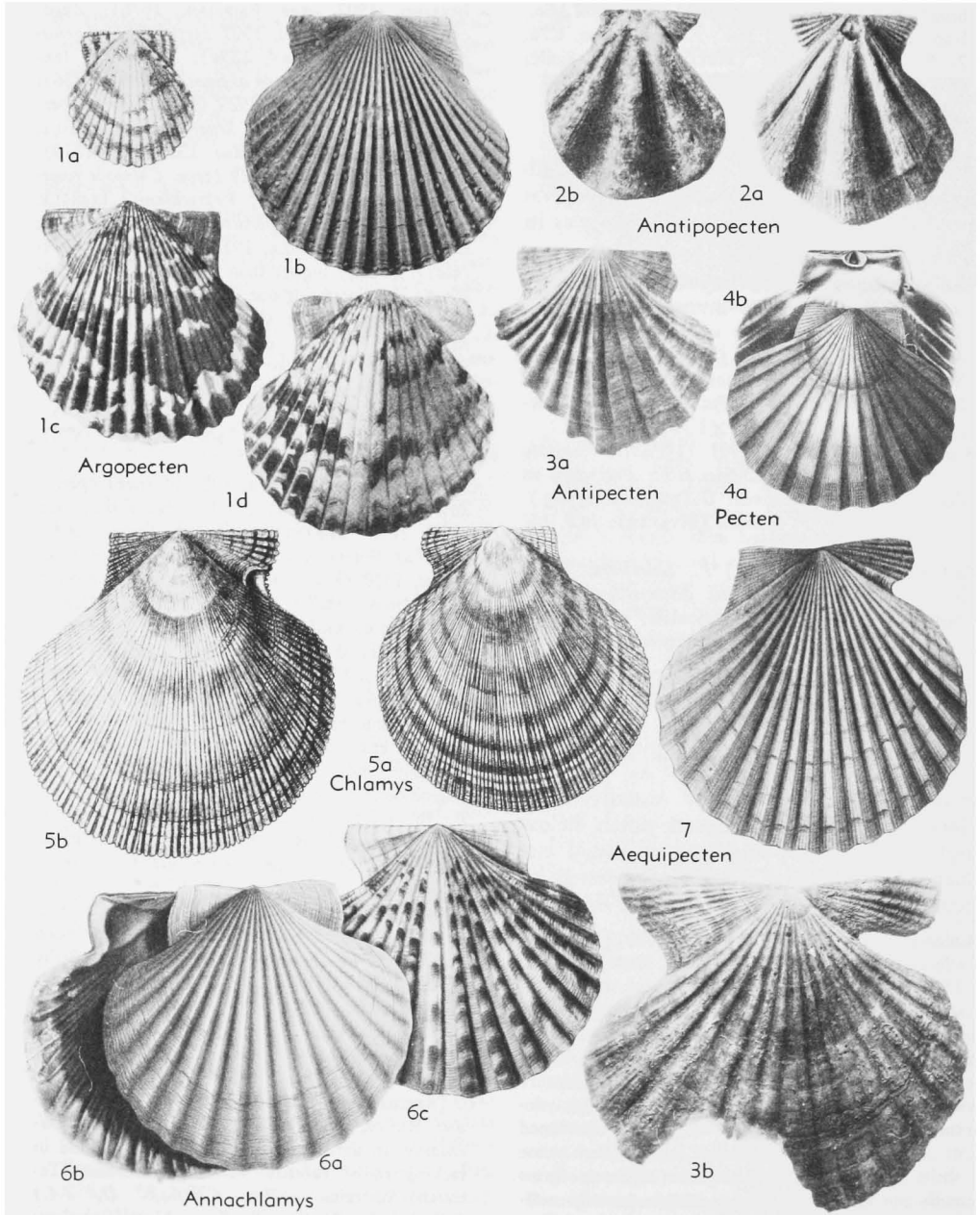


FIG. C78. Pectinidae (Chlamys Group) (p. N355-N357).



- 1842, *nom. nov. pro Pecten tumidus* SOWERBY, 1835, *non* DUJARDIN, 1832, *nec* HARTMANN in ZIETEN, 1833, =*P. circularis* SOWERBY, 1835); *Plagiopecten* G. D. HANNA, 1924 (*nom. null.*); *Plagiopectenium* STEWART, 1930 (*nom. null.*); *Haumea* DALL, BARTSCH & REHDER, 1938 (type, *H. juddi*); *Corymbichlamys* IREDALE, 1939 (type, *Chlamys corymbiatus* HEDLEY, 1909); *Vola-chlamys* IREDALE, 1939 (type, *Pecten cumingii* REEVE, 1853)]. Differs from *Aequipecten* in more highly and nearly equally inflated valves, lacking secondary radial riblets and with larger auricles; concentric sculpture in looped lamellae; with tendency to oblique growth in adult stage (256a-e). *L.Mio.-Rec.*, cosmop. (tropic, subtropic, warm temperate).—FIG. C78,1a. \*C. (*A.*) *solidula* (REEVE), *Rec.*, ?loc.(unknown); 1a, LV ext.,  $\times 1$  (Reeve, 1853).—FIG. C78,1b. C. (*A.*) *gibba* (LINNÉ), *Rec.*; 1b, LV ext.,  $\times 1$  (Perry & Schwengel, 1940).—FIG. C78,1c,d. C. (*A.*) *circularis* (SOWERBY) (type of *Plagiopectenium*), *Rec.*, Gulf Calif.; 1c,d, LV ext., RV ext.,  $\times 0.7$  (Arnold, 1906).
- C. (*Athlopecten*) MARWICK, 1928 [*\*Pecten athleta* ZITTEL, 1864; OD]. Large; RV with low rounded radial ribs, LV with twice as many ribs which are narrower, paired, and imbricated; hinge almost smooth (593). *M.Oligo.*, N.Z.—FIG. C79,4. \*C. (*A.*) *athleta* (ZITTEL); LV ext.,  $\times 0.3$  (Zittel, 1864).
- C. (*Cryptopecten*) DALL, BARTSCH & REHDER, 1938 [*\*C. alli*; OD] [= *Gloripallium* IREDALE, 1939 (type, *Ostrea pallium* LINNÉ, 1758)]. Major ribs and interspaces sculptured with radial riblets covered with fluted scales; cardinal crura present; *Mio.-Rec.*, IndoPac.—FIG. C79,1a. \*C. (*C.*) *alli*, *Rec.*, Hawaii; 1a,b, LV ext., RV ext.,  $\times 1.5$  (Dall, Bartsch & Rehder, 1938).—FIG. C79,1c. C. (*C.*) *pallium* (LINNÉ) (type of *Gloripallium*), *Rec.*, W.Pac.; LV ext.,  $\times 0.5$  (124).
- C. (*Duplipecten*) MARWICK, 1928 [*\*Pecten waihaensis* SUTER, 1914; OD]. Equivalve, gaping; auricles subequal, byssal notch well developed but no ctenolium; RV almost smooth, LV sculptured with faint, well-spaced radial ribs (593). *L.Eoc.-M.Eoc.*, N.Z.—FIG. C79,5. \*C. (*D.*) *waihaensis* (SUTER), *M.Eoc.* (Barton.); 5a,b, LV ext. (lectotype), RV ext.,  $\times 0.7$  (Suter, 1917).
- C. (*Equichlamys*) IREDALE, 1929 [*\*Pecten bifrons* LAMARCK, 1819; OD]. LV more convex than RV, auricles nearly equal, byssal notch small, ctenolium nearly obsolete in adult stage; with 7 to 9 ribs which grade into broad flattened folds of shell, whole covered with fine radial threads; interior with radial ridges corresponding to major ribs. *L.Plio.-Rec.*, W.Pac.—FIG. C79,3. \*C. (*E.*) *bifrons* (LAMARCK), *Rec.*, Australia; 3a,b, LV ext., RV ext.,  $\times 0.4$ ; 3c, RV int.,  $\times 0.4$  (Chenu, 1844).
- C. (*Flexopecten*) SACCO, 1897 [*\*Ostrea flexuosa* POLI, 1795; OD] [= *Glabropecten* SACCO, 1897; *Lissopecten* VERRILL, 1897 (type, *Ostrea hyalina* POLI, 1795); *Proteopecten* MONTEROSATO, 1899 (type, *Pecten proteus* SOLANDER in DILLWYN, 1817); *Flexipecten* OPPENHEIM, 1903 (*nom. null.*)]. Rounded, RV more convex than LV; several rather broad, plicate, radial ribs, hinge with single pair of cardinal lamellae on each side of ligamental pit (821a,b). *M.Mio.(Helvet.)-Rec.*, *Medit.*; *Plio.*, Iran; *Quat.*, E.Afr.—FIG. C79,2. \*C. (*F.*) *flexuosa* (POLI), *Rec.*, *Medit.*; 2a,b, RV ext., LV ext.,  $\times 1$  (Chenu, 1844).
- C. (*Hilberia*) VON TEEPNER, 1922 [*\*Pecten söl-lingensis* VON KOENEN, 1868; OD]. RV more arched than LV, auricles large; radial ribs numerous, fine, those on RV wider than on LV (793, 906). *Eoc.-M.Mio.(Helvet.)*, N.Eu.—FIG. C80,1. \*C. (*H.*) *soellingensis* (VON KOENEN), *M.Oligo.*, Ger.; 1a,b, LV ext., RV ext.,  $\times 0.7$  (von Koenen, 1868).
- C. (*Juxtamusium*) IREDALE, 1939 [*\*J. oblectatum*; OD]. Thin, compressed, equivalve, gaping slightly at sides; auricles unequal; sculpture of fine radial striae, nearly obsolete on LV, crossed by microscopic concentric striae; internal margin, only, ribbed. *Rec.*, Australia.—FIG. C80,4. \*C. (*J.*) *oblectata* (IREDALE); 4a,b, LV ext., RV hinge,  $\times 1.5$  (437).
- C. (*Kaparachlamys*) BOREHAM, 1965 [*\*Pecten hectori* HUTTON, 1873; OD]. Resembles *C. (Placopecten)* but probably derived from *Phialopecten*. *Plio. (Opoitian Waitotaran-L.Nukumaruan)*, N.Z.
- C. (*Leochlamys*) MACNEIL, 1967 [*\*C. (L.) tugidakensis*; OD]. Differs from *C. (Chlamys)* in longer anterior auricle, deep, broad byssal notch, and coarse, usually spinose ribs. ?*Jur.-Cret.*, W. Eu.; *Mio.*, ?Alaska-W.Can.-Japan-Medit.-E.Atl.; *Plio.*, Alaska-Sakhalin-Japan-Pak.-Eng.; *Pleist.-Rec.*, Japan-?Eng.
- C. (*Leptopecten*) VERRILL, 1897 [*\*Pecten monotimeris* CONRAD, 1837; OD]. Small, thin, very oblique, shell corrugated to form broad radial folds; cardinal crura small, hinge plate crossed by fine transverse grooves (219, 936). *Mio.-Rec.*, N.Am.-S.Am.—FIG. C80,2. \*C. (*L.*) *monotimeris* (CONRAD); *Rec.*, Calif.; 2a,b, LV ext., RV ext.,  $\times 1.5$  (Oldroyd, 1924).
- C. (*Lyropecten*) CONRAD, 1862 [*\*Pallium estrellanum* CONRAD, 1856; SD DALL, 1898] [= *Lyropectin* CONRAD, 1863 (*nom. null.*); *Liropecten* GABB, 1869 (*nom. null.*)]. Large, thick, nearly equivalve, some shells with concentric undulations; auricles nearly equal, byssal notch well developed; radial ribs undivided, entire surface covered with radial striae; hinge with 2 or 3 pairs of coarse cardinal crura (219). *L.Mio.-M.Plio.*, E. Pac.-?W.Atl.—FIG. C80,3a-c. \*C. (*L.*) *estrellana* (CONRAD), U.Mio., USA(Calif.); 3a,b, LV ext., LV int.,  $\times 0.5$ ; 3c, RV ext.,  $\times 0.6$  (Arnold,

1906).—FIG. C80,3d. *C. (L.) crassicardo* (CONRAD), U.Mio., USA (Calif.); RV ext.,  $\times 0.3$  (Arnold, 1906).

**C. (Macrochlamys)** SACCO, 1897 (June) [*Ostrea latissima* BROCCHI, 1814; OD] [=*Macrochlamys* SACCO, 1897 (Dec.) (non *Macrochlamys* BENSON, 1832) (obj.); *Oopecten* SACCO, 1897 (type, *Pecten rotundatus* LAMARCK, 1819); *Machrochlamys* DE GREGORIO, 1898 (nom. null.); *Giganto-*

*pecten* ROVERETO, 1899 (pro *Macrochlamys* SACCO, 1897, non BENSON, 1832) (obj.); *Inaequipecten* UGOLINI, 1906 (type, *Pecten tournali* DE SERRES, 1829); *Grandipecten* COSSMANN & PEYROT, 1914 (pro *Machrochlamys* SACCO, 1897, non BENSON, 1832) (obj.)]. Differs from *C. (Lyropecten)* in that the LV usually more convex than RV (but this character variable), byssal notch shallower and cardinal crura weaker

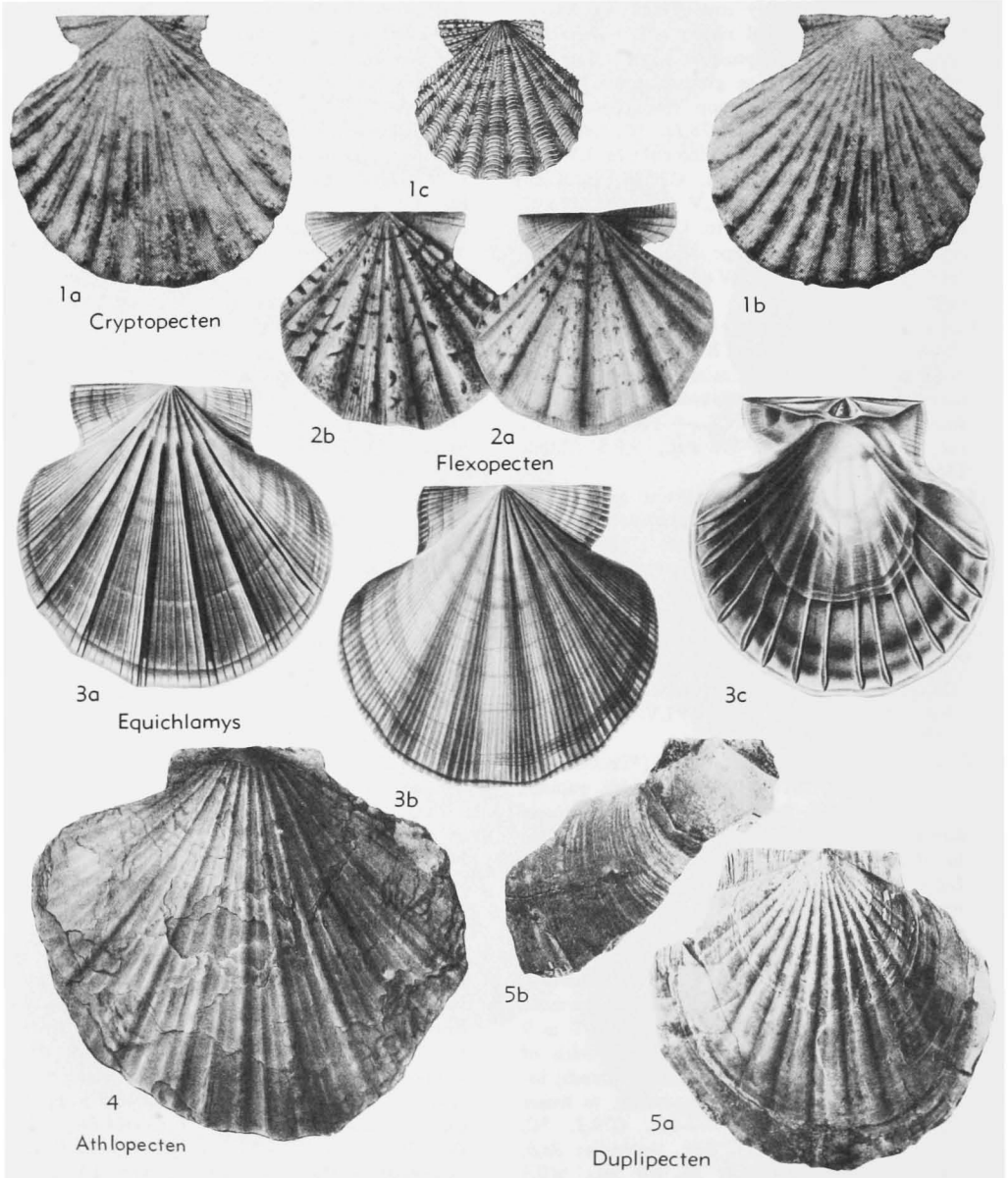


FIG. C79. Pectinidae (Chlamys Group) (p. N357).

(821a,b). *Oligo.(Tongr.)-Plio.*, Eurasia(Tethyan); ?*Mio., Plio.*, W.Atl.—FIG. C81,I. \**C. (M.) latissima* (BROCCHI), *Plio.(Ast.)*, Italy; 1a,b, LV ext., RV ext.,  $\times 0.3$ ; 1c, RV int.,  $\times 1$  (821a).

**C. (Manupecten)** MONTEROSATO, 1889 [\**Ostrea pes-felis* LINNÉ, 1758; SD SACCO, 1897] [= *Felipes* LOCARD in CARUS, 1889]. Elongated (beak to base); with few coarse, elevated radial ribs which, with interspaces, are sculptured by numerous, small riblets; cardinal margin of some shells

strongly crenulated with tubercles (821a,b). *M. Mio.(Helvet.)-Rec.*, Medit.—FIG. C82,2. \**C. (M.) pesfelis* (LINNÉ), *Rec.*; 2a,b, LV ext., LV int.,  $\times 0.5$  (Chenu, 1844).

**C. (Mixtopecten)** MARWICK, 1928 [\**Pecten (Aequipecten) amuriensis* WOODS, 1917; OD] [= *Mixtopecten* TUCKER-ROWLAND, 1938 (*nom. null.*)]. Small, RV almost flat, left convex, auricles large, byssal notch deep; RV with few weak radial ribs at extremities, LV having many narrow, primary ribs with secondaries in interspaces

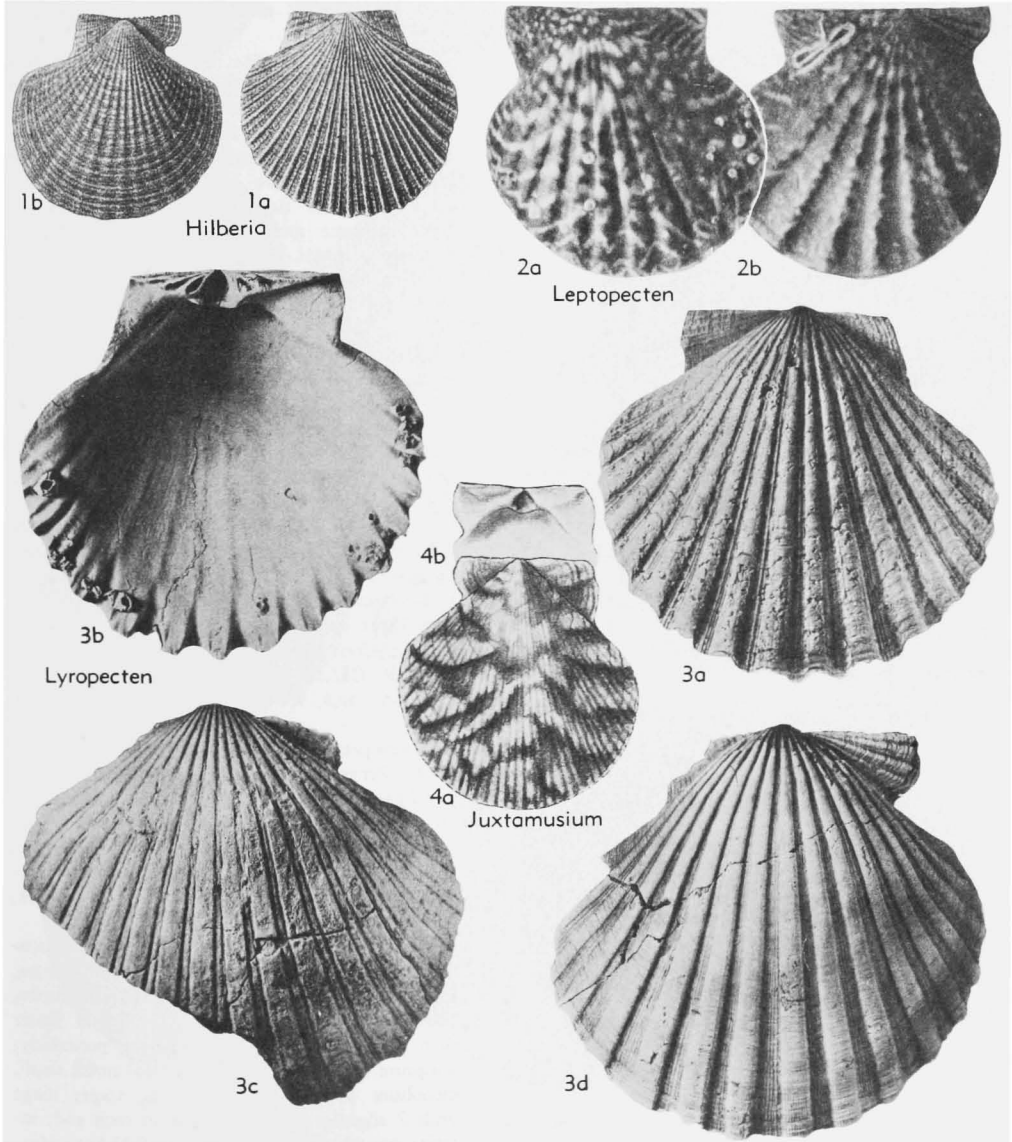


FIG. C80. Pectinidae (Chlamys Group) (p. N357).

(593). *U.Cret.*, N.Z.—FIG. C82,3. \**C. (M.) amuriensis* (WOODS), Pirapauan; 3*a,b*, LV ext., RV ext.,  $\times 1.5$  (WOODS, 1917).

**C. (Miyagipecten)** MASUDA, 1952 [\**M. matsumoriensis*; OD]. Differs from *C. (Placopecten)* in

that RV has only concentric sculpture, radial sculpture on LV weak; in stronger cardinal crura, and in lacking ctenolium in young stage. *M.Mio.*, Japan.—FIG. C82,4. \**C. (M.) matsumoriensis* (MASUDA); 4*a*, LV ext.,  $\times 0.5$  (53); 4*b*, RV ext.,  $\times 0.5$  (Masuda, 1952).

**C. (Nanaochlamys)** HATAI & MASUDA, 1953 [\**Pecten notoensis* YOKOYAMA, 1929; OD]. Differs from *C. (Swiftopecten)* in having more numerous, bifid ribs, shorter anterior ear, and more rounded outline. *M.Oligo.-Mio.*, Japan.—FIG. C82,1. \**C. (N.) notoensis* (YOKOYAMA); 1*a,b*, RV ext., LV ext.,  $\times 0.8$  (Hatai & Masuda, 1953).

**C. (Nodipecten)** DALL, 1898 [\**Ostrea nodosa* LINNÉ, 1758; OD] [= *Nodopecten* OLSSON, 1914 (*nom. null.*); *Neodipecten* VON TEPFNER, 1922 (*nom. null.*)]. Differs from *C. (Lyropecten)* in that ribs are intermittently nodose (hollow nodes) and posterior auricle is smaller than anterior; ctenolium well developed; imbricated surface layer in some species very marked (219). *M.Mio.-Rec.*, E.Atl.-W.Atl.; *Plio.-Rec.*, W.N.Am.—FIG. 41,1. \**C. (N.) nodosa* (LINNÉ), Rec., W.Atl.(off Fla.); 1*a*, LV,  $\times 0.45$ ; 1*b*, RV,  $\times 0.45$  (Chenu, 1844).

**C. (Pacipecten)** OLSSON, 1961 [\**Pecten tumbezensis* D'ORBIGNY, 1846; OD]. Differs from *C. (Leptopecten)* in its more equilateral form, presence of auricular crura, and thicker shell. *U.Mio.-Rec.*, E.Pac.—FIG. C82,6. \**C. (P.) tumbezensis* (D'ORBIGNY), Rec., off Peru; 6*a,b*, LV ext., RV ext.,  $\times 1$  (688).

**C. (Pethopecten)** HERTLEIN, 1936 [\**Pecten (Chlamys) szerémensis* PETHÖ, 1896; OD]. Shell oblique, hinge line short; sculpture of about 10 broad round corrugated ribs which on dorsal area bear short spines, interspaces with fine, spinose riblets. *Cret. (Cenoman.-Senon.)*, Eu. (Hung.).—FIG. C82,5. \**C. (P.) szerémensis* (PETHÖ), U.Senon.; 5*a,b*, RV ext., LV ext.,  $\times 0.7$  (Pethö, 1906).

**C. (Phialopecten)** MARWICK, 1928 [\**Pecten triphooki* ZITTEL, 1864; OD]. Differs from *C. (Sectipecten)* in its flatter RV and more numerous, narrower ribs which form radial ridges rather than folds of shell (593). *L.Plio.-M.Plio.*, N.Z.—FIG. C82,7. \**C. (P.) triphooki* (ZITTEL), *L.Plio.*; 7*a*, LV ext.,  $\times 0.5$  (Marwick, 1948); 7*b*, RV ext.,  $\times 0.5$  (Zittel, 1864).

**C. (Placopecten)** VERRILL, 1897 [\**Pecten clintonius* SAY, 1824; OD] [= ?*Nipponopecten* MASUDA, 1962 (type, *Pecten akihoensis* MATSUMOTO, 1930)]. Large, compressed, RV slightly flatter than LV, gaping both anteriorly and posteriorly; sculpture of fine radial riblets; byssal notch small, ctenolium present only in young stage; hinge with 2 slightly divergent crura on each end; interior smooth (936). *L.Mio.-Rec.*, E.N.Am.; *Mio.*, ?Japan.—FIG. C83,4. \**C. (P.) clintonia*

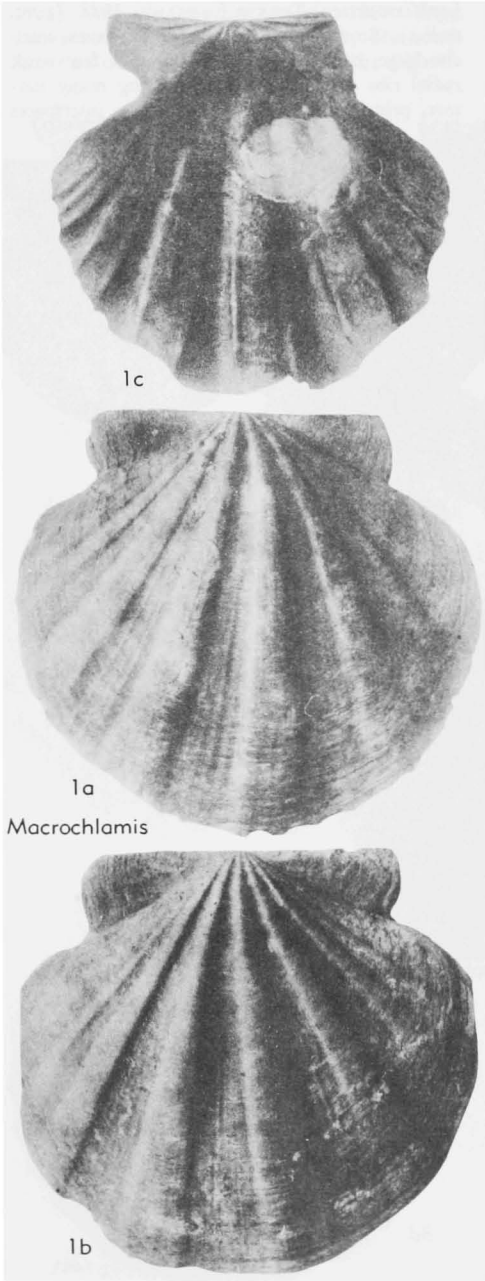


FIG. C81. Pectinidae (Chlamys Group) (p. N358).

(SAY); 4a, LV ext., Mio., USA(Md.),  $\times 0.4$  (Glen, 1904); 4b, RV ext., Mio., USA(Va.),  $\times 0.4$  (Tucker-Rowland, 1938).

C. (Radiopecten) STEPHENSON, 1941 [*\*Pecten weeksi* STEPHENSON, 1941; OD]. Valves slightly convex, LV (upper) more so than RV; auricles

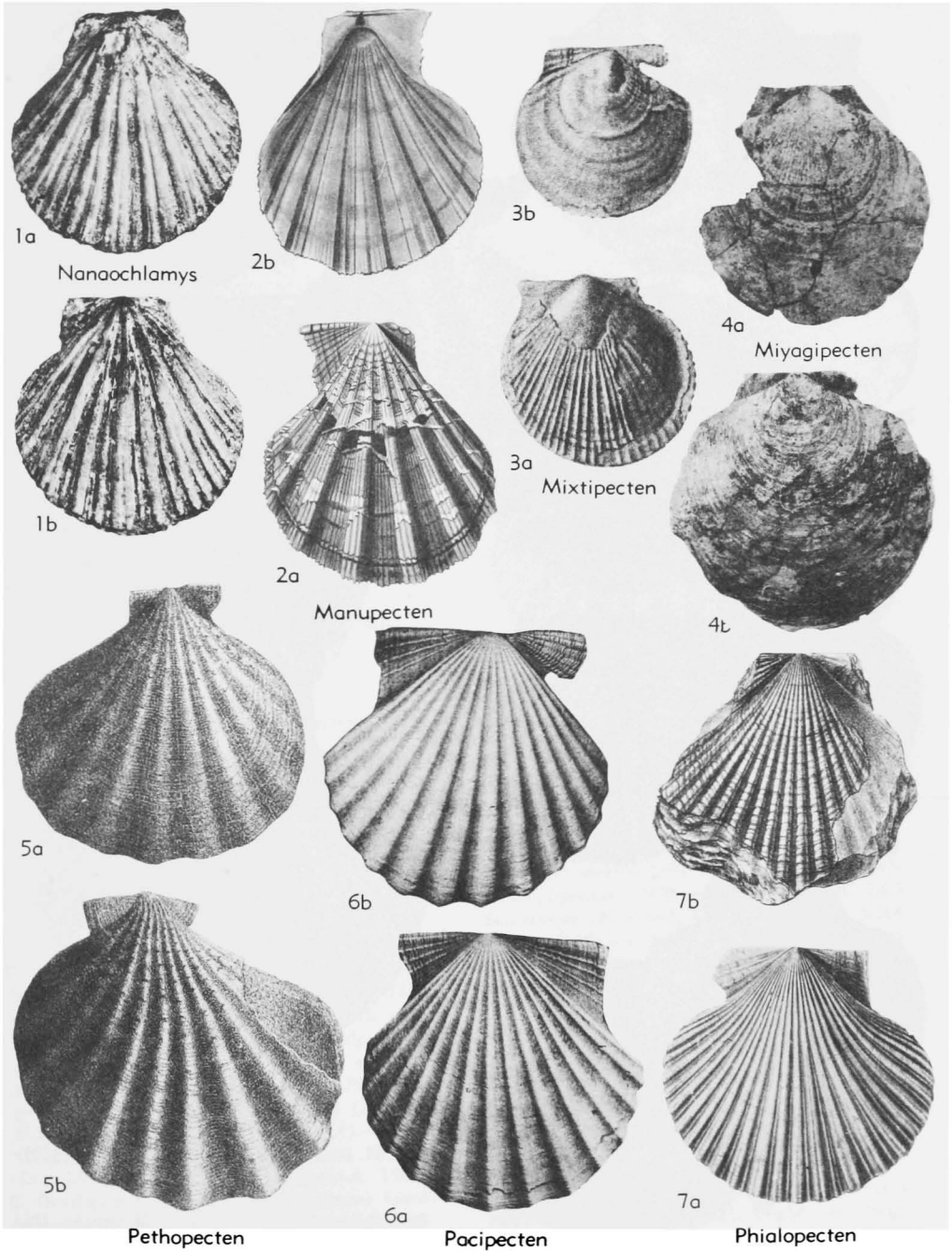


FIG. C82. Pectinidae (Chlamys Group) (p. N359-N360).

subequal; about 5 or 6 broad, rounded ribs on RV, entire surface grooved, giving rise to about 30 radial ribs, those on LV narrow and sharp. *U. Cret.*(*Senon.*), E. N. Am.-Eu.—FIG. C83,3.

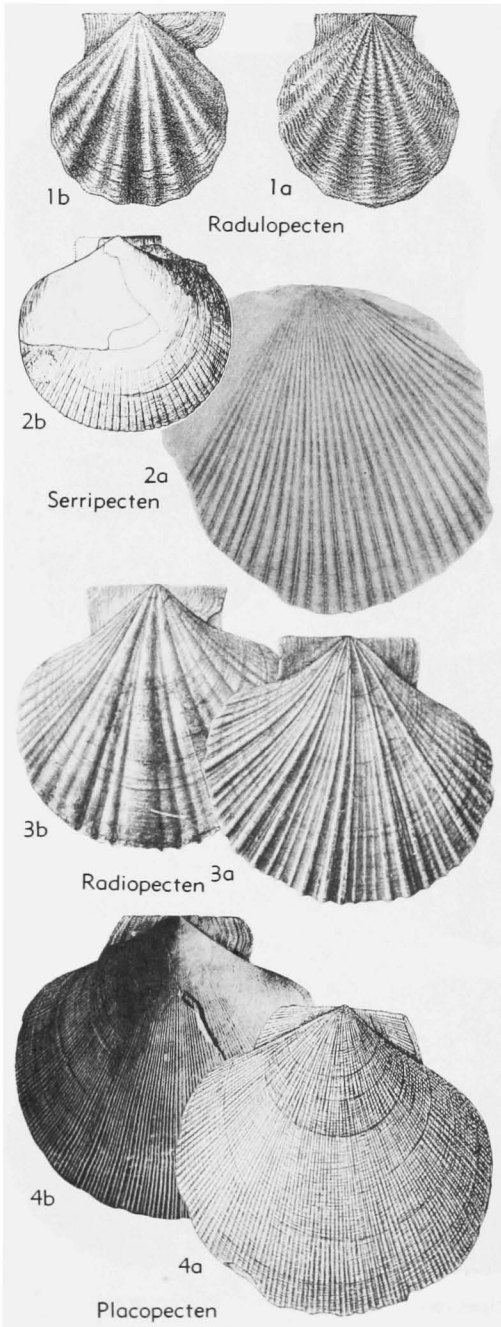


FIG. C83. Pectinidae (Chlamys Group) (p. N360-N363).

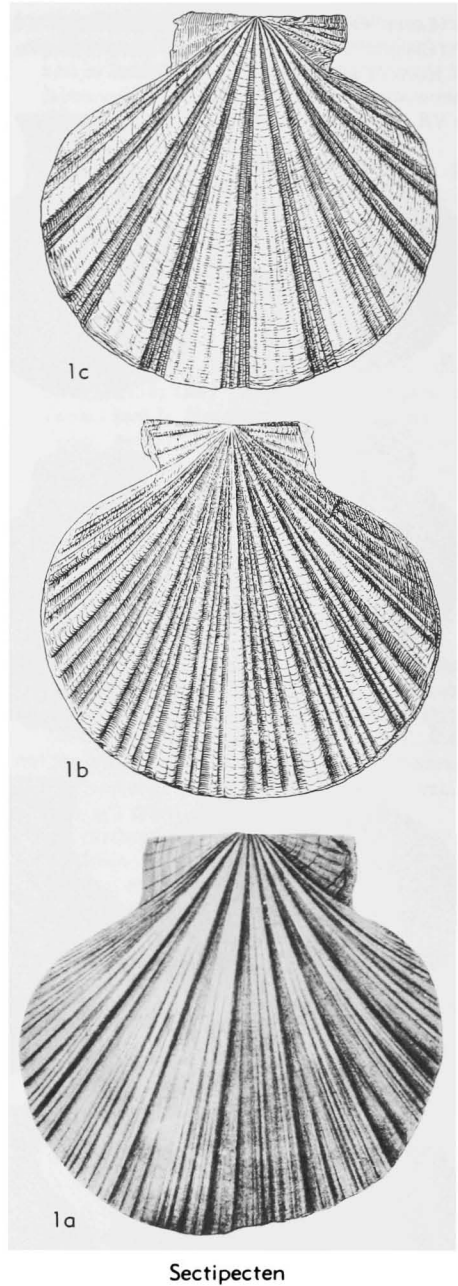


FIG. C84. Pectinidae (Chlamys Group) (p. N363).

\**C. (R.) weeksi* (STEPHENSON), Maastricht, USA (Tenn.); 3a,b, LV ext., RV ext.,  $\times 0.7$  (951).  
*C. (Radulopecten) ROLLIER*, 1911 [*\*Pecten hemi-costatus* MORRIS & LYCETT, 1853; OD]. LV flatter than RV, which bears 5 pairs of twinned ribs,



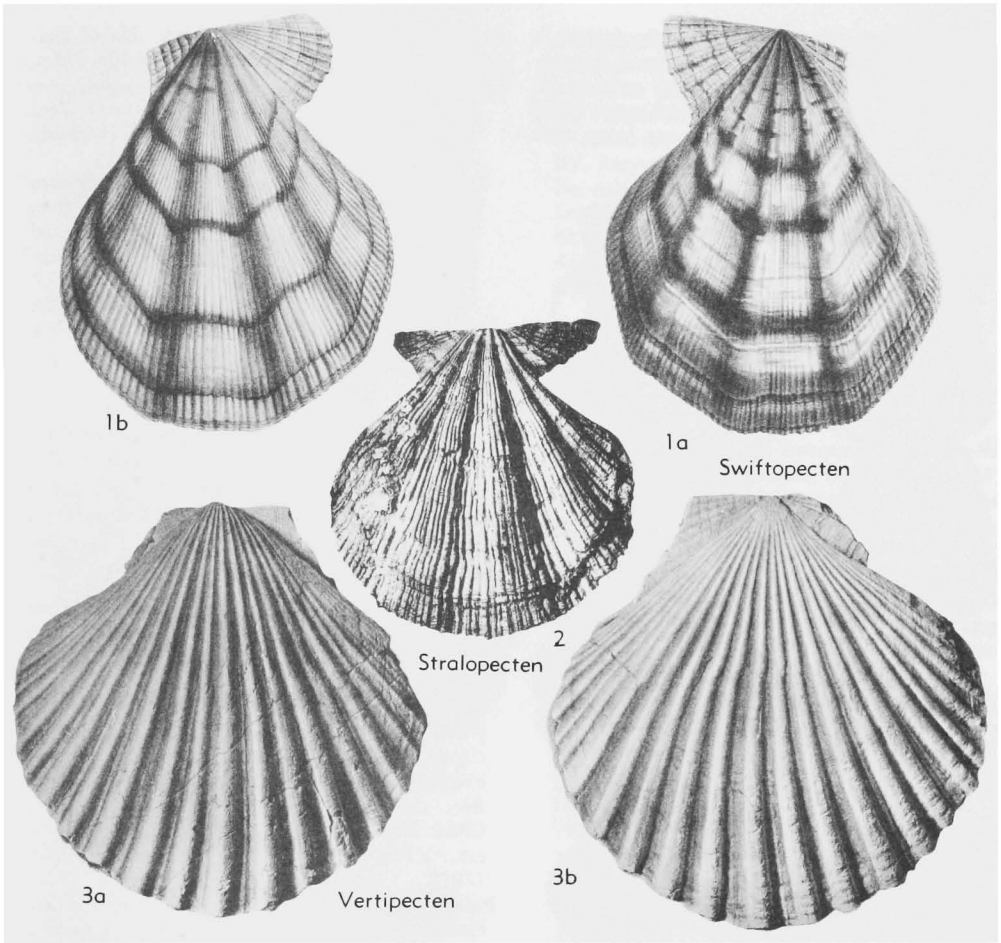


FIG. C85. Pectinidae (Chlamys Group) (p. N363-N364).

LV with 5 squamose ribs corresponding to sulci of opposite valve (193). *Jur.(Bajoc.-Tiathon.)*, Eurasia (Tethyan). — FIG. C83,1. \**C. (R.) hemicostata* (MORRIS & LYCETT), Bathon., Eng.; 1a,b, LV ext., RV ext.,  $\times 1$  (Philippi, 1900).

**C. (Sectipecten)** MARWICK, 1928 [\**Pecten wollastoni* FINLAY, 1926 (= *P. sectus* HUTTON, 1873, non GOLDFUSS, 1833; OD)]. Byssal notch moderately developed, no ctenolium; sculpture of about 8 radial folds, radially grooved and with riblets in interspaces (593). *U.Mio.-M.Plio.*, N.Z. — FIG. C84,1a. \**C. (S.) wollastoni* (FINLAY), *U.Mio.*; RV ext.,  $\times 0.5$  (Suter, 1914). — FIG. C84,1b,c. *C. (S.) allani* (MARWICK), *M.Tert.*; 1b,c, LV ext., RV ext.,  $\times 0.5$  (Marwick, 1927).

**C. (Serripecten)** MARWICK, 1928 [\**Pecten hutchinsoni* HUTTON, 1873; OD] [= *Janupecten* MARWICK, 1928 (type, *Pecten utleyi* MARWICK, 1924)]. RV more convex than LV; auricles sub-

equal; radial sculpture of numerous, sharp, scaly ridges and threads (593). *L.Eoc.(Mangaorapan)-L.Plio.(Opoitian)*, N.Z. — FIG. C83,2a. \**C. (S.) hutchinsoni* (HUTTON), *U.Oligo.*; RV ext.,  $\times 0.4$  (Suter, 1914). — FIG. C83,2b. *C. (S.) utleyi* (type of *Janupecten*); LV ext.,  $\times 0.6$  (Marwick, 1924).

**C. (Stralopecten)** TUCKER-ROWLAND, 1938 [\**Pecten ernestsmithi* TUCKER, 1931; OD]. Differs from *Anatipecten* in larger size, larger triangular auricles, and wider byssal notch; cardinal crura obsolete in adult. *Mio.-Plio.*, E.N.Am. — FIG. C85,2. \**C. (S.) ernestsmithi* (TUCKER), *Plio.*, USA (N.C.); RV ext.,  $\times 0.4$  (Tucker-Rowland, 1938).

**C. (Swiftopecten)** HERTLEIN, 1936 [\**Pecten swiftii* BERNARDI, 1858; OD]. Higher than long, nearly equivalve, auricles nearly equal and with well-developed byssal notch and ctenolium in



adult; 4, 5 or more folded radial ribs (paired in some shells), thickened where crossed by concentric undulations, commonly with nodes at intersections on LV, entire surface with coarse radial striae and microscopic tessellations; hinge with

strong cardinal crura, 1 on each side of ligamental pit. *M.Mio.-Rec.*, Japan; *M.Mio.-Pleist.*, USA (Alaska); *U.Mio.-M.Plio.*, USA (Calif.).—FIG. C85,1. \**C. (S.) swiftii* (BERNARDI), *Rec.*, Japan; 1a,b, LV ext., RV ext.,  $\times 0.5$  (Bernardi, 1858).

**C. (Vertipecten) GRANT & GALE, 1931** [\**Pecten bowersi* ARNOLD, 1906; OD]. Differs from *Athlopecten* in that ribs of LV are not paired and about every 3rd one is elevated above others. *L.Oligo.-L.Mio.*, W.N.Am.-Japan.—FIG. C85,3. \**C. (V.) bowersi* (ARNOLD), *L.Mio.*, USA (Calif.); 3a,b, LV ext., RV ext.,  $\times 0.4$  (Arnold, 1906, mod.).

**HINNITES GROUP**

Free in early growth stages, resembling *Chlamys*, later cemented to substrate at RV umbo and developing irregular form, some resembling *Spondylus* (*Spondylopecten*). [Relationships poorly known, probably polyphyletic.] *M.Jur. (Bajoc.)-Rec.*

**Hinnites** DEFRANCE, 1821 [\**H. corteysii* (= *Ostrea crisa* BROCCHI, 1814); SD GRAY, 1847] [= *Hinnita* FÉRUSAC, 1822 (obj.) (nom. van.); *Hinnus* S.WOOD in GRAY 1826 (type, *Lima gigantea* GRAY, 1825); *Hynnites* HERRMANNSEN, 1847 (obj.) (nom. van.)]. Free in early stages similar to *Chlamys* but later attached by RV which becomes irregular (793). [Probably polyphyletic.] *U.Eoc.-Rec.*, cosmop. (tropic-warm temperate).—FIG. C86,3. \**H. crisa* (BROCCHI), *Plio.*, Italy; 3a, LV ext.,  $\times 0.5$ ; 3b, LV int. and RV hinge,  $\times 0.3$  (793).

**Pedum** LAMARCK, 1799 [\**Ostrea spondyloidea* GMELIN, 1790; SD SCHMIDT, 1818] [= *Pedinus* RAFINESQUE, 1815 (nom. nud.)]. Wedge-shaped, compressed, lower valve flat, deeply sinuated near hinge; hinge toothless, ligament partially external in open groove similar to that of *Spondylus*; young like *Chlamys*; permanently attached, commonly embedded in masses of corals. *Rec.*, IndoPac.—FIG. C86,1. \**P. spondyloideum* (GMELIN); 1a, LV ext.,  $\times 1.5$ ; 1b, RV int.,  $\times 1.5$  (7c).

**Prohinnites** GILLET, 1922 [\**Hinnites leymerii* DESHAYES in LEYMERIE, 1842; SD EBERSIN, 1960]. Similar to *Hinnites* but without obvious relationship. *L. Cret. (Valangin.-Apt.)*, Eu.-Mex.-S.Am.—FIG. C86,2. \**P. leymerii* (DESHAYES), Neocom., France; 2a,b, LV ext., RV hinge,  $\times 1$  (124b).

**Spondylopecten** ROEDER, 1882 [\**Pecten (S.) cf. erinaceus* BUVIGNIER, ROEDER, 1822 (= *Pecten (Chlamys) roederi* DE LORIO, 1901); M] [= *Plesipecten* MUNIER-CHALMAS in FISCHER, 1886 (type, *Pecten subspinosus* VON SCHLOTHEIM, 1820); *Cardinopecten* ROLLIER, 1904 (type, *Pecten erinaceus* BUVIGNIER, 1852; SD HERTLEIN, herein)]. Sculp-

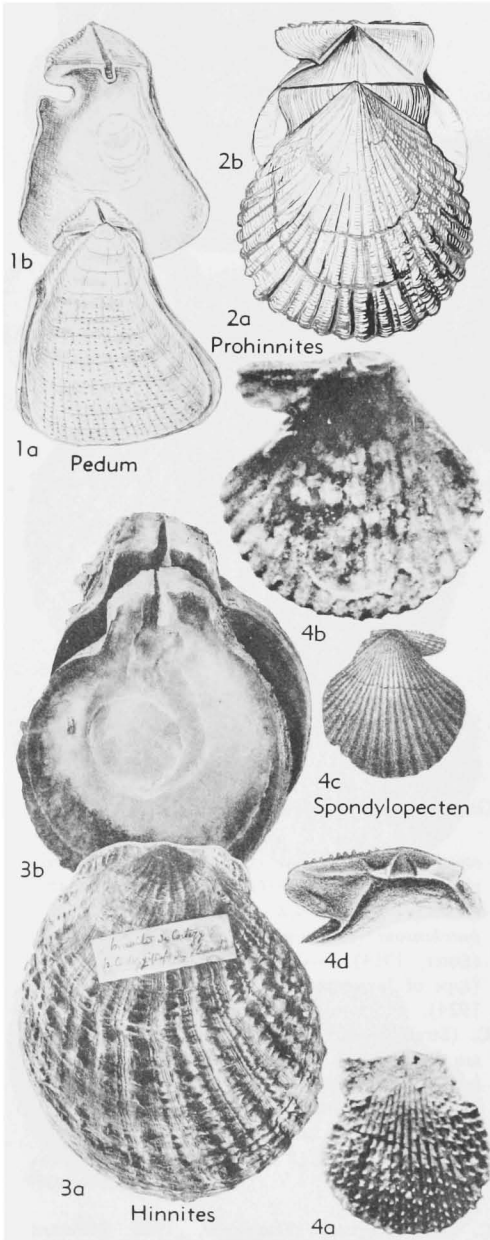


FIG. C86. Pectinidae (Hinnites Group) (p. N364-N365).

tured with number of strong, usually rounded radial ribs, those of LV spinose in some species; byssal notch deep; cardinal area of RV with nar-

row median groove (similar to *Spondylus*) which continues to ligamental pit; hinge of RV with 2 prominent thick teeth (1 each side of ligamental pit) which fit into corresponding sockets in LV. [Apparently some species are attached to tip of RV. Restricted to reef facies.] *Jur.(Bajoc.-Tithon.)*, Eu.-Asia (India).—FIG. C86,4. \**S. roederi* (DE LORIO), Oxford. (4a,b, France; 4c,d, Switz.); 4a, LV ext.,  $\times 2$ ; 4b, RV int.,  $\times 2$  (Roeder, 1882); 4c, RV ext.,  $\times 1.5$ ; 4d, RV hinge,  $\times 2$  (Loriot, 1901).

#### DECATOPECTEN GROUP

RV more convex than LV, usually with few ribs; hinge generally short. ?*Paleoc.*, *Mio.-Rec.*

**Decatopecten** RÜPPEL in SOWERBY, 1839 [*\*Pecten plica* LINNÉ, 1758 (= *Ostrea plica* LINNÉ, 1758); M] [= *Decatopecten* SWAINSON, 1840 (type, *Pecten plicata* SOWERBY, 1839, *errore pro P. plica* SOWERBY, 1839, *non P. plicata* J. DE C. SOWERBY, 1829, *nom. van.*)]. Elongate orbicular, flattish, auricles subequal, byssal notch very small or lacking, no ctenolium; ribs radially striated; hinge short, with few strong, nearly transverse crura. ?*Paleoc.*, *Mio.-Rec.*, W.Pac.-Ind.O.

[SWAINSON (1840) published the name *Decatopecten* (an invalid subsequent spelling) attributed to RÜPPEL (1839), citing as the sole included species "*D. plicata* Sow. Man. f. 172," which is evidently a misspelling of SOWERBY'S *Pecten plica* as recorded for his Fig. 172. Confusion is introduced further by the existence of *Pecten plicata* J. DE C. SOWERBY, 1829, as the name of a different species (*non Pecten plicatus* CHEMNITZ, 1784).]

**D. (*Decatopecten*)** [= *Pallium* MARTINI, 1774 (nonbinominal); *Pallium* SCHUMACHER, 1817 (*non* SCHRÖTER, 1802); *Dentipecten* GRAY, 1847 (obj.)]. Longer than high, with about 6 finely grooved costae formed by corrugations of shell; byssal notch very small. *L.Plio.-Rec.*, IndoPac.—FIG. C87,4. \**D. (D.) plica* (LINNÉ), Rec.; 4a,b, LV ext., RV hinge,  $\times 1$  (Sowerby, 1839).

**D. (*Anguipecten*)** DALL, BARTSCH & REHDER, 1938 [*\*A. gregoryi*; OD]. Differs from *D. (Decatopecten)* in its vertically elongated form and more numerous, finer ribs. *Mio.-Rec.*, IndoPac.—FIG. C87,2. \**D. (A.) gregoryi* (DALL, BARTSCH & REHDER), Rec., USA (Hawaii); 2a, LV ext.,  $\times 0.7$ ; 2b, LV int.,  $\times 0.7$  (Dall, Bartsch & Rehder, 1938).

**D. ?(*Sinectenolium*)** EAMES & COX, 1956 [*\*S. douglasi*; OD]. Small, thin, ears obtusely triangular; radially ribbed, margin fluted; no byssal notch or ctenolium. Hinge unknown. *Paleoc.*, Iran.—FIG. C87,1. \**D. (S.) douglasi* (EAMES & COX); 1a,b, RV ext., LV ext.,  $\times 1$  (Eames & Cox, 1956).

**Semipallium** JOUSSEAUME, 1928 [*\*Pecten tigris* LAMARCK, 1819; OD]. Oblique elongate, apical angle usually less than  $90^\circ$ ; RV more convex than LV; auricles unequal or nearly equal, hinge line rather short, byssal notch moderately well de-

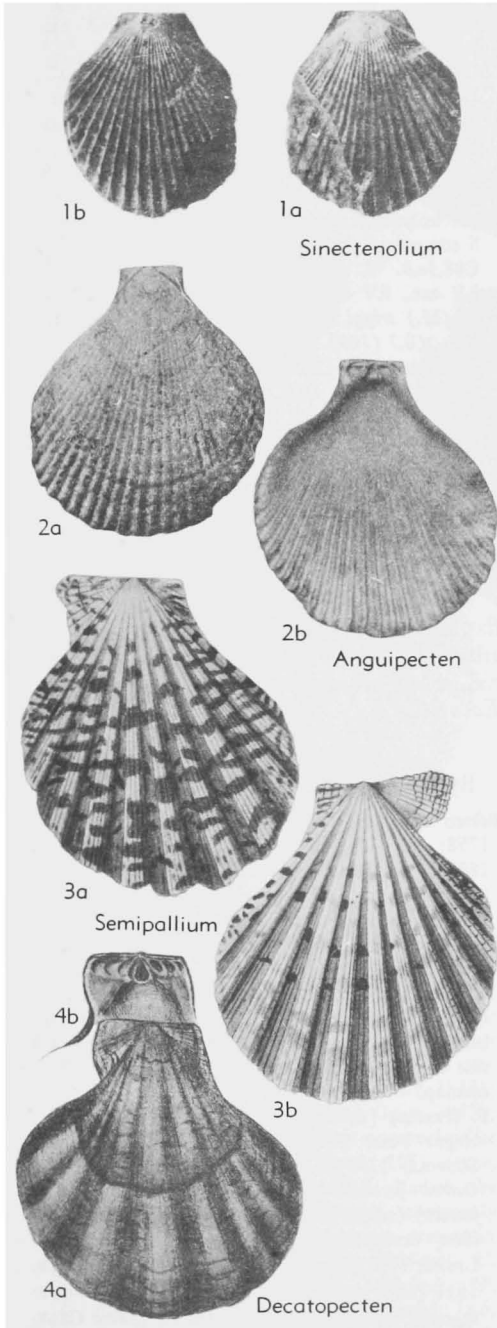


FIG. C87. Pectinidae (Decatopecten Group) (p. N365-N366).

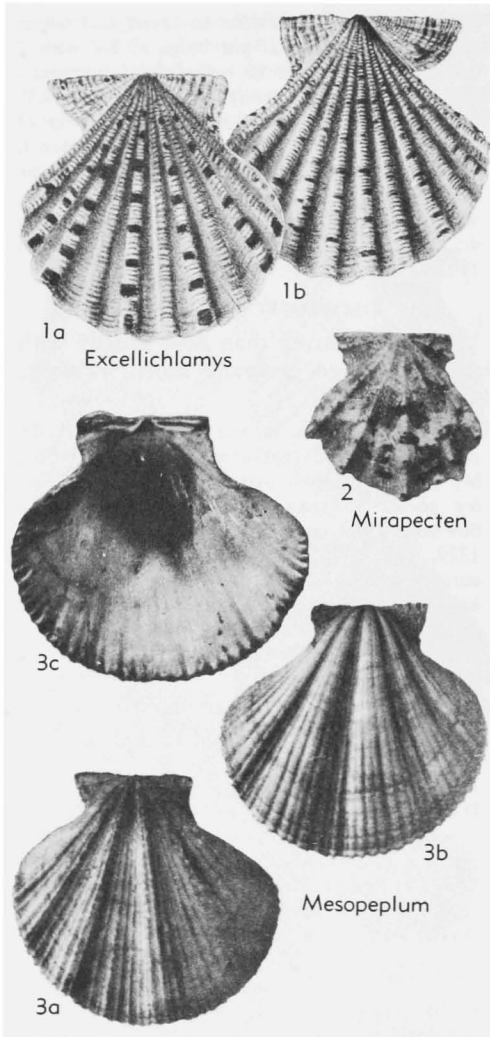


FIG. C88. Pectinidae (Decatopecten Group) (p. N366).

veloped; several compound ribs usually not bifurcating; hinge as in *Chlamys*, or with weak cardinal crura. *Mio.-Rec.*, IndoPac.

**S. (Semipallium)** [= *Pera* CHEMNITZ, 1784 (non-binominal); *Bractechlamys* IREDALE, 1939 (type, *B. evecta*); *Complicachlamys* IREDALE, 1939 (type, *C. wardiana*); *Comptopallium* IREDALE, 1939 (type, *C. pauciplicatum*)]. Several compound ribs, not bifurcating. *Mio.-Rec.*, IndoPac.—FIG. C87,3. \**S. (S.) tigris* (LAMARCK), Rec.; 3a,b, LV ext., RV ext.,  $\times 0.7$  (Chenu, 1844).

**S. (Exccllichlamys)** IREDALE, 1939 [*\*Pecten spectabilis* REEVE, 1853; OD]. Small to medium-

sized, auricles large, unequal; sculpture of raised rounded ribs separated by deep interspaces, those on LV alternating in height. *Mio.*, Fiji; *Plio.-Rec.*, IndoPac.-N.Australia.—FIG. C88,1. \**S. (E.) spectabile* (REEVE), Rec., Japan; 1a,b, LV ext., RV ext.,  $\times 1$  (Dunker, 1882).

**S. (Mesopeplum)** IREDALE, 1929 [*\*M. caroli*; OD] [= *Notochlamys* COTTON, 1930 (type, *Chlamys anguineus* FINLAY, 1927 = *Pecten undulatus* SOWERBY, 1847, non NILSSON, 1827); *Dendopecten* HERTLEIN, 1936 (type, *Pecten dendyi* HUTTON, 1902)]. Suborbicular; ctenolium present in young, obsolete in adult; sculptured with 5 compound ribs. *M.Mio.-Rec.*, Australia.—FIG. C88,3a,b. \**S. (M.) caroli* (IREDALE), Rec.; 3a,b, LV ext., RV ext.,  $\times 0.7$  (437).—FIG. C88,3c. *S. (M.) triggi* (COTTON & GODFREY), Rec.; RV int.,  $\times 0.7$  (169).

**S. (Mirapekten)** DALL, BARTSCH & REHDER, 1938 [*\*M. thaanumi*; OD]. Small, thin, with several radial ridges bearing hollow spines; hinge finely transversely denticulated. *U.Mio.-Rec.*, C.Pac.-W. Pac.—FIG. C88,2. \**S. (M.) thaanumi* (DALL, BARTSCH & REHDER), Rec., USA (Hawaii); LV ext.,  $\times 1.5$  (Dall, Bartsch, & Rehder, 1938).

#### PECTEN GROUP

RV decidedly convex, LV gently convex, flat, or concave; auricles nearly equal; radial ribs fairly broad usually; hinge with cardinal crura or almost lacking armature. *U. Eoc.-Rec.*

#### Pecten (Pecten) Subgroup

Byssal notch very shallow. *U.Eoc.-Rec.*

**Pecten** MÜLLER, 1776 [*\*Ostrea maxima* LINNÉ, 1758; SD SCHMIDT, 1818] [= *Pectinium* LINK, 1807 (type, *P. maximum*, = *Ostrea maxima* LINNÉ, SD HERTLEIN, herein); *Pectinigenus* RENIER, 1807 (obj.); *Pectinites* VON SCHLOTHEIM, 1820 (non GESNER, 1758; nec GMELIN, 1793); *Pecten* RAFINESQUE, 1815 (*nom. nud.*)]. Radial ribs well developed and on RV usually wider than interspaces, radially striate, grooved, or nearly smooth; hinge with cardinal crura extending from each side of ligamental pit (256a-e, 732c). *U.Eoc.-Rec.*, cosmop.

**P. (Pecten)** [= *Vola* KLEIN, 1753 (pre-Linnaean); *Argus* POLI, 1791 (non BOHADSCH, 1761; nec SCOPOLI, 1777); *Argoderma* POLI, 1795 (type, *Ostrea jacobaea* LINNÉ, 1758, SD HERTLEIN, herein) (refers to shell of *Argus* POLI, 1791); *Pallium* SCHRÖTER, 1802 (type, *Pecten maximus* LINNÉ, 1758); *Pandora* MEGERLE von MÜHLFELD, 1811 (obj.) (non LAMARCK, 1799); *Janira* SCHUMACHER, 1817 (non LEACH, 1814); *Janera* GRAY, 1847 (*nom. null.*); *Vola* MÖRCH, 1853 (non MULSANT, 1850); *Argodesma* PAETEL, 1875

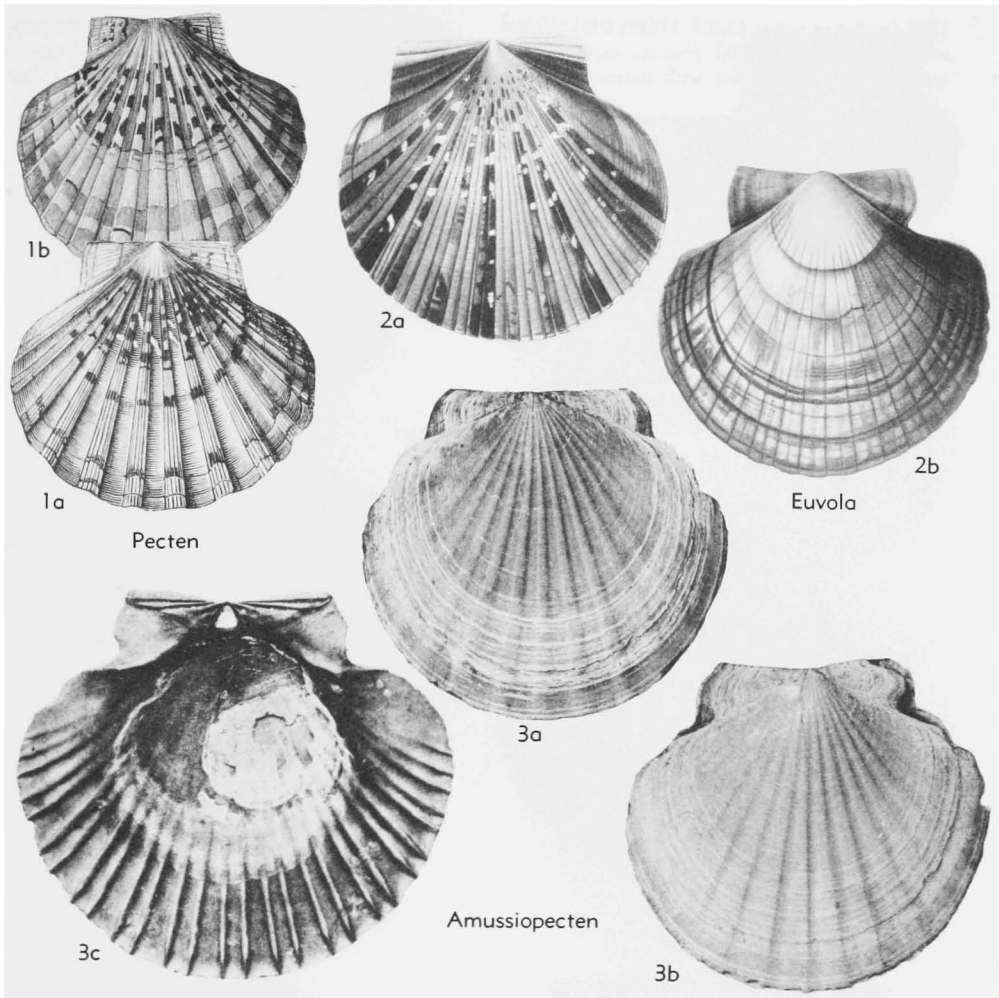


FIG. C89. Pectinidae (Pecten Group—Pecten (Pecten) Subgroup) (p. N366-N368).

(*nom. null.*); *Deperetia* VON TEPPNER, 1922 (type, *Pecten cristatocostatus* SACCO, 1897); *Heritschia* VON TEPPNER, 1922 (type, *Pecten aduncus* EICHWALD, 1830); *Jaworskia* VON TEPPNER, 1922 (type, *Pecten grandis* SOWERBY, 1828); *Philippia* VON TEPPNER, 1922 (*non* GRAY, 1847); *Notovola* FINLAY, 1926 (*Pecten novaezelandiae* REEVE, 1852); *Serratovola* HABE, 1951 (type, *Pecten tricarinatus* ANTON, 1839)]. Radial ribs well developed, usually flat-topped, commonly radially striated or grooved; concavity present in many shells on LV umbonal area (256a-e). *U. Eoc.-Rec.*, N.Eu.-Medit.—FIG. C89, 1a,b. \**P. (P.) maximus* (LINNÉ), Rec., Eng.Channel; 1a,b, LV ext., RV ext.,  $\times 0.25$  (124b).—FIG. 78,4. *P. (P.) jacobaeus*, Rec., Medit.; 4a,b, RV ext., LV int.,  $\times 0.2$  (Brown, 1844).

*P. (Amussiopecten)* SACCO, 1897 [*\*Pecten burdigalensis* LAMARCK, 1809; OD] [= *Amussiopecten* OPPENHEIM, 1903 (*nom. null.*); *Amussiopecten* FOLDVÁRI, 1929 (*nom. null.*)]. Differs from *Flabellipecten* in its nearly obsolescent radial ribs with correspondingly stronger internal radial riblets similar to *Amusium*; cardinal margin of hinge commonly more angulated with high angulated auricles (256a-e, 821a,b). *U.Oligo. (Chatt.) - U.Mio. (Torton.)*, Eurasia (Tethyan)-Medit.; *L.Mio.*, N.Am.(Calif.)-E.Indies-E.Afr.; *L.Mio.-M.Mio.*, Iran; *M.Mio.*, S.Am.(Venez.); *U.Mio.* or *L.Plio.*, Japan.—FIG. C89,3. \**P. (A.) burdigalensis* (LAMARCK), *L.Mio.*(Burdigal.), France; 3a,b, LV ext., RV ext.,  $\times 0.5$  (256d); 3c, RV int.,  $\times 0.5$  (Cossmann & Peyrot, 1914). *P. (Euvola)* DALL, 1898 [*\*Pecten ziczac* LINNÉ,

1758 (= *Ostrea ziczac* LINNÉ, 1758); OD]. Valves smooth except for radial grooves, especially on umbonal portion; interior with narrow, rounded

riblets corresponding to exterior radial sculpture. *Oligo.-Rec.*, Carib.; *Plio.*, Gulf Calif. (19i).— FIG. C89,2. \**P. (E.) ziczac* (LINNÉ), *Rec.*,

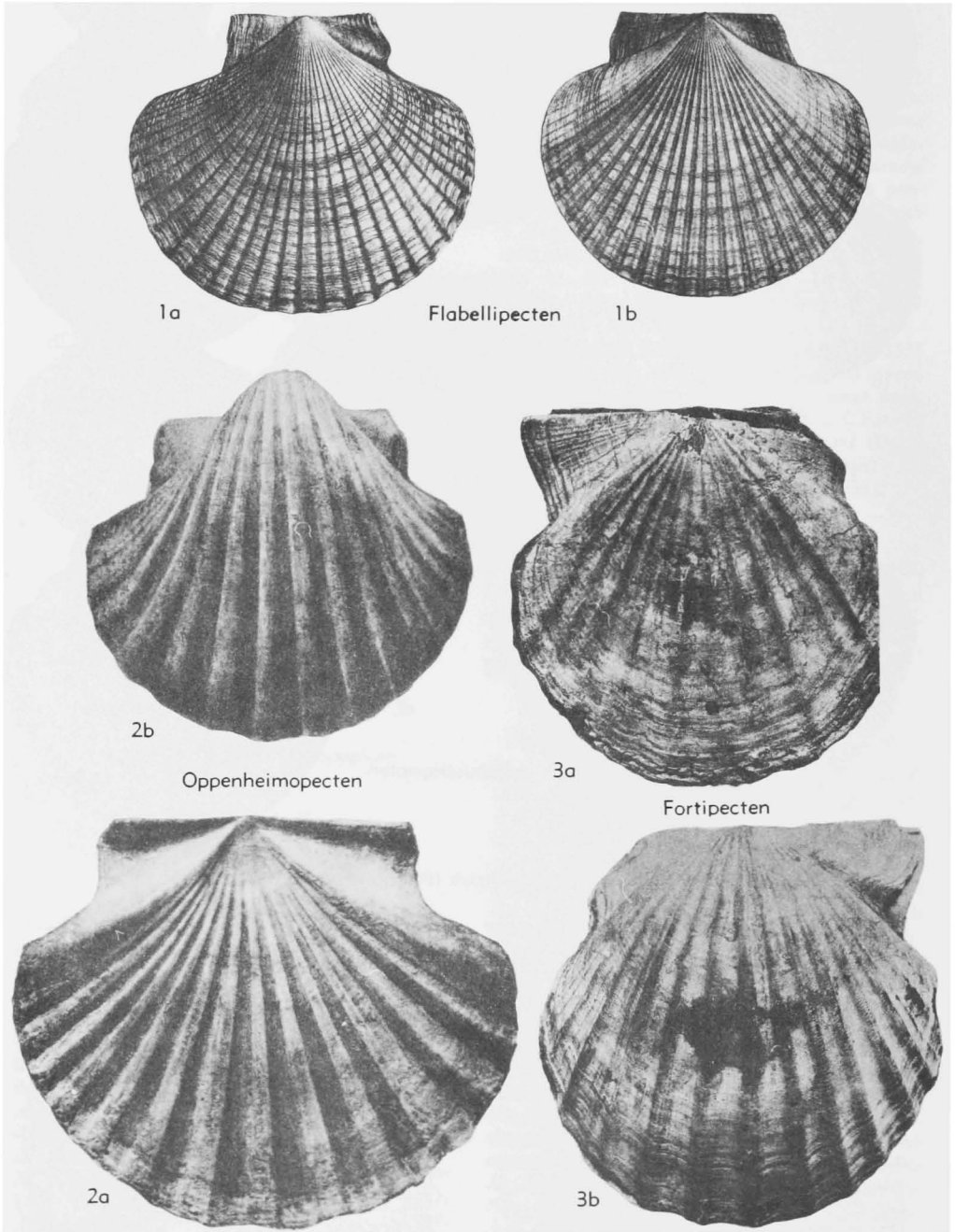


FIG. C90. Pectinidae (Pecten Group—Pecten (Pecten) Subgroup) (1-2), (Pecten Group—Pecten (Patinopecten) Subgroup) (3) (p. N369-N371).



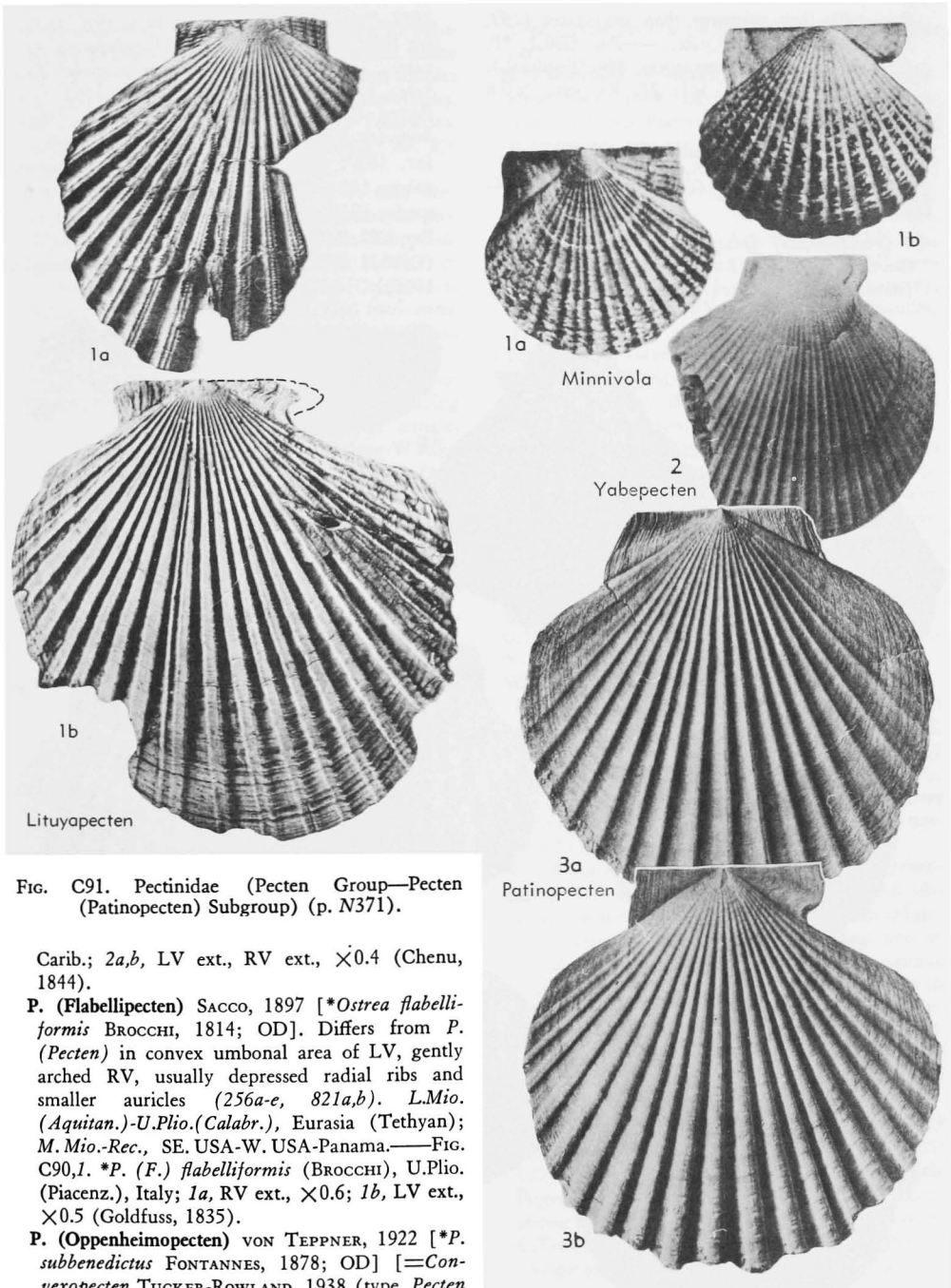


FIG. C91. Pectinidae (Pecten Group—Pecten (Patinopecten) Subgroup) (p. N371).

Carib.; 2a,b, LV ext., RV ext.,  $\times 0.4$  (Chenu, 1844).

**P. (Flabellipecten)** SACCO, 1897 [*Ostrea flabelliformis* BROCCHI, 1814; OD]. Differs from *P. (Pecten)* in convex umbonal area of LV, gently arched RV, usually depressed radial ribs and smaller auricles (256a-e, 821a,b). *L.Mio. (Aquitain.)-U.Plio.(Calabr.)*, Eurasia (Tethyan); *M. Mio.-Rec.*, SE. USA-W. USA-Panama.—FIG. C90,1. \**P. (F.) flabelliformis* (BROCCHI), U.Plio. (Piacenz.), Italy; 1a, RV ext.,  $\times 0.6$ ; 1b, LV ext.,  $\times 0.5$  (Goldfuss, 1835).

**P. (Oppenheimopecten)** VON TEPPNER, 1922 [*P. subbenedictus* FONTANNES, 1878; OD] [= *Convexopecten* TUCKER-ROWLAND, 1938 (type, *Pecten joslingi* SMITH, 1847); *Oppenheimia* ROGER, 1939 (nom. null.)]. RV very strongly convex (beak strongly incurved and overhanging that of LV), ribs rounded to subrectangular, auricles squarely terminated; LV flat to concave, ribs

FIG. C92. Pectinidae (Pecten Group—Pecten (Patinopecten) Subgroup) (p. N370-N371).



low, wide, but narrower than interspaces (793, 906). *L.Mio.(Aquit.)-Rec.*—FIG. C90,2. \**P. (O.) subbenedictus* FONTANNES, Mio.(Burdigal.), France; 2a, LV ext.,  $\times 1$ ; 2b, RV ext.,  $\times 0.8$  (256a).

**Pecten (Patinopecten) Subgroup**

Byssal notch deep, cardinal crura weak. *U.Oligo.-Rec.*

**P. (Patinopecten)** DALL, 1898 [\**Pecten caurinus* GOULD, 1850; OD] [= *Platinopecten* DALL, 1914 (nom. null.); *Blanckenhornia* VON TEPPNER,

1922 (type, *Pecten oweni* ARNOLD, 1906, = *Pecten lohri* HERTLEIN, 1928); ?*Masudapecten* AKIYAMA, 1962 (type, *Patinopecten masudai* AKIYAMA, 1962); ?*Kotorapecten* MASUDA, 1962 (type, *Pecten kagamianus* YOKOYAMA, 1923); ?*Mizuhopecten* MASUDA, 1963 (type, *Pecten yessoensis* JAY, 1857; OD)]. Large round, gently convex valves, LV nearly flat; radial ribs sulcate in some species (219). *U.Oligo.-Rec.*, N.Pac.-NE.Pac.—FIG. C92,3. \**P. (P.) caurinus* GOULD, Plio., USA (Calif.); 3a,b, LV ext., RV ext.,  $\times 0.5$  (Arnold, 1906).

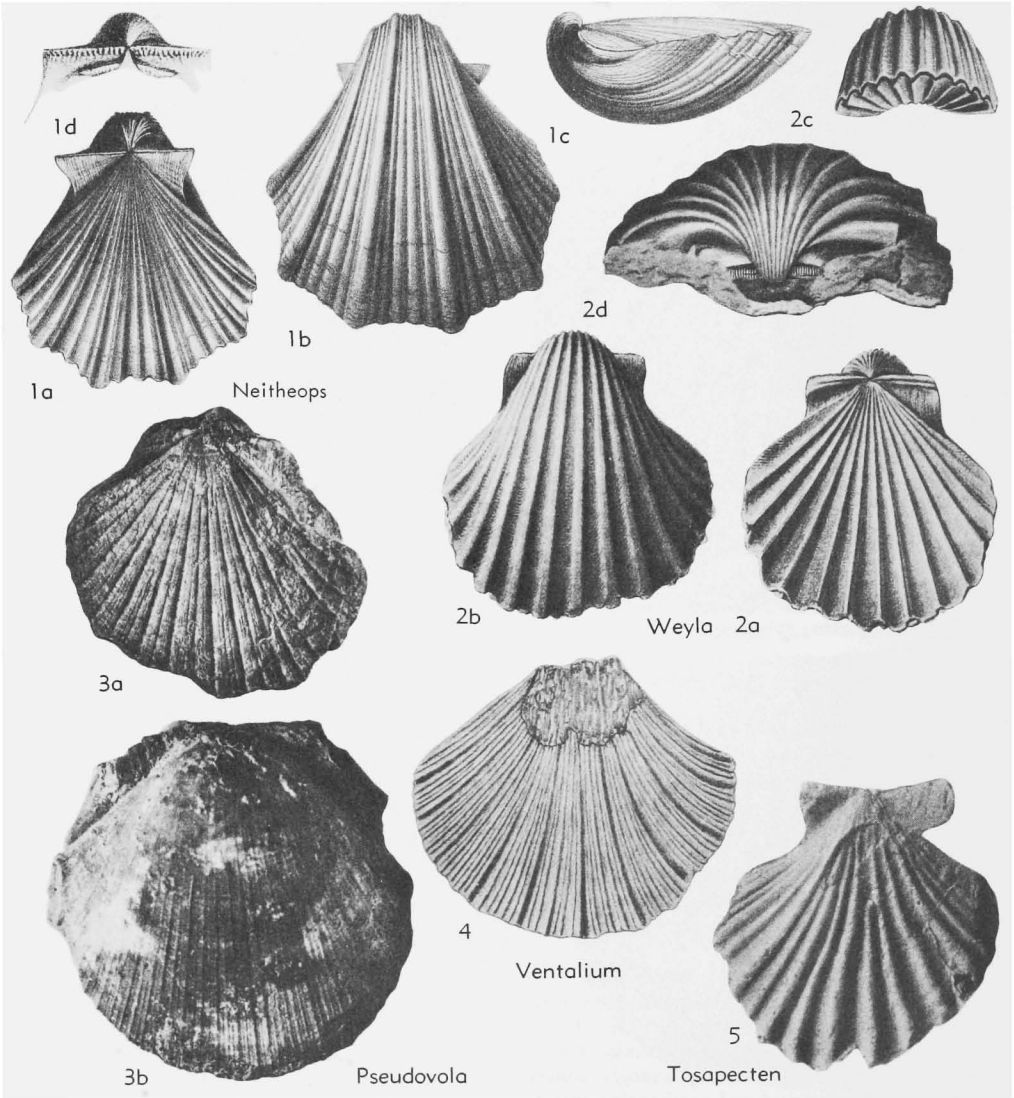


FIG. C93. Pectinidae (Neithea Group) (p. N371).

- P. (Fortipecten)** YABE & HATAI, 1940 [\**P. takahashii* YOKOYAMA, 1930; OD]. Shell thick, umbo of RV overhanging that of LV; ribs coarse, simple; auricles very large. *L.Plio.-M.Plio.*, Japan-Alaska.—FIG. C90,3. \**P. (F.) takahashii* YOKOYAMA, Japan; 3a, LV ext.,  $\times 0.4$  (71, mod.); 3b, RV ext.,  $\times 0.4$  (Yabe & Hatai, 1940).
- P. (Lityapecten)** MACNEIL, 1961 [\**P. (L.) lituyaensis*; OD]. Differs from *Patinopecten* in possessing 1 to several rows of frill-like flanges on ribs (rounded to flat-topped) of LV. *U.Oligo.* or *L.Mio.*, USA (Alaska); *Plio.*, USA (Calif.)-Mex. (Baja Calif.).—FIG. C91,1. \**P. (L.) lituyaensis*, *Plio.*, Alaska; 1a, LV ext.,  $\times 0.39$ ; 1b, RV ext.,  $\times 0.25$  (MacNeil, 1961).
- P. (Minnivola)** IREDALE, 1939 [\**Minnivola isomeres*; OD]. Differs from *P. (Euvola)* in having deep byssal notch below right anterior auricle; ctenolium present. *M.Mio.-Plio.*, Iran-W.Pak.; *Rec.*, Australia-Philip.—FIG. C92,1. \**P. (M.) isomeres* (IREDALE), *Rec.*, Australia; 1a,b, LV ext., RV ext.,  $\times 1$  (Eames & Cox, 1956).
- P. (Yabepecten)** MASUDA, 1963, p. 149 [\**Pecten tokunagai* YOKOYAMA, 1911; OD]. Differs from *Patinopecten* in shallower byssal notch of RV and more numerous, rounded, radial ribs. *Plio.*, Japan.—FIG. C92,2. \**P. (Y.) tokunagai* (YOKOYAMA), RV ext.,  $\times 0.9$  (Masuda, 1963).

## NEITHEA GROUP

RV more convex than LV; byssal notch usually slight but may be well developed; hinge commonly with coarse cardinal crura or denticles, entire hinge vertically striated in many species. *U.Trias.-Cret.*, ?*L.Eoc.*

- Neithea** DROUET, 1825 [\**Pecten aequicostatus* LAMARCK, 1819; SD CHENU, 1862] [= *Neithaea* GRAY, 1840 (*nom. null.*); *Neithea* D'ORBIGNY, 1846 (*nom. null.*); *Mithea* ANDERSON, 1902 (*nom. null.*); *Neitha* PRESTON, 1925 (*nom. null.*); *Meithea* STEWART, 1930 (*nom. null.*); *Nerithea* GRANT & GALE, 1931 (*nom. null.*)]. Equal or nearly equal radial ribs, or with 4 to 6 raised radial ribs separated by 3 or 4 smaller ones or with radial striae; auricles equal or anterior one larger, shallow byssal notch present; hinge with two diverging, transversely striated cardinal teeth, 1 on each side of ligamental pit, and two lamellae corresponding to each of these on LV; rows of small denticles along interior upper margin of auricles (892). *Cret. (Neocom.-Senon.)*, cosmop. ?*L.Eoc.*, Switz.
- N. (Neithea)** [= *Aequineithea* HAYAMI, 1960 (*obj.*)]. Numerous radial ribs equal or nearly equal in size. *Cret. (Neocom.-Senon.)*, cosmop.
- N. (Neithella)** HAYAMI, 1960 [\**Janira wrightii* SHUMARD, 1860; OD]. Sculpture of 4 or 5 prominent radial ribs; anterior auricle much larger than posterior one (which is only slightly developed)].

*Cret. (Neocom.-Turon.)*, Eu.-E.N.Am.-Madagascar.

- N. (Neitheops)** STEWART, 1930 [\**Neithea grandicosta* GABB, 1869; OD] [= *Rogeria* VON TEPPER, 1922 (*non* EMERY, 1894)]. Sculpture of 5 or 6 prominent ribs commonly separated by 3 or 4 smaller ones. *Cret. (Valangin.-Maastricht.)*, ?*L.Eoc.*, Switz., cosmop.—FIG. C93,1a-c. *N. (N.) quinquecostata* (SOWERBY), Cenoman., France; 1a-c, LV view of both valves, RV ext., both valves ant.,  $\times 0.7$  (D'ORBIGNY, 1847).—FIG. C93,1d. *N. (N.) phaseola* (D'ORBIGNY), Cenoman., France; RV hinge,  $\times 1$  (D'ORBIGNY, 1847).
- ?**Ventalium** DE GREGORIO, 1930 [\**V. insignis*; OD]. Flattish, fan-shaped, sculptured with minute radial riblets; about 10 deep, radiating sulci, each of which separates groups of about 6 to 8 riblets; hinge unknown. [Type imperfect, characters not fully known but considered by DE GREGORIO to be related to *Pecten*.] *L.Jur. (Lias.)*, Sicily.—FIG. C93,4. \**V. insignis*; RV ext.,  $\times 0.7$  (de Gregorio, 1930).
- Weyla** J. BÖHM, 1922 [\**Pecten alatus* VON BUCH, 1835; OD]. RV very highly convex, byssal sinus slight; hinge with 1 or 2 pairs of cardinal laminae, striated vertically. *U.Trias.-M.Jur.*, N.Am.-S.Am.-N.Afr.-Medit.
- W. (Weyla)** [= *Parapecten* CRICKMAY, 1930 (type, *P. nilakapamuxanus*)]. Both valves sculptured with coarse radial costae. *L.Jur. (Lias.)*, N.Am.-S.Am.-N.Afr.-Medit.—FIG. C93,2. \**W. (W.) alata* (VON BUCH), Peru (2a-c), Arg. (2d); 2a-c, LV view of both valves, RV ext., both valves ventral,  $\times 0.5$  (Steinmann, 1929); 2d, RV umbonal view showing hinge,  $\times 0.7$  (445).
- W. (Pseudovola)** LISSAJOUS, 1923 [\**P. depereti*; OD]. RV sculptured with about 100 radial ribs of which about one-fourth are higher than others, all crossed by concentric striae giving rise to reticulate pattern; LV flattish, slightly concave near beak, sculptured with about 15 radial ribs in interspaces of which about 6 smaller riblets occur, 1 higher than others, all crossed by concentric imbrications. *M.Jur. (Bathon.)*, France.—FIG. C93,3. \**W. (P.) depereti* (LISSAJOUS); 3a, LV ext.,  $\times 1$ ; 3b, RV ext.,  $\times 1.5$  (Lissajous, 1923).
- W. (Tosapecten)** KOBAYASHI & ICHIKAWA, 1949 [\**Pecten (Velopecten) suzukii* KOBAYASHI, 1931; OD]. RV convex, LV nearly flat; anterior auricle larger and with byssal notch well developed; strong radial ribs differ in arrangement on valves. *U.Trias.*, Japan.—FIG. C93,5. \**W. (T.) suzukii* (KOBAYASHI); RV ext.,  $\times 1$  (Kobayashi, 1931).

## PSEUDOPECTEN GROUP

LV of many shells nearly as convex as RV; distinct byssal notch present. *U.Trias.-M.Jur.*

**Pseudopecten** BAYLE, 1878 [*\*Pecten aequivalvis* J. SOWERBY, 1816; M]. Nearly equivalve; about 15 or 16 radial ribs which are nearly smooth or with spines on RV. *L.Jur.-M.Jur.*, Eu.-S.Am.-E.Indies.  
**P. (Pseudopecten)**. Radial ribs on RV smooth or some with spines (732c). *L.Jur.*(*Sinemur.-Domer.*), Eu.—FIG. C94,5a,b. *\*P. (P.) aequivalvis* (J. SOWERBY), Eng.; 5a,b, LV, RV,  $\times 0.4$  (Chenu, 1944).  
**P. (Echinopecten)** BRASIL, 1895 [*\*Pecten barbatus* J. SOWERBY, 1819; OD]. RV generally flatter

than LV and bearing long, depressed spines. *Jur. (Hettang.-Bajoc.)*, Eu.-S.Am.—FIG. C94,3. *\*P. (E.) barbatus* (J. SOWERBY), Inf. Oolite, Eng.; RV ext.,  $\times 1$  (Sowerby, 1819).  
**Indopecten** DOUGLAS, 1929 [*\*Pecten clignetti* KRUMBECK, 1913 (= *Pecten (Aequipecten) clignetti* G. BÖHM, 1906, *nom. nud.*); OD]. RV moderately convex; valves corrugated to form 5 or 6 rounded radial folds, some bearing secondary riblets, smooth or with rows of knobs or tubercles at regular intervals; shallow byssal notch present;

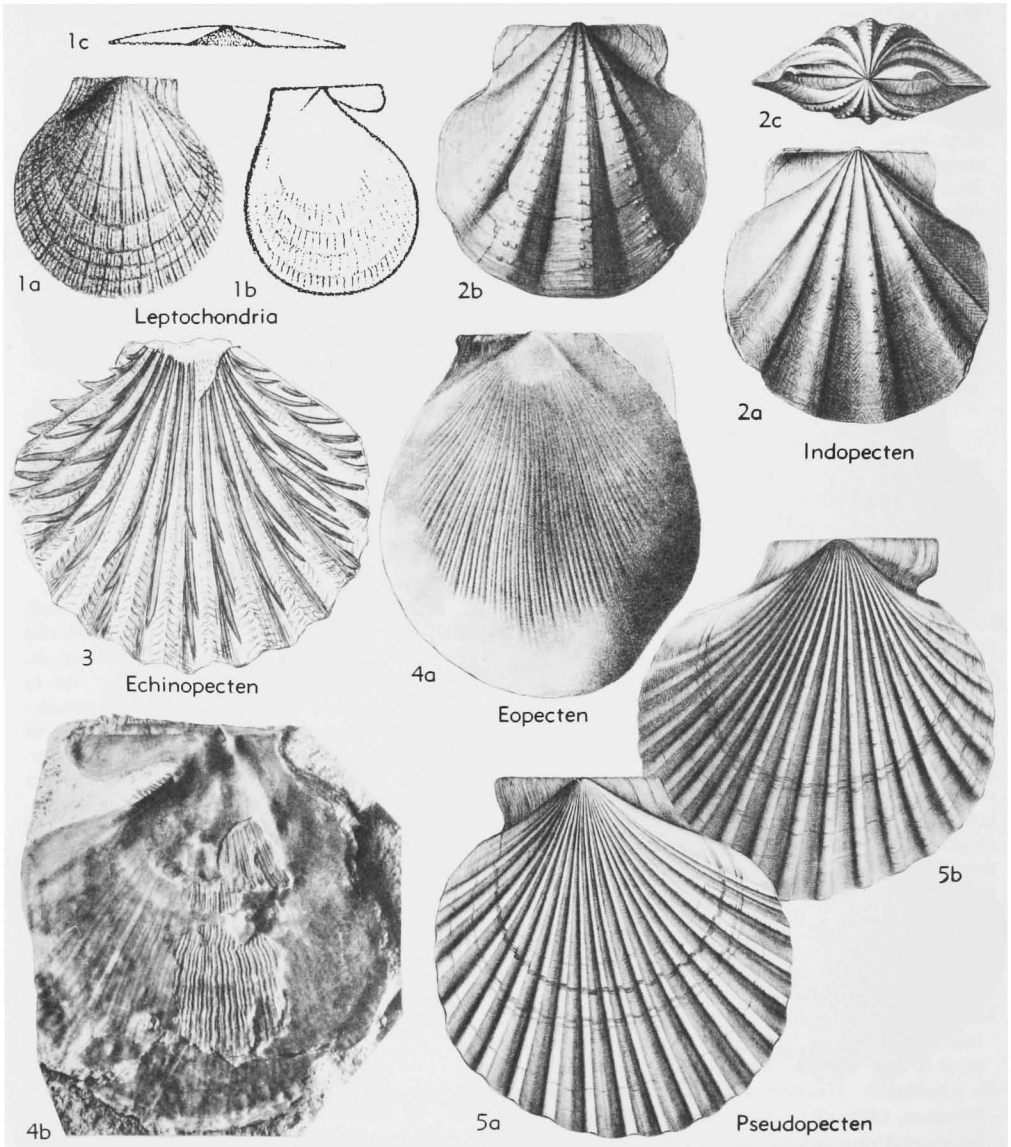


FIG. C94. Pectinidae (Pseudopecten Group) (2-3,5); Aviculopectinidae (Aviculopectininae) (1); Group Uncertain (4) (p. N338, N372-N373).

interior structure of LV with series of regular zigzag lines. [Relationships not well known.] *U.Trias.* (*U.Nor.*), *E.Indies.*—FIG. C94,2. \**I. clignetti* (KRUMBECK), 2*a-c*, LV ext., RV ext., both valves umbonal views,  $\times 0.7$  (Krumbeck, 1913).

#### GROUP UNCERTAIN

*Eopecten* DOUVILLÉ, 1897, p. 203 [\**Hinnites tuberculatus* GOLDFUSS, 1836 (*errore pro Spondylus tuberculatus* GOLDFUSS, 1836; OD) [= *Velata* QUENSTEDT, 1856 (*non* GRIFFITH & PIDGEON, 1834, obj.; *Velopecten* PHILIPPI, 1899 (*pro Velata* QUENSTEDT, 1856 (*non Velates* MONTFORT, 1810); *Velopecten* ROLLIER, 1906 (*nom. van.*)]. Medium-sized to large, acline, more or less irregular in outline at all stages of growth, some specimens irregularly puckered or with allomorphic ornament; inequivalve, with LV convex and RV flat or concave, with indications of having grown attached at umbo; left anterior wing large, indistinctly demarcated, right anterior auricle elongate, deep subauricular notch with ctenolium below it; posterior wing rather small; RV with narrow, obtusely triangular cardinal area with deep narrowly triangular pit below beak corresponding to internal resilium, corresponding features of LV uncertain; interior of RV in some specimens with blunt oblique internal ridge originating near resilifer; ornament of radial ribs of 2 or 3 orders of strength increasing by implantation. *L.Jur.* (*Lias.*)-*L.Cret.* (*Alb.*), cosmop.—FIG. C94,4*a*. \**E. tuberculatus* (GOLDFUSS), *M.Jur.*, Ger.; LV ext.,  $\times 0.5$  (341*b*).—FIG. C94,4*b*. *E. abjectus* (PHILIPPS), *M.Jur.*, Inf. Oolite, Eng. (Dorset.), RV int.,  $\times 0.7$  (184).

?*Mclearnia* CRICKMAY, 1930, p. 45 [\**M. mclearnii*; OD]. Large, suborbicular, subequilateral, not pronouncedly inequivalve; posterior wing obtuse, not clearly delimited from body of shell; right anterior auricle narrow, more elongate than posterior wing, with deep sinus below it; resilium pit deep, triangular, subcentral, no evidence of crura; adductor scar unknown; pallial line split up into small depressions dorsally, but with its anterior and posterior branches meeting below resilium pit; *Chlamys*-like ornament of radial riblets impressed on interior in early growth stages, ornament apparently lacking in later stages. [Needs further investigation.] *L.Cret.*, Can. (B.C.).—FIG. C74,4. \**M. mclearnii*; RV int.,  $\times 0.5$  (Crickmay, 1930).

#### Family MONOTIDAE P. Fischer, 1887

[*nom. transl.* KITTL, 1912, p. 166 (*ex Monotinae* P. FISCHER, 1887, p. 95)] [Materials for this family prepared by L. R. Cox]

Thin-shelled, of feeble to moderate convexity, subequivalve or distinctly inequi-

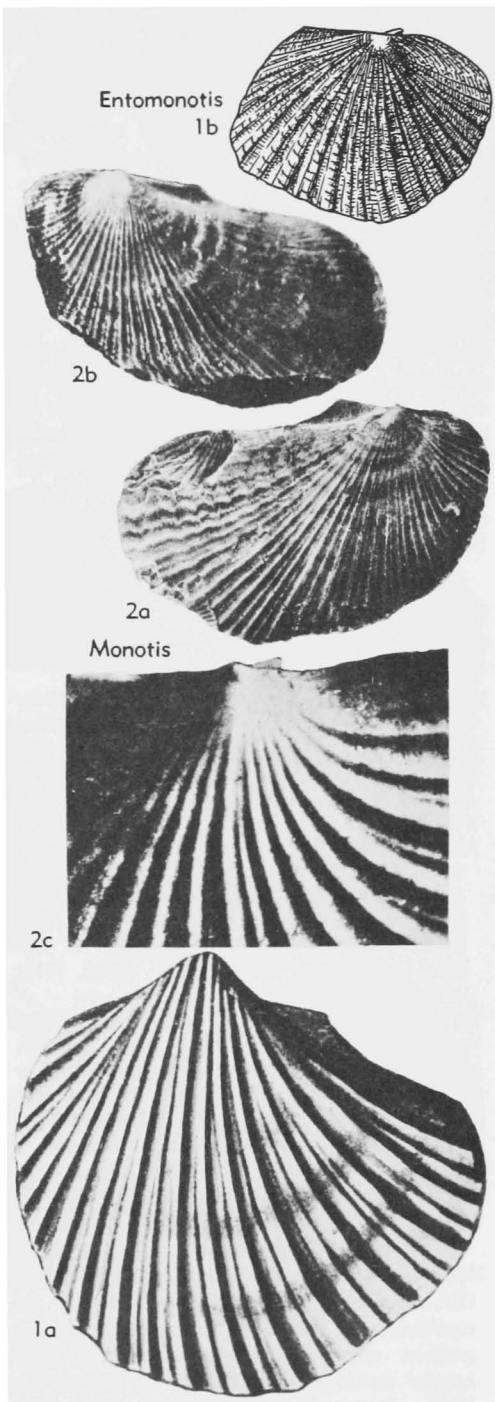


FIG. C95. Monotidae (p. N374).

valve, with RV flatter, obliquely ovate, prosocline, inequilateral, obtusely subalate posteriorly, posterior wing (except in *Pleuromysidia*) more or less distinctly demarcated from body of shell in both valves; LV without distinct anterior wing, its anterodorsal margin evenly rounded; very small, commonly uptilted right anterior auricle present, but hidden from view in many specimens by dorsal part of body of valve; subauricular notch narrow, deep; hinge edentulous; ligamental area external, forming narrow, inequilateral triangle entirely posterior to beaks, longitudinally striated and (in *Monotis*) with single, shallow, wide ligamental pit; ornament similar in both valves, consisting usually of radial ribs which increase by intercalation, but absent in some specimens; muscle scars not observed; original shell structure unknown. *U. Trias.*

The presence of the right anterior auricle distinguishes this family from the Halobiiidae; the small size of this auricle from the Aviculopectinidae.

**Monotis** BRONN, 1830, p. 284 [*\*Pectinites salinarius* VON SCHLOTHEIM, 1820, p. 230; SD HERMANNSEN, 1852, p. 86)]. Hinge line of moderate length; posterior wing more or less distinctly demarcated in both valves; right anterior auricle uptilted. *U. Trias.*, cosmop.

**M. (Monotis)**. Subequivalve to slightly inequivalve; right anterior auricle very small. *U. Trias.*, Aus.-Yugosl. (Dalmat.)-Sicily.—FIG. C95,2. **\*M. (M.) salinaria** (VON SCHLOTHEIM), Nor., Aus.; 2a, LV ext.,  $\times 1$ ; 2b, RV ext.,  $\times 1$ ; 2c, LV umbonal region with auricle,  $\times 3.3$  (Kittl, 1912; 423).

**M. (Entomonotis)** MARWICK, 1935, p. 298 [*\*Monotis richmondiana* ZITTEL, 1864, p. 26 (as *\*M. salinaria*, var.); OD]. All specimens distinctly inequivalve, with LV well inflated; right anterior auricle larger than in *M. (Monotis)*. *U. Trias. (Nor.)*, N.Z.-N.Caledon.-Indon.-Japan-Spitz.-USSR (Crimea-E.Sib.-Cauc.)-?Iran-Mex.-W.S.Am.-W.N.Am.—FIG. C95,1. **\*M. (E.) richmondiana** (ZITTEL), N.Z.; 1a, LV ext.,  $\times 1$ ; 1b, RV ext.,  $\times 0.7$  (Frech, 1908; 596).

?**Pleuromysidia** ICHIKAWA, 1954, p. 52 [*\*P. dubia*; OD]. Subequivalve, well inflated, strongly inequilateral and prosocline; hinge line very short; posterior wings obtuse, scarcely defined; right anterior auricle small, as in *Monotis*, but not uptilted, ornament weak, of close-set radial striae. *U. Trias. (Carn.)*, Japan.

### Family BUCHIIDAE Cox, 1953

[Buchiidae Cox, 1953, p. 6] [=Aucellidae FISCHER, 1887 (*nom. transl.* LAHUSEN, 1897, ex Aucellinae FISCHER, 1887); suppressed by ICZN Opinion 492 (1957)] [Materials for this family prepared by L. R. Cox]

Shell obliquely ovate, with relatively short hinge margin and posterior wings absent or obtuse and ill-demarcated; height most commonly well exceeding length; usually more or less inequivalve, with LV more gibbose, but equivalve in *Pseudaucella*; right anterior auricle well demarcated, with deep, acute subauricular sinus in most genera and extending out of plane of valve margins toward LV in some forms; ligamental area triangular and external or subexternal in both valves, with single shallow ligamental pit; no hinge teeth; ornament lacking or of concentric ribs, with subordinate radial threads in a few forms; ostracum entirely calcitic. *U. Trias.-Cret.*

**Buchia** ROUILLIER, 1845, p. 289 [*\*Avicula mosquensis* VON BUCH, 1844, p. 537; M] [=*Aucella* KEYSERLING, 1846 (suppression confirmed by ICZN Opinion 492); *Ancella* STOLICZKA, 1866 (*nom. null.*); *Anaucella* PHELINTSEVA, 1955 (type, *Aucella bronni* LAHUSEN, 1888 (*non* ROUILLIER, 1848))]. Strongly prosocline, height well exceeding length; highly inequivalve, LV strongly convex with more or less prominently projecting umbo and prosogyrous beak, RV flat to feebly convex with its umbo scarcely projecting; right anterior auricle concave tongue-like process which is not in alignment with hinge margin but extends toward LV and rests in socket in its cardinal area in front of beak; cardinal area an inequilateral triangle of moderate breadth in each valve, with shallow ligamental pit directed backward from beak, pit of LV with raised margins; ornament of concentric ridges or ribs, with subordinate radial threads in some species. (The differences between the type species of *Anaucella* (not yet renamed) and typical *Buchia* appear not to be of more than specific importance. PHELINTSEVA, however, also included in *Anaucella* the Triassic species "*Lima*" *ussuriensis* VORONETZ; this probably should be made the type of a new genus which may not belong to the Buchiidae.) *M. Jur. (Aalen.)-L. Cret.*, cosmop., most abundant in boreal regions; *U. Jur.-U. Cret. (Maastricht.)*, Ind.O. (Madag.)-USSR. — FIG. C96,1a,b. **\*B. mosquensis** (VON BUCH), U. Jur. (L. Volg.), USSR; 1a,b, LV ext., RV view of both valves,  $\times 1$  (Lahusen, 1888). — FIG. C96,1c,d. **B. subovalis** (PAVLOV), U. Jur. (L. Volg.), USSR; 1c,d, RV ext., int.,  $\times 1$ ,  $\times 2$ , showing auricle (Pavlov, 1907). — FIG. C96,1e. **B. keyserlingi** LAHUSEN, L. Cret.

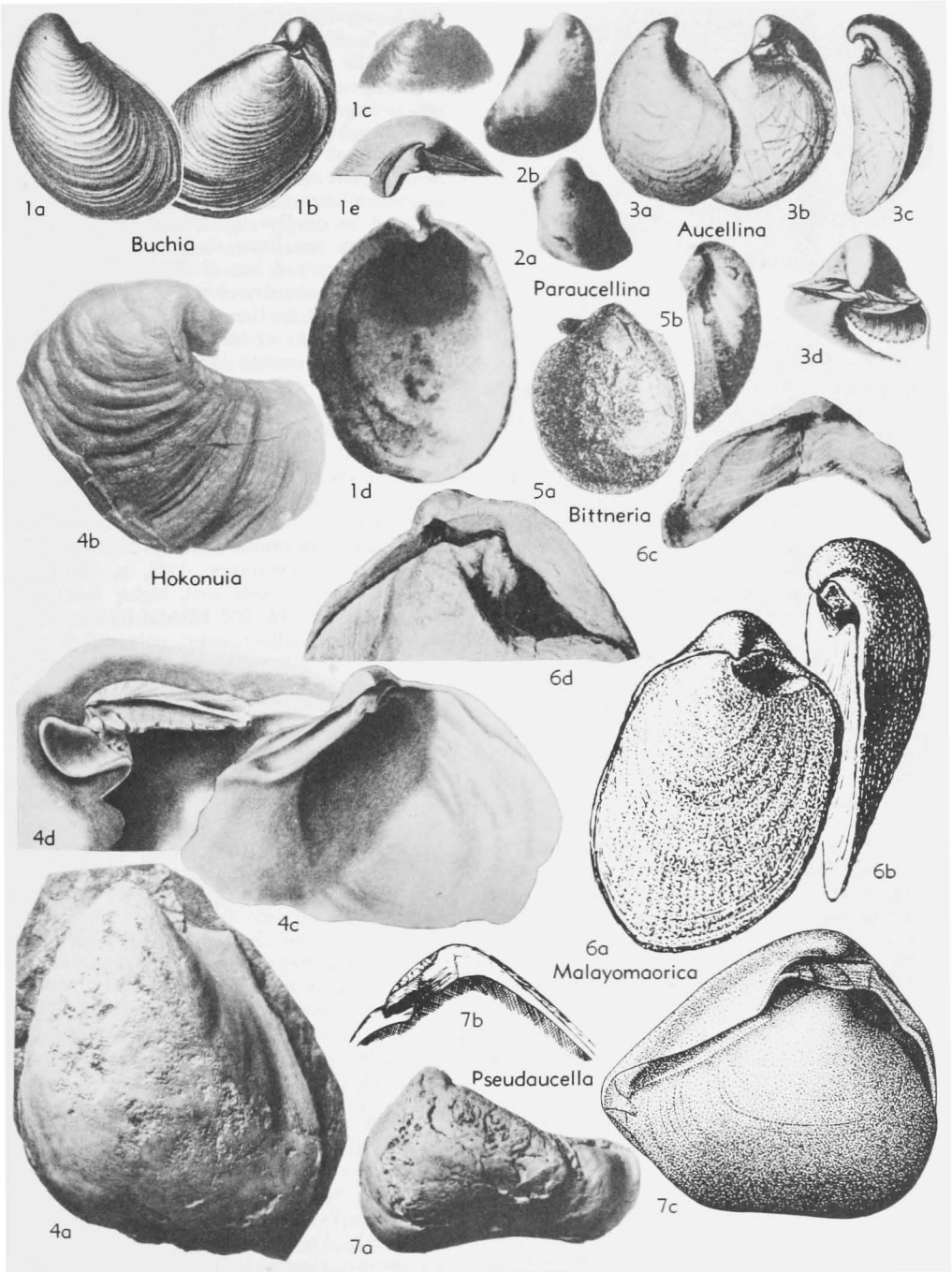


FIG. C96. Buchiidae (p. N374, N376-N377).





FIG. C97. Buchiidae (p. N376).

(L.Neocom.), USSR; dorsal view RV showing auricle and ligamental pit,  $\times 2$  (747).

**Anningella** COX, 1958, p. 44 [*pro Anningia* COX, 1936 (non BROOM, 1927)] [*\*Anningia carixensis* COX, 1936, p. 468; OD]. Known only by RV, which is ovate, higher than long, almost acline, flattened in earlier growth stages, later moderately convex; anterior auricle projecting prominently, lying in plane of valve margins, its lower margin strongly sinuate but not forming side of deep notch; ornament of concentric growth imbrications. *L.Jur.(L.Lias.)*, Eng.—FIG. C97,1. *\*A. carixensis* (COX); RV ext.,  $\times 1.3$  (178).

**Aucellina** POMPECKJ, 1901, p. 365 [*\*Avicula gryphaeoides* J. DE C. SOWERBY, 1836, p. 335 (non SEDGWICK, 1828) (= *Inoceramus coquandianus* D'ORBIGNY, 1846, p. 505); SD MARWICK, 1939, p. 463]. Resembling *Buchia*, except that RV is always almost flat and its anterior auricle is in alignment with hinge margin, with cardinal area extending to its extremity; subauricular notch extending to beak; ctenolium present. *Cret.(Apt.-Turon.)*, Eu.-Caucasus-Australia-Patag.-Antarctic.—FIG. C96,3. *A. coquandiana* (D'ORBIGNY), Alb., Ger. (3a-c); Eng. (3d); 3a-c, LV ext., RV and ant. views of both valves, all  $\times 1$  (747); 3d, Eng.; RV ant. auricle and cardinal area,  $\times 3$  (WOODS, 1905).

?**Bittneria** BROILI, 1904, p. 168 [*\*Avicula? efflata* BROILI, 1904, p. 167; M]. Higher than long, prosocline; LV strongly convex, with well-protruding umbo; RV unknown; LV posterior wing quite undemarcated but small anterior wing well defined, separated from body of valve by deep sinus; surface smooth. *U.Trias.*, Eu.(S.Tyrol.).—FIG. C96,5. *\*B. efflata* (BROILI); 5a,b, LV ext. and ant. views,  $\times 1$  (950).

**Hokonuia** TRECHMANN, 1918, p. 202 [*\*H. limaeformis*; SD DIENER, 1923, p. 118] [= *Nuggetia* WILCKENS, 1927, p. 29 (type, *N. morgamiana*, = *H. limaeformis*); M]. Large, prosocline, gibbose, slightly inequivalve, commonly irregular in form, especially anteriorly; LV well inflated, with prominent umbo and strongly prosogyrous beak; RV

less convex than LV, with strongly prosogyrous, angular beak; posterodorsal region obtusely angular in each valve; left anterior wing ill-defined, extending only slightly beyond beak, right anterior auricle large, nearly parallel-sided, extending almost at right angles to hinge line so as to project into cavity of other valve below its hinge margin; deep, angular subauricular notch present, its margin, which bears ctenolium, lying in narrow lunule bordered by sharply angular and strongly curved ridge which passes from beak to projecting anterior margin; both valves with broad, concave, triangular ligamental area posterior to beak, area bearing 2 toothlike longitudinal ridges in some specimens; surface of shell unornamented except for irregular concentric undulations. *U.Trias.(Carn.)*, N.Z.—FIG. C96,4. *\*H. limaeformis*; 4a, LV ext.,  $\times 0.7$  (COX, n); 4b, dorsal ant. part of RV showing auricle and ridge bordering lunule,  $\times 0.7$  (COX, n); 4c, LV int. showing ligamental area,  $\times 1$  (Waterhouse, 1961); 4d, RV int. showing auricle and ligamental area,  $\times 1$  (Waterhouse, 1961).

**Malayomaorica** JELETZKY, 1963, p. 149 [*\*Aucella malayomaorica* KRUMBECK, 1923, p. 65; OD]. Medium-sized, obliquely oval, higher than long, strongly inequivalve, LV moderately to strongly convex with broadly rounded, only slightly protruding umbo, RV feebly convex; hinge margin short, posterior wings obtuse, not clearly demarcated; left beak well removed from anterior end of hinge line; left anterior wing well developed in some specimens, almost absent in others; right anterior auricle relatively large, bent towards LV, with wide notch beneath it; ligamental area of LV broad, almost in plane of valve margins, longitudinally striated, with its lower margin indented by deep transverse furrow originating below beak, and with irregular anterior toothlike bulge which fits into interior of right anterior auricle; ligamental area of RV with ridge which fits into transverse furrow of LV; ornament of subimbricate growth lamellae crossed by radial threads, best seen on LV, small tubercles or spines at points of intersection. *U.Jur.(Kimmeridg.)*, Indonesia-N.Z.—FIG. C96,6. *\*M. malayomaorica* (KRUMBECK), E.Celebes (6a,b), N.Z. (6c,d); 6a,b, viewed from right side and from ant. end,  $\times 1.5$  (Wandel, 1936); 6c, ligamental area of LV, showing furrow and bulge; 6d, dorsal region of both valves juxtaposed, RV in front; both  $\times 2$  (Jeletzky, 1963).

**Paraucellina** PAVLOV, 1907, p. 89 [*\*P. krasnopolskii*; M]. Very thin and fragile; LV strongly convex, trigonally ovate, slightly prosocline; umbo prominent, beak almost at middle of hinge margin; left anterior wing well defined, its outer angle approximately right angle; ligamental area narrow; RV unknown. *U.Cret.(Cenoman.)*, USSR.—FIG. C96,2. *\*P. krasnopolskii*; 2a,b, LV

viewed from side and front,  $\times 2$  (Pavlov, 1907). *Pseudaucella* MARWICK, 1926, p. 305 [*\*Aucella? marshalli* TRECHMANN, 1923, p. 269; OD]. Rather small subequivalve, well inflated, variable in shape but commonly subtrigonal, longer than high; beaks at about anterior third of length, orthogyrous; hinge margin very short; postero-dorsal region with broad, well-impressed escutcheon; ventral margin commonly with broad sinus; anterior margin extending well beyond right anterior auricle, which is small and narrow, with acute sinus beneath it, and projects over LV to some extent; ligamental area relatively wide, extending almost equally on both sides of beak in LV; ligamental pit broad; at top of ligamental area, in LV, horizontal groove anterior to beak apparently received upper margin of right anterior auricle; ligamental area of RV apparently extending on to lower part of auricle. *L.Jur.(U.Lias.)*, N.Z.-N.Caledonia.—FIG. C96,7. *\*P. marshalli* (TRECHMANN), N.Z.; 7a, LV,  $\times 1$  (Cox, n); 7b, RV ligamental area and anterior auricle,  $\times 2.7$  (Marwick, 1926); 7c, specimen with valves displaced, showing LV ligamental area,  $\times 2.7$  (Cox, n).

#### Family PLICATULIDAE Watson, 1930

[*nom. transl.* IREDALE, 1939 (*ex Plicatulinae* WATSON, 1930)]  
[Materials for this family prepared by L. R. Cox and L. G. HERTLEIN]

Small to medium-sized, oval, orbicular or subtrigonal, mostly subequilateral, commonly somewhat irregular in outline, usually rather compressed; inequivalve to subequivalve, valve margins closed, byssal notch lacking; auricles small or absent; RV attached to umbo or by larger area of its surface; monomyarian, with adductor scar relatively small, suborbicular or irregular in shape; cardinal area small or absent, not differing appreciably in size in the two valves when present; resilium deeply sunk in triangular pit; hinge typically with isodont crura, 2 in each valve; surface concentrically lamellose and usually with irregular radial costae, costellae or threads; shell structure as in Spondylidae. Separated from that family mainly on grounds of soft anatomy. *M.Trias.-Rec.*

*Plicatula* LAMARCK, 1801, p. 132 [*\*Spondylus plicatus* LINNÉ, 1758; SD SCHMIDT, 1818] [= *Plicatuligenus* RENIER, 1807 (suppressed ICZN); *Micatula* CARPENTER, 1859 (*nom. null.*); *Plycatula* MONTEROSATO, 1877 (*nom. null.*)]. Small to medium-sized, subequivalve or with RV usually more convex; attachment area small to moderately large; cardinal area small; resilium pit acutely

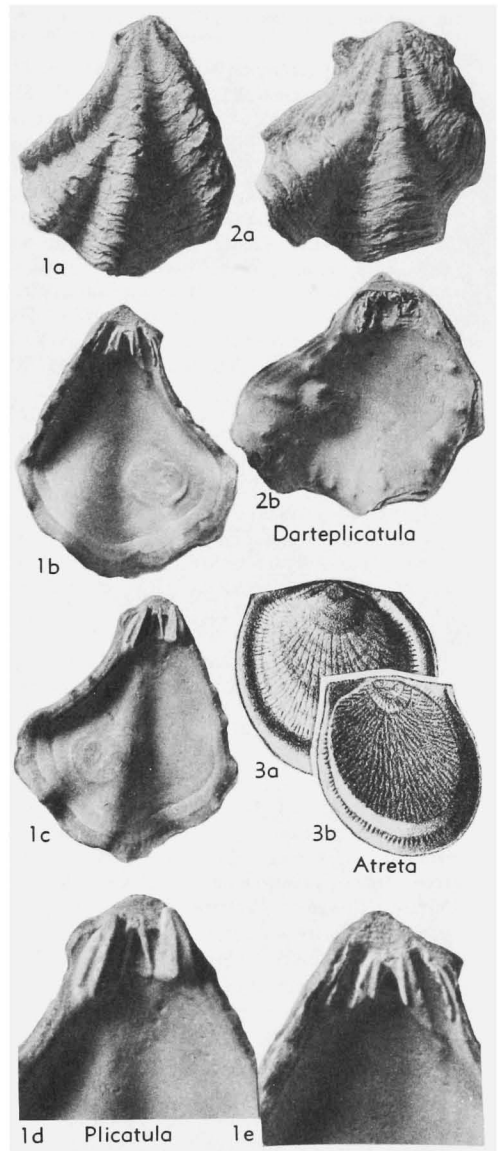


FIG. C98. Plicatulidae (p. N377-N388).

triangular; crura straight, narrow, prominent, narrowly divergent, crenulated, those in RV adjacent to resilium pit; in addition, sides of pit in LV formed by raised ridges simulating 2nd pair of crura; adductor scar situated in relatively posterior position. *M.Trias.(Ladin.)-Rec.*, Eu.-Afr.-N.Am.-Indon.

[Many authors have considered *P. gibbosa* LAMARCK to be synonymous with the Linnean species *Spondylus plicatus*,

but according to H. DODGE (1952, *Bull. Am. Mus. Nat. Hist.*, v. 100, p. 127) "this identification cannot be supported.")

**P. (Plicatula)** [= *Harpax* PARKINSON, 1811, p. 221 (type, *H. parkinsoni* BRONN, 1824, p. 52; SD, M); ?*Ostrenomia* CONRAD, 1872, p. 216 (type, *O. carolinensis*; M); *Plicatulopecten* NEUMANN, 1907, p. 104 (type, *Plicatulopecten boehmi*; SD Cox, herein)]. Auricles absent or ill-defined; most species with radial ornament, which may range from fine costellae to broad costae, and with imbricating growth lamellae; short spines present in many forms. *M.Trias.*(*Ladin.*)-*Rec.*; fossil forms cosmop., *Rec.*, trop. only.—FIG. C98.1. *P. (P.) marginata* SAY, Mio., USA (Va.); *1a,b*, LV ext., int., *1c*, RV int., all  $\times 1$ ; *1d,e*, RV and LV hinge,  $\times 2$  (Cox, n).

**P. (Darteplicatula)** FRENEIX & GORODISKI, 1963, p. 35 [\**P. polymorpha* BELLARDI, 1854, p. 197; OD]. With more or less distinct auricles; ornament of broad radial costae and submicroscopic radial striation; interior with tubercles or short costae near margin. *Eoc.-L.Mio.*, Eu.-N.Afr.-W. Afr.-N.Am.—FIG. C98.2. \**P. (D.) polymorpha*, *Eoc.*, S.Nigeria; *2a,b*, RV ext., LV int.,  $\times 1.1$  (Cox, n).

**P. (Pseudoplacunopsis)** BITTNER, 1895, p. 215 [\**Pseudoplacunopsis affixa*; OD]. Orbicular, not auriculate, compressed, RV flatter than LV, some specimens attached by almost its entire surface; ornament of fine radial threads. *U.Trias.*, Eu.-Jordan-Indon.

**Atrata** ÉTALLON, 1862, p. 192 [\**Ostrea blandina* D'ORBIGNY, 1850, p. 375; SD Cox, 1964, p. 45] [= *Diploschiza* CONRAD, 1866, p. 77 (type, *D. cretacea*); *Cyclostreon* EICHWALD, 1868, p. 406 (type, *Ostrea plicatuloides* LEYMERIE, 1851, p. 195; M); *Dimyopsis* BITTNER, 1895, p. 219 (type, *Ostrea intusstriata* EMMRICH, 1853, p. 377; M)]. Small, orbicular; RV shallowly bowl-shaped with flattened rim, attached by greater part of its surface and bearing internal divaricating or anastomosing riblets ending in some species as transverse crenulations of rim; LV flat or almost so, with concentrically lamellose exterior; resilium pit very small; crura short and thin, rarely observable; adductor scar obscure. *U.Trias.*(*Carn.*)-*U.Cret.*(*Camp.*), Eu.-N.Am.—FIG. C98.3. \**A. blandina* (D'ORBIGNY), U.Jur.(Oxford.), France (Jura); *3a,b*, RV int., RV int.,  $\times 2$  (de Loriol, 1904).

**Saintiopsis** SACCO, 1898, p. 11 [\**Plicatula laevis* SACCO, 1898 (*ex* BELLARDI MS.)]. Small, sub-orbicular to subquadrate, subalate, thin-shelled, smooth; RV broadly adherent, flat, LV feebly convex; hinge structure as in *Plicatula* but crura widely divergent. *Plio.*, Italy.

[The type species, attributed to BELLARDI, appeared as a *nom. nud.* in faunal lists long before its description by SACCO.]

## Family SPONDYLIDAE Gray, 1826

[Materials for this family prepared by L. G. HERTLEIN & L. R. COX]

Small to (mostly) medium-sized, orbicular or oval, gibbous, inequivalve, RV usually more convex; nearly equilateral, pectiniform, closed, with byssal notch lacking, slightly auriculate; attached at umbo or by larger area of surface of RV; monomyarian, with large, subcircular, posteriorly placed adductor scar; cardinal area amphidetic, much larger on attached valve, where it commonly forms acute triangle; ligament alivincular, resilium deeply sunk in triangular pit; hinge taxodont in early stage, with isodont crura, two in each valve, in adult stage, those in RV adjacent to resilium pit, sculpture of irregular radial costellae, commonly spinose; inner layers of ostracum aragonitic but not nacreous, outer layer calcitic, lamellar. *Jur.-Rec.*

While the outer shell layer is relatively persistent in this family, as in the Pectinidae, the inner layer, including the hinge crura, may disappear in fossilization. Hence many fossil specimens, such as those from the Upper Cretaceous upon which the genus *Dianchora* was founded, appear to be edentulous.

**Spondylus** LINNÉ, 1758, p. 690 [\**S. gaederopus*; SD SCHMIDT, 1818, p. 61] [= *Spondyligenus* RENIER, 1807 (suppressed ICZN); *Gaideropa* DESHAYES, 1832, p. 163 (obj.); *Spondilus* VERANY, 1846 (*nom. null.*); *Spodylus* NAGAO, 1934 (*nom. null.*)]. Characters of family. *Jur.-Rec.*, W.Pac.-IndoPac.-Medit.

**S. (Spondylus)** [= *Dianchora* J. SOWERBY, 1815, p. 183 (type, *D. striata*; SD Cox, herein); *Podopsis* LAMARCK, 1819, p. 194 (type, *P. truncatus*; SD Cox, herein); *Pachytos* DEFURANCE, 1825, p. 207 (type, *Plagiostoma spinosa* J. SOWERBY, 1814, p. 177; SD HERRMANNSEN, 1847, p. 188); *Pachytes* HOENINGHAUS, 1830 (*nom. van.*); *Pachyta* MENKE, 1830 (*nom. van.*); *Pachytus* AGASSIZ, 1846 (*nom. van.*); *Pachites* D'ORBIGNY, 1846 (*nom. null.*); *Diachora* DESMAREST, 1859 (*nom. null.*); *Eleutherospondylos* DUNKER, 1882 (type, *Spondylus regius* LINNÉ; SD Cox, herein); *Lanilda* IREDALE, 1939, p. 373 (type, *Spondylus ducalis* ROEDING, 1798, p. 194; OD); *Sponvola* IREDALE, 1939, p. 379 (type, *S. ella*)]. Well inflated, mostly with strong radial sculpture, many forms spiny or foliaceous; cardinal area of RV large, triangular; crural teeth short, heavy, smooth or with weakly crenulated edges. *Jur.-Rec.*, fossil forms cosmop., *Rec.*, pantropic.—FIG. C99,

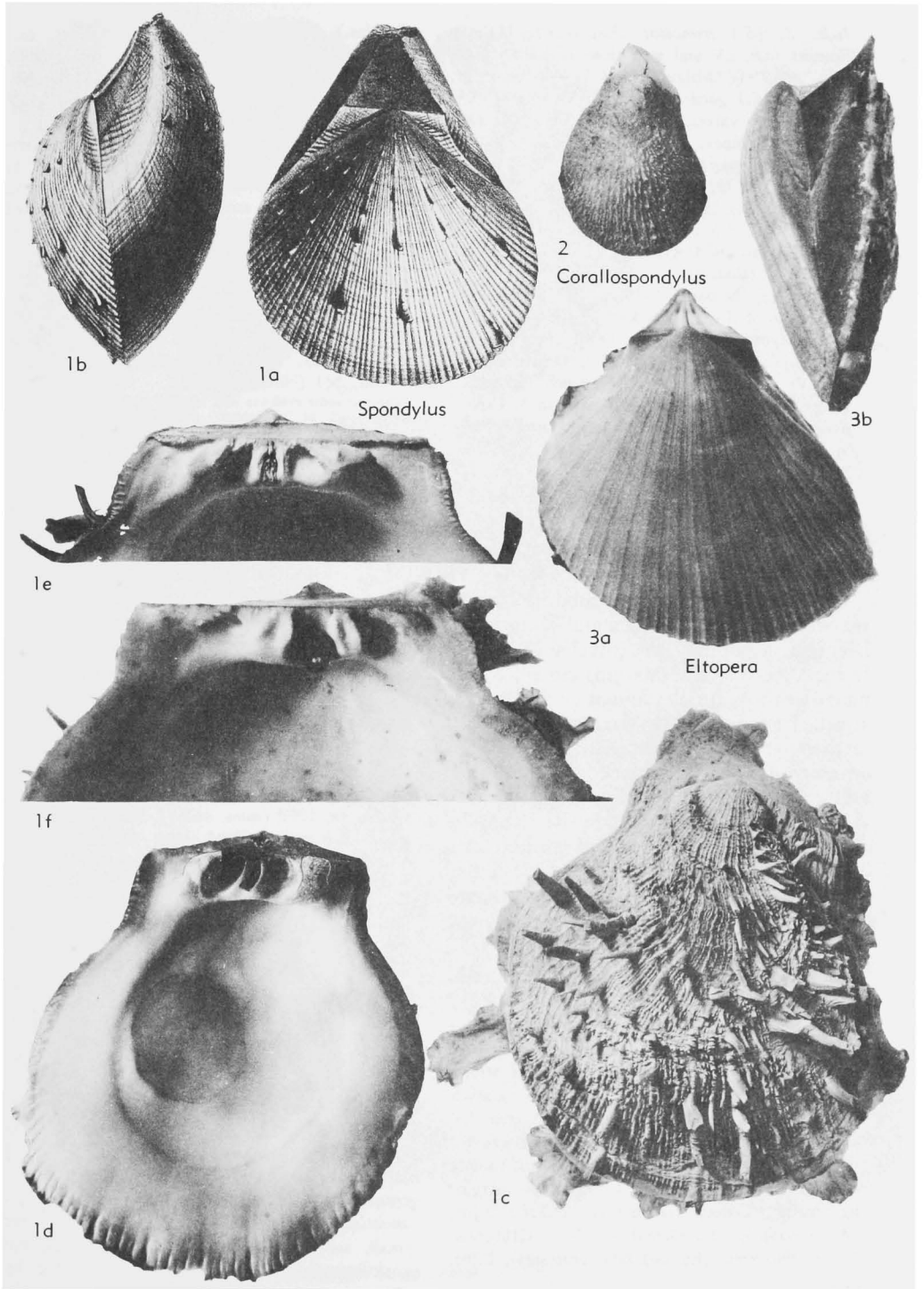


FIG. C99. Spondylidae (p. N378, N380).

*1a,b*. *S. (S.) truncatus* (LAMARCK), U.Cret., France; *1a,b*, LV and ant. views of both valves, both  $\times 0.7$  (d'Orbigny, 1843-7).—FIG. C99, *1c-f*. \**S. (S.) gaederopus*, Rec., Medit.; *1c*, LV view of both valves,  $\times 1$ ; *1d*, LV int.,  $\times 1$ ; *1e,f*, LV and RV hinge,  $\times 1$  (all Cox, n).

**S. (Corallospondylus)** MONTEROSATO, 1917, p. 2 [\**S. gussonii* O. G. COSTA, 1829, p. xli; M]. Small, terebratuloid, with delicately spinose radial costellae. *Oligo.-Rec.*, Medit.—FIG. C99,2. \**S. (C.) gussonii* COSTA, Rec.; LV view of both valves,  $\times 2$  (Cox, n).

**S. (Eltopera)** IREDALE, 1939, p. 377 [\**S. fortior* (as subsp. of *S. pacificus* REEVE, 1856, based on its holotype, expl. pl. 1); OD]. Less inflated than *S. (Spondylus)*, attached by entire surface of RV; cardinal area of RV much elongated; radial ornament more delicate than in *S. (Spondylus)*; crural teeth small, rather widely separated. *Rec.*, W.Pac.-IndoPac.—FIG. C99,3. \**S. (E.) pacificus*, Lord Hood I.; *3a,b*, ext., LV facing observer, and end view, both  $\times 1$  (Cox, n).

### Family TERQUEMIIDAE Cox, 1964

[Materials for this family prepared by L. R. Cox]

Small to medium-sized, suborbicular or subovate, mostly subequilateral, commonly irregular in outline; subequivalve to strongly inequivalve, valve margins closed, byssal notch lacking; auricles absent or ill-defined; attached at umbo or by larger area of surface of RV<sup>1</sup>; monomyarian; each valve typically with well-developed cardinal area with median ligamental pit which is triangular in shape or at least has dorsally converging sides; no internal resilium pit; crura absent<sup>2</sup>; surface with irregular radial costae, costellae, or threads, spinose in some forms; original shell structure unknown. ?*L.Perm.*, *Trias.-U.Jur.*, ?*Cret.*

**Terquemia** TATE, 1867, p. 395 [*pro Carpenteria* EUDES-DESLONGCHAMPS, 1860 (*non* GRAY, 1858)] [\**Carpenteria pectiniiformis* EUDES-DESLONGCHAMPS, 1860, p. 130; SD STOLICZKA, 1871, p. 443]. Moderately large, oyster-like, with strong radial ribs, not auriculate; RV strongly convex with medium-sized to large attachment area, LV almost flat to moderately convex; cardinal area of moderate breadth, longitudinally extended, usually not triangular but truncated by its upper margin; ligamental pit deep and narrow. *U.Trias.-U.Jur. (Kimmeridg.)*, Eu.-Greenl.—FIG. C100,3a,b. \**T. pectiniiformis* (EUDES-DESLONGCHAMPS), L.Jur.

(M.Lias.), France(Calvados); *3a,b*, RV ext., int.,  $\times 1$  (Eudes-Deslongchamps, 1860).—FIG. C100,3c. *T. ostreiformis* (D'ORBIGNY), U.Jur.(U. Oxford.), France(Jura); RV cardinal area,  $\times 0.7$  (550).

**Enantiostreon** BITTNER, 1901, p. 70 [\**E. hungaricum*; SD DIENER, 1923, p. 128]. Similar to *Terquemia* in form and strongly costate ornament, but with cardinal area triangular, less elongated longitudinally and with relatively broader ligamental pit. ?*U.Perm.*, Japan; *L.Trias.(Scyth.)-U.Trias.(Rhaet.)*, Eu. (Ger.-N. Alps-S. Alps-Hung.-Spain)-China.—FIG. C100,5a. \**E. hungaricum*, U.Trias.(Rhaet.), Bavaria; RV ext.,  $\times 0.7$  (Frech, 1907).—FIG. C100,5b. *E. cristadiforme* (VON SCHLOTHEIM), M.Trias.(Muschelkalk), L.Silesia; LV int.,  $\times 1$  (Noetling, 1880).

[There is some evidence that Middle Triassic (Muschelkalk) species such as "*Ostracites cristadiformis* VON SCHLOTHEIM, which have been included in *Enantiostreon*, may be attached by LV or RV indifferently (cf. SEILACHER, 1954, *Neues Jahrb. Geol. Paläont., Monatsh.*, v. 4, p. 173, who refers these forms to the ostrean genus "*Alectryonia*," = *Lopha*).]

?**Gerlus** DE GREGORIO, 1930, p. 21 [\**Placunopsis hystrix* GEMMELLARO, 1875, p. 64; M]. Small to medium-sized, subtrigonal to orbicular, not auriculate; attached valve strongly convex, free valve flat or concave; ornament of narrow beaded costellae with broader intervals; internal characters unknown. *U.Trias.*, Sicily.—FIG. C100,1. \**G. hystrix* (GEMMELLARO); *1a-c*, RV ext., LV ext., RV lat.,  $\times 1$  (Gemmellaro, 1875).

**Newaagia** HERTLEIN, 1952, p. 275 [*pro Philippiella* WAAGEN, 1907 (*non* PFEIFFER, 1886)] [\**Spondylus obliquus* VON MÜNSTER, 1841, p. 74; SD DIENER, 1923, p. 124, for *Philippiella*] [= *Lucasiella* COSSMANN, 1909 (*non* BANKS, 1900); *Philippiella* COSSMANN, 1909 (*nom. null.*)]. Small to medium-sized; RV well inflated, with moderately large attachment area, LV flat to feebly convex; anterior and posterior wings small but distinct; cardinal area elongated longitudinally, obtusely triangular; ligamental pit narrow, triangular; ornament of spinose radial ribs, recalling that of *Spondylus*. ?*L.Perm.*, *U.Trias.(Carn.)*, USA(Tex.)-Eu.(Ger.-N.Alps-S.Alps)-Asia(Iran).—FIG. C100,2a,b. *N. noetlingi* (FRECH), M.Trias.(Muschelkalk), U.Silesia; *2a,b*, LV and RV ext.,  $\times 1$  (Frech, 1907).—FIG. C100,2c. \**N. obliqua* (VON MÜNSTER), M. Trias.(Ladin.), S.Tyrol; LV int.,  $\times 1$  (58).

?**Placunopsis** MORRIS & LYCETT, 1853, p. 5 [\**P. fibrosa* LAUBE, 1867, p. 16 (= *P. jurensis* (*non* ROEMER sp.) MORRIS & LYCETT; ICZN pend.) [= *Placunopsis* MEEK, 1873 (*nom. null.*)]; ?*Holocraspedum* CRAGIN, 1893, p. 190 (type, *Ostrea anomiaeformis* ROEMER, 1852, p. 75; M)]. Rather small, suborbicular or ovate, subequilateral, not auriculate; lower valve (?RV) flat, attached by almost its entire surface when evidence of attachment exists, specimens with smaller attachment

<sup>1</sup> See note with *Enantiostreon*, however.

<sup>2</sup> See note on *Placunopsis*, however.

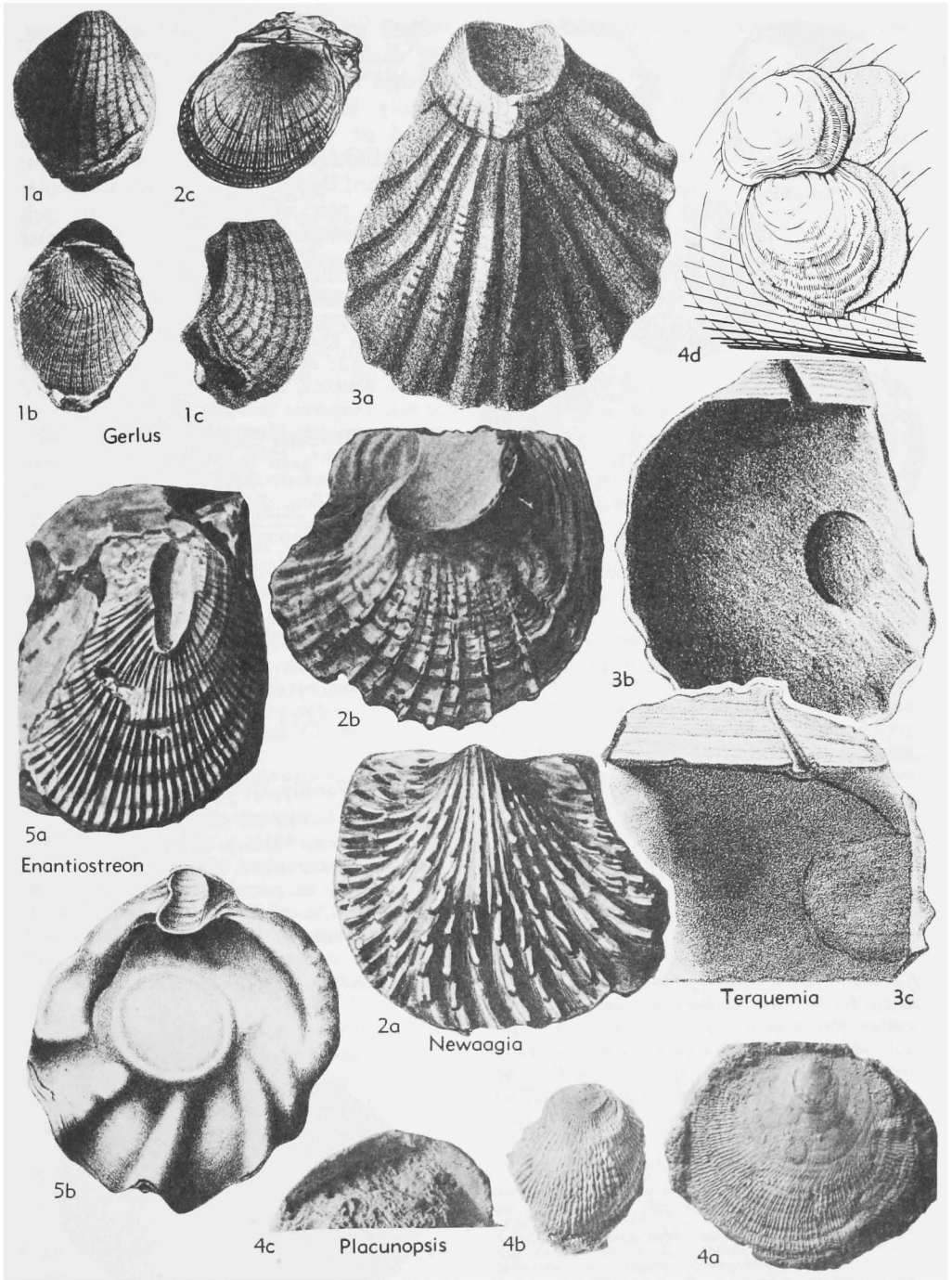


FIG. C100. Terquemiidae (p. N380, N382).



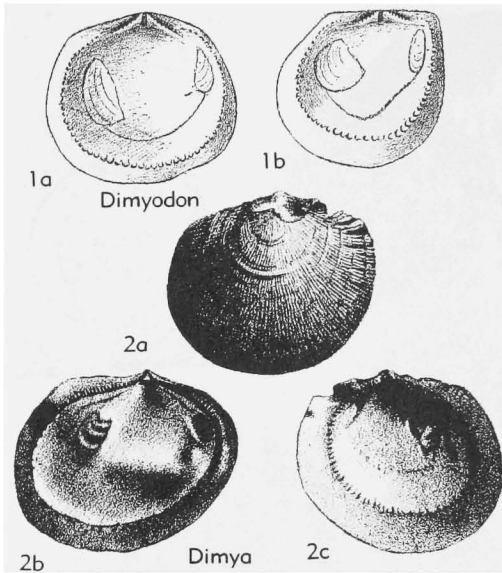


FIG. C101. Dimyidae (p. N382).

areas rare or wanting; upper valve almost flat to strongly inflated, with distinct, not quite marginal umbo, some specimens with allomorphic sculpture derived from shells to which lower valve had grown attached; adductor scar relatively large, not quite median in position; no well-defined cardinal area, ligamental pit or chondrophore; an uneven thickening along the hinge margin may have been cardinal area; irregular transverse ridge or swelling, function of which is uncertain, occupies umbonal cavity of free valve; crura typically absent (note 1); ornament of irregular radial threads, barely visible in some species, well developed in others; ostracum foliaceous. *M.Trias-U.Cret.(Maastricht.)*, cosmop. (note 2).—FIG. C100, *4a-c*. \**P. fibrosa* (LAUBE), *M.Jur.(Bathon.)*, Eng.; *4a*, flat but presumed LV ext.,  $\times 1$ ; *4b,c*, convex specimen, also presumed to be LV ext.,  $\times 1$ , and int. of hinge region, arrow pointing to swelling in umbonal cavity,  $\times 2.3$  (all Cox, n).—FIG. C100, *4d*. *P. plana* (GIEBEL), *M.Trias.(Muschelkalk)*, Ger.; specimens sessile on *Lima* shell,  $\times 1.3$  (Seilacher, 1954).

[1] SEILACHER (1954, *Neues Jahrb. Geol. Paläont., Monatsh.*, v. 4, p. 168, fig. 3) has illustrated the interior of 4 attached valves of "*Placunopsis*" *matricula* (QUENSTEDT) from the Lower Muschelkalk, each with a single oblique ridge anterior to the beak. No comparable structure has been observed in any other species. (2) Certain species from the Pennsylvanian of the USA which have been referred to *Placunopsis* are probably pseudomonotids (N. D. NEWELL, *in litt.*.)

### Family DIMYIDAE P. Fischer, 1886

[=Dimyacidae AUERT.] [Materials for this family prepared by L. R. COX and L. G. HERTLEIN]

Shell small, thin, suborbicular or oval, not auriculate, rather compressed, closed, attached by RV, which is less convex; externally lamellose, some species radially ribbed or striated; interior porcelaneous, with faint radial ridges in some forms; dimyarian; ligament an internal, alivincular resiliium; pair of cardinal crura in each dimyarian; ligament an internal, alivincular valve. *M.Jur.-Rec.*

**Dimya** ROUAULT, 1850, p. 470 [\**D. deshayesiana*; OD] [=Dymya ROUAULT, 1850 (*nom. nud.*), *Margariona* KOBELT (*ex DALL*, MS), 1882 (genus without sp.); *Deuteromya* COSSMANN, 1903 (*pro Dimya* ROUAULT, *non MENKE*, 1830, subordinal name), *Dimyarina* IREDALE, 1936, p. 269 (type, *Dimya corrugata* HEDLEY, 1902, p. 309; OD); *Dymia* NOSZKY, 1939 (*nom. null.*)]. Cardinal crura short and weak; posterior adductor scar bilobed. *Eoc.-Rec.*, Eu.-Carib.-Indon.-Australia-N. Z.-IndoPac.-E.Pac.—FIG. C101, 2. \**D. deshayesiana*, *Eoc.*, France; *2a,b*, RV ext., int., LV int.,  $\times 1.7$  (Rouault, 1850).

**Dimyodon** MUNIER-CHALMAS in FISCHER, 1886, p. 937 [\**D. schlumbergeri*; OD] [=Dimyodus WÖHRMANN, 1894 (*nom. van.*)]. Cardinal crura prominent, elongate, transversely striated; posterior adductor scar not bilobed. *M.Jur.(Bathon.)*, Eu. (France).—FIG. C101, 1. \**D. schlumbergeri*; *1a,b*, LV int., LV int.,  $\times 3.4$  (305).

### Family UNCERTAIN

[Materials for this family prepared by L. R. COX]

**Oretia** MARWICK, 1953, p. 62 [\**O. coxi*; OD]. Large to medium-sized, obliquely ovate, hinge margin short, no posterior wing; RV more inflated than LV, with well-protruding, anterior, slightly prosogyrous umbo, shallow lunule, and very small transverse anterior auricle with wide notch beneath it; hinge probably edentulous, liga-

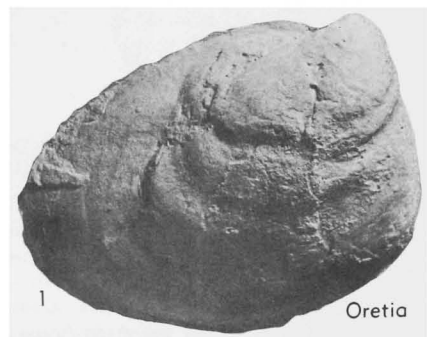


FIG. C102. Family uncertain (p. N382-N383).

ment unknown; surface with coarse, irregular concentric folds; ostracum relatively thin. *U.Trias.* (*Carn.*), N.Z.—FIG. C102,1. \**O. coxi*; RV,  $\times 0.7$  (Cox, n).

## Superfamily ANOMIACEA

### Rafinesque, 1815

[*nom. transl. et correct.* GILL, 1871 (ex family Anomia RAFINESQUE, 1815)] [Materials for this superfamily prepared by MYRA KEEN]

Monomyarian, anterior adductor muscle obsolete; gills filibranchiate; hinge lacking true teeth but with central ligament supported in some by ridges (*crura*); inner layer of shell lustrous. ?*Perm., Cret.-Rec.*

### Family ANOMIIDAE Rafinesque, 1815

[*nom. correct.* H. ADAMS & A. ADAMS, 1858 (pro family Anomia RAFINESQUE, 1815)] [=Placunidae GRAY, 1842]

Shells irregular in outline, mostly sessile, slightly to markedly inequivalve. Byssus present in young stages, later modified in most to become pluglike, horny, passing through embayment or foramen in lower valve (normally RV). Adductor muscle scar subcentral, with one or more pedal and byssal retractor muscle scars above it, best seen on LV, opposite to foramen. ?*Perm., Cret.-Rec.*

**Anomia** LINNÉ, 1758 [\**A. ehippium*; SD SCHMIDT, 1818] [=Echion POLI, 1791 (type, *A. caepa* LINNÉ = *A. ehippium*; SD KEEN, 1959); *Echio-noderma* POLI, 1795 (obj.), SD KEEN, 1959; *Fenestella* RÖDING, 1798 (obj.), SD WINCKWORTH, 1945; *Operculella* MONTEROSATO, 1915 (type, *O. operculata*; *nom. nud.*) (?non REICHENBACH, 1828)]. Shell thin, partially attached, foramen in RV, LV with 3 muscle scars on central area. ?*Perm., Cret.-Rec., Eu.-Afr.-AsiaM.-N.Am.-Australia-N.Z.*

**A. (Anomia)**. Surface sculptured with radial striae; byssal retractor muscle scars 3, subequal; foramen of moderate size. ?*Perm., Cret.-Rec., Eu.-Afr.-Asia-N.Am.*—FIG. C103,4. \**A. (A.) ehippium*, *Rec., Eu.*; *4a,b*, RV ext., LV int.,  $\times 0.5$  (Keen, n).

**A. (Paraplacuna)** OPPENHEIM, 1892 [\**A. gregaria* BAYAN, 1870; M]. Lower retractor scar partly coalesced with adductor scar; sculpture somewhat reticulate. [In brackish-water beds.] *Eoc., Eu.*—FIG. C103,1. \**A. (P.) gregaria* BAYAN, *Hung.*; *1a-c*, LV ext., int., RV int.,  $\times 0.7$  (691).

**A. (Patro)** GRAY, 1850 [\**A. elyros* (= *A. australis* GRAY, 1847; M)] [= *Patros* GRAY, 1850 (*nom. null.*)]. Byssal foramen small, 2 retractor

scars smaller than lower (adductor) scar. *Rec., Australia.*

**A. (Prismatro)** MARWICK, 1948 [\**A. undata* HUTTON, 1885; OD]. Shell lacking radial striae; RV thick, prismatic. *Plio., N.Z.*

**Carolia** CANTRAINE, 1838 [\**C. placunoides*; M] [= *Hemiplacuna* GRAY, 1850 (type, *H. rozieri* GRAY, 1850; M)]. Compressed-orbicular, byssal foramen small to wanting; adductor scar without accessory retractor scars. *Eoc.-Mio., N.Afr.-N.Am.-S.Am.*

**C. (Carolia)**. Surface radially striate; byssal foramen nearly closed in adult; resilium received by chondrophore in lower valve. *Eoc., N.Afr.-Carib.*—FIG. C103,9. \**C. (C.) placunoides*, *Egypt.*; *9a-b*; RV int., LV hinge,  $\times 0.5$  (1026).

**C. (Parinomya)** OLSSON, 1928 [\**C. (P.) parinensis*; OD]. Sculpture radial, with prickles and fimbriations; foramen persistent in adult. *Eoc., W.S.Am.-India.*

**C. (Wakullina)** DALL, 1896 [\**C. (W.) floridana*; OD]. Smooth, byssal foramen obsolete, resilium of upper valve on diverging *crura*. *Oligo.-Mio., E.N.Am.*

**Enigmonia** IREDALE, 1918 [*nom. subst. pro Aenigma* KOCH in MARTINI & CHEMNITZ, 1846 (non NEWMAN, 1836)] [\**Anomia rosea* GRAY, 1825 (= *A. aenigmatica* HOLTEN, 1803); OD]. Shell extremely thin, adapted to sessile attachment on mangrove roots. *Eoc.-Rec., Eu.-IndoPac.*—FIG. C103,2. \**E. aenigmatica* (HOLTEN), *Rec., Philip. Is.*; *2a-c*, LV ext., int., RV ext.,  $\times 1$  (1009).

?**Hemiplicatula** DESHAYES, 1861 [\**Placuna solida* DESHAYES in MELLEVILLE, 1843; M] [= *Semiplicatula* (*nom. null.*)]. Small, compressed, smooth, *crura* thick, resembling teeth; muscle scar sunken, submarginal. *Eoc., Eu.*—FIG. C103,7. \**H. solida* (DESHAYES in MELLEVILLE), *France.*; *7a-c*, RV ext., int., LV int.,  $\times 5$  (Deshayes, 1861).

?**Isomonnia** DAUTZENBERG & FISCHER, 1897 [\**Monia alberti* DAUTZENBERG & FISCHER, 1896; M]. Dorsal margin with auricles as in Pectinidae but without any byssal notch; upper retractor muscle scar large, coalesced with lower and with adductor scar. *Rec., Medit.*—FIG. C103,10. \**I. alberti* (DAUTZENBERG & FISCHER); *10a,b*, LV ext., int.,  $\times 1$  (Dautzenberg & Fischer).

**Paranomia** CONRAD, 1860 [\**Placunanomia (P.) saffordi* (= *Placuna scabra* MORTON, 1834); SD STOLICZKA, 1871] [= *Paronomia* GARDNER, 1916 (*nom. null.*)]. Byssal foramen closed in adult; one retractor scar in either valve; sculpture of spinose radial riblets. *U.Cret., E.N.Am.*—FIG. C103,8. \**P. scabra* (MORTON), *USA(Tenn.)*, *8a-c*, RV int., LV int., ext.,  $\times 0.7$  (951).

**Placuna** LIGHTFOOT, 1786 [\**Anomia placenta* LINNÉ, 1758; SD SCHMIDT, 1818] [= *Placenta* PHILIPSSON, 1788, ex RETZIUS MS (obj.; T); *Ehippium* RÖDING, 1798 (type, *E. polonicum* = *Anomia sella* GMELIN, 1791) ?= *Placenta quadrangula* PHILIPSSON

SON, 1788; SD DALL, 1898); *Sellaria* LINK, 1807 (type, *S. anglicana* = *Anomia sella* GMELIN, 1791; SD KEEN, 1959); *Placunema* STOLICZKA,

1871 (type, *Anomia sella* GMELIN, 1791; OD)]. Outline of shell regularly orbicular to saddle-shaped, mostly compressed; resilium buttressed by

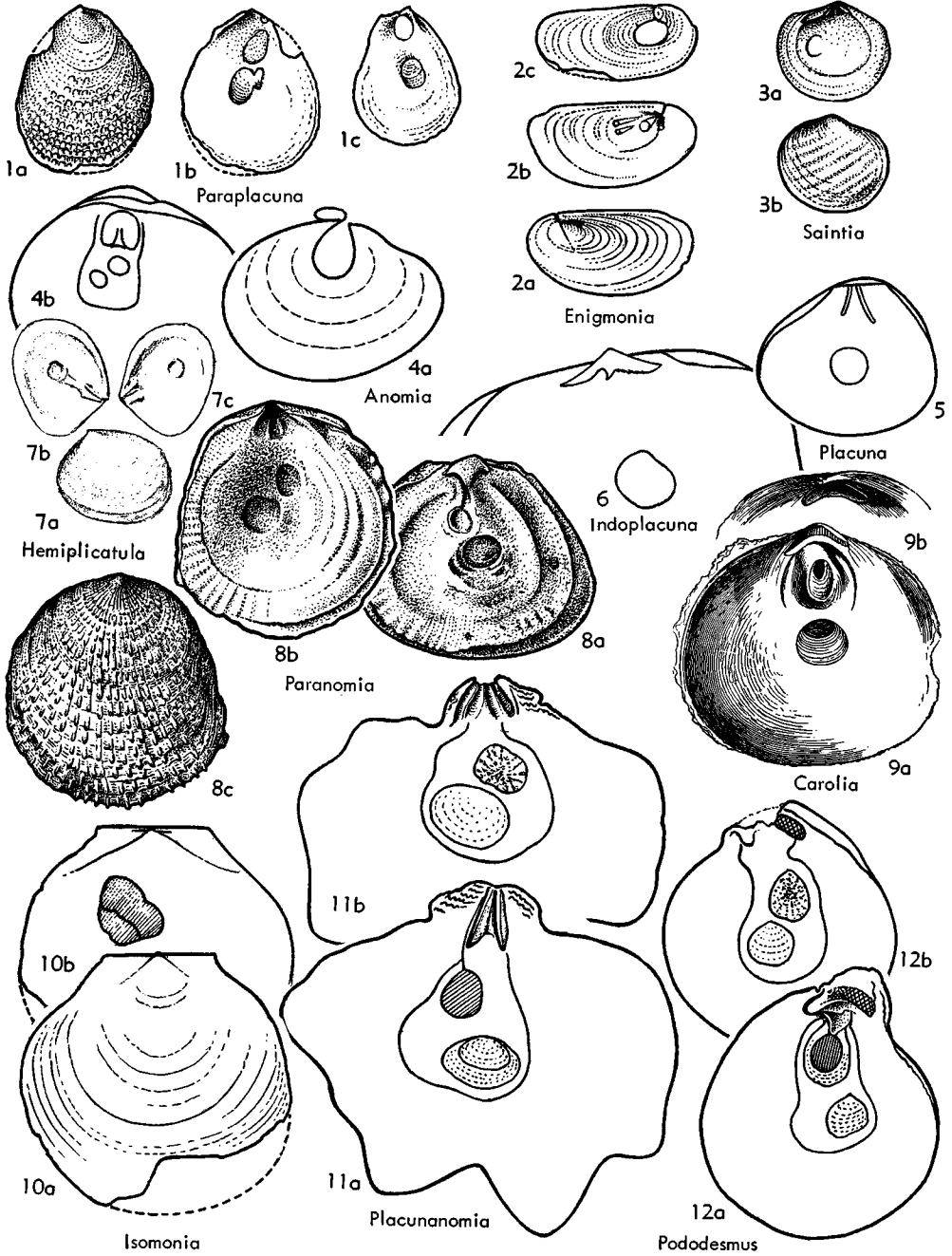


FIG. C103. Anomiidae (p. N383-N385).

long ridges or crura; not sessile. *Eoc.-Rec.*, Eu.-IndoPac.-Asia-N.Afr.

**P. (Placuna).** Flattened, crura widely diverging; central cavity small. *Oligo.-Rec.*, Eu.-IndoPac.—FIG. C103,5. \*P. (*P.*) *placenta* (LINNÉ), *Rec.*, Ceylon; RV int.,  $\times 0.25$  (242).

**P. (Indoplacuna)** VREDENBURG, 1924 [\*P. (*I.*) *sindiensis*; SD KEEN, 1959]. Resilifer bent sharply; primary crural ridges supplemented by less divergent secondary pair. *L.Mio.-M.Mio.*, S.Eu.-N.Afr.-Asia.—FIG. C103,6. \*P. (*I.*) *sindiensis*, India; RV int.,  $\times 0.5$  (242).

**P. (Pseudoplacuna)** MAYER, 1877 [\**Pseudoplacuna helvetica* MAYER, 1877; M]. Internal cavity larger, valves more inflated than in *P. (Placuna)*. *M.Eoc.*, Eu.

**Placunanomia** BRODERIP, 1832 [\*P. *cumingii*; M] [= *Placumonya*, *Placunanomya* WHITFIELD, 1885 (*nom. null.*); *Placunanomia* OLSSON, 1961 (*nom. null.*)]. With about 3 strong radial plications; byssal foramen obsolete in adult; interior with 1 retractor scar. *Mio.-Rec.*, E.N.Am.-W.C.Am.-W.N.Am.—FIG. C103,11. \*P. *cumingii*, *Rec.*, W.C.Am.; 11a,b, RV int., LV int.,  $\times 0.5$  (Stanford Univ. specimen).

**Pododesmus** PHILIPPI, 1837 [\*P. *decipiens* (= \**Placunanomia rudis* BRODERIP, 1834); M]. Sculpture of irregular corrugations; shell attached, byssal foramen large, small, or even obsolete; LV with 1 large and radially striate byssal retractor scar. ?*Oligo.*, *Mio.-Rec.*, N.Am.-S.Am.-Eu.-Australia.

**P. (Pododesmus).** Foramen small to partially or entirely closed outside. *Mio.-Rec.*, Japan-N.Am.-S.Am.—FIG. C103,12. \*P. (*P.*) *rudis* (BRODERIP), *Rec.*, E.S.Am.; 12a,b, RV int., LV int.,  $\times 0.5$  (Stanford Univ. specimen).

**P. (Heteranomia)** WINCKWORTH, 1922 [\**Anomia squamula* LINNÉ, 1758; OD]. Muscle scars small; gills U-shaped. *Rec.*, Eu.

**P. (Monia)** GRAY, 1850 [\**Anomia zelandica* GRAY in DIEFFENBACH, 1843; SD KOBELT, 1881] [= *Monica* COEN, 1933 (*nom. null.*)]. Byssal retractor scar large; foramen of moderate to large size. ?*Oligo.*, *Mio.-Rec.*, N.Z.-N.Am.-Eu.

**P. (Tedinia)** GRAY, 1853 [\**T. pernoides*; M]. Byssal foramen obsolete in adult; resilium elevated on pedestal-like chondrophore. *Rec.*, W.N.Am.

?**Saintia** RAINCOURT, 1877 [\**S. munieri*; OD]. Hinge with 2 bifid crura and central denticle; adductor scar large, circular, excentric; retractor scars not evident. *Eoc.(Cuis.)*, Eu.—FIG. C103,3. \**S. munieri*, France; 3a,b, LV int., ext.,  $\times 1$  (772).

## Superfamily LIMACEA Rafinesque, 1815

[*nom. transl.* NEWELL, herein (ex *Limidae* RAFINESQUE, 1815)] [Diagnosis by N. D. NEWELL]

Characters of *Limidae*. *L.Carb.-Rec.*

## Family LIMIDAE Rafinesque, 1815

[*nom. correct.* D'ORBIGNY, 1846 (pro family *Limaridia* RAFINESQUE, 1815)] [= *Radulidae* ADAMS & ADAMS, 1858] [Materials for this family prepared by L. R. COX and L. G. HERTLEIN]

Shell usually equivalve (slightly inequivalve in one subgenus), moderately to *Ctenostreon*), ovate, orbicular or subtrigonal, most commonly higher than long, many forms somewhat extended obliquely in anteroventral direction (i.e., opisthoclinal); typically biauriculate but with anterior auricle reduced or absent in some forms and posterior wing or auricle usually obtuse and commonly ill-differentiated from body of shell; triangular cardinal area with shallow triangular ligament pit present in both valves, umbones well separated; many forms with anterior gape close to or well separated from hinge margin and some with posterior gape also, gapes affecting both valves equally; hinge edentulous or with weak teeth of taxodont type; monomyarian, adductor scars rather obscure in most forms; surface smooth or with radial ornament, concentric ornament very rare; ostracum with outer calcitic layer and middle and inner layers of non-nacreous aragonite. [Some Recent forms capable of swimming by flapping of valves, with valve margins disposed vertically; some constructing protective nest with byssal threads.] *L.Carb.-Rec.*

**Lima** BRUGUIÈRE, 1797, pl. 206 [\**L. alba* CUVIER, 1797 (= *Ostrea lima* LINNÉ, 1758, p. 699); M, CUVIER, 1797, p. 421] [= *Mantellum* RÖDING, 1798 (obj.); *Limigenus* RENIER, 1807 (suppressed ICZN); *Limaria* RAFINESQUE, 1815 (*non* LINK, 1807); *Glaucion* OKEN, 1815 (obj.); *Radula* MÖRCH, 1853 (*non* GRAY, 1847)]. Subtrigonal, higher than long, with rather short hinge margin; auricles relatively well differentiated, anterior one slightly the smaller; anterior umbonal ridge not strongly marked; inflation only moderate; gapes of valve margins only slight; hinge edentulous or with weak denticles near ends of hinge margin; ornament of scaly radial ribs. *Jur.-Rec.*, cosmop.

[Although the year 1798 is usually cited as that of the publication of CUVIER's *Tableau élémentaire de l'histoire naturelle des animaux*, the title page of which bears the date "An 6," it is evident from an entry in the *Journal typographique et bibliographique*, Paris, Ann. 1, no. xi, p. 81, that its actual date of publication was prior to Dec. 24, 1797. Even then, however, it is most probable that it appeared later than BRUGUIÈRE's plate illustrating *Lima* in *Encyclopédie méthodique*.—¶Only the bare generic name *Lima* appeared in BRUGUIÈRE's plate illustrating a series of shells, so that to decide what species to take as type it is necessary to apply Article 69, a, ii, of the International Code. This Article does not make it clear whether it is applicable only if the generic name and its author are

cited in the earliest publication in which nominal species are referred to the genus. The present contributors consider that, although CUVIER did not state that the genus *Lima*, in which he included the single nominal species *Lima alba* (= *Ostrea lima* LINNÉ), was the genus which BRUGUIÈRE has founded rather than a supposedly new one, it may be reasonably assumed that it was BRUGUIÈRE's genus because (1) CUVIER omitted to mention the authors' names of most of the genera which he cited, including many which LINNÉ had founded in 1758; (2) CUVIER and BRUGUIÈRE both worked in Paris and maintained close touch with each other; and (3) it is highly improbable that two different authors would independently and in the same year have conceived the idea not only of erecting the same new zoological genus, but also of applying the same name *Lima* to it.—[VOKES (1963, *Tulane Studies in Geology*, v. 1, p. 75) has argued that the fixing of *Ostrea lima* as type species of *Lima* BRUGUIÈRE should be attributed to LAMARCK (1801, *Système des animaux sans vertèbres*, p. 136), but here again there is no mention of BRUGUIÈRE by name. The references given by LAMARCK, however, include one to the plate in the *Encyclopédie méthodique* in which BRUGUIÈRE established the genus *Lima*.]

**L. (Lima)** [= *Austrolima* IREDALE, 1929, p. 165 (type, *L. nimbifer*; *Australima* COTTON, 1931 (*nom. null.*)). Inequilateral, oblique, equivalve; some species with weak denticles in dorsal angles. *Jur.-Rec.*, cosmop.—FIG. C104.3. \**L. (L.) lima* (LINNÉ), *Rec.*, Philip. Is.; 3a, LV ext.; 3b, LV int. of hinge region, both  $\times 1$  (Cox, n).

**L. (Meotolima)** OYAMA, 1943, p. 36 [\**L. (M.) ogasawarana*; OD]. Subequilateral; slightly inequivalve, LV more inflated than RV and with wider ligament area. *Eoc.*, Japan.

**Acesta** ADAMS & ADAMS, 1858, p. 558 [\**Ostrea excavata* FABRICIUS, 1779, p. 368; M]. Large, thin-shelled, ovate, inequilateral, ventricose, with moderate byssal gape; anterior umbonal ridge ill-defined; anterior auricle reduced; cardinal area mainly posterior to beak, ligament pit broad, curved. [Now in cold waters or at great depths.] *U.Jur.-Rec.*, cosmop.

**A. (Acesta)** [= *Callolima* BARTSCH, 1913, p. 235 (type, *Lima (Callolima) rathbuni* BARTSCH)]. Ornament of superficial radiating riblets, commonly strongest laterally and grading into fine striae on median portion of valves. *U.Jur.-Rec.*, cosmop.—FIG. C104.2. \**A. (Acesta) excavata* (FABRICIUS), *Rec.*, Norway; LV ext.,  $\times 0.5$  (Cox, n).

**A. (Costellacesta)** KAUFFMAN, 1964, p. 95 [\**Lima (Costellacesta) riddlei*; OD]. Anterior auricle absent; byssal gape lanceolate, extended; entire surface bearing narrow rounded riblets of equal strength, with intervals each occupied by 1 to 6 weak subequal threads. *U.Cret. (Maastricht.)*, E. N.Am.

**A. (Plicacesta)** VOKES, 1963, p. 90 [\**Lima smithi* G. B. SOWERBY, 1888, p. 207; OD]. With radial ribbing more strongly developed on middle of valves than laterally and affecting whole thickness of test. *Eoc.-Rec.*, Japan-USA (Calif.). —FIG. C104.1. \**A. (Plicacesta) smithi* (G. B. SOWERBY), *Rec.*, Japan; LV ext.,  $\times 0.7$  (Oyama, 1943).

**Antiquilima** COX, 1943, p. 179 [\**Lima antiquata* J. SOWERBY, 1818, p. 25 (= *Chamites succinctus*

VON SCHLOTHEIM, 1813, p. 72); OD]. Obliquely ovate, rather compressed; anterior umbonal ridge absent except near umbo; anterior auricle large and well differentiated, its gaping margin extended downward; teeth lacking; ornament of rather sinuous radial riblets of 2 or more orders of strength and of irregularly spaced growth rugae. *Jur. (Lias.-Bajoc.)*, cosmop.—FIG. C104.4. \**A. succincta* (VON SCHLOTHEIM), *L.Jur. (Lias.)*, Ger.; LV,  $\times 1$  (Quenstedt, 1856).

?**Aviculolima** E. PHILIPPI, 1900, p. 622 [\**A. jaekeli*; OD]. Body of shell recalling that of *Pteria*, but obliquely elongated in anterior instead of posterior direction; posterior wing acutely pointed, anterior wing rounded; cardinal area wide, with broad, posteriorly directed ligament pit. [Known only by LV.] *M.Trias. (L. Muschelkalk)*, Eu. (Ger.). —FIG. C105.1. \**A. jaekeli*; 1a, b, LV,  $\times 1$  (732).

**Badiotella** BITTNER, 1890, p. 94 [\**B. schaurothiana* BITTNER, 1895, p. 201; SM BITTNER, 1895]. Small, trigonally orbicular, highly inequilateral, with sharp, backward-pointing umbones; antero-dorsal outline straight or gently arched, coinciding with umbonal ridge which borders concave lunule; no anterior auricle, posterior auricle very small or absent; cardinal area broad, with narrow median ligament pit; LV with small tooth below each end of hinge margin, fitting into recess in RV; ornament of radial ribs. *M.Trias. (Ladin.)*, S. Tyrol.—FIG. C105.2. \**B. schaurothiana* BITTNER; 2a-c, RV ext., int., end view, all  $\times 2$ ; 2d, ligament area,  $\times 3.3$  (58).

[As originally published, *Badiotella* must be considered as a genus proposed validly but without an included nominal species, as the specimens on which it was founded were compared to *Spirifer spuria* VON MÜNSTER, a brachiopod, and were not distinguished under the specific name *schaurothiana* until 1895.]

**Ctenoides** MÖRCH, 1853, p. 56 [\**Ostrea scabra* BORN, 1778, p. 96; SD STOLICZKA, 1871, p. xxii] [= *Divaricolima* ROVERETO, 1898, p. 153 (type, *Lima eximia* GIEBEL, 1864); *Ptenoides* SMITH, 1904 (*nom. null.*)]. Ovate to subtrigonal, subequilateral, high in proportion to length, somewhat compressed, with well-developed byssal gape bordered by liplike reflections of margins; no umbonal ridges; auricles well differentiated, subequal or anterior one slightly larger, with gaping margin extended downward; cardinal area narrow; hinge with moderately strong lateral teeth; sculpture of rounded radial riblets, divaricating ventrally and bearing fine scales. *U.Jur. (Tithon.)-Rec.*, cosmop.—FIG. C105.5. \**C. scabra* (BORN), *Rec.*, W. Indies; 5a, b, RV ext., RV int.; 5c, anterior view bivalve shell showing gape, all  $\times 1$  (Cox, n).

**Ctenostreon** EICHWALD, 1862, p. 374 [\**Ostracites pectiniiformis* VON SCHLOTHEIM, 1820, p. 231; M] [= *Ostreopecten* QUENSTEDT, 1867 (obj.); ?*Pseudostenostreon* BURCKHARDT, 1930 (no nomi-

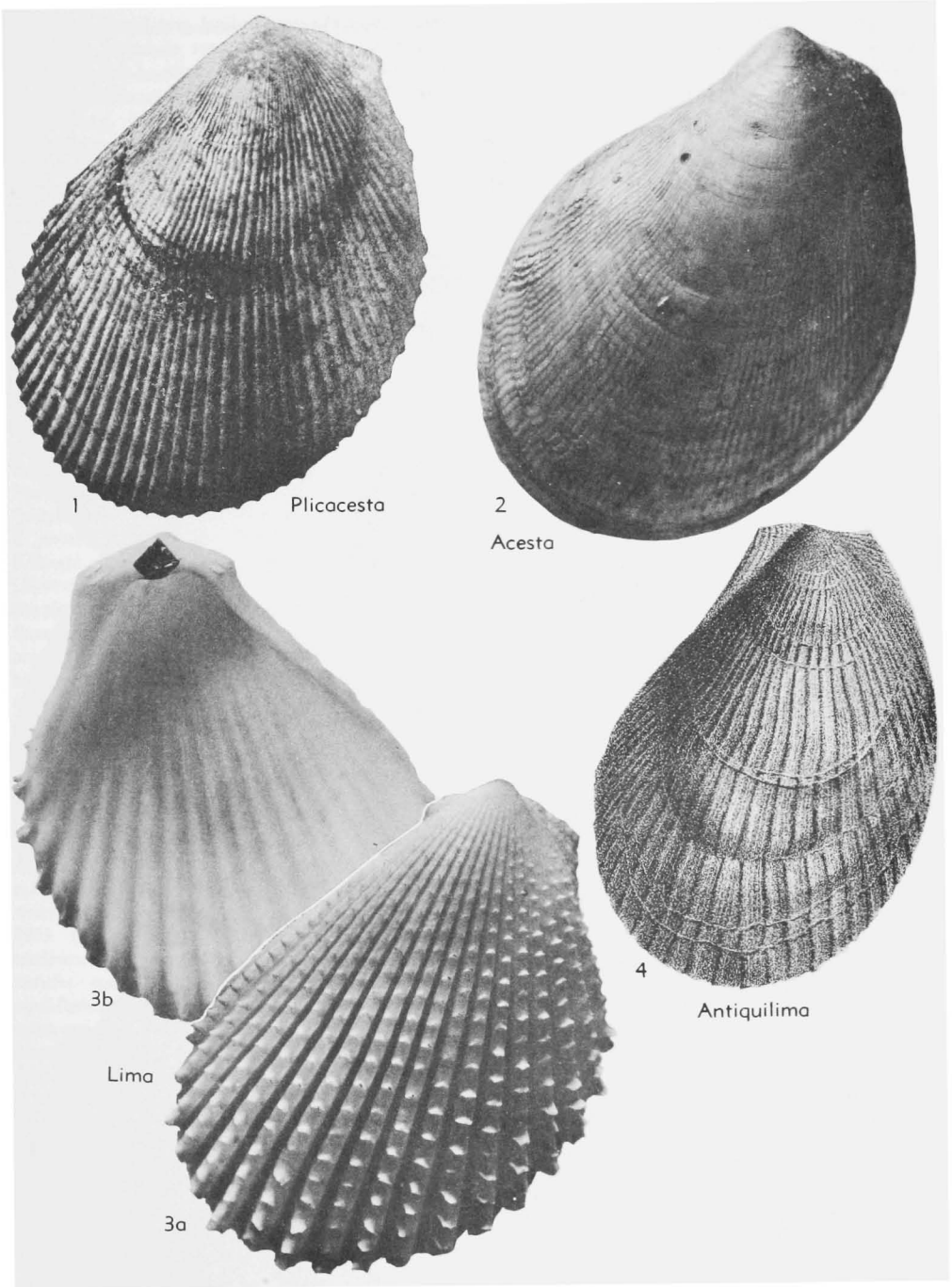


FIG. C104. Limidae (p. N385-N386).



nal species)]. Large, thick-shelled, suborbicular, irregular in outline, rather compressed; auricles large, anterior one usually smaller; gape of anterior margins wide and extended in earlier growth

stages, later closing; cardinal area broad; adductor scar well marked; ornament of broad, rounded, squamose or spinose radial ribs. *L. Jur. (Lias.)-L. Cret. (Neocom.)*, cosmop.—FIG. C105,6. \*C.

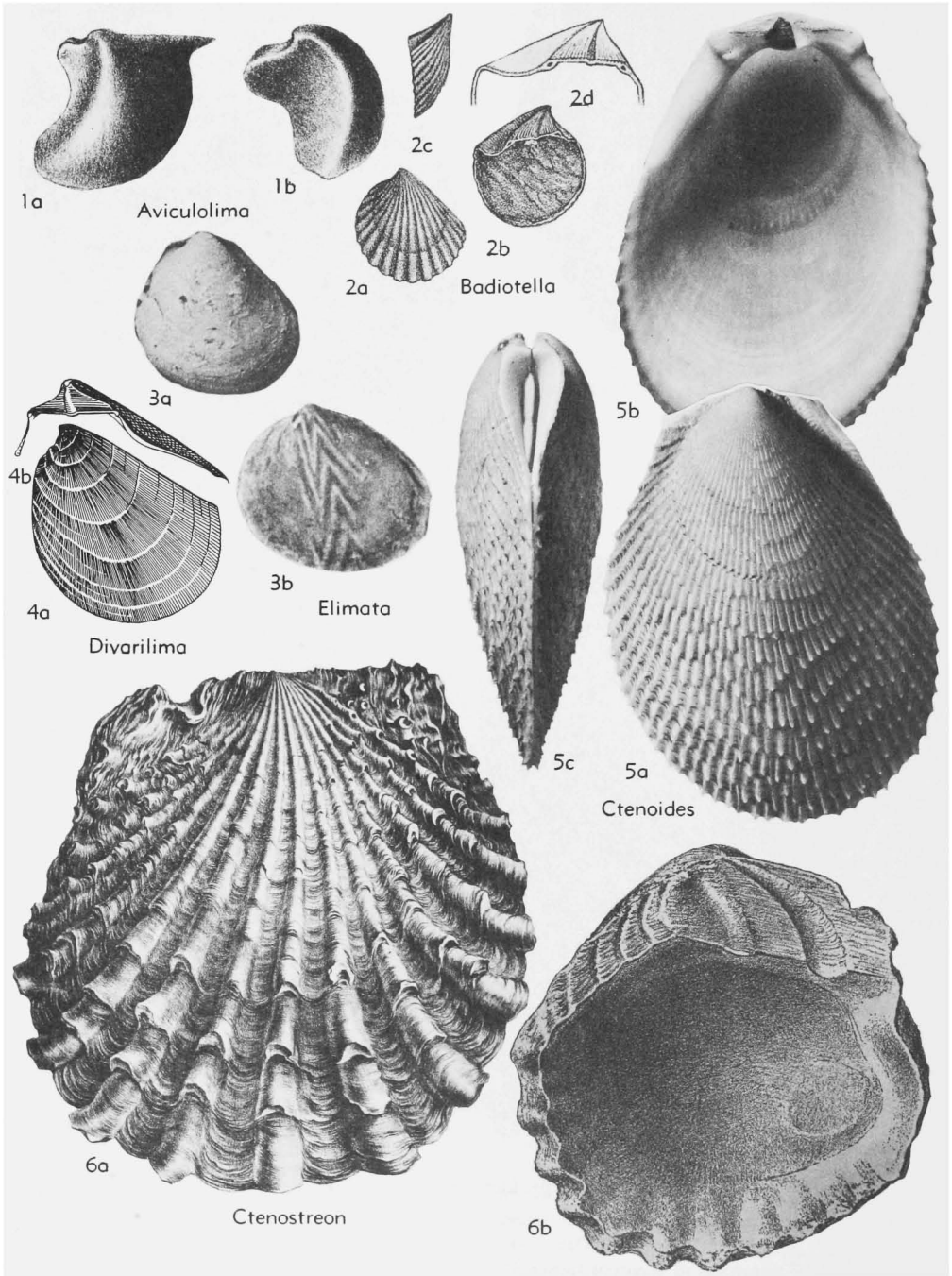


FIG. C105. Limidae (p N386, N388-N389).

- pectiniiformis* (VON SCHLOTHEIM), M.Jur.(Bajoc.); 6a (Ger.), LV ext.,  $\times 0.5$  (341b); 6b (France, Calvados), RV int.,  $\times 0.7$  (732).
- Divarilima** POWELL, 1958, p. 72 [*\*Lima sydneyensis* HEDLEY, 1904, p. 200; OD]. Very small, trigonally ovate, strongly inequilateral, with sharp, backward-pointing umbones; anterodorsal outline almost straight, extended, coinciding with well-marked umbonal ridge bordering concave lunule; auricles very small; cardinal area with rather narrow median ligament pit; hinge edentulous; ornament of radial riblets interrupted by growth lamellae at irregular intervals. *Rec.*, E. Australia-Kermadec Is.—FIG. C105.4. *\*D. sydneyensis* (HEDLEY), NewS.Wales; 4a,b, RV, hinge,  $\times 3.7$  (396).
- Elimata** DICKENS, 1963 [*\*E. guppyi*; OD]. Sub-oval shells with poorly developed auricles; surface smooth save for faint growth lines. *L.Perm.-U. Perm.*, W. Australia-W. Eu.-Greenl.-SW. USA.—FIG. C105.3a. *\*E. guppyi*, *L.Perm.* (Poole Ss.), W. Australia; LV ext.,  $\times 3$  (263).—FIG. C105.3b. *E. permiana* (NEWELL), *U.Perm.*, Cape Stosch F., E.Greenl.; 3b, LV ext.,  $\times 3$  (Newell, 1955). [NEWELL]
- ?**Gryphellina** NEWELL, 1940 [*\*Capulus sellardsi* BEEDE, 1907; OD]. RV ventricose, gibbous, with protuberant and strongly overhanging prosogyrous beak; somewhat opisthoclinal, auricles small and rounded, with poorly defined byssal sinus; body of shell cancellated with intersecting costellae and fila; hinge comparable to that of *Lima*; LV unknown. *L.Perm.* (*Whitehorse*), SW.USA.—FIG. C106.2. *\*G. sellardsi* (BEEDE), Dozier Dol., Tex.; 2a, LV ext.,  $\times 2$ ; 2b, LV hinge, enl. (665). [NEWELL]
- Limaria** LINK, 1807, p. 157 [*\*L. inflata* (= *\*Ostrea tuberculata* OLIVI, 1792, p. 120); SD WINCKWORTH, 1930, p. 116] [= *Mantellum* MÖRCH, 1853 (*non* RÖDING, 1798)]. Small to small medium-sized, ovate, without umbonal ridges; auricles small, subequal; cardinal area almost equilateral, ligament pit broad; hinge edentulous; ostracum thin. *Eoc.-Rec.*, cosmop. [= *Winckworthia* GLIBERT & VAN DE POEL, 1965, p. 49 (obj.)].
- [This species, originally described by the nonbinominal author CHEMNITZ, was named binominally by LAMARCK and LINK independently in 1807, LAMARCK's *Lima inflata* having priority. In 1791, however, GMELIN had assigned the name *Ostrea inflata* to a distinct species of Limidae and, although this already bore the name *Ostrea bullata* BORN (1778), its subsequent inclusion in *Lima* rendered the species of LAMARCK and LINK a secondary homonym. OLIVI's *Ostrea tuberculata* may be revived for *Lima inflata* LAMARCK.]
- L. (Limaria)** [= *Promantellum* IREDALE, 1939, p. 385 (type, *P. parafragile*); *Submantellum* OLSSON & HARBISON, 1953, p. 60 (type, *Lima orbigny* LAMY, 1833, = *L. angulata* SOWERBY, 1844, *non* VON MÜNSTER, 1841)]. Somewhat oblique, rather strongly inflated with wide posterior gape and narrower anterior gape well separated from hinge margin; ornament of narrow radial riblets. *Mio.-Rec.*, cosmop.—FIG. C106.10. *\*L. (L.) tuberculata* (OLIVI), *Rec.*, Malta; 10a, LV, side view; 10b, posterior view; 10c, anterior view of bivalve shell showing gapes, all  $\times 1$  (Cox, n).
- L. (Limatulella)** SACCO, 1898, p. 16 [*\*Lima loscombii* G. B. SOWERBY, 1820, explan. *Lima* fig. 4; OD]. Like *L. (Limaria)* but without appreciable gapes; ornament of weak unequal radial riblets. *Eoc.-Rec.*, Eu.—FIG. C106.4. *\*L. (L.) loscombii* (G. B. SOWERBY), *Rec.*, Scot.; 4a, LV ext., 4b, posterior view bivalve shell, both  $\times 1.4$  (Cox, n).
- L. (Mantellina)** SACCO, 1904, p. 148 [*\*Mantellum (Mantellina) inoceramoides*; OD]. Small, delicate, concentrically crenulated. *Mio. (Helvet.)*, Italy.
- L. (Stabilima)** IREDALE, 1939, p. 390 [*\*S. tadena*; OD]. High in proportion to length, subequilateral, scarcely oblique; ornament of jagged radial riblets with broader intervals. *Rec.*, E. Indies-Australia.—FIG. C106.5. *\*L. (S.) tadena*, Australia (Moreton Bay); RV ext.,  $\times 1$  (Cox, n).
- Limatula** WOOD, 1839, p. 235 [*\*Pecten subauriculata* MONTAGU, 1808, p. 63; SD GRAY, 1847, p. 200] [= *Cystigenus*, *Cystia* RENIER, 1807 (suppressed ICZN); *Limacula* GRAY, 1840 (*nom. null.*); *Limula* D'ORBIGNY, 1846 (*nom. null.*); ?*Linatulina* HERRICK, 1889 (*nom. null.*)]. Small, oval, subequilateral, relatively high, strongly inflated, without umbonal ridges; auricles small, subequal; margins not gaping; hinge edentulous; sculpture of fine radial riblets, most conspicuous toward center of valves and absent from posterior end. *Trias.-Rec.*, cosmop.—FIG. C106.6. *L. gibbosa* (J. SOWERBY), M.Jur.(Bajoc.), Eng. (Dorset); LV,  $\times 1$  (Cox, n).
- Limea** BRONN, 1831, p. 623 [*\*Ostrea strigilata* BROCCHI, 1814, p. 571; M] [= *Lima* GRAY, 1847 (*nom. van.*)]. Small, suborbicular or ovate, not gaping; sculpture of radial ribs which crenate margin; cardinal area narrow; hinge with series of short denticles on each side; adductor impression subcentral. *M.Trias.-Rec.*, cosmop.
- L. (Limea)**. Obliquely ovate, umbones prominent; ornament of numerous very weak costae; teeth narrow, oblique, unequal, located in angles at ends of hinge margin; ligament pit relatively large. *Mio.-Rec.*, Eu.—FIG. C106.7. *\*L. (L.) strigilata* (BROCCHI), *Mio.*, Austria; 7a,b, RV ext., RV int.,  $\times 10$  (411).
- L. (Eolimea)** COX, new subgenus, herein [*\*Lima margineplicata* KLIPSTEIN, 1845,<sup>1</sup> p. 248]. Trigonally ovate, inequilateral, rather weakly inflated; ornament of broad, transversely lamellose, rounded radial costae; teeth transverse, extending along whole hinge margin except below relatively large

<sup>1</sup> KLIPSTEIN, A. VON, *Beiträge zur geologischen Kenntniss der östlichen Alpen*. Giessen.

ligament pit. *M.Trias.*(*Ladin.*), Eu.(S.Tyrol).  
 —FIG. C106,1. \**L. (E.) margineplicata* (KLIPSTEIN); 1a,b, RV ext. and dorsal view, X4; 1c, hinge teeth, X6 (Bittner, 1896).

*L. (Escalima)* IREDALE, 1929, p. 165 [\**Limea acclinis* HEDLEY, 1905, p. 46; OD]. Obliquely ovate, entire surface with weak angular costae; teeth and ligament pit as in *L. (Limea)*. *Rec.*,

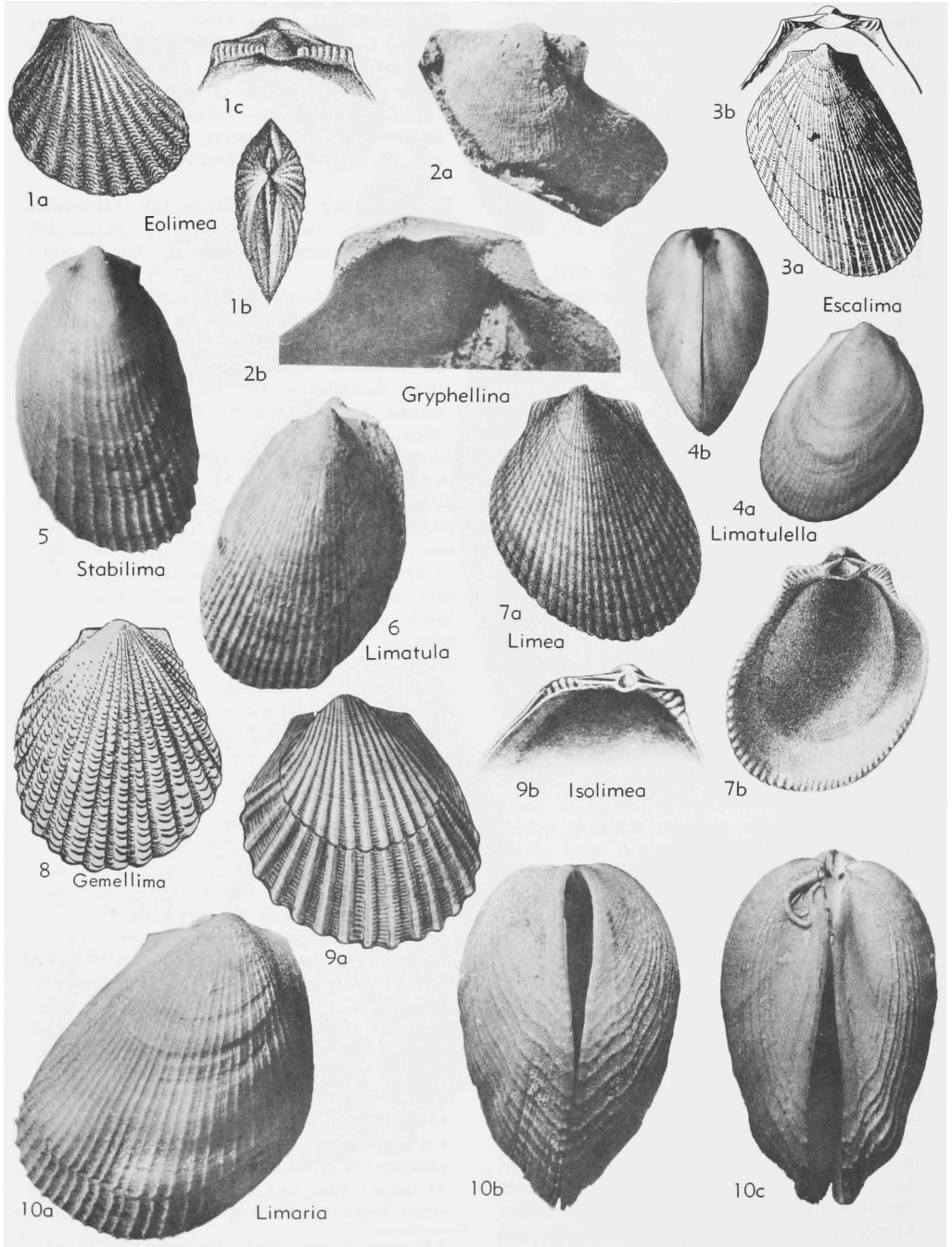


FIG. C106. Limidae (p. N389-N391).

- Australia.—FIG. C106,3. \**L. (E.) acclinis* HEDLEY, NewS.Wales; 3a, RV, ext.,  $\times 3.4$ ; 3b, hinge line,  $\times 4.6$  (Hedley, 1905).
- L. (Gemellima)** IREDALE, 1929, p. 166 [\**Limea austrina* TATE, 1886, p. 73; OD]. Sculpture of fairly coarse lamellose ribs with narrow intervals; hinge denticles minute, transverse, extending along whole hinge margin; ligament pit small. *Rec.*, Australia.—FIG. C106,8. \**L. (G.) austrina* TATE, S.Australia; LV ext.,  $\times 5.4$  (169).
- L. (Isolimea)** IREDALE, 1929, p. 166 [\**Limea parvula* VERCO, 1908, p. 345; OD]. Suborbicular; sculpture of relatively small number of strong costae with broad intervals; teeth and ligament pit as in *L. (Limea)*. *Rec.*, Australia.—FIG. C106,9. \**L. (I.) parvula* VERCO, S.Australia; 9a,b, RV ext., RV int.,  $\times 10$  (Verco, 1908).
- L. (Notolimea)** IREDALE, 1924, p. 194 [\**Lima australis* SMITH, 1891, p. 444; OD]. Suborbicular, strongly costate; teeth small, numerous, transverse, extending along whole hinge margin; ligament pit small. *U.Oligo.-Rec.*, Australia-N.Z.—FIG. C107,4. \**L. (N.) australis* (SMITH), *Rec.*, off Sydney, New S.Wales; RV ext.,  $\times 4$  (Smith, 1891).
- Mysidioptera** SALOMON, 1895, p. 117 [\**M. ornata*; SD DIENER, 1923, p. 111] [= *Misidioptera* REIS, 1926 (*nom. null.*)]. Ovate to suborbicular; posterodorsal margin rather elongated, posterior wing not clearly demarcated from body, anterior auricle absent or small; no anterior umbonal ridge; cardinal area inequilateral, ligament pit directed posteriorly from beak; small byssal gape present in some if not in all species. *L.Trias.-U.Trias.*, cosmop.
- M. (Mysidioptera)** [= *Latemaria* WILCKENS, 1909, p. 220 (type, *Mysidioptera kittlii* BITTNER, 1895); *Pseudolucina* WILCKENS, 1909, p. 207 (type, *Mysidioptera cassiana* BITTNER, 1895)]. Acline or opisthoclinal; anterior auricle absent or small; surface smooth or with radial striae or ribs. *L.Trias.-U.Trias.*, cosmop.—FIG. C107,7. *M. (M.) incurvostriata* (GÜMBEL), U.Trias., S.Tyrol; 7a,b, RV ext. and cardinal area,  $\times 1$  (58).
- M. (Pseudacesta)** WAAGEN, 1907, p. 113 [\**M. (Pseudacesta) dieneri*; M]. Ovate, prosoclinal, smooth, with very distinct anterior auricle. *U. Trias.*, Eu.(S.Tyrol).
- Palacolima** HIND, 1903, p. 38 [\**Pecten simplex* PHILLIPS, 1836, p. 212; SD COX, 1952, p. 48]. Small, obliquely ovate, opisthoclinal, length commonly slightly exceeding height, inflation moderate; beaks near middle of moderately long hinge margin; auricles obtuse; no distinct umbonal ridge; cardinal area (observed in Triassic but not yet in Paleozoic forms) as in typical Limidae; surface smooth or with radial ribs, grouped in pairs or bunches in some species. Differs very little from *Plagiostoma*, but size is invariably small and umbonal ridge and lunule are absent. *L.Carb.-U.Trias.*, Eu.-Asia-N.Am.—FIG. C107,2. *P. footei* (WAAGEN), Perm., Salt Range, Pakistan; RV ext.,  $\times 3.3$  (Waagen, 1887).
- Plagiostoma** J. SOWERBY, 1814, p. 175 [\**P. giganteum*; SD STOLICZKA, 1871, p. xxii] [= *Plagiostomatites* KRUEGER, 1823 (obj.); *Plagiostomata* BERTHOLD, 1827 (*nom. van.*); *Plagiostoma* COQUAND, 1880 (*nom. null.*); ?*Anomalolima* PHILIPPI, 1900, p. 635 (type, *Lima maxima* D'ARCHIAC, 1837); ?*Anomalolima* COSSMANN, 1901 (*nom. null.*)]. Medium-sized to large, obliquely ovate, opisthoclinal, length commonly slightly exceeding height, inflation moderate to strong; beaks more or less anterior to middle of moderately long cardinal area; ligament pit broad; auricles obtuse; anterior umbonal ridge well defined, with excavated lunule in front of it; marginal gapes small or absent; edentulous or with 1 or 2 broad, longitudinally directed teeth in each dorsal angle; surface smooth, radially striated, or with weak ribs commonly with punctate intervals. *M.Trias.-U. Cret.*, cosmop.—FIG. C107,8. \**P. giganteum*, L.Jur.(L.Lias.), Eng.; 8a, RV ext., 8b, LV cardinal area and lunule,  $\times 0.75$  (202).
- Pseudolimea** ARKELL in DOUGLAS & ARKELL, 1932, p. 161 [\**Plagiostoma duplicata* J. DE C. SOWERBY, 1827, p. 114; OD] [= *Limoarca* von MÜNSTER, 1832, p. 421 (genus without nominal species, name never adopted); *Limnoarca* PAETEL, 1875 (*nom. null.*)]. Rather small, gibbose, obliquely ovate to orbicular; anterior umbonal ridge ill-defined; beaks near middle of moderately long cardinal area; ligament pit broad; hinge commonly with slightly oblique teeth occupying dorsal angles, but many specimens edentulous; ornament of angular ribs, commonly with thread in each interval. *Trias.-U.Cret.*, cosmop.—FIG. C107,3. *P. hettangiensis* (TERQUEM), L.Jur.(L.Lias.), S. Switz.; 3a,b, RV ext., RV int.,  $\times 1.3$  (von Bistram, 1903).
- Regalilima** COX, 1943, p. 177 [\**Lima oolitica* LYCETT, 1857, p. 126; OD]. Large, trapeziform, inequilateral, without anterior auricle; anterior umbonal ridge well developed and extended, with flattened area in front of it; cardinal area broad; anterior gape wide; ornament of broad flat ribs, obscure in some specimens. *M.Jur.(Bajoc.)*, Eng.—FIG. C107,6. \**R. oolitica* (LYCETT); 6a, RV ext.,  $\times 0.5$ ; 6b, RV, ant. end showing gape,  $\times 0.67$  (185).
- ?**Roncania** DE GREGORIO, 1896, p. 107 [\**R. prima*; M]. Founded on small trigonally ovate shell with broad radial ribs, some divaricating; tentatively included in Limidae by its author, but systematic position uncertain. *U.Eoc.*, N.Italy.
- Serania** KRUMBECK, 1923, p. 218 [\**S. seranensis*; M]. Narrowly ovate, very inequilateral and oblique; anterior umbonal ridge well defined and extended, with flattened region in front of it, descending steeply to margin; no anterior auricle,

posterior wing not demarcated from body; fold within anterior area delimiting lunule-like depression, margin of which forms deep byssal gape; cardinal area with broad ligament pit, wholly posterior to beak; ornament of irregular concentric

folds. *U.Trias.*, E.Indies(Ceram).—FIG. C107,1. \**S. seranensis*; RV, 1a, side view, 1b, dorsal view showing cardinal area and byssal gape, both  $\times 1$  (486).

*Tirolidia* BITTNER, 1895, p. 202 [*\*Lima (Tirolidia)*

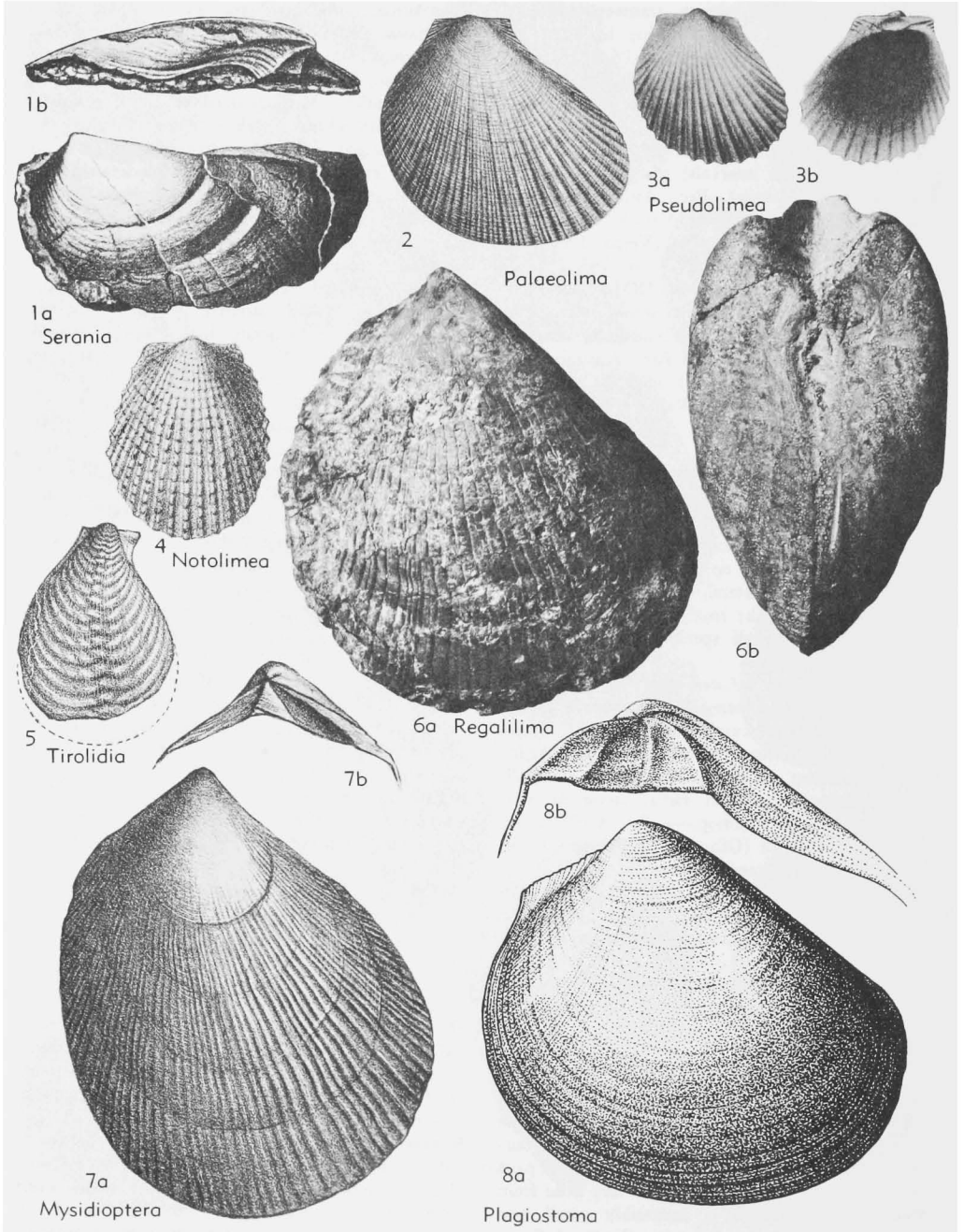


FIG. C107. Limidae (p. N391-N393).

*haueriana*; SD DIENER, 1923, p. 118]. Sub-trigonal, only slightly inequilateral, with relatively short hinge margin and narrowly rounded, slightly protruding umbo; auricles small, well differentiated, anterior one acute at tip; inflation rather weak; gape of valves slight; cardinal area imperfectly known; surface with discontinuous subconcentric ribs, or smooth. *M.Trias.-U.Trias.*, Eu.(S.Alps).—FIG. C107,5. *T. cassiana* BITTNER, *M.Trias.*(Ladin.); RV,  $\times 2$  (58).

### Suborder OSTREINA Férussac, 1822

Because completion of systematic descriptions for taxa of this suborder was delayed too long for placement here, they are assigned out-of-sequence position (*see* Part N, Volume 3).

### Subclass PALAEOHETERODONTA Newell, 1965

[Diagnosis by N. D. NEWELL]

Equivalve, with closed margins and, where preserved, prismatic-nacreous shells; ligament amphidetic or opisthodontic, external and parivincular; dentition generally consisting of few teeth more or less radial and divergent from umbonal region, striated in some genera, rarely becoming taxodont in few genera (certain Unionoidea); where lateral teeth occur, they originate below beaks and are not separated from cardinals by edentulous interval, as in Heterodonta. [These forms include the actinodonts (earliest known Bivalvia), Trigonioidea and Unionoidea. They lead in various lines to the Pteriomorphia, Heterodonta, and possibly to the Mytiloidea early in the Paleozoic.] *M.Cam.-Rec.*

### Order MODIOMORPHOIDA Newell, new order

[=Actinodonta DOUVILLÉ, 1912; Actinodontoidea NEWELL, 1965] [Diagnosis by N. D. NEWELL]

Extinct Paleozoic marine ovoid bivalves; shell microstructure unknown; generally unornamented, otherwise possessing characters of subclass. [This somewhat heterogeneous, poorly understood assemblage is grouped together for convenience. Clearly

it includes ancestral radicals of many major lines.] *M.Cam.-L.Perm.*, ?*U.Perm.*

### Superfamily MODIOMORPHACEA Miller, 1877

[*nom. transl.* NEWELL, 1965 (ex Modiomorphidae S. A. MILLER, 1877)] [Materials for this superfamily prepared by AURÈLE LA ROCQUE & N. D. NEWELL]

Elongate, isomyarian or slightly anisomyarian, with anterior, but not terminal beaks; edentulous(?) or possessing a few posterior laterals and differentiated subumbonal cardinals. [This superfamily anticipates and strongly resembles certain Unionacea, Mytilacea and Carditacea, but differs especially in that the laterals originate below the beaks and essentially extend to the posterior extremity of the hinge under the ligament.] *L.Ord.-L.Perm.*, ?*U.Perm.*

### Family MODIOMORPHIDAE S. A. Miller, 1877

[=Modiolopsidae FISCHER, 1887]

Shell subovate with or without radial ornamentation, opisthodontic, without extended posterior wing, more or less modioloid in form, commonly, but not invariably expanded posteriorly, with anterior lobe ahead of umbones and commonly with umbonal ridge or carina extending obliquely backward from umbones to posteroventral region; anterior adductor generally small, deeply impressed, in many shells reinforced by bordering buttress; posterior adductor relatively large, ovoid; anterior laterals absent, cardinals and posterior laterals may or may not be present. [It has been claimed but not satisfactorily demonstrated that some of these forms are edentulous. Some resemble Mytilacea and may represent ancestors of that group.] *L.Ord.-L.Perm.*, ?*U.Perm.*

*Modiomorpha* HALL & WHITFIELD, 1869, p. 72 [\**Pterinea concentrica* CONRAD, 1838; SD HALL, 1885] [=Palanatina HALL & WHITFIELD, 1870 (type, *P. typa*; OD); *Dechenia* SPRIESTERSBACH, 1915, p. 70 (type, *D. rhenana*; SD LA ROCQUE & NEWELL, herein); *Spriestersbachia* MAILLIEUX, 1930, p. 62 (*nom. van. pro Dechenia* SPRIESTERSBACH, 1915)]. Mesial ventral sinus and oblique preumbonal sulcus distinct; LV with 1 large wedge-shaped tooth; RV with corresponding socket; without laterals (159). *M.Sil.-L.Perm.*,